Water and sanitation interventions to prevent and control mosquito-borne diseases: focus on emergencies

World Health Organization

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ISBN (WHO) 978-92-4-009064-4 (electronic version)
ISBN (WHO) 978-92-4-009065-1 (print version)
ISBN (UNICEF) XXX

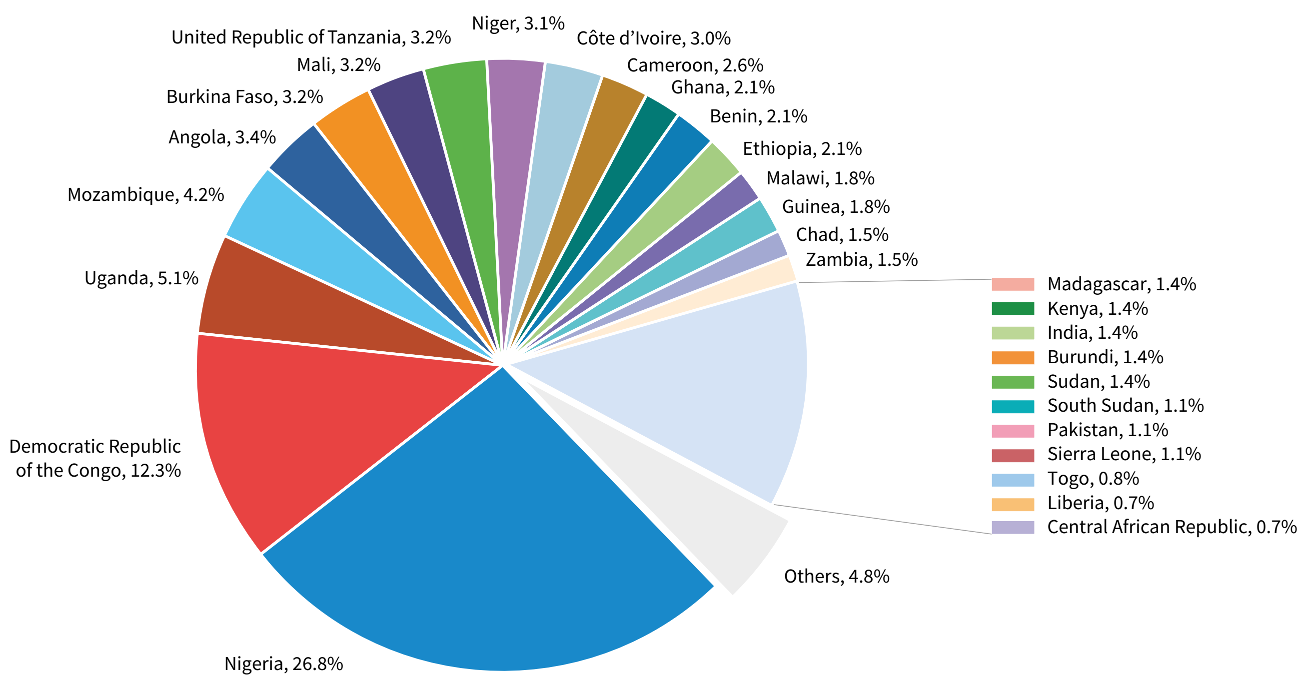
Acknowledgements

This document was written by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF)-Maggie Montgomery, Sophie Boisson, Nosheen Usman, Arabella Hayter, April Baller, Bruce Gordon (WHO) and Pierre-Yves Oger, Omar El Hattab, Michael Emerson Gnilo, Ida Ameda, Jerome Pfaffmann (UNICEF). WHO and UNICEF are grateful to Richard Allan for his expert inputs and contributions as well as to the following individuals who provided written and oral comments during a one-day WHO expert meeting and in the review after, "Addressing emerging vector-borne disease risks through water, sanitation, and hygiene in emergencies": Corey LeClair, MSF Brussels; Claire Dorion, MSF Geneva; Elisa Riquier, IFRC Geneva; Estrella Lasry, Global Fund Geneva; Robert Opoku, IFRC Geneva; Tom Handzel, US CDC Atlanta; William Carter, IFRC Geneva; Maria Teresa Bejarano, SIDA Stockholm; Ylva Schwinn, SIDA Stockholm; Tracey Wise, USAID Washington DC; Damien Blanc ECHO, Washington DC; Haroldo Bezerra WHO, Washington DC; Eba Al-Muna Pasha, WHO Geneva, Florence Fouque, WHO Geneva, Jordi Sacristan Llobet, WHO Geneva; Kamal Ait-Ikhlef, WHO Geneva; Kate Medlicott, WHO Geneva; Madison Moon, WHO Geneva; Maria Neira, WHO Geneva; Nedret Emiroglu, WHO Geneva; Raman Velayudhan, WHO Geneva; Stefan Hoyer, WHO Geneva; Seth Irish, WHO Geneva. The document was edited by Tom Watkins.

1. Background

Mosquito-borne diseases are a major global health threat, with nearly 80% of the world's population at risk of infection *(1)*. For example, there were an estimated 249 million cases of malaria in 2022, 608 000 of which were fatal. The total number of cases represented an increase of 5 million (2.0%) since 2021 (**see Image 1**). Unless current prevention and treatment strategies are changed, the total is likely to rise further.

Image 1: Distribution of Global Malaria Cases in 2022.



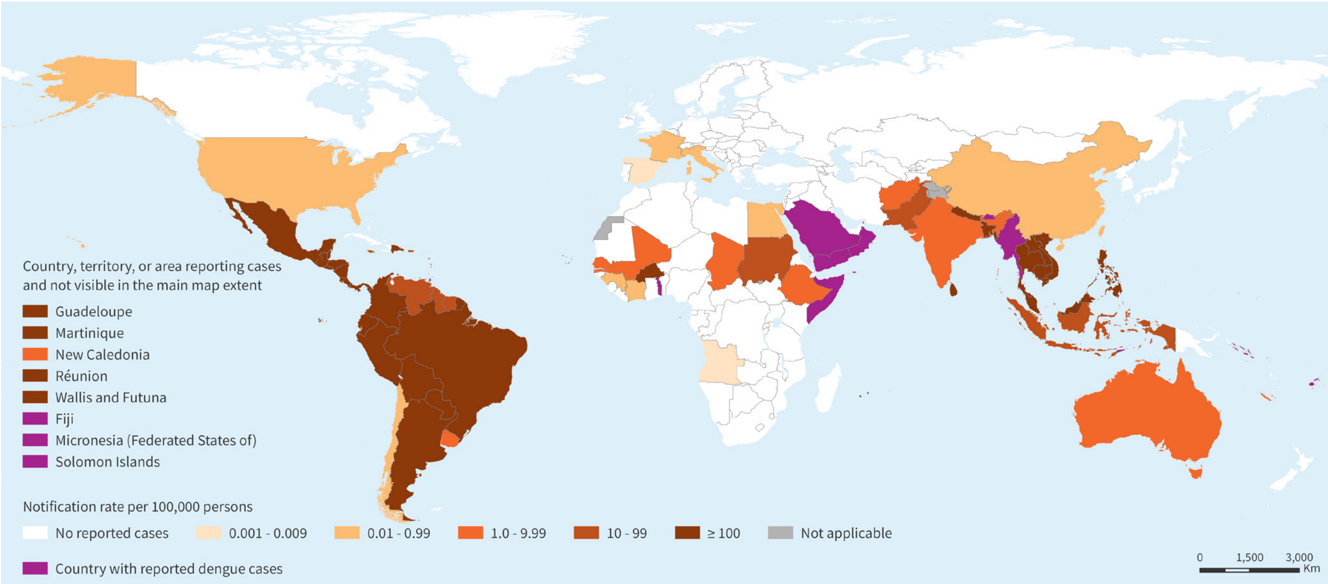
Source: WHO 2023 Global Malaria report.

Dengue, another mosquito-borne disease, is on the rise, with over 5 million cases in 2023 and more than 5000 deaths in 80 countries (**see Image 2**) *(3)*. Emerging evidence indicates that children are significantly affected by dengue fever. For example, in 2019 in the one island in the Caribbean children under 15 accounted for >40% of Dengue cases and >40% of those hospitalized *(4)*. Globally, mosquitoes are the most important vectors of parasites, viruses and bacteria. The pathogens that cause malaria, dengue, yellow fever, chikungunya, Zika, lymphatic filariasis and West Nile virus are all transmitted by mosquitoes, which can thrive in the living conditions common in refugee camps and the unplanned urban settlements where low-income people often live.

Sounding the alarm: new threats call for a renewed focus on preventive water and sanitation interventions

Climate change, conflict and human displacement are all growing in scale, increasing the spread of mosquito-borne diseases. Mosquito species and the pathogens they transmit are temperature- and climate-sensitive; most thrive optimally in tropical climates *(5)*. However, climate change is making more of the world's land-mass conducive for both mosquitoes and pathogen life cycles, including in zones outside the tropics *(6,7)*. Furthermore, the increased global movement of goods and people help transport vectors and pathogens to new locations. In addition, the number of people affected by humanitarian crises and displacement has increased significantly in recent years *(8)*. The result is a growing number of densely populated, unplanned urban settlements, often lacking safely managed water and sanitation services and with limited solid waste collection and stormwater drainage (**Box 1**). Households are often forced to store water because of unpredictable and limited water services; have improperly and infrequently cleaned containers; and poor drainage and sanitation, all of which expand the number of sites suitable for mosquitoes to lay their eggs. Finally, emerging evidence suggests that some mosquitoes are becoming increasingly resistant to insecticides, a long-proven method for malaria control *(7)*. While all people are at risk of mosquito borne disease, children may suffer more severe disease due to weaker immune systems and are likely to also benefit from WASH interventions which protect also against childhood diarrhoea."

Image 2. Number of countries reporting Dengue (2022-2023).



Source: World Health Organization, European Centre for Disease Prevention and Control. Map production: WHO Health Emergencies Programme. Map Date: 8 December 2023.

Box 1. Overlap of conflict, displacement, limited water and sanitation services and mosquito-borne disease.

- **363 million** were affected by humanitarian crises in 2023 *(8)*.
- **58%** of the displaced live in unofficial settlements and low-income, unplanned urban areas *(9,10)*.
- In 2022 natural disasters occurred in 84 countries, displacing **8.7 million people** *(11)*.
- In the period of 2019—2022, 41 malaria-endemic countries suffered humanitarian and health emergencies *(2)*.
- In 2022, only **54%** of urban households and **28%** of rural households had access to safely managed drinking-water services; even fewer had access to safely managed sanitation *(12)*. Furthermore, **2.3 billion** people were living in water-stressed areas *(13)*. These figures underscore the widespread dependency on the kinds of water-storage practices that can increase sites amenable to mosquito breeding.

Target audience

This technical note provides practical information for implementing critical water, sanitation and waste management measures for preventing mosquito-borne diseases in the context of public health emergencies. The intended users of this note are water, sanitation and hygiene (WASH) health partners and practitioners, national and local public health authorities and humanitarian and community-based organizations.

2. Proven, cost-effective water and sanitation interventions exist

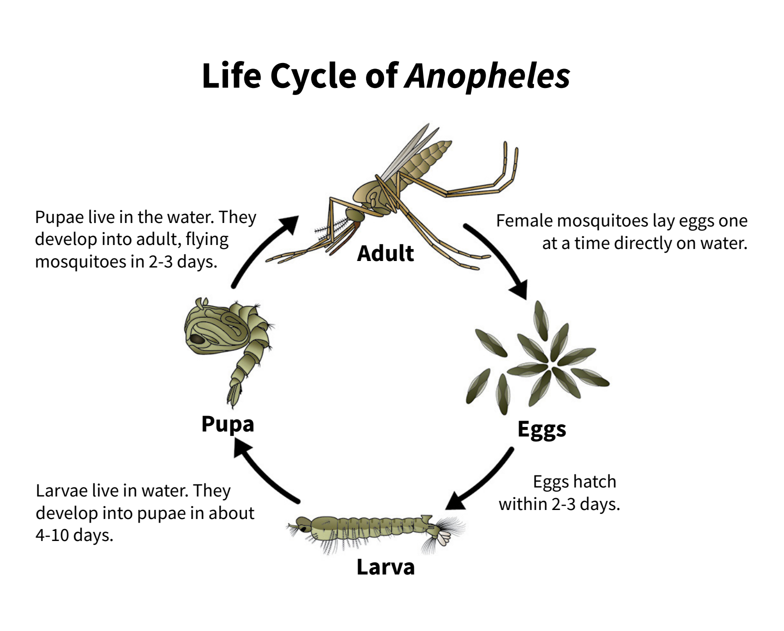
A number of key interventions exist that reduce mosquito populations and risk of disease. Effective implementation requires greater investment, intersectoral coordination and policies addressing health, urban planning and water and sanitation alongside strengthening trust and engagement with local communities, whose members are often tasked with implementation. These interventions include:

- **Preventing standing water formation in camps and urban areas**
- **Securely covering, regularly cleaning and disinfecting water storage containers**
- **Removal and management of accidental containers such as used coconut shells, empty cans, bottles, tires, and other discarded containers**
- **Safe storage and removal of domestic waste to well-managed dump sites**
- **Where applicable, application of larvicides to water containers**

3. Mosquitoes of concern in camps and urban settings

Mosquitoes lay their eggs on the surface of water. Without access to water, mosquitoes will not lay eggs, nor will eggs develop successfully (**see Box 2**). Different mosquito species prefer different bodies of water so depending on the species, that water can be drinking water, rainwater, stormwater or water that has been used for washing. When access to a species' preferred water body is restricted, the local insect population will decline, as will transmission of the human diseases that they transmit.

Box 2. Mosquito lifecycle *(14)*.



3.1 Malaria and Anopheles mosquitoes

Each year, the majority of malaria infections occur in rural Africa, Asia and Latin America, where they are transmitted by an abundance of mosquitoes belonging to a few highly specialized, efficient and nocturnal *Anopheles* species *(15-18)*. Global annual malaria deaths were halved (2000—2015), largely as a result of scaling up access to insecticide-treated mosquito nets, indoor residual spraying and better testing and access to treatment. However, by 2020, the annual death toll was rising, and it continues to do so *(2)*. Of the nine countries that account for over 65% of global malaria cases, all are in sub-Saharan Africa and are countries that are either affected by conflict or are hosting displaced populations in camps or in low-income urban areas with limited piped and regular water supplies and sanitation services *(2)*. These conditions typically result in increased dependency on household water storage. When combined with poorly managed drainage, wastewater and solid-waste systems, this exacerbates the risk of mosquito breeding.

Only *Anopheles* mosquitoes transmit malaria (in some locations, some *Anopheles* species may also transmit filariasis). Most of these vector species lay and develop their eggs on open-surface, clean-water pools, although some have been found in water in abandoned tires. Consequently, malaria has been essentially a disease of rural settings, and the major vectors do not normally thrive in urban settings. However, that is changing with the introduction of a new malaria vector to Africa (from South Asia and parts of the Arabian Peninsula): *An. stephensi*, identified in 2012 in Djibouti *(19)*, where it led to a 30-fold increase in urban malaria cases *(20)*.

A*nopheles stephensi* is unique among malaria vector species: it is able to establish itself in both rural and urban settings by laying its eggs in a wide variety of clean and grey/wastewater bodies (**see Table 1**). This makes it a highly invasive vector of malaria, able to efficiently transmit *Plasmodium falciparum* (the most dangerous malaria parasite) as well as *P. vivax*. Even though large-scale surveillance of *An. stephensi* is still in its infancy, the vector has already been identified in urban settings across the Horn of Africa and in major urban areas in Ghana and Nigeria *(21-25)* thus, it is likely that the vector is already in many other countries and cities in the African Region. Early modelling estimates that an additional 126 million people living in urban settings are at risk of malaria *(26)*. The risk is to all age groups in urban settings, as most are immunologically naïve (with no prior exposure to malaria and thus no naturally acquired immunity to severe malaria *(7)*).

3.2 Dengue, yellow fever, chikungunya and Zika viruses and *Aedes spp.* mosquitoes

The *Aedes* mosquito is highly invasive; two *Aedes* species are responsible for the rapid spread of dengue fever. Dengue fever has expanded from nine countries in the 1960s to 129 in 2022 *(26)* including the Mediterranean *(27)*.

Like *An. stephensi*, *Aedes spp.* also lay their eggs on urban water bodies. Their preferences for laying their eggs in camps and urban sites overlap, though *Aedes aegypti* and *Aedes albopictus* do not normally lay eggs on grey/wastewater and are instead limited to the water stored in containers (e.g. stored drinking or rainwater) (**see Table 1**).

3.3 West Nile virus and *Culex spp.*

Culex spp. mosquitoes are increasingly a problem in camps and urban emergency settings in Africa, where they coexist with *Anopheles spp.* and *Aedes spp.* mosquitoes. They are also invasive vectors and can transmit West Nile virus, a re-emerging disease that can cause life-threatening symptoms for the 20% of those infected who become clinically ill *(28)*. *Culex spp.* breed successfully in a wide range of clean water and grey or polluted water sources and formats, many of which are common in camps and urban habitats *(29)*.

4. Rationale for water, sanitation and hygiene-based disease-vector control

The benefits of water, sanitation and hygiene interventions include the prevention of a number of life-threatening water- and vector-borne pathogens. The control of mosquito vectors that preferentially lay eggs on clean water, wash-water and wastewater in camps and urban settings does not require complex technical expertise. However, it does require thinking beyond diarrhoeal disease interventions to include collaboration with disease-focused efforts (e.g. malaria and dengue) as well as with urban planning and municipal authorities. In emergency settings where the cluster system is activated, the WASH cluster is the nominal lead for vector-borne disease control in humanitarian crises and increasingly is collaborating with the health cluster to provide a multi-pronged approach to disease prevention and control. In addition, women come into frequent contact with vector breading sites in households, during water collection and while practicing agriculture *(30)*. Thus, all interventions should have a gender and equity lens, addressing in particular risks to women (and children).

4.1 Why invasive mosquitoes can be controlled through water and sanitation interventions

The life cycle of mosquitoes has two phases: aquatic (usually 10-14 days) and terrestrial (2-4 weeks). The aquatic phase comprises the egg, larval and pupal stages. Egg-to-adult development time varies with species, climatic temperature and availability of nutrients in the water. Adult females lay hundreds of eggs in several batches. Not all eggs develop fully and emerge as adults capable of flight.

The ideal way to control *An. stephensi*, *Aedes aegypti* and *Aedes albopictus* through water and sanitation interventions is to target the aquatic-phase environments upon which these vectors depend to proliferate. The key actions are detailed below and include: 1. prevention of standing water formation in camps and urban areas; 2. securely covering, regularly cleaning and disinfecting water-storage containers; 3. removal and management of accidental containers; and 4. safe storage and removal of domestic waste to well-managed dump sites. In addition, where applicable, consider application of larvicides to water containers.

Open drains and solid waste in slums. Northern Venezuela – 2023. © MENTOR Initiative

4.2 Description of priority water and sanitation interventions for mosquito control

1. Prevent stagnant water formation in camps and urban areas

Coordinate with agencies responsible for camp planning and management and/or urban municipal authorities to ensure:

- Wherever possible, camps or urban settlements are not flood prone or sited on marshes;
- Water-collection points are designed or rehabilitated to avoid creation of pools of surface water, or water held in any form, including in open troughs, basins, wells or drain entry points;
- Water pressure at supply points is not greater than required and is at the right height for users to access easily with commonly used water containers;

Aedes spp. Identified in domestic rooftop water tank. Aden, Yemen - 2021. © MENTOR Initiative

- Water sources (e.g. hand pumps) are designed with adequately large drainage aprons to capture falling water and direct it into a drain to avoid creation of surface-water pools;
- Where surface and below-surface wastewater and stormwater drainage channels are required next to building infrastructure or roadsides, these are:
    i. Designed in consultation with hydrologists and climate scientists to collect and channel the rainwater or/and groundwater volumes based on short- and longer-term intensity and frequency of rainfall events.
    ii. Designed with adequate access points to facilitate clearing vegetation and solid waste from drainage channels or underground drainpipes to maintain optimal water flow and movement.
    iii. Well-managed, regularly checked and kept clear of solid waste or plant material so that water movement is unrestricted. (This also applies to roof gutters and their downpipe entry points on human and animal housing and community buildings, which should be intact and kept clear at all times to avoid the formation of water pools.)

Note: Where rainwater capture systems exist, see the following recommendations on preventing mosquito entry and egg laying, and on modification of water containers.

2. Securely cover, regularly clean and disinfect water-storage containers

Invasive *Aedes spp.* and *An. stephensi* will lay eggs in most water containers, regardless of size (**see Table 1**). The plasticity they display for egg-laying sites is extraordinary *(25)*. Prevention of container breeding can be achieved as follows: in camp or urban settings in which large, static (e.g. concrete, corrugated iron sheets) or mobile (e.g. water trucks, bladder tanks, rigid plastic tanks) water tanks exist, ensure that all entry points above the tank water level are either permanently sealed or are covered with tight-fitting lids to prevent mosquito entry.

Note: Corrugated metal or canvas tank tops are unlikely to be adequate. See recommendations for modifying water containers to make them unsuitable for egg development.

Where jerrycans or other water containers are sold or distributed to households, ensure that they are covered with tight, well-fitting lids. Coordinate with camp/urban service providers to align their container supply with this requirement. Work with municipal authorities and community health and hygiene promoters to integrate safe household water storage messaging into their activities. One example would be to encourage households to always use tight-fitting lids on their water carriers/storage vessels.

Note: Buckets are particularly problematic as they are commonly used to carry/store water, but they often have no lids. Invasive *Aedes spp.* eggs stick to the sides of containers, can survive desiccation and resume development when buckets are refilled. See recommendations for modifying water containers to make them unsuitable for egg development.

Water barrels (including rainwater collection barrels) at community or household level come in different shapes and sizes and are often the most abundant breeding sites for invasive *Aedes spp.* and *An. stephensi*.

Providing metal bin lids with tight-fitting edges is sometimes a local manufacturing option and longer-lasting solution. However, it is generally expensive and requires a relatively long production lead time. In addition, distribution can be challenging as households may have multiple water-storage barrels of different sizes. Local production of flexible polypropylene or polyethylene sheeting, cut into circles and with an elasticated band sewn into the edging, provides a more flexible and adequately robust medium-term, tight-fitting lid for variable-sized water barrels. This solution can be adapted to local needs and produced locally, is relatively low cost and is effective at blocking mosquito entry. For all interventions, it is important that communities are mobilized and supported to follow correct practices.

Elasticated plastic lids to prevent *aedes spp.* Entry into domestic water drums in urban slums. Northern Venezuela – 2023. © MENTOR Initiative

3. Remove and manage accidental containers

Aedes spp. and *An. stephensi* lay their eggs in a huge variety of water containers, from discarded bottle caps to large, underground, concrete water tanks (see Table 1), and everything that holds water between these extremes. Households generate a variety of containers. Some of them are filled with water intentionally (e.g. water storage containers used for washing, cooking and drinking) and others contain water unintentionally (e.g. tires, coconut shells).

Households in camps and urban settings should be engaged and supported to control invasive vectors themselves.

Dissemination of key household preventive actions can be done through existing community worker and civil society networks. Specific messaging includes:

- Household should completely empty household water containers that are portable (flowerpots, water barrels) or fixed, but drainable (concrete or metal water tanks), once a week.
- Households should clean (ideally, with a scrub brush) the inner walls of the empty containers to remove any *Aedes spp.* eggs that may have adhered to the container walls. They should then rinse out and drain the rinse water/wash-water into a sink, toilet or another drain. This will prevent any *Aedes spp.* and *An. stephensi* eggs laid in the water container during the week from completing their aquatic life-cycle phase.

Filling coconut shells with sand to prevent *aedes spp.* egg laying. Yangon city. Cyclone Nargis – May 2008. © MENTOR Initiative

- Households should also check the area near their home's exterior at least weekly for unintended water containers and waste items (cans, etc.); then drain them, fill them with sand/dirt or turn them upside down (shells, pots, watering cans, etc.).

4. Safely store and remove domestic waste to a well-managed dump site

Domestic solid waste, including empty food waste containers (i.e. cans, bottles and plastic bags) need to be carefully managed to prevent access and use by vectors. Unmanaged waste is an ideal breeding ground and habitat for many pathogen-carrying vectors, including mosquitoes. Local authorities and humanitarian partners should ensure that household-level waste and any waste accumulating in roads, community buildings, markets, etc., is collected, removed and disposed of safely.

Key measures to support effective domestic waste collection include:

- Community and public health-promotion messages that encourage families to put their solid waste into sacks and to keep them closed/ stored when not in use. Filled/full sacks should be tied and closed and placed in agreed waste-collection sites away from households and, ideally, protected from rain to prevent water from pooling.
- Individuals responsible for collecting waste should be clearly identified and waste should be collected at least weekly. Doing so would ensure that no vectors would be able to develop beyond the aquatic stage (typically around 10 days, depending on the temperature and water quality). Where collection is less frequent, vectors have time to complete their aquatic life cycle phase and emerge as flying adults.

Solid waste management in urban slums. Northern Venezuela – 2023. © MENTOR Initiative

- Ideally, domestic waste final dumping/processing sites should be located at least 3 km from residential areas. This distance is far enough that most mosquitoes that complete their aquatic life cycle in waste dump areas are unlikely to reach residential areas. This distance will also reduce the chance that other flying vectors, including filth flies, will return to camps and urban settlements.

- A few inches of topsoil should be added regularly to the top of waste dumping pits. If this is done once a week, it will prevent insects from using solid waste as a breeding ground and will also reduce the numbers of rats and other vermin.

Note: Discarded vehicle tires are a major problem, as they tend to accumulate in settings where humans live, including in camps and low-income urban settings. Tires hold water effectively and provide shaded areas, which mosquitoes prefer for laying eggs. They are also very difficult to empty out, and invasive mosquito vector species may use these for egg laying *(31, 32)*. Key measures to reduce the threats posed by discarded tires include:

- Store them under a roof to prevent rainwater entry.
- Stack and cover them with any sort of impermeable sheet that prevents rainwater entry.

Where tires cannot be protected from rain, cut drain holes in their walls or treat them with larvicide, just as household water-storage containers are treated.

5. Where applicable, consider applying larvicides to water containers

In settings where static/fixed water containers are too large to be manually emptied and cleaned each week, are undrainable or inaccessible (e.g. water tanks on roof, under the house), consider applying larvicides. Larviciding is generally most cost-effective in areas where larvicide habitats are few, fixed and findable. Community members should be included in any decision-making process regarding the use of larvicides and other chemicals . Increased levels of participation (e.g. consultation, inclusion and shared decision-making) should be included in the development and deployment of vector-control interventions. Only trained community workers — not individual households — should apply larvicides, and it should be done periodically, with the agreement of concerned households. Application of larvicides should be carried out in accordance with WHO and CDC larvicide guidelines (see Further Reading) and should follow product-specific dosage and treatment schedule guidance *(33)*.

Larvicides come in different forms (e.g. liquids, tablets, pellets, granules, briquettes) and types. Bacterial larvicides are made from natural substances. Two of these are effective for mosquito larvae control are *Saccharopolyspora spinosa* (Spinosad) and *Bacillus thuringiensis israelensis*. They are found in soil and are toxic to mosquitoes. Insect growth regulators do not kill larvae but do prevent their development to adults. WHO has tested and approved seven larvicidal compounds for the control of mosquito larvae in container habitats. These include: diflubenzuron, methoprene, novaluron, pirimiphos-methyl, pyriproxyfen, spinosad and temephos and a bacterial larvicide (*Bacillus thuringiensis israelensis*) *(34)*.

Note: These larvicides are safe for human consumption when applied at the recommended doses in drinking water *(35)*. Also, in areas where insecticides will be applied over long periods of time (months/years), it is necessary to put in place a larvicide-resistance surveillance system so that this phenomenon can be detected and managed, including through targeted, diversified and comprehensive vector-control strategies *(36)*.

6. Complementary chemical measures targeting both invasive and non-invasive adult mosquito species

A number of vector-control tools provide potentially useful options for controlling invasive vector species at household level as part of an integrated, vector-control management strategy for camps and low-income urban settlements.

Spatial repellent emanators using an effective and safe repellent have shown very encouraging trial results in reducing the number of *Anopheles and Aedes* vectors and sandflies that enter houses. Two low-cost, simple, light weight emanators are now available. Both types can be hung inside a shelter or house and effectively repel insects. The simplest emanator is effective for around one month, while the second emanator type has proven to be effective for more than eight months in field trials. Several insect traps, bated and unbated, have also shown promising results. (However, there are limitations to indoor residual spraying for controlling invasive *Aedes spp.* **(Box 3)**).

For control of non-invasive mosquito species such as *An. gambiae*, *An. arabiensis*, *An. coluzzii*, and *An. funestus*, which are important malaria vectors in many camp settings, humanitarian actors should use **indoor residual spraying** wherever insecticide-treated nets cannot be hung easily or are unlikely to last for long due to harsh living conditions. Spraying and nets are usually effective for controlling these nocturnal vector species and, to some extent, for controlling *Culex spp.* Screening doorways, windows, open eves and shelter air vents, with intact, appropriate-sized netting will also help reduce the number of mosquitoes that can enter a structure.

Box 3. Limitations of indoor residual spraying and insecticide-treated nets for invasive *Aedes spp.*

Indoor residual spraying of internal household/camp wall surfaces or sleeping under an insecticide-treated net may have limited impact on the control of the invasive *Aedes spp*., since they bite earlier in the evening and later in the morning, times when humans are often awake and outside. In addition, *An. stephensi* has been shown to be a night feeder as well as crepuscular, feeding during twilight hours - at dawn and dusk - when many people are awake and often outside and unprotected *(26)*. *Anopheles stephensi* may also feed later in the night, when indoor residual spraying and long-lasting insecticide nets offer some protection for people sleeping indoors. Importantly, *An. stephensi* mosquitoes prefer poorly constructed shelters, such as those commonly found in camps and in low-income, urban areas (**see Table 1**). Implementing water- and sanitation-based interventions to control these invasive vector species in their aquatic life stages, where they are most vulnerable to control, is vital.

Note: When using larvicides in any setting, public health officials must engage with community authorities and members to ensure that they understand the disease risks targeted, the human safety profiles of the products and their effectiveness in reducing target vectors.

Table 1. Priority water and sanitation interventions for mosquito-borne disease

Intervention	Implementation considerations	Mosquito species	Pathogens and Diseases	Notes
Prevent still water formation in camps and urban areas	• Plan for appropriate siting of households; implement drainage systems and safely manage water and sanitation services	Other *Anopheles* species	Pathogen: *Plasmodium* Disease: malaria	Requires strong coordination with urban planners, camp management, etc.
		Possibly *An. stephensi*	Pathogen: *W. bancrofti* Disease: lymphatic-filariasis	
		Culex spp.	Pathogen: flaviviruses Diseases: West Nile, Rift Valley fever, Japanese encephalitis	
Securely cover and regularly clean and disinfect water-storage containers	• Ensure buckets in hygiene kits have secure covers/lids and scrub brushes • Empty and scrub containers weekly • Larvicide larger containers that cannot be cleaned manually	*An. stephensi* *Aedes aegypti*	Pathogen: *Plasmodium* Disease: malaria	Where regular cleaning and disinfection are not possible, use approved larvicides
		Aedes albopictus	Pathogen: flaviviruses Diseases: dengue, chikungunya, yellow fever, Zika	
Remove and manage accidental containers	• Ensure car tires are stored inside or covered • Empty and ensure accidental containers near households cannot collect water	*An. stephensi* *Aedes aegypti*	Pathogen: *Plasmodium* Disease: malaria	Requires support for household and community interventions
		Aedes albopictus	Pathogen: flaviviruses Diseases: dengue, chikungunya, yellow fever, Zika	
Safely store and remove domestic waste to well-managed dump sites	• Collect, bag, remove and safely dispose of waste	*An. stephensi*	Pathogen: *Plasmodium* Disease: malaria	Requires support for household and community interventions
		Aedes aegypti *Aedes albopictus*	Pathogen: flaviviruses Diseases: dengue, chikungunya, yellow fever, Zika	
Cover latrine pits, safely manage fecal waste	• Cover latrine holes • Ensure raw sewage is transported in covered pipes, trucks	*Culex spp.*	Pathogen: Virus Diseases: West Nile, Rift Valley fever, Japanese encephalitis	Requires strong coordination with urban planners, camp management, etc.
		Musca spp.	Pathogen: Virus (mainly) Diseases: Enteric diarrheal	

Table 2. Key characteristics of mosquitoes which transmit malaria, dengue and other viruses

Mosquito	Preferred aquatic egg-laying site	Where they live	Preferred blood feeding times/ locations	Where they rest after feeding
An. stephensi	Open water-storage containers, and accidental containers. Often the same container habitats as *Aedes* species Also in natural habitats (marshes, slow-flowing rivers, ponds)	Urban, camps and rural	Crepuscular: twilight (dusk and dawn) hours while people are still outside. Also late at night	Mostly outside but also inside in some settings later at night
Other *Anopheles*	Open, still surface water (normally clean), accidental containers	Rural	Major vectors: predominantly late at night and inside. However, there are many other less-efficient vector species that are crepuscular, preferring animal blood and biting animals and humans outdoors when unprotected in twilight hours	Primarily inside human housing (vulnerable to indoor spraying)
Aedes aegypti	Unsafe water sources and water storage with loose-fitting or no lids; accidental containers	Urban, camps, rural areas	Late afternoon, early evening and late morning, feeding inside and outside	Mostly outside human housing in shade
Ae. albopictus	Unsafe water sources and water storage with loose fitting or no lids; accidental containers	Urban, camps, rural areas	Late afternoon, early evening and late morning, feeding predominantly outside	Mostly outside human housing in shade
Culex spp.	Wastewater rich in organic matter, latrine pits	Urban, camps, rural areas	Evening and night, feeding predominantly inside	Primarily inside human housing (vulnerable to indoor spraying)

Suggested further reading

- WHO/WEDC, 2013. Technical Notes for WASH in Emergencies [website]. https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/environmental-health-in-emergencies/technical-notes-on-wash-in-emergencies
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