GA4: Environmental Committee

Student Officer: Sıla Nur Yorulmaz

Issue: The increase of outbreaks in climate-driven, vector-borne diseases

TIMUN '22

Turkish International Model United Nations

THIMUN Affiliated Conference

Committee: Environmental Committee (GA4)

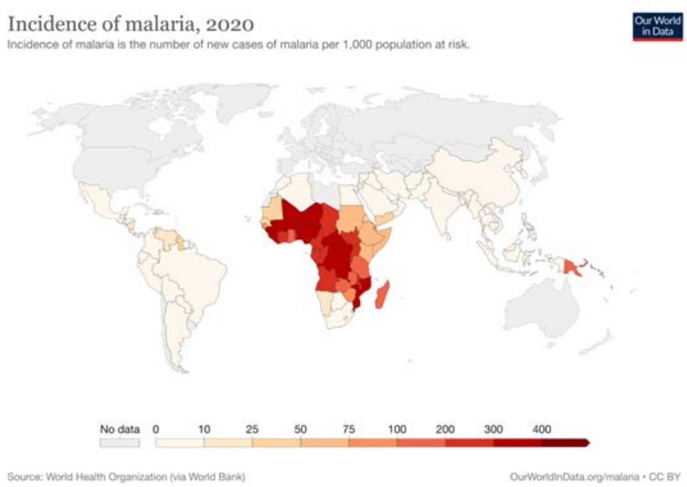
Issue: The increase of outbreaks of climate-driven, vector-borne diseases

Student Officer: Sıla Nur Yorulmaz – Deputy Chair

I. Introduction

Ensuring access to appropriate and affordable healthcare systems has been of the utmost importance for decades, as it is a necessity for social development. Over the years, health emergencies have affected nations in many negative ways. Therefore, organizations and countries have been working in order to eliminate the world's major health threats. One of the biggest health challenges that the world currently faces is vector-borne diseases (VBDs). Accounting for more than one-sixth of all infectious diseases, vector-borne diseases result in the death of more than 700,000 people each year (WHO). For instance, malaria is thought to be responsible for 219 million illnesses and more than 400,000 fatalities annually, and dengue puts more than 3.9 billion people in 129 different countries at risk (WHO). Especially since 2014, vector-borne disease outbreaks have been contributing to the overall burden of disease while threatening health security and leading to significant socioeconomic outcomes around the globe. This is mainly because once an outbreak is detected, it requires not only extensive medical investments but also various societal measures to eliminate the further spread of the disease among the community, such as lockdowns and government provision of healthcare supplies. Research suggests that such diseases also create a long-term effect on per capita Gross Domestic Product (pcGDP).

The increase in the rate of transmission of vector-borne diseases is influenced by numerous factors like rapid unplanned urbanization, changing land use patterns, increased international travel and trade, in addition to climate and other environmental changes. Among these factors, the climate is strongly linked to the increase in the number of vector-borne disease outbreaks since the arthropod species - the vectors of such diseases - are quite sensitive to climatic factors. As climate change becomes more evident throughout many regions, the ongoing trends of increasing temperatures and variable weather pose significant problems that undermine recent global progress against these diseases. Many vector-borne diseases that were limited to tropical and sub-tropical regions have started to be seen more



Map 1: Malaria Incidence in Countries

often in temperate regions as well. According to the World Health Organization (WHO), 80% of the world population is currently at risk of one or more vector-borne diseases. Considering the gravity of the issue, tackling climate-driven vector-borne diseases is vital to prevent future health emergencies that would cause severe damage to the political and socio-economic state of the world.

There have been several attempts to minimize the number of climate-driven vector-borne disease outbreaks such as the "Global Vector Control Response." Nevertheless, none of the solution attempts have been entirely successful due to the changing patterns in climate and the variable nature of the determinants of vector-borne diseases.

II. Involved Countries and Organizations

World Health Organization (WHO)

As the UN organization responsible for ensuring global health, the World Health Organization has been tackling climate-driven, vector-borne diseases. Apart from projects to raise awareness, WHO officials gave numerous speeches and published many articles to educate the public about VBDs, their effects, and methods of prevention. Moreover, WHO has helped many countries at higher risk of VBD outbreaks to come up with effective solutions like establishing surveillance systems, providing medical and technical support, and offering evidence-based recommendations for managing vectors and preventing infection in humans. In 2017, WHO published the "Global Vector Control Response (GVCR) 2017–2030." This response aimed to improve people's health outcomes and increase healthy life expectancy through prevention by addressing social, economic and environmental factors influencing the spread of VBDs. Throughout the report, the necessity to elevate and strengthen vector control as a key public health service and also integrate it across other sectors such as water sanitation and education, was stressed. WHO also states the need for careful evaluation and re-alignment of national programs along with increased global financing, technical capacity, strengthened monitoring and surveillance systems, and better use of interventions. The organization also prioritizes cooperation through effective partnerships with increased participation of communities and others such as private industry, to develop and apply solutions for vector control.

Afghanistan

The incident of malaria in Afghanistan is the third highest in the world. 11% of cases in the WHO Eastern Mediterranean area originate here. More than 76% of Afghans reside in high-risk locations. Eastern Afghanistan has the highest malaria rates, with 123 districts at high risk and 213 districts at low risk. In 2017, the SPR was 17.64 percent and the incidence rate of confirmed malaria infections was 8 per 1,000. Arthropod vectors including mosquitoes, ticks, and sand flies can be found in significant quantities throughout the warmer months of May to November due to the climate and ecological habitat. The country continues to see significant disease transmission, even in urban areas. The main risk from vector-borne diseases in Afghanistan is malaria and leishmaniasis. Due to inadequate surveillance and diagnostic tools, many additional dangerous diseases can also go unrecognized or unreported. In order to tackle the issue, WHO and other related organizations helped provide technical and financial support to pilot the Malaria and Leishmaniasis Information System (MLIS) to improve surveillance and trained 59 master trainers on MLIS in the scaling up of implementation. These organizations also conducted monitoring and evaluation of malaria control and elimination activities through the Chronic Care Model (CCM) oversight committee, revised National Malaria Treatment guidelines, and provided information education materials for health facilities to enhance public awareness. During the implementation of these measures, WHO faced some risks and challenges such as limited financial support with which to cover all components of the National Strategy, insufficient skilled staff at service delivery and programme management levels, weakness in the monitoring system, and poor healthcare -seeking behavior in communities.

India

India's climate provides a near-perfect habitat for vectors. India is endemic to six major vector-borne diseases, namely malaria, dengue, chikungunya, filariasis, Japanese encephalitis and visceral leishmaniasis. Over the years, there has been a reduction in the incidence of almost all diseases except chikungunya which has reemerged since 2005. The upcoming issue of climate change has surfaced as a new threat and challenge for ongoing efforts to contain vector-borne diseases. There is greater awareness about the potential impacts of climate change on VBDs in India and research institutions and national authorities have initiated actions to assess the impacts. The National Vector Borne Disease Control Program (NVBDCP) and National Center for Disease Control (NCDC) carry out operations and preventative measures relating to vectors and VBD on a national scale. Numerous additional national institutions working under the auspices of the Department of Biotechnology, the Indian Council of Agricultural Research, and the Indian Council of Medical Research complement the initiative by carrying out research into these illnesses.

Pakistan

Pakistan shares the highest burden of major vector-borne diseases with regard to key vector-borne illnesses like malaria, leishmaniasis, dengue, chikungunya, and Crimean-Congo hemorrhagic fever. Malaria is a major source of morbidity and mortality in Pakistan, just like it is in other parts of the world. It is one of the six top communicable illnesses that endanger the health of millions of people. Pakistan has been grouped with Afghanistan, Somalia, Sudan, and Yemen, accounting for more than 95% of the overall regional malaria burden, with one million estimated and 300,000 confirmed reported cases annually. In

Pakistan, malaria transmission has typically had a seasonal and erratic pattern. Districts and agencies near the border with the Islamic Republic of Iran and Afghanistan, as well as the coastal belt in Sindh and Balochistan, experience intense transmission. Effective malaria control measures were first implemented in 1950; and in 1961, WHO, the United Nations International Children's Emergency Fund (UNICEF), and the United States Agency for International Development (USAID) joined forces to undertake a nationwide eradication effort (WHO). Due to this program, malaria was almost completely eradicated from the nation with a noticeable drop in malaria incidence from an estimated 7 million cases in 1961 to 9,500 cases in 1967 (WHO). The overall slide positive rate was found to have decreased from 15% to less than 0.1%. The reprieve was only short-lived, though, as malaria rates started to rise in 1969 as a result of cessation of attempts. The strategies and policies were in line with principles of global control from 1975 until 2010. WHO has been the only technical partner supporting the national and provincial control programs since 2002. This support is provided in the areas of strategic planning, policy guidelines development, operational research, disease surveillance, resource mobilization, advocacy, capacity-building, assessments and situation analyses, introduction of new interventions and technologies for improving quality in diagnosis, treatment and prevention measures (WHO).

Gabon

Gabon is one of the countries with the highest incidences of malaria and other vector-borne diseases in the world. While Gabon has an annual malaria risk, the risk is especially high during, and immediately after, the country's rainy seasons. The disease is mainly transmitted through Anopheles mosquitoes that feed from dusk to dawn. To guarantee that all of its residents have access to high-quality medical treatment, the government of Gabon started to construct new medical facilities in 2013. This was a crucial milestone in the fight against malaria and other widespread illnesses. Furthermore, a vaccine known as RTS,S was discovered in July 2017 to have the power to halt malaria before it even begins. In Gabon, the vaccine underwent testing from May 2009 until early 2014. The vaccine received a "positive scientific opinion" from the European Medicines Agency in July 2015, indicating that future cases of malaria in Gabon may benefit from its use. Nevertheless, actions are still being taken to stop disease epidemics in Gabon. The Africa Center for Disease Control and Prevention launched a Regional Collaborating Center in August 2017 which will coordinate initiatives to prevent non-communicable and infectious diseases in Gabon and other central African nations.

III. Focused Overview of the Issue

Vector-borne diseases have been hindering the welfare of people for centuries. The major vector-borne diseases together account for approximately 17% of the estimated global burden of infectious diseases and claim more than 700,000 lives annually (WHO). The tropical and subtropical areas are the places in which the burden is highest. As stated previously, more than 80% of the global population live in areas at risk from at least one major vector-borne disease, with more than half at risk from two or more (WHO). The risk of infection for certain viral pathogens is particularly high in towns and cities where Aedes and Culex mosquitoes increase rapidly due to favorable conditions for their survival and reproduction and close contact with humans. In poorer populations, mortality and morbidity rates of such diseases are immensely high. Moreover, the survivors of these diseases have the risk of becoming permanently disabled. Vector-borne diseases also jeopardize economies and impede both rural and urban development

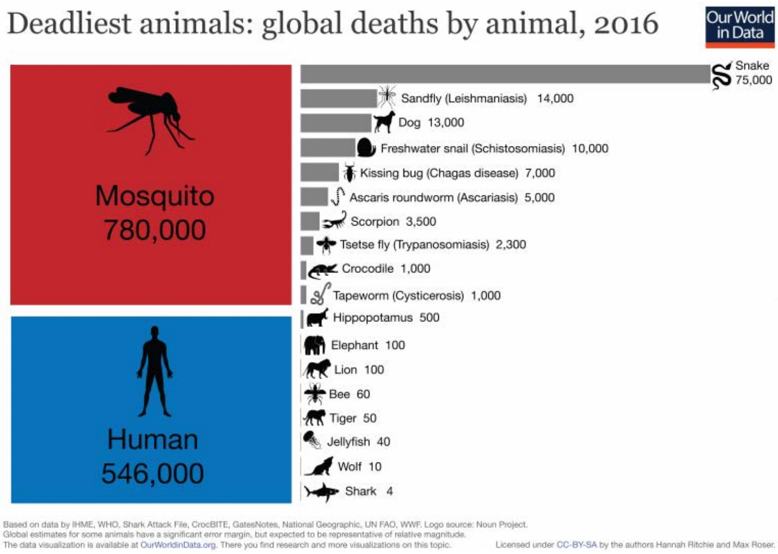


Table 1: Deadliest Animals

The transmission rates of these diseases used to be particularly high in tropical humid regions that provide suitable habitats for vectors like mosquitoes, ticks, black flies, etc. Nonetheless, many vector-borne illnesses are expanding into hitherto constrained geographic and host range, due partly to anthropogenic reasons. In the developing world, epidemics of malaria, dengue, and other once-contained vector-borne diseases are on the rise. Hence, there is an urgent need to address the increase in the number of vector-borne diseases. Throughout the report, the importance of preventing vector-borne disease outbreaks, the factors that influence the transmission patterns, and climate change's impact on the combat of these diseases will be discussed.

1. Importance of Climate-driven Vector-borne Diseases

Apart from contributing greatly to the overall burden of disease putting the lives of billions at risk, climate-driven vector-borne diseases have broader socioeconomic effects like worsening health inequities and hampering socioeconomic progress. Poor urban populations, children, pregnant women, elderly people, nomads, refugees and people living in post-conflict settings are the most vulnerable groups hit by climate-sensitive vector-borne diseases. For instance, the per capita mortality rate from VBDs is nearly 300 times higher in developing countries than in developed regions, due to the higher prevalence of vector-borne diseases in many developing countries' tropical climates as well as the lack of socioeconomic development and access to healthcare in these regions (WHO). Due to poorer environmental and social conditions (such as lower-quality housing located closer to vector breeding sites) and lack of access to preventive and curative health services, poor people in any population typically face much higher risks of contracting vector-borne diseases. Even for diseases that do not have a strong correlation with poverty and populations that have relatively better protection, vector-borne diseases nonetheless have a significant effect on individuals, households, and health systems. Every year, an estimated 500 000 patients with severe dengue necessitate hospitalization, with a high proportion of them being children. According to estimates based on studies from eight different countries, a typical dengue episode results in 14.8 lost days for patients who are ambulatory (at an average cost of US$ 514) and 18.9 days for patients who are non-fatally hospitalized (at an average cost of US$ 1491) (Suaya). Vector-borne illness outbreaks have the potential to devastate health systems and have an influence on other industries, like tourism.

Through a combination of poverty reduction and socioeconomic development, improved access to healthcare services, more extensive and well-coordinated control programs, and the creation and implementation of more efficient interventions, significant progress has been made against vector-borne diseases. These achievements have led to a decrease in the percentage contribution of vector-borne diseases to worldwide mortality. However, significant obstacles still exist. Some vector-borne diseases, like malaria, are not all experiencing a global decline in incidence. Furthermore, factors like insecticide and drug resistance, the challenges of maintaining political will and resources for disease control programs, and the potential for disease transmission or reemergence with much greater health impacts in populations that have lost immunity threaten the sustainability of the accomplishments in combating vector-borne diseases.

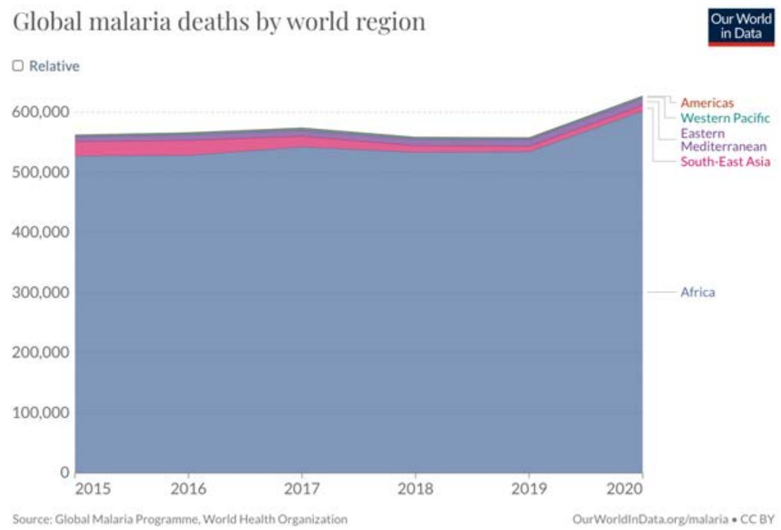


Chart 1: Malaria Deaths

2. Factors that Affect the Transmission Patterns

Demographic, social, and environmental factors have altered pathogen transmission patterns, resulting in geographical spread, intensification, re-emergence or extension of transmission seasons. In particular, unplanned urbanization, lack of reliable piped water supply and inadequate solid waste or waste management can render large populations in towns and cities at risk of viral diseases spread by mosquitoes. Increased global travel and trade, combined with environmental factors such as altered land use patterns (i.e. deforestation) and climate change, may also have an effect. Together, such factors influence the increase of the reach of vector populations and the transmission patterns of disease-causing pathogens. The dynamic and complex nature of vector-borne pathogens complicates predictions of the impact of existing, re-emerging or new diseases on human health.

Despite this unpredictability, it is reasonable to expect emergence of some new vector-borne diseases and further intensification of others, particularly those viral diseases transmitted by Aedes mosquitoes that are closely associated with urbanization (WHO). Also of concern are pathogens that may be transmitted by Culex mosquito species and other arthropods (WHO). This complexity and unpredictability underscore the critical need for adaptive and sustained approaches to prevent and reduce pathogen transmission to reduce disease burden.

Due to their high disease burden, widespread occurrence, and great susceptibility to climatic influences, vector-borne diseases are among diseases linked to climate change that have received the most research. The influence of climatic conditions is less direct and more varied, both within and between individual diseases, as compared to some other climate-sensitive health concerns, such as heat stress or exposure to storms and floods. The most direct links exist between temperature and the rates of biting, reproduction, and survival of vectors as well as the development and survival of the infections they carry. In fact, since arthropod vectors (such as mosquitoes and ticks) lack thermostatic mechanisms, temperature variations have a significant impact on reproduction and survival rates. For example, the 1990s have witnessed an increase in arthropod-borne emerging infectious disease occurrences as a result of climatic irregularities. Precipitation also has a strong effect, especially in the case of diseases that are transmitted by vectors that have aquatic developmental stages like mosquitoes and through increased humidity levels that would provide a more favorable habitat for the vectors. Additionally, pathogens inside of vectors tend to incubate for a shorter amount of time at warmer temperatures. Thus, as temperatures rise, mosquito and other vector distribution may also grow.

Climate and weather conditions also have a number of indirect influences on the natural environment and human systems, such as drought altering water storage, land-use and irrigation techniques, and population movement, which in turn affects vector ecology and human exposure to infection. In a recent WHO report summarizing the significance of vector-borne diseases, for instance, it is stated that previously relatively stable geographic distributions are now changing as a result of a variety of factors, such as "climate change, intensive farming, dams, irrigation, deforestation, population movements, rapid unplanned urbanization, and phenomenal increases in international travel and trade." These socio-ecological elements could either amplify or mitigate the effects of climate change.

3. Vector Control

Targeting the vectors that transmit disease-causing pathogens is an effective preventive approach against most important vector-borne diseases. Interventions that reduce human–vector contact and vector survival can suppress and even halt transmission. History provides clear examples of when rigorous vector control has led to significant reductions in disease burden. Major declines in malaria, onchocerciasis and Chagas disease have been largely due to strong political commitment and substantial investment in vector control. Malaria reduction and elimination was achieved in some areas through intensive spraying with DDT in the 1950s and 1960s and, more recently, through the widespread scaling up of insecticide-treated mosquito nets and indoor residual spraying. Large-scale use of larvicides aimed at reducing vector populations of human onchocerciasis along with community-directed treatment with ivermectin have contributed to substantial reductions in disease.

For Chagas disease, elimination of domestic vectors by indoor residual spraying and housing improvements together with enhanced blood screening of donors and supportive treatment for those infected have been impactful in southern countries of South America. Vector control was applied effectively against dengue and yellow fever in the Americas (1950s–1960s), and was effective against dengue for decades in Singapore (during the 1970s and 1980s) and Cuba (during the 1980s and 1990s).

IV. Key Vocabulary

Vector: Vectors are organisms that can spread contagious infections from animals to humans and between humans. Some examples of vectors are mosquitoes, aquatic snails, blackflies, fleas, lice, sandflies, ticks, triatomine bugs, and tsetse flies (WHO).

Vector-borne Diseases: Vector-borne diseases are caused by parasites, viruses, and bacteria transmitted to humans by mosquitoes, sandflies, triatomine bugs, blackflies, ticks, tsetse flies, mites, snails, and lice. The major global vector-borne diseases of humans include malaria, dengue, lymphatic filariasis, schistosomiasis, chikungunya, onchocerciasis, Chagas disease, leishmaniasis, Zika virus disease, yellow fever, and Japanese encephalitis. Other vector-borne diseases, such as human African trypanosomiasis, Lyme disease, tick-borne encephalitis and West Nile fever, are of local importance in specific areas or populations (WHO).

Climate Change: Climate change is a shift in global or regional climate patterns that lasts in the long term. The term is commonly used to refer to the global rise in average temperatures, also called global warming. There is an important distinction between climate and weather to be made: the weather is a daily, monthly phenomenon while climate is the entirety of weather events and fluctuations over a long period of time (years and/or decades).

Pathogens: A pathogen brings disease to its host. Another name for a pathogen is an infectious agent, as they cause infections. As with any organism, pathogens prioritize survival and reproduction. There are five main types of pathogens: bacteria, viruses, fungi, protists, and parasitic worms.

Dichloro-diphenyl-trichloroethane (DDT): DDT was developed as the first of the modern synthetic insecticides in the 1940s. It was initially used with great effect to combat malaria, typhus, and the other insect-borne human diseases among both military and civilian populations. It also was effective for insect control in crop and livestock production, institutions, homes, and gardens. DDT's quick success as a pesticide and broad use in the United States and other countries led to the development of resistance by many insect pest species (EPA).

Incubation Period: Incubation period is the time elapsed between exposure to an infectious or pathogenic organism and when symptoms are first apparent.

V. Important Events & Chronology

Date (Day/Month/Year)	Event
1346-1353	Bubonic plague, also known as the “Black Death” is the most fatal pandemic recorded in human history, causing the death of 30-60% of the European population at that time.
1793	The Philadelphia yellow fever epidemic was one of the most severe epidemics in US history.
2005	In the 2005 dengue outbreak in Singapore, a significant rise in the number of dengue fever cases was reported in Singapore, becoming the country's worst health crisis since the 2003 SARS epidemic.
2006	The outbreaks of dengue fever in the Philippines, India, and Pakistan claimed over a thousand lives.
24 May 2008	The sixty-first World Health Assembly passed a resolution concerning climate change and health, with the mention of its impact on vectors.
21 April 2009	The World Health Organization has prepared a report on the status of implementation of integrated vector management titled “Status of implementation of integrated vector management.”
2013-2014	The 2013–2014 chikungunya outbreak in the Americas represented the first recorded outbreak of the disease outside of tropical Africa and Asia.
April 2015-November 2016	An epidemic of Zika fever, caused by the Zika virus, began in Brazil and affected other countries in the Americas. The epidemic also affected other parts of South and North America, as well as several islands in the Pacific.

31 May 2017	The seventieth World Health Assembly published and decided to implement the Global Vector Response 2017-2030. A resolution was passed under the name of “Global vector control response: an integrated approach for the control of vector-borne diseases” regarding the action plan.
2019-2020	The 2019–2020 dengue fever epidemic was an epidemic of the infectious disease dengue fever in Asia-pacific and Latin America

VI. Past Resolutions and Treaties

- Status of Implementation of Integrated Vector Management (UNEP/POPS/COP.4/INF/3)

  https://www.informea.org/en/status-implementation-integrated-vector-management

  The World Health Organization has prepared this report on Integrated Vector Management (IVM) which is defined as "A rational decision-making process for the optimal use of resources for vector control", i.e. a management approach where decisions are based on evidence and surveillance data, where there may be multiple vector-control methods and the diseases they address, and where there is broad participation across sectors and within the community. Importantly, IVM includes a large component for capacity building at all levels to implement and monitor these vector-control interventions. The overall recommendations from the report are to strengthen promotion of IVM on the global agenda and to implement the Global Action Plan. Specific recommendations include launching a global advocacy strategy; strengthening capacity through development of a comprehensive modular training package; establishing a network on IVM; strengthening the evidence base and data-sharing for IVM, including the documentation of case examples; and developing a system for evaluation of IVM.

- Evaluation of the Continued Need for DDT for Disease Vector Control and Promotion of Alternatives to DDT (UNEP/POPS/COP.7/5)

  https://www.informea.org/en/evaluation-continued-need-ddt-disease-vector-control-and-promotion-alternatives-ddt-0

  This report under the Stockholm Convention on Persistent Organic Pollutants focuses on the usage of DDT and alternate insecticides for disease vector control mainly, but there are also some valuable information and proposed solutions about minimizing the spread of vector-borne diseases. It is stated that many national malaria control programs have inadequate human capacity and infrastructure to sustain control programs. It is also mentioned that the lack of capacity by programs to monitor and respond to the increasing levels of insecticide resistance and outdoor transmission in malaria vectors is a serious threat to vector control programmes. Therefore, the need to strengthen coordinated action between the Ministry of Health and other relevant ministries to ensure planning of effective disease vector control and drive the elimination agenda is highlighted. The report also writes that the integration of IVM principles into control programs is progressing slowly and increased support is required if IVM is to be significantly up-scaled, while more evidence is needed to guide IVM implementation.

- Global Vector Control Response 2017-2030

  https://apps.who.int/iris/bitstream/handle/10665/259205/9789241512978-eng.pdf

  The World Health Assembly endorsed the "Global Vector Control Response (GVCR) 2017-2030" in 2017. It offers countries and development partners strategic direction for urgently bolstering vector management as a crucial strategy for preventing disease and controlling outbreaks. To do this, it is necessary to realign vector control programs, which must be backed by enhanced infrastructure, monitoring and surveillance systems, and increased community mobilization. In the end, this will facilitate the execution of a thorough vector control strategy that will enable the attainment of national and international goals related to diseases and help reach the Sustainable Development Goals and Universal Health Coverage. The WHO Secretariat offers nations and development partners strategic, normative, and technical support for enhancing vector control as a key strategy based on GVCR for disease prevention and outbreak response.

- Global Vector Control Response: an Integrated Approach for the Control of Vector-borne Diseases (A70/26 Rev.1)

  https://apps.who.int/gb/ebwha/pdf_files/WHA70/A70_R16-en.pdf

  This document focuses on the report on the global vector control response

VII. Failed Solution Attempts

Although most of the solutions that were proposed and implemented had great potential to prevent outbreaks of climate-driven vector-borne diseases, there are still some concerns regarding the continuity of the effectiveness of such solutions. The main reason why the solutions cannot be long-lasting is the aforementioned variability of the determinants, primarily the climate conditions, which leads to an unpredictability in the transmission patterns of the climate-driven vector-borne diseases. In addition, as the diseases start to spread in new areas that do not have advanced vector control mechanisms and adequate educated technical staff, the unadapted surveillance systems fail, and the prevention of epidemics of VBDs become a significant burden. Furthermore, over the past years, the increase in VBD outbreaks were mainly observed in less economically developed countries (LEDCs) like Afghanistan which made it difficult to finance adequate healthcare systems and infrastructure without the help of other organizations. Such countries did not capitalize on available resources and capacity as well as experience learned from other diseases. Political and financial commitments have been lacking, with limited investments in vector control beyond scale-up of deployment of insecticide-treated nets and indoor residual spraying against malaria vectors. Moreover, the alterations in the transmission patterns within short intervals of time due to the climate change has hindered the accuracy of the scenario-based models that were designed to project future changes in risk for specific diseases.

VIII. Possible Solutions

The primary step to prevent the increase in the number of climate-driven vector-borne diseases should be vector control. Only with sufficient human resources, an enabling infrastructure, and a functional healthcare system can vector control be effective and sustainable.A vector control needs assessment will help to appraise current capacity, define the requisite capacity to conduct proposed activities, identify opportunities for improved vector control delivery efficiency, and guide resource mobilization to implement the national strategic plan. These should consider continuing, regular vector control measures as well as actions planned for particular situations such as the reaction to epidemics, outbreaks, or humanitarian disasters. The first steps in improving the vector control capacity and capability should include the enhancement or formulation of an inventory of infrastructural, financial, institutional, and human resources.

Since it is important to provide a career structure to attract and maintain capable staff at all technical levels of the vector control programme, an evaluation of career structures within national and subnational programmes must also be undertaken.

Capacity requirements should then be carefully and comprehensively defined, in accordance with established national strategic plans and aligned with recommendations in this response. Programs should include staff with knowledge and experience in multiple disciplines beyond the core technical fields of vector control, surveillance, and intervention monitoring and evaluation. Skills in information and communication technologies and community and local authority engagement are also required.

Programmes should then establish the necessary posts and recruit into the civil service necessary public health entomology staff at central and decentralized levels. This should include operational staff required for ongoing implementation of vector control as well as those needed for outbreak or epidemic response. To ensure availability of a cadre of sufficiently trained personnel, there is a need to strengthen and upgrade pre-service education and training through revision of secondary and tertiary core curricula in line with programme needs. Inclusion of basic concepts and activities related to vectors and their control in primary level education will help to sensitize and engage community members and enable effective community-driven approaches. This will require engagement with ministries of education, subnational education departments, and tertiary institutes to ensure integration into the curriculum.

Research has been, and must continue to be, a foundation upon which vector control programmes are built. Further basic research is needed to better understand the interactions between pathogens, vectors and human and non-human hosts in relation to changes in the physical and social environment.

IX. Useful Links

- https://wellcome.org/news/how-climate-change-affects-vector-borne-diseases

  An interesting article that simply summarizes climate's impact on vector-borne diseases and provides some feasible solutions

- https://www.ecdc.europa.eu/en/climate-change/climate-change-europe/vector-borne-diseases

  An official website of the European Union that explains vector-borne diseases according to different vectors in detail

- https://hms.harvard.edu/magazine/viral-world/diseases-take-flight-climate-change

  A comprehensive and recent Harvard Medicine article that discusses the emergence of infectious diseases (including vector-borne diseases) with an emphasis on climate change and other determinants

- https://whatworks.co.ke/climate-workshop/

  A website about a webinar about climate-driven vector-borne disease outbreak prevention responses. It mentions current vector control mechanisms and the link between climate and VBD outbreaks. There are also interesting links that explain the issue and solutions with scientific data

- https://extranet.who.int/kobe_centre/sites/default/files/pdf/vbdfactsheet.pdf

  The World Health Organization's factsheet about vector-borne diseases

X. Works Cited

Amy. "Common Diseases in Gabon." *The Borgen Project*, Amy, 9 July 2020, www.borgenproject.org/common-diseases-in-gabon/.

AP, Dhiman RC; Pahwa S; Dhillon GP; Dash. "Climate Change and Threat of Vector-Borne Diseases in India: Are We Prepared?" *Parasitology Research*, U.S. National Library of Medicine, www.pubmed.ncbi.nlm.nih.gov/20155369/.

Bourgarel, M, et al. "Emerging Viral Threats in Gabon: Health Capacities and Response to the Risk of Emerging Zoonotic Diseases in Central Africa." Emerging Health Threats Journal, CoAction Publishing, 2010, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3167654/.

Braks, Marieta, et al. "Making Vector-Borne Disease Surveillance Work: New Opportunities from the SDG Perspectives." *Frontiers*, Frontiers, 16 July 2019, www.frontiersin.org/articles/10.3389/fvets.2019.00232/full.

Caminade, Cyril, et al. "Impact of Recent and Future Climate Change on Vector-Borne Diseases." *Annals of the New York Academy of Sciences*, John Wiley and Sons Inc., Jan. 2019, www.ncbi.nlm.nih.gov/pmc/articles/PMC6378404/.

Campbell-Lendrum, Diarmid, et al. "Climate Change and Vector-Borne Diseases: What Are the Implications for Public Health Research and Policy?" *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, The Royal Society, 5 Apr. 2015, www.ncbi.nlm.nih.gov/pmc/articles/PMC4342958/.

"Climate Change and Infectious Disease." *High Meadows Environmental Instute*, www.environment.princeton.edu/research/climate-change-and-infectious-disease/.

"Climate-Driven Vector-Borne Diseases." *Nursing and Climate Drive Vector-Borne Disease*, www.vbd.casn.ca/eresource/index.html.

"DDT - A Brief History and Status." *EPA*, Environmental Protection Agency, www.epa.gov/ingredients-used-pesticide-products/ddt-brief-history-and-status.

"Diseases Carried by Vectors." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 21 Dec. 2020, www.cdc.gov/climateandhealth/effects/vectors.htm#.

Ma, Yan, et al. “Linking Climate and Infectious Disease Trends in the Northern/Arctic Region.” *Nature News*, Nature Publishing Group, 19 Oct. 2021, www.nature.com/articles/s41598-021-00167-z.

“Malaria and Other Vector-Borne Diseases in Pakistan.” *World Health Organization*, World Health Organization, www.emro.who.int/pak/programmes/roll-back-malaria.html.

“Malaria.” *World Health Organization*, World Health Organization, www.emro.who.int/afg/programmes/malaria-leishmaniasis.html.

“OIE Regional Meeting on Vector-Borne Diseases in North Africa .” *WOAH*, 10 Dec. 2020, www.rr-africa.woah.org/en/news/oie-regional-meeting-on-vector-borne-diseases-in-north-africa-3-december-2020/.

Ritchie, Hannah, and Max Roser. “Causes of Death.” *Our World in Data*, 14 Feb. 2018, www.ourworldindata.org/causes-of-death.

Rochlin, Ilia, et al. “Malaria and Lyme Disease - the Largest Vector-Borne Us Epidemics in the Last 100 Years: Success and Failure of Public Health.” *BMC Public Health*, BioMed Central, 24 June 2019, www.ncbi.nlm.nih.gov/pmc/articles/PMC6591822/.

Roser, Max, and Hannah Ritchie. “Malaria.” *Our World in Data*, 12 Nov. 2019, www.ourworldindata.org/malaria.

“Vector-Borne Disease Emergence and Resurgence - NCBI Bookshelf.” *National Library of Medicine*, www.ncbi.nlm.nih.gov/books/NBK52945/.

“World Health Day: Un Urges Countries to Prioritize Combat against Vector-Borne Diseases | | UN News.” *United Nations*, United Nations, 7 Apr. 2014, www.news.un.org/en/story/2014/04/465532-world-health-day-un-urges-countries-prioritize-combat-against-vector-borne.