



Department of
Education

Year 11 ATAR Geography

The study of an ecological hazard: Malaria



Depth Study 2

AE GEO

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The study of an ecological hazard: Malaria



Image: <https://pixabay.com/photos/mosquito-biting-female-parasite-542156/>

Depth study: Malaria

Instructions

- This work booklet should be completed over four (4) weeks.
- Work with this booklet in conjunction with four key texts below.
- Occasionally, there are links and references to materials online but this should not prevent you from completing the booklet.

Essential texts

Griffin, A. (ed.) (2018) *WA ATAR Geography: Units 1 & 2*, Geographical Association of WA Inc., Perth, Western Australia.

- Note: this resource is referred to as the **'textbook'** in this package

World Health Organisation 2019, *World Malaria Report - Briefing Kit*, United Nations, viewed 27 March 2020, <<https://www.who.int/malaria/publications/world-malaria-report-2019/World-Malaria-Report-2019-briefing-kit-eng.pdf?ua=1>>.

- Note: this resource is referred to as the **'WHO briefing'** in this package.

World Health Organisation 2019, *World Malaria Report 2019 At A Glance*, United Nations, viewed 27 March 2020, <<https://www.who.int/news-room/feature-stories/detail/world-malaria-report-2019>>.

- Note: this resource is referred to as the **'WHO summary'** in this package.

World Health Organisation 2019, *Malaria Fact Sheet*, United Nations, viewed 27 March 2020, <<https://www.who.int/news-room/fact-sheets/detail/malaria>>

- Note: this resource is referred to as the **'WHO fact sheet'**

Useful SCSA ATAR Geography documents

Year 11 Geography Syllabus

https://senior-secondary.scsa.wa.edu.au/data/assets/pdf_file/0005/10121/Geography-Y11-Syllabus-AC-ATAR-2016-GD_pdf.pdf

Geography Year 11 and 12 Glossary of key words used in the formulation of questions

http://senior-secondary.scsa.wa.edu.au/data/assets/pdf_file/0006/348549/Glossary-of-key-words-used-in-the-formulation-of-questions.pdf

Syllabus points – Unit 1 Depth Study 2

https://senior-secondary.scsa.wa.edu.au/_data/assets/pdf_file/0005/10121/Geography-Y11-Syllabus-AC-ATAR-2016-GD_pdf.pdf page 11.

This is what the syllabus says you need to know.

“Students study an ecological hazard. The context will be malaria in less developed countries such as the Sub Saharan region of Africa, in order to investigate:

- the nature and causes of the hazard
- the nature of the risks to be managed, such as:
 - loss of property/life
 - effects on infrastructure, jobs and the economy
 - the impact on physical and mental health
- the spatial and temporal distribution of the hazard, and how an understanding of biophysical and human processes can be used to explain the patterns that are identified
- the magnitude, duration, frequency, probability and scale of spatial impact of the hazard
- the physical and human factors that explain why some places and people are more vulnerable to the hazard than others
- the means by which the activities of people can intensify the impacts of the hazard, such as:
 - deliberate or accidental introduction of foreign plant or animal species to natural ecosystems.
 - global transport systems, human settlement and agriculture facilitating the spread of infectious diseases
- the environmental, economic and social impacts of the hazard in a developed country such as Australia compared with those in at least one less developed country or region
- the stakeholders affected by the hazard and their values and viewpoints on recovery and adaptation to future hazards in terms of modifying:
 - human vulnerability (susceptibility to future loss)
 - loss burden (cost of loss mitigation and adaptation)
- the sustainability of risk management policies, procedures and practices designed to reduce the impacts of the hazard, in the short and long term, through prevention, mitigation and preparedness.

Highlight these syllabus points as you complete them.

Glossary

As you complete the booklet, you will be asked to complete the topic glossary. It is always useful to know the key words and what they mean exactly in this context.

Malaria	
Plasmodium	
Plasmodium Falciparum	
Morbidity	
Mortality	
Vertebrate host	
Vector	
Anopheles mosquito	
Sporozoites	
Merozoites	
Gametocytes	
Gametes	
Nocturnal	
Crepuscular	
Notifiable disease	
Productivity	
Symptoms	
Sub-Saharan	
Anaemia	
High burden	
Biophysical factors	
Endemic	
Magnitude	
Incubation	

Infectious	
Prophylaxis drugs	
Travel advice	
Frequency	
Artemisinin	
Drug resistance	
Epidemic	
Vulnerability	
In utero	
Unregulated	
Economic impact	
Malnutrition	
Immunity	
Vector control	
Chemoprevention	
Roll Back Malaria	
LLIN	
Stakeholders	

Table of contents

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Work Schedule:

Week allocation.	Refer to the table of contents.	Check list of completion (Date).
Week 1	1 – 3	
Week 2	4 - 6	
Week 3	7 - 9	
Week 4	10 - 12	

1. What is Malaria?

Malaria is classified as an ecological hazard - a biological hazard that has the potential to impact adversely on the well-being of people or on the environment.

Malaria is a notifiable disease worldwide. This means it is required by law to be reported to government authorities. Reporting and collation of information allows the local and international authorities to monitor the disease, conduct research and provide early warnings of possible outbreaks.

Malaria is an infection caused by a parasite called *Plasmodium*. There are four species of *Plasmodium* which infect humans – *Plasmodium vivax*, *Plasmodium falciparum*, *Plasmodium malariae* and *Plasmodium ovale*. Of these, *Plasmodium falciparum* infection is the most severe and can cause death in up to 10% of cases. It can be rapidly fatal. Pregnant women and children are especially at risk. Other types of malaria are less severe, but may still cause death.

Malaria is caused by a parasite transmitted to humans by the bite of infected female *Anopheles* mosquitoes. The parasites multiply in the liver and the bloodstream and may be taken up by another mosquito when it bites. The mosquito is then infected for the duration of its life and can infect other humans when it bites them.

Occasionally malaria is transmitted by blood transfusion so for this reason people who have travelled to countries where malaria occurs may be prevented from giving blood for a short period.

Read pages 100 – 101 in the textbook for description of malaria, its causes, lifecycle, transmission and its clinical symptoms.

You can add to this knowledge by accessing World Health Organisation (WHO) website for more detail <https://www.who.int/malaria/en/>

The parasite that causes malaria, is found in the warmer, tropical and subtropical regions of the world. Researchers at University of Alabama believe the malaria parasite has evolved from a gorilla parasite thousands of years ago. Understanding the link between the species and reasons for the jump from one to another may help in prevention and development of a cure. Below is a link to the media story that provides more background on this particular issue:

<https://www.latimes.com/archives/la-xpm-2010-sep-22-la-sci-malaria-gorillas-20100923-story.html>

Diagnosing malaria is important in administering proper care, reducing the cases of overtreatment and decreasing the risk of drug resistance. Sometimes it is necessary to repeat the test a number of times, as the parasites can be difficult to detect. Diagnosis is made by a blood test. Conducting blood tests can be very difficult in the most malaria prone regions due to the lack of availability of testing kits and facilities. Developments in alternative methods of testing have had a significant impact on diagnostic abilities.

- **Diagnosing malaria infection and providing prompt treatment** with an effective antimalarial are critical to reducing severe malaria-related disease and death. Based on surveys conducted in 29 sub-Saharan African countries, the percentage of children with a fever that received a diagnostic test in the public health sector reached **76%** in the period 2015–2018 compared to 48% in the previous four-year period. This steep jump in coverage was due, in large part, to the greater availability of inexpensive and high-quality rapid diagnostic tests in the public sector.

Image: [WHO World Malaria Report 2019](#)



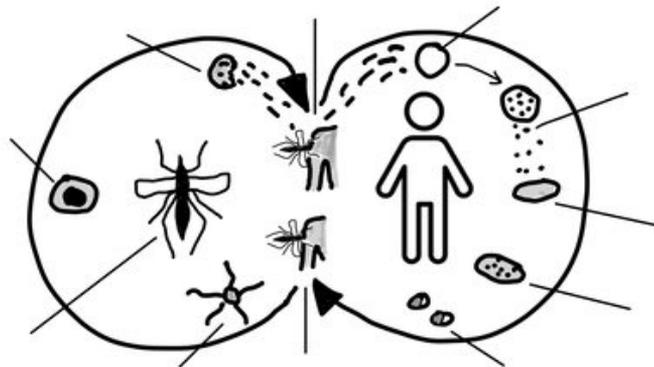
creativecommons.org/licenses/by-nc-sa/3.0/igo/



Read page 102 in the textbook, paying particular attention to *diagnosis*.

Check your understanding

1. **Complete** the glossary entries for *malaria*, *notifiable disease*, *plasmodium*, *plasmodium falciparum*, *vertebrate host*, *vector*, *anopheles mosquito*, *sporozoites*, *merozoites*, *gametocytes*, *gametes*, *nocturnal*, *crepuscular*, *ecological hazard*, *WHO*
2. **Annotate** the simplified diagram (based on the textbook) and **describe** the lifecycle and transmission cycle of malaria



Describe the lifecycle and transmission cycle of malaria

3. **Account** for developments in diagnosing malaria

4. **Create** two multiple choice **questions and answers** based on the material you have covered so far:

Q1	Q2
A	A
B	B
C	C
D	D

2.1 Risk to be managed – Loss of Property/Life

Despite a great success of initiatives to eradicate malaria worldwide, malaria remains one of the world’s deadliest communicable diseases. While it claims lives mostly of people living in the susceptible regions, it also affects travellers to those regions.

28 June 2019

Every 2 minutes, a child dies of malaria. And each year, more than 200 million new cases of the disease are reported. Although countries have dramatically reduced the total number of malaria cases and deaths since 2000, progress in recent years has stalled. Worryingly, in some countries, malaria is on the rise.

Image: <https://www.who.int/news-room/facts-in-pictures/detail/malaria>

Cases	Deaths
228 million	405 000
malaria cases worldwide in 2018	malaria deaths worldwide in 2018

Image: <https://www.who.int/malaria/en/>

Malaria is a mosquito-borne disease caused by a parasite. People with malaria often experience fever, chills, and flu-like illness. Left untreated, they may develop severe complications and die. In 2018 an estimated 228 million cases of malaria occurred worldwide and 405,000 people died, mostly children in the African Region. About 2,000 cases of malaria are diagnosed in the United States each year. The vast majority of cases in the United States are in travelers and immigrants returning from countries where malaria transmission occurs, many from sub-Saharan Africa and South Asia.

Image: <https://www.cdc.gov/parasites/malaria/index.html>

Read pages 102 – 103 Section 5.2 ‘Nature of the risks to be managed’ in your textbook.

Read pages 4 – 6 in the WHO briefing (Key Message 2)

According to World Health Organisation (WHO), malaria deaths are also the hardest to count. This is mostly due to the poor data collection systems that miss many unreported deaths and attribution of death to malaria where other factors and illnesses may have caused death, especially among children.

For more on this issue, you can read a WHO bulletin ‘Malaria deaths are hardest to count’, accessible at <https://www.who.int/bulletin/volumes/84/3/news10306/en/>

Check your understanding

1. **Complete** the glossary entries for *morbidity*, *mortality*.
2. Compare at least two different sources to **outline** the trends in malaria-related deaths worldwide. Acknowledge the source used for each trend.

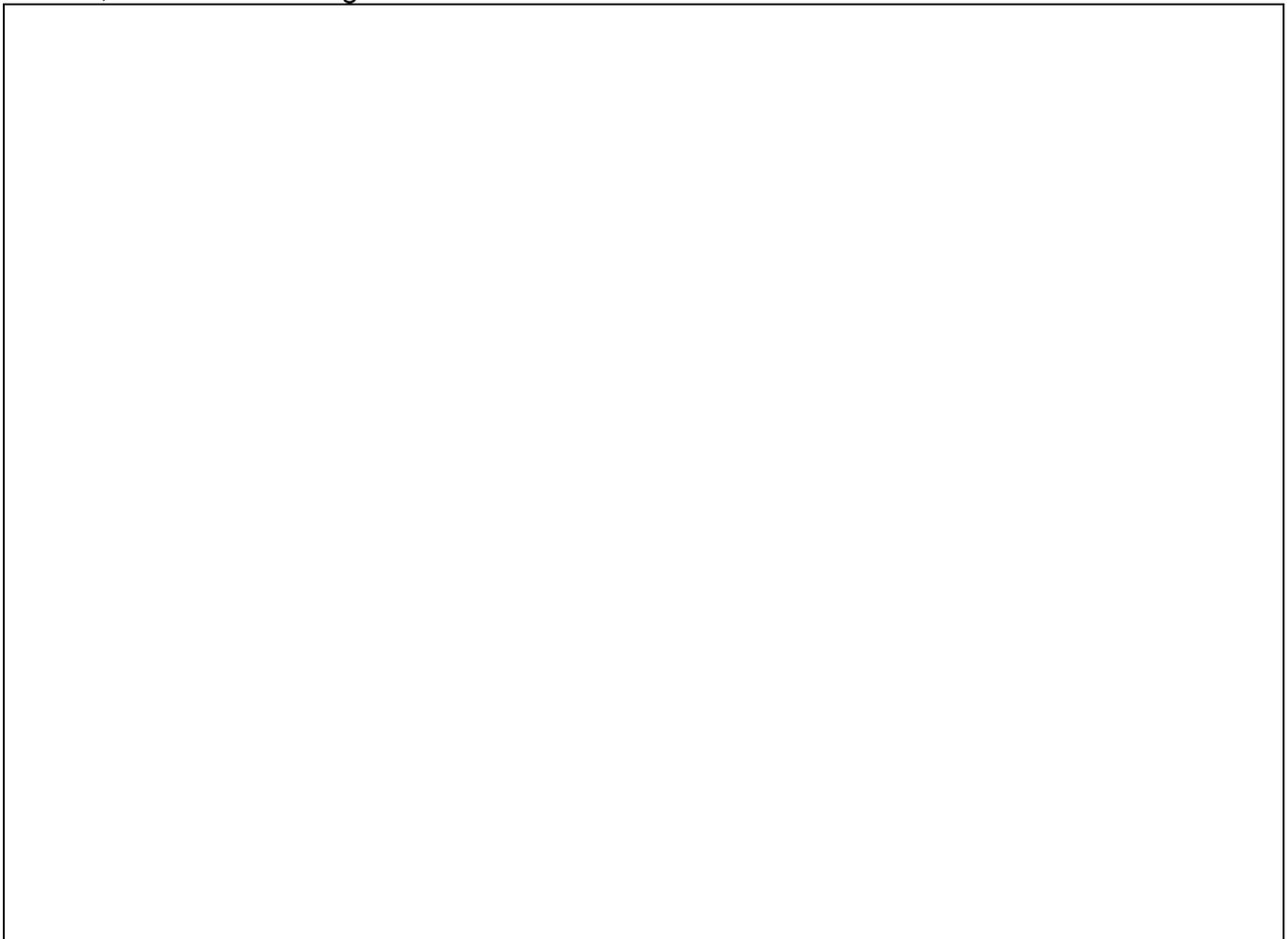
3. **Sketch** an infographic containing at least three points from the following excerpt from the WHO summary

Malaria deaths

- In 2018, there were an estimated 405 000 deaths from malaria globally, compared with 416 000 estimated deaths in 2017, and 585 000 in 2010.
- Children aged under 5 years are the most vulnerable group affected by malaria. In 2018, they accounted for 67% (272 000) of all malaria deaths worldwide.
- The WHO African Region accounted for 94% of all malaria deaths in 2018. Although this region was home to the highest number of malaria deaths in 2018, it also accounted for 85% of the 180 000 fewer global malaria deaths reported in 2018 compared with 2010.
- Nearly 85% of global malaria deaths in 2018 were concentrated in 20 countries in the WHO African Region and India; Nigeria accounted for almost 24% of all global malaria deaths, followed by the Democratic Republic of the Congo (11%), the United Republic of Tanzania (5%), and Angola, Mozambique and Niger (4% each).
- In 2018, only the WHO African Region and the WHO South-East Asia Region showed reductions in malaria deaths compared with 2010. The WHO African Region had the largest absolute reduction in malaria deaths, from 533 000 in 2010 to 380 000 in 2018. Despite these gains, the malaria mortality reduction rate has also slowed since 2016.

Image: <https://www.who.int/news-room/feature-stories/detail/world-malaria-report-2019>

Sketch of your infographic. For an example of a simple infographic, see section 3 of this booklet, 'Risk to be managed'.



2.2 Risk to be managed – Effects on employment

Malaria has a significant impact on the individuals, organisations and entire economies. People who fall ill cannot work themselves and may have to be cared for in their homes and medical facilities. This affects productivity, the amount of useful output that comes from using capital, energy, material and human resources. Put simply, when we fall ill it takes us longer to do things, or we may do them to a lower standard, or we may not be able to do them at all. This is a waste of not only our own labour but of the capital, energy and material invested in producing a good or service.

Symptoms of malaria include:

- fever, which may come and go, or may be constant
- chills
- profuse sweating
- malaise (feeling unwell)
- muscle and joint pain
- headache, confusion
- nausea, loss of appetite, diarrhoea
- vomiting
- abdominal pain
- cough.

On the most severe side of the spectrum, malaria causes coma and ultimately death in some people, particularly among the most vulnerable population.

In Less Economically Developed Countries (LEDC) the rates of paid employment are lower than in MEDS. According to the textbook, “on the household level, it is estimated that each African household will lose up to 25 per cent of their annual income as a result of malaria infection.” (GAWA, p. 103, 2018) In LEDC, many people work also work at subsistence levels producing food and satisfying basic needs of their own and their families.

Read page 103 in your textbook for more on the effects of malaria on jobs and economy.

Effect of malaria on productivity in a workplace: the case of a banana plantation in Zimbabwe

Akim Tafadzwa Lukwa^{1*}, Richard Mawoyo², Karen Nelwin Zablon³, Aggrey Siya⁴ and Olufunke Alaba¹

Abstract

Background: Malaria is known to contribute to reduction in productivity through absenteeism as worker-hours are lost thus impacting company productivity and performance. This paper analysed the impact of malaria on productivity in a banana plantation through absenteeism.

Methods: This study was carried out at Matanuska farm in Burma Valley, Zimbabwe. Raw data on absenteeism was obtained in retrospect from the Farm Manager. Malaria infection was detected using malaria Rapid Diagnostic Test. Measures of absence from work place were determined and included; incidence of absence (number of absentees divided by the total workforce), absence frequency (number of malaria spells), frequency rate (number of spells divided by the number of absentees), estimated duration of spells (number of days lost due to malaria), severity rate (number of days lost divided by number of spells), incapacity rate (number of days lost divided by the number of absentees), number of absent days (number of spells times the severity rate), number of scheduled working days (actual working days in 5 months multiplied by total number of employees), absenteeism rate.

Results: A total of 143 employees were followed up over a 5-month period. Malaria positivity was 21%, 31.5%, 44.8%, 35.7% and 12.6% for January 2014 to May 2014, respectively. One spell of absence [194 (86.6%)] was common followed by 2 spells of absence [30 (13.4%)] for all employees. Duration of spells of absence due to malaria ranged from 1.5 to 4.1 working-days, with general workers being the most affected. Incidence of absence was 143/155 (93.3%), with total of spells of absence of over a 5-month period totalling 224. The frequency rate of absenteeism was 1.6 with severity rate of absence being 2.4. and incapacity rate was 3.7.

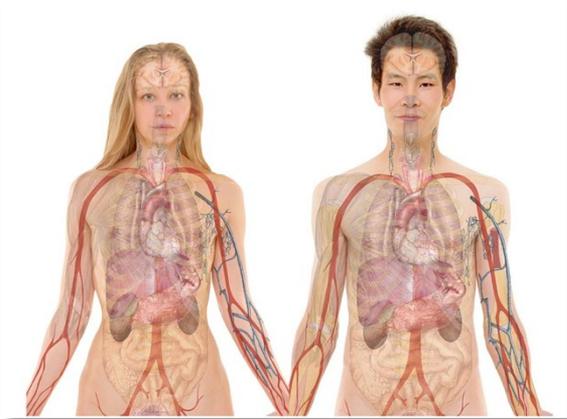
Conclusion: Malaria contributes significantly to worker absenteeism. Employers, therefore, ought to put measures that protect workers from malaria infections. Protecting workers can be done through malaria educative campaigns, providing mosquito nets, providing insecticide-treated work suits, providing repellents and partnering with different ministries to ensure protection of workers from mosquito bites.

Keywords: Malaria, Absenteeism, Productivity, Agriculture

Source: Lukwa, A.T. et al. (2019) <https://malariajournal.biomedcentral.com/articles/10.1186/s12936-019-3021-6#citeas>

Check your understanding

1. **Complete** the glossary entries for *symptoms*, *productivity*.
2. **Annotate** the symptoms and **list** the effects of malaria on human body using the picture below.



Effects:

Image: <https://pixabay.com/photos/woman-human-pair-man-face-body-254133/>

3. **Create** a short answer question regarding the effects of malaria on employment and productivity of either individuals, families or organisations and **answer** the question with a well-structured paragraph.

Question:

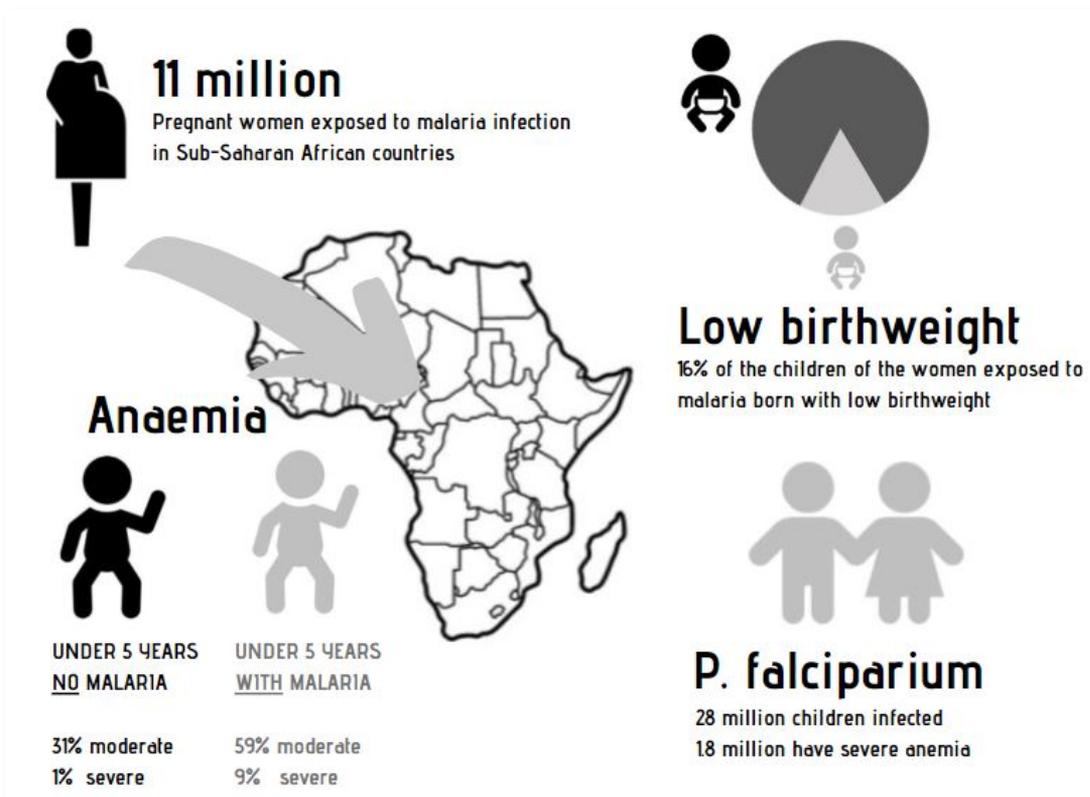
Answer:

2.3 Risk to be managed – Health impacts

Poverty and vulnerability to malaria are closely linked. The most vulnerable people in the community are those with little or no immunity against the disease and are weakened by malnutrition. In areas of high transmission (such as sub-Saharan Africa), the most vulnerable groups are:

- young children who have not yet developed partial immunity to malaria,
- pregnant women, whose immunity is decreased by pregnancy,
- travellers or migrants who lack immunity, coming from areas with little or no malaria transmission (such as Australia).

Infection with malaria also predisposes particularly children to anaemia. Anaemia is a condition where the person lacks the red blood cells or haemoglobin. Haemoglobin is particularly important part of red cells as it carries oxygen from the lungs around the body. Remember the diagram of malaria infection and the role red blood cells play in the lifecycle and transmission of malaria?



Data source: <https://www.who.int/news-room/feature-stories/detail/world-malaria-report-2019>

View Figure 5.2.1 (Global malaria deaths by age group) and Figure 5.2.2 (Estimated malaria cases by region) in the textbook, pg. 103

Check your understanding

1. **Complete** the glossary entry for *Sub Saharan, anaemia*.
2. **Identify** ONE demographic group of people affected by malaria.

3. **Describe** the location (both relative and absolute) of the ONE region affected by malaria identified in this infographic.

Absolute location is the exact spot of a feature on the Earth . When describing the absolute location, people use specific coordinates, like latitude and longitude. Relative location is the location of a feature in comparison to the location of another feature. For example, Mandurah is located to the south of Perth.

4. **Outline** THREE impacts of malaria on physical and mental health for a particular demographic group? Use statistical evidence to support your answer.

Impact 1	Impact 2	Impact 3

3. Spatial distribution and temporal change of malaria

With estimated over 3 billion people at risk of malaria, 228 million cases and 405 000 deaths in 2018, malaria remains one of the world's most infectious and deadliest communicable diseases for people living in the tropical and subtropical regions. Many thousands of tourists also get malaria during their travels to countries where malaria is present. Tourists often get severe illness because they have had no previous exposure to malaria and have no resistance to the disease.

Malaria occurs in most tropical and subtropical areas of the world, including Africa, Central and South America, Asia, Southeast Asia, Papua New Guinea and the Western Pacific islands. This is a geographical limitation to approximately between the Tropic of Cancer and Tropic of Capricorn.

In the document below, highlight references to location (countries, regions) and any words or phrases that indicate a trend or change (eg. 'decline', 'little progress').

Malaria cases

- In 2018, an estimated 228 million cases of malaria occurred worldwide (95% confidence interval [CI]: 206–258 million), compared with 251 million cases in 2010 (95% CI: 231–278 million) and 231 million cases in 2017 (95% CI: 211–259 million).
- Most malaria cases in 2018 were in the World Health Organization (WHO) African Region (213 million or 93%), followed by the WHO South-East Asia Region with 3.4% of the cases and the WHO Eastern Mediterranean Region with 2.1%.
- Nineteen countries in sub-Saharan Africa and India carried almost 85% of the global malaria burden. Six countries accounted for more than half of all malaria cases worldwide: Nigeria (25%), the Democratic Republic of the Congo (12%), Uganda (5%), and Côte d'Ivoire, Mozambique and Niger (4% each).
- The incidence rate of malaria declined globally between 2010 and 2018, from 71 to 57 cases per 1000 population at risk. However, from 2014 to 2018, the rate of change slowed dramatically, reducing to 57 in 2014 and remaining at similar levels through to 2018.
- The WHO South-East Asia Region continued to see its incidence rate fall – from 17 cases of the disease per 1000 population at risk in 2010 to five cases in 2018 (a 70% decrease). In the WHO African Region, case incidence levels also declined from 294 in 2010 to 229 in 2018, representing a 22% reduction. All other WHO regions recorded either little progress or an increase in incidence rate. The WHO Region of the Americas recorded a rise, largely due to increases in malaria transmission in the Bolivarian Republic of Venezuela.
- Between 2015 and 2018, only 31 countries, where malaria is still endemic, reduced case incidence significantly and were on track to reduce incidence by 40% or more by 2020. Without accelerated change, the *Global technical strategy for malaria 2016–2030* (GTS) milestones for morbidity in 2025 and 2030 will not be achieved.
- Plasmodium falciparum is the most prevalent malaria parasite in the WHO African Region, accounting for 99.7% of estimated malaria cases in 2018, as well as in the WHO South-East Asia Region (50%), the WHO Eastern Mediterranean Region (71%) and the WHO Western Pacific Region (65%).
- Globally, 53% of the *P. vivax* burden is in the WHO South-East Asia Region, with the majority being in India (47%). *P. vivax* is the predominant parasite in the WHO Region of the Americas, representing 75% of malaria cases.

Image: <https://www.who.int/news-room/feature-stories/detail/world-malaria-report-2019>

Read Section 5.3 (pages 104 – 106) in your textbook and examine Figure 5.3.1 (Global distribution of malaria transmission), 5.3.2 (Historical distribution of malaria transmission) and 5.3.3 (Countries certified malaria-free by WHO)

Not all countries and regions are the same when it comes to exposure to malaria and the burden it carries on the human and natural environment. In many countries and regions, malaria is endemic. This means it is regularly found among the people in this area, particularly due to the biophysical factors such as temperature, rainfall, altitude and relative humidity. Some countries carry a particularly high-burden in terms of infections and deaths and have been classified as such by the World Health Organisation (WHO).

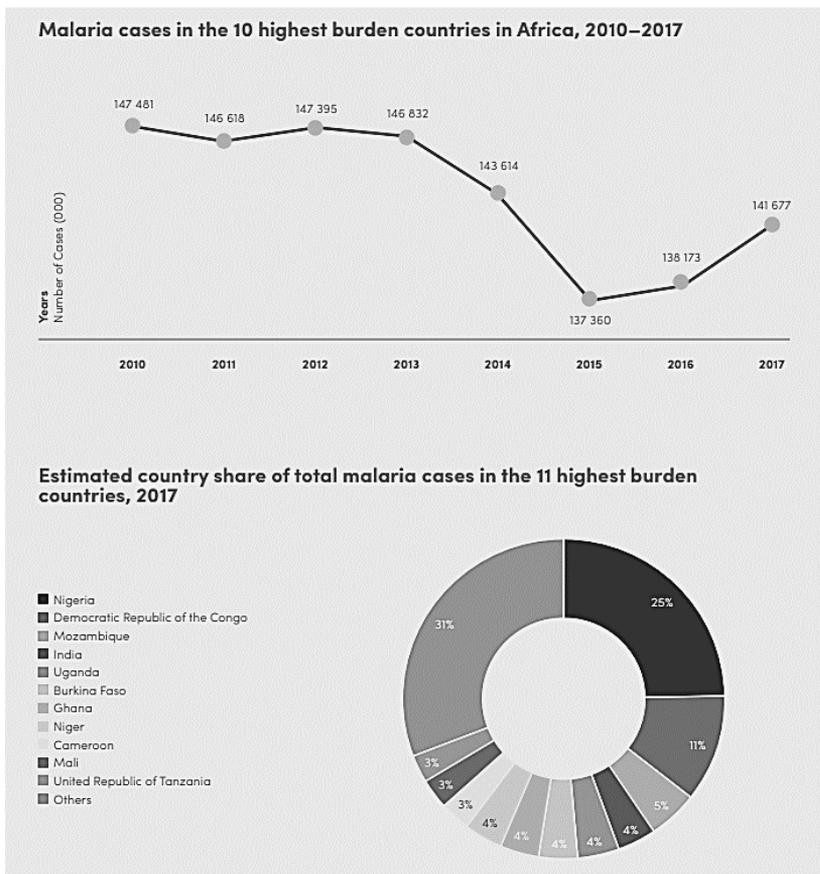


Image: WHO <https://www.who.int/malaria/publications/atoz/high-impact-response/en/>

Research and find at least one more resource on spatial distribution and temporal change of malaria in one high-burden country (eg. Nigeria).

You may like to do an Image Search in your favourite search engine to find useful graphic resources.

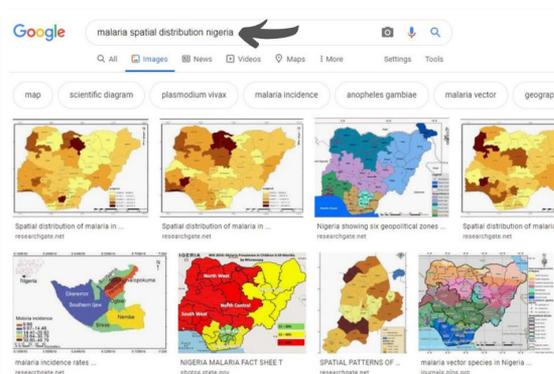


Image: [Google Image Search](#)

Additional activity

Go to gapminder.org, select Tools, select World regions, select Health, select Malaria and build at least one map for malaria for the **whole world** and one for a **specific region or country**
 HINT: Use the top right corner of the site to select your geographical area first, then an indicator on the bottom right.

Check for **spatial** and **temporal** change in malaria infections and deaths.

Check your understanding

1. **Complete** glossary entries for *high burden*, *biophysical factors*, *endemic*.
2. **Construct** a world map (can use the blank map below) with at least ONE aspect of spatial or temporal distribution of malaria. Ensure that you
 - **shade or colour in** the aspect (you can choose alternative ways of course, eg graph, bars)
 - create a **legend**
 - create a **scale**
 - create a **title**:



3. Research and **describe** the absolute and relative location of the state of Tamil Nadu in India.

Absolute location of Tamil Nadu
Relative location of Tamil Nadu

4. Using information in the table below:

MALARIA INCIDENCE RURAL AND URBAN AREAS OF TAMIL NADU (2010 – 2020).

YEAR	STATE CASES	RURAL CASES	CHENNAI CASES	CHENNAI%
2010	17086	6031	9789	57.20
2011	22171	6602	14927	67.30
2012	18869	7146	11090	58.80
2013	15081	5893	8537	56.60
2014	8729	3708	4669	53.50
2015	5587	2045	3338	59.75
2016	4340	1409	2743	62.40
2017	5449	1360	3895	71.5
2018	3758	806	2823	75.1
2019	2088	596	1452	69.5
2020 (Jan '20)	54	10	44	81.5

Image: Malaria, Health & Family Welfare Department, Government of Tamil Nadu.
<https://www.tnhealth.org/tngovin/dph/dphdbmal.php>

- **Construct** a line graph of the Chennai Cases of Malaria from 2010 - 2020

Line graph

- **Describe** the trend in malaria cases in Tamil Nadu from 2010 - 2020.

Identify key points to **account for** the trend in malaria cases in Tamil Nadu from 2010 – 2020.

5. **Describe** the temporal distribution (changes over time) of cases of malaria and deaths due to malaria, worldwide.

4. Magnitude and duration

Magnitude is the measure of the size and intensity of the impact of a hazard on natural and cultural environments.

Biologic or ecological hazards can be measured by observing and recording the impacts they have on a community. For example:

- extent (geographical territory impacted)
- transmission rates
- mortality (death rates per 1,000 of the population or % mortality rates)
- exposure (different age groups, gender, socio-economic status, level of fitness...)
- health impacts
- infection and hospitalisation rates
- biologic/genetic changes

Magnitude can be indicated by the number of deaths and people infected by the malaria virus or the extent of the spread of the disease globally. This includes people who are newly infected, have full-blown malaria and those who are recovering or recovered.

Duration

Duration is the time during which the hazard continues. The impact of malaria can be short and intense or build up over a long period of time. Duration is an important factor in determining level of risk. With proper treatment, symptoms of malaria usually go away quickly, with a cure within two weeks. Without proper treatment, malaria episodes (fever, chills, sweating) can return periodically over a period of years. After repeated exposure, patients will become partially immune and develop milder disease.

Incubation period, the time between becoming infected and developing symptoms, varies with the type of malaria the person is infected with:

P. falciparum: 9 – 14 days

P. vivax: 12 –18 days but some strains may have an incubation period of 8 – 10 +days

P. ovale: 12 – 18 days

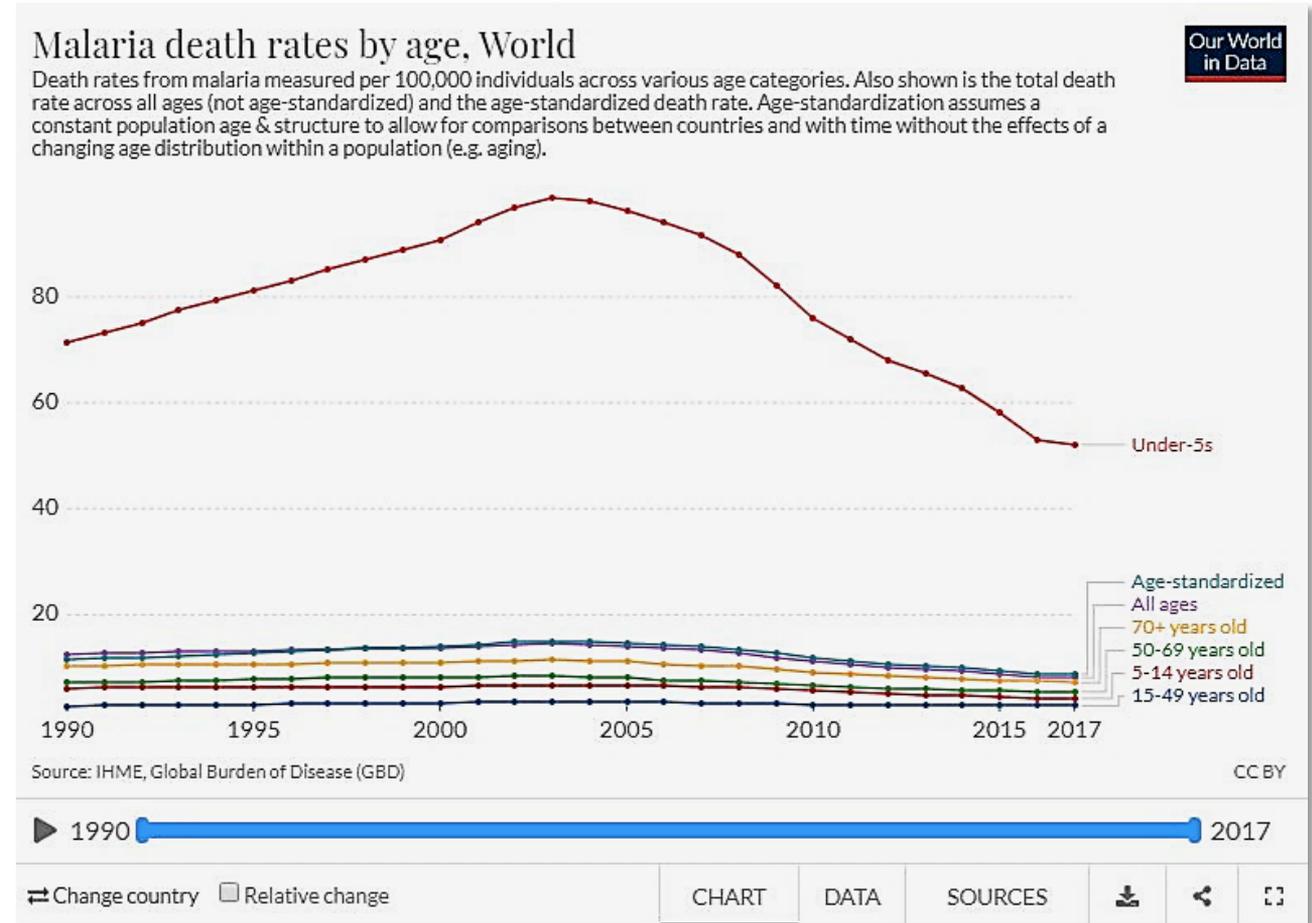
P. malariae: 18 – 40 days.

These periods are approximate and may be longer if the person has been taking prophylaxis, the drugs taken to prevent infection.

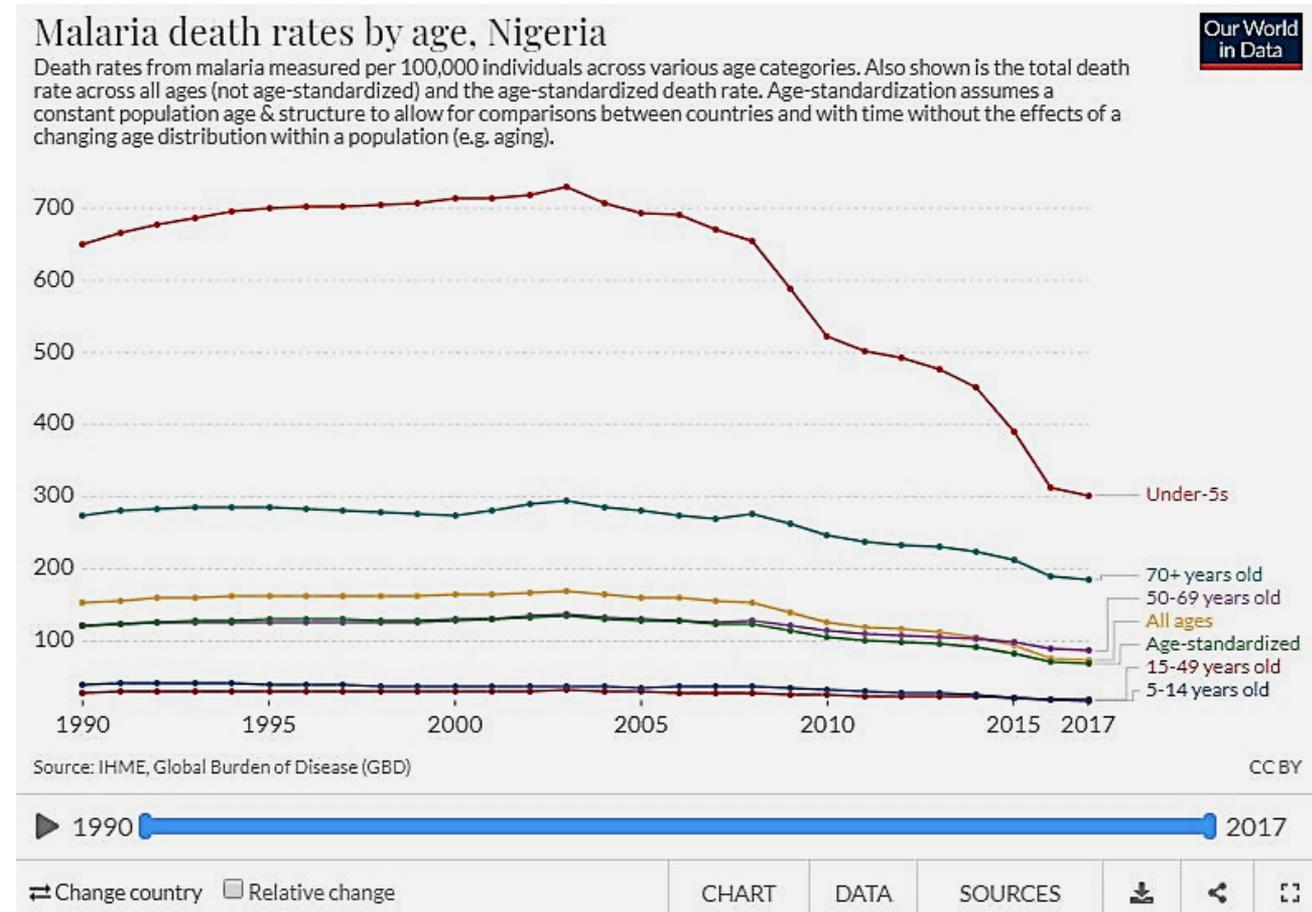
Direct person-to-person spread does not occur but a person remains infectious as long as the parasites are present in the blood. This may be several years if adequate treatment is not given. Parasites disappear from the blood within a few days of commencing appropriate treatment. Mosquitoes remain infected for life.

Specific antimalarial treatment is available and must always be started immediately malaria is diagnosed. The treatment should be carried out by an infectious diseases physician or other expert in the field. This is not only to diagnose and administer medicine correctly but also to prevent overuse that would increase the speed of genetic adaptation by the mosquitoes and their resistance to the currently available drugs.

Source 1 (World)



Source 2 (Country – Nigeria)



Images: ourworldindata.org <https://ourworldindata.org/malaria#malaria-deaths>

Source 3 (Region – Western Australia).

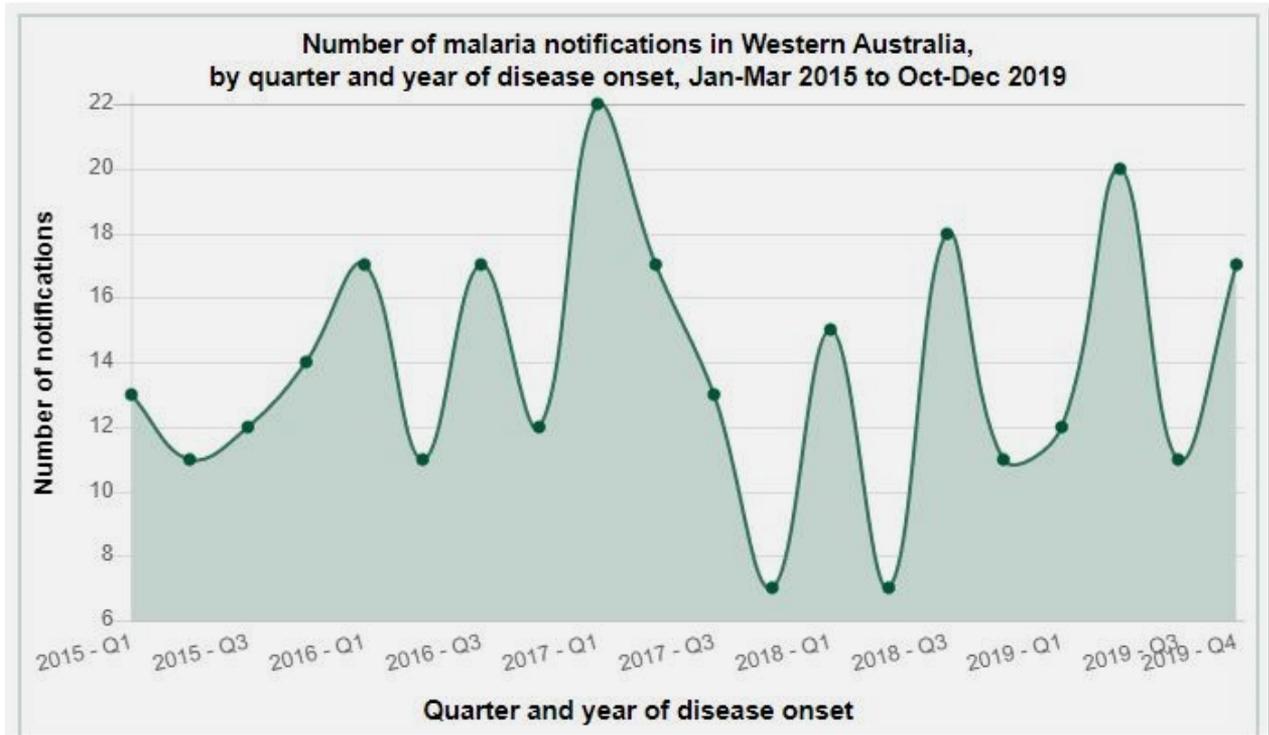


Image: Department of Health WA, https://ww2.health.wa.gov.au/Articles/N_R/Notifiable-infectious-disease-report?report=malaria

If you are travelling to malaria-prone countries, you will likely see the following advice:

- See a travel medicine expert before you go to get specific advice for the places you will be visiting. Always take malaria prophylaxis drugs exactly as prescribed and take the full course. Be aware of their potential side effects.
- Protect yourself from mosquito bites. Travel medicine centres have good information on how to do this. Be aware that no preventive measures are 100% effective, so always seek medical attention immediately if you develop a fever while travelling in, or after return from, a country where malaria occurs. Always give your doctor the information about your travel if you become sick.
- There is no vaccine available to prevent malaria.
- Exclusion from school, child care or work is not necessary.

Check your understanding

1. **Complete** the glossary entries for *magnitude*, *incubation*, *infectious*, *prophylaxis drugs*, *travel advice*.
2. **Identify** the duration of malaria.

3. Use Source 1 (World), Source 2 (Nigeria) and Source 3 (WA) to **describe and compare** the magnitude of malaria in these territories.

4. **Explain** the factors that increase the magnitude of the hazard of malaria.

4.1 Frequency and intensity

In the context of geography of hazards, frequency is the number of times a hazard is present and it can impact on the level of risk.

Biological/ecological hazards may occur on a seasonal basis. Malaria is more likely to develop and spread when hot, wet conditions and flooding are present. As you now know, malaria is transmitted in the tropical and subtropical regions of the world. This is where the malaria-spreading Anopheles mosquitoes can most easily survive and multiply. Temperature is particularly important for the spread of malaria. This is because the *Plasmodium falciparum* parasite cannot complete its development cycle if the temperatures are constantly above +20C and as a result can't be transmitted. This is why malaria transmissions are more frequent and more intense closer to the equator, where the temperatures remain warm throughout the year.

Intensity

Intensity is the quality of being very strong, concentrated or difficult or the degree to which something is difficult or strong. The intensity of malaria is indicated by the degree of impact on communities.

Communities that are subject to frequent malaria events will generally develop a range of strategies and plans to minimise their impact. One of such strategies is changing the existing and developing new drugs to prevent genetic mutation and adaptation to them by the parasite.

Malaria is forever outrunning its attackers, shifting its shape to survive the drugs invented to eradicate the parasite.

Chloroquine was widely effective around the world, but it began to lose its grip on malaria after mass dosing in endemic areas. Malaria grew resistant to the drug by the 1950s. Sulfadoxine-pyrimethamine, commonly sold as Fansidar, came next and proved effective until the end of the last century, when resistance proved common.

Artemisinin, derived from sweet wormwood, followed. China's People's Liberation Army at the behest of the Communist party leader, Mao Zedong, developed the drug as part of a secretive project during the Vietnam war. The highly effective drug was kept out of the global marketplace by China, partly due to global pharmaceutical disagreements, however in 2006, it became the world's frontline malaria treatment.

Today, artemisinin still works within a combination drug. Because of a global abundance of fake drugs and bad dosing, its days are numbered.

WHO tracks and maps these efforts found within *World Malaria Maps*.

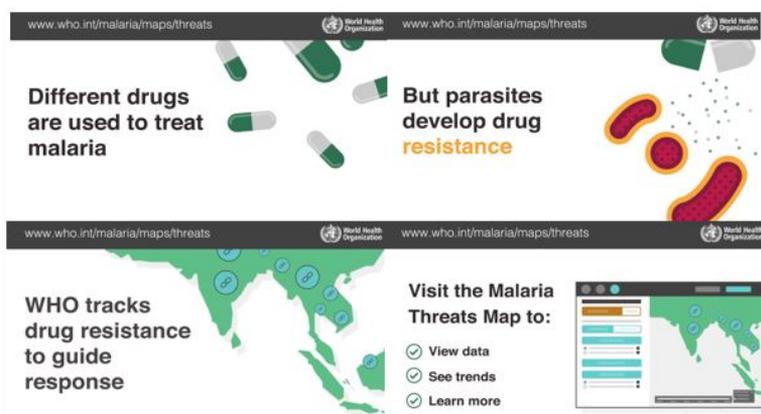


Image: WHO World Malaria Maps – Vector Insecticide Resistance. <https://apps.who.int/malaria/maps/threats/>

Malaria Threats Map – Vector Resistance

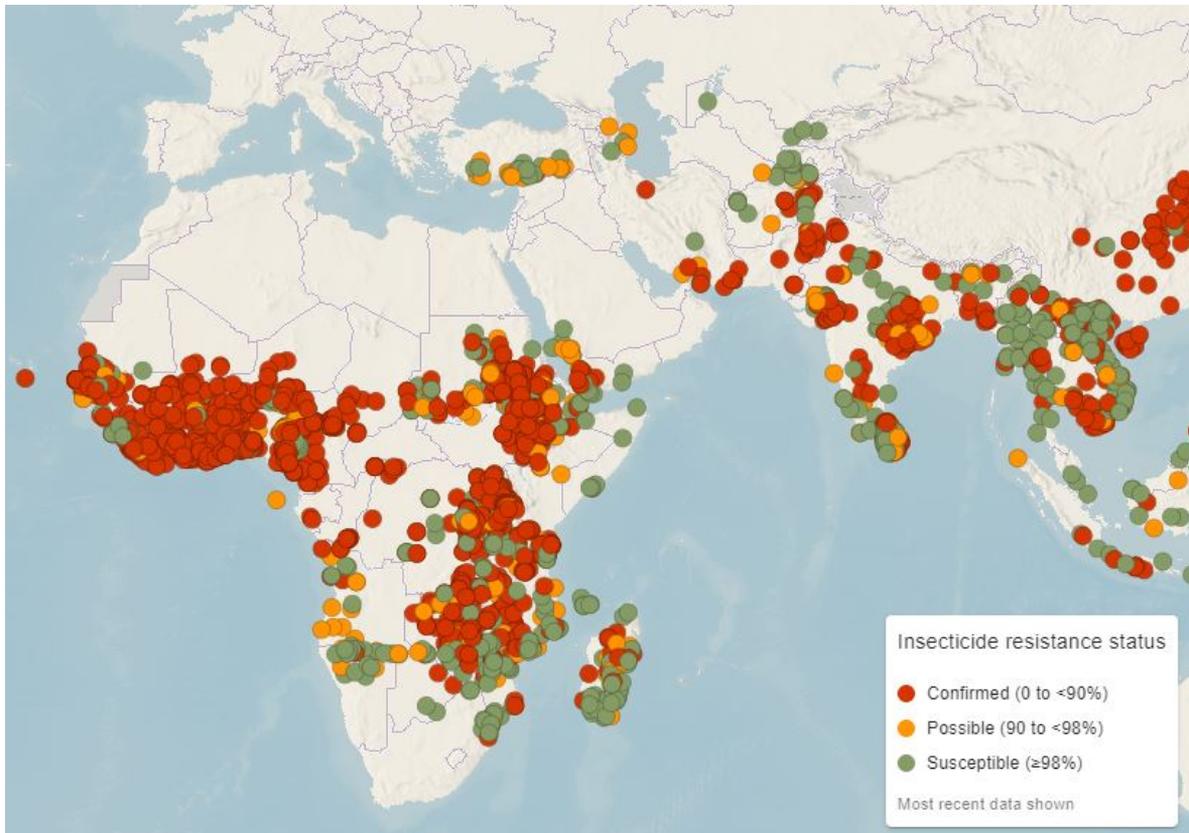


Image: WHO, <https://apps.who.int/malaria/maps/threats/>

Read the section titled ‘Antimalarial resistance’ on pages 109 and 110 in your textbook.

Read the sections on ‘Antimalarial drug resistance’ and ‘Insecticide resistance’ in the WHO Fact Sheet.

Check your understanding

1. **Complete** glossary entries for *frequency*, *artemisinin*, *drug resistance*
2. **Create** two multiple choice **questions and answers** about development of malaria drugs.

Q1	Q2
A	A
B	B
C	C
D	D

4.2 Malaria and seasonal variations

Source 1 Extrinsic Incubation Period (EIP) across Kenya.

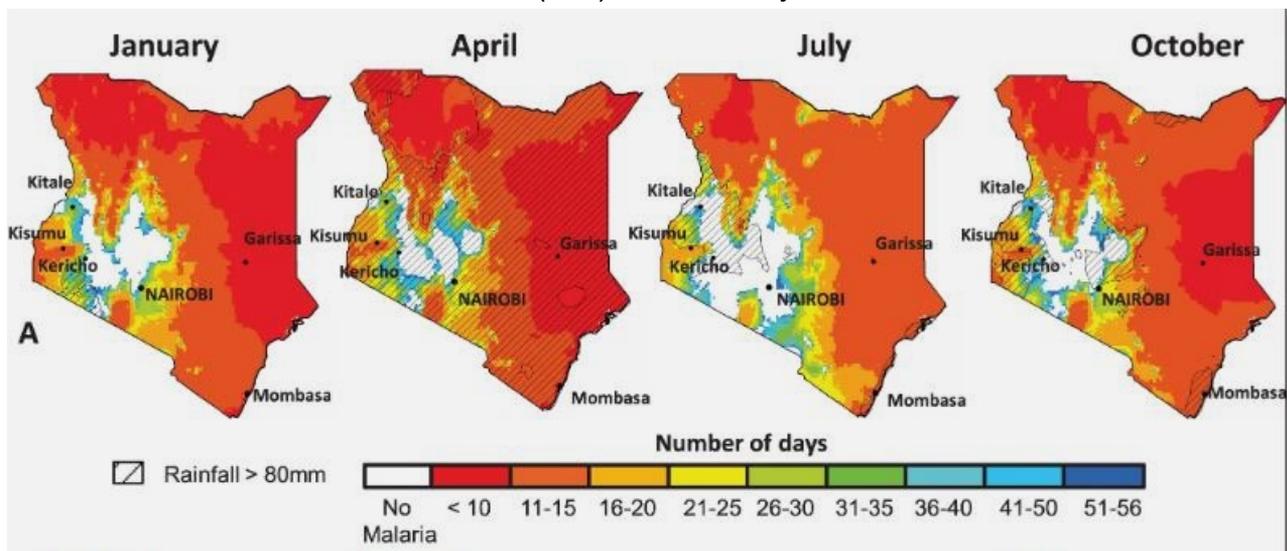


Image: Blanford, J. I et al (2013) <https://www.nature.com/articles/srep01300/figures/4> creativecommons.org/licenses/by-nc-nd/2.0/au/

Above is the series of maps illustrating the number of days for malaria to become transmittable (Extrinsic Incubation Period - EIP) across Kenya. It shows the number of days taken to complete incubation period of *P. falciparum* using mean monthly temperatures. The longer the EIP the better. Hatched areas indicate where sufficient rainfall (> 80 mm) has fallen to support mosquito breeding.

Source 2 The EIP periods in detail for the town of Kisumu over 12 months.

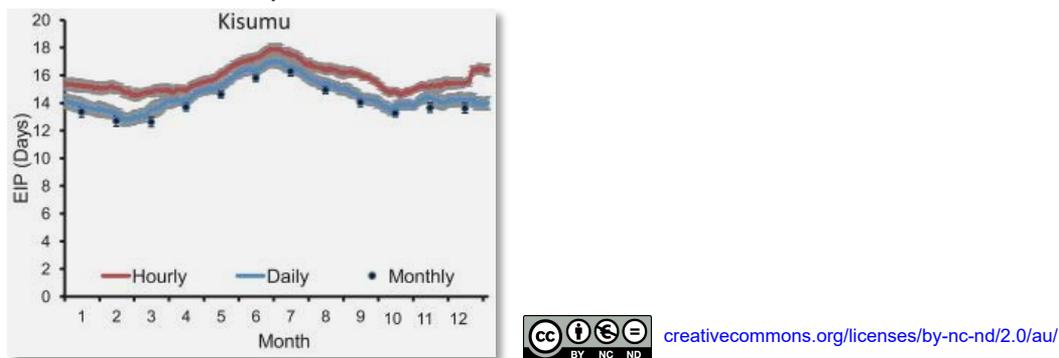


Image: Blanford, J. I et al (2013) <https://www.nature.com/articles/srep01300/figures/4> creativecommons.org/licenses/by-nc-nd/2.0/au/

Source 3 The annual rainfall and temperature in Kisumu, Kenya. See link for climate summary - <https://en.climate-data.org/africa/kenya/kisumu/kisumu-715071/>

Source: Climate-data.org, <https://en.climate-data.org/africa/kenya/kisumu/kisumu-715071/>

Read ‘Biophysical processes influencing malaria transmission’ in your textbook, pages 104 – 106.

Impact of climate change on malaria in the future

Malaria is caused by a parasite that develops to maturity inside certain species of mosquitoes. When the mosquitoes bite, they transmit the parasite that survives only above +20° Celsius. More mosquitoes and warmer weather create ideal conditions for spread of malaria.

If global temperatures climb, the risk of malaria may climb with them. The sensitivity of malaria to temperature change has been noted in some highland regions in Africa, where El Niño-associated warming and increases in rainfall have triggered epidemics. An epidemic is a widespread occurrence of an infectious disease in a community at a particular time. Warmer temperatures reduce the time it takes for the malaria-causing parasite to develop to maturity. This increases the odds that a mosquito will pass the mature parasite along to a new host before the mosquito dies.

Due to the rising temperatures globally, a growing body of evidence (Parham, 2010, Martens et al. 1995) predicts a substantial increase in conditions conducive to transmission of tropical diseases like malaria in Europe and the eastern United States and could potentially result in (greater) number of cases of malaria in these regions. These predictions of course do not necessarily account for account human efforts to reduce the mosquito population and to combat the disease through risk reduction and mitigation measures.

Check your understanding

1. **Complete** the glossary entry for *epidemic*.
2. **Identify** and **compare** the most dangerous and least dangerous periods for the spread of malaria in Kenya and particularly the town of Kisumu in Kenya.

Kenya (country)	Kisumu (town)
-----------------	---------------

3. **Discuss**, including examples, the impact of changes in rainfall and temperature on the spread of malaria.

5. Vulnerable Places and People

Why are some people more vulnerable to malaria than others? What activities of humans can intensify the impacts of the hazard?

Changes to the physical or cultural environment have the capacity to change the level of risk associated with tropical diseases such as malaria.

Physical factors affecting the level of risk of malaria include:

- high temperature of the atmosphere
- high humidity
- the presence of the female Anopheles mosquito
- rainfall and presence of stagnant water bodies
- global warming has led to malaria expanding into new regions in the tropics
- rice paddy fields in tropical Asia provide excellent breeding grounds for mosquitoes.

Cultural or human factors affecting the level of risk of malaria include:

- poverty (malaria is often called 'epidemic of the poor')
- large populations of people for the mosquito to feed on
- poor sanitation and drainage of stagnant water
- high density of housing that provides protective shade for mosquitoes.

Factors **influencing the vulnerability** to malaria include:

- poverty
- large populations of people for the mosquito to feed on
- poor sanitation and drainage of stagnant water
- high density of housing that provides protective shade for mosquitoes.

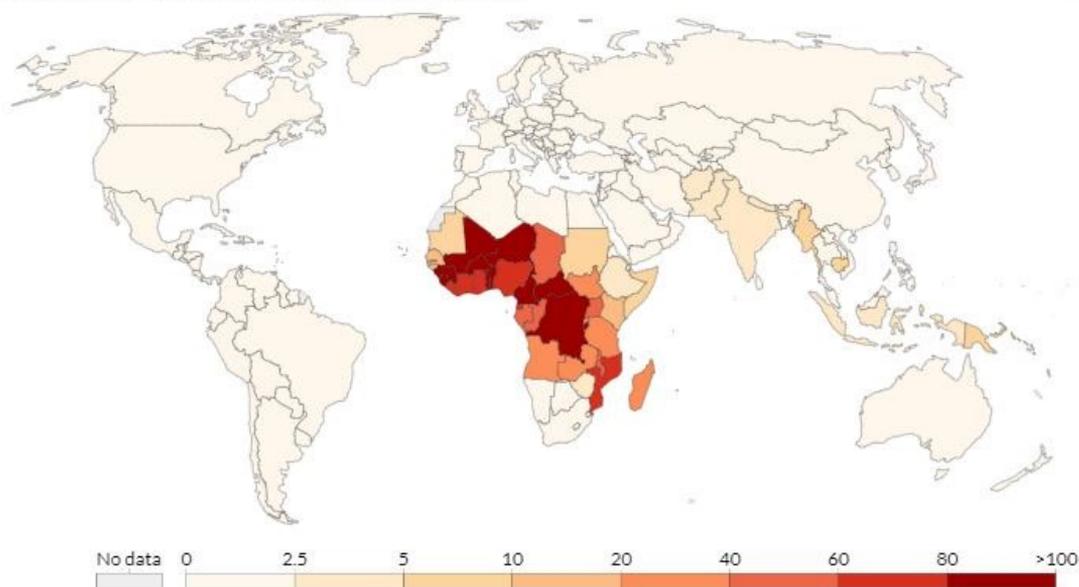
Read section 5.4 'High Risk populations and factors contributing to their vulnerability' on pages 106 – 108 of your textbook. Compare Figure 5.3.1 (page 104) and Figure 5.3.4 (page 106) in your textbook.

Source 1

Death rate from malaria, 2017

The annual number of deaths from malaria per 100,000 people.

Our World
in Data



Source: IHME, Global Burden of Disease (GBD)

Note: To allow comparisons between countries and over time this metric is age-standardized.

CC BY

Image: ourworldindata.org <https://ourworldindata.org/malaria>

Source 2

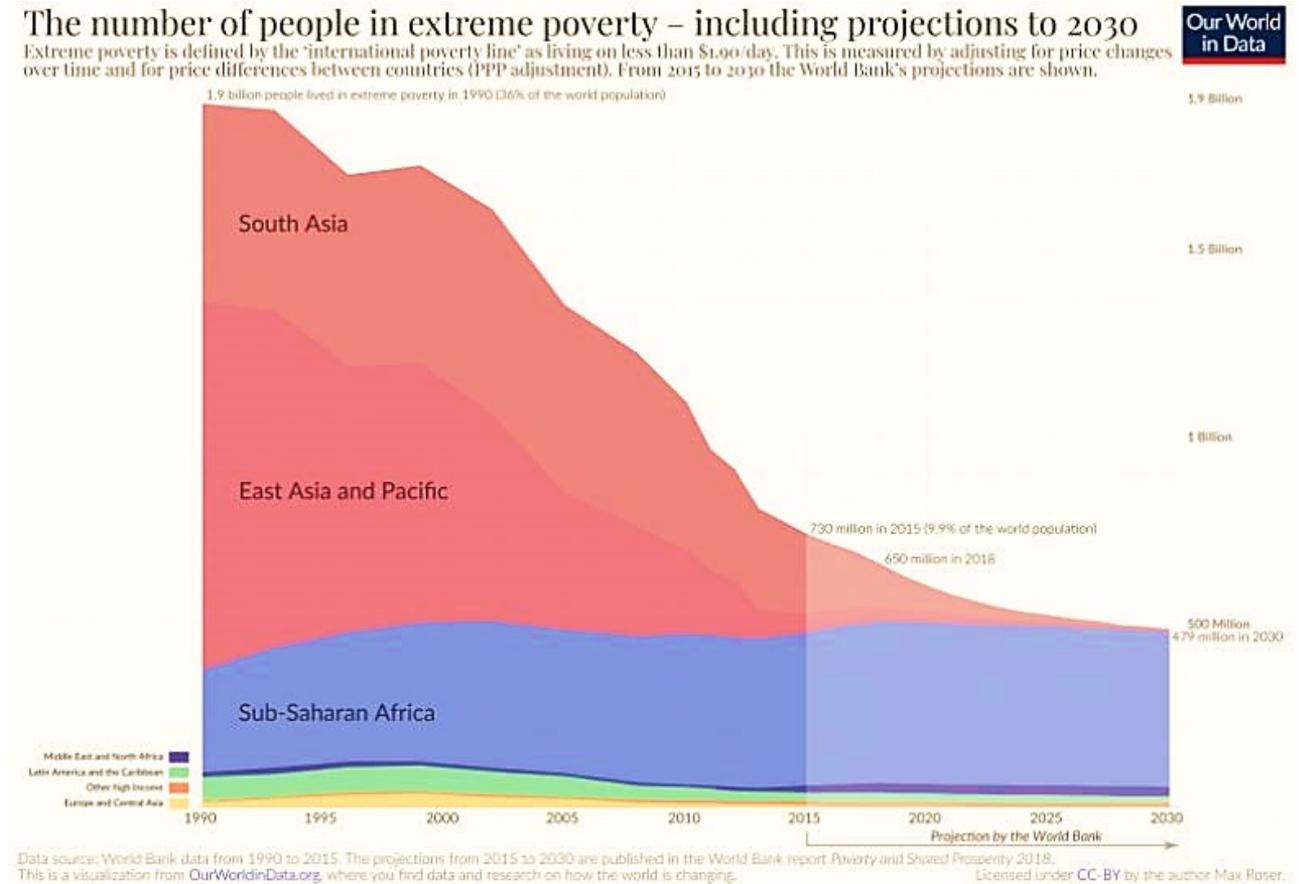


Image: ourworldindata.org <https://ourworldindata.org/extreme-poverty>

Additional resource:

Use [World Bank Open Data](#) (free resource) to research population trends in at least two different regions or countries that carry high burden of malaria. This is what the map looks like, as shown in the screenshot below.

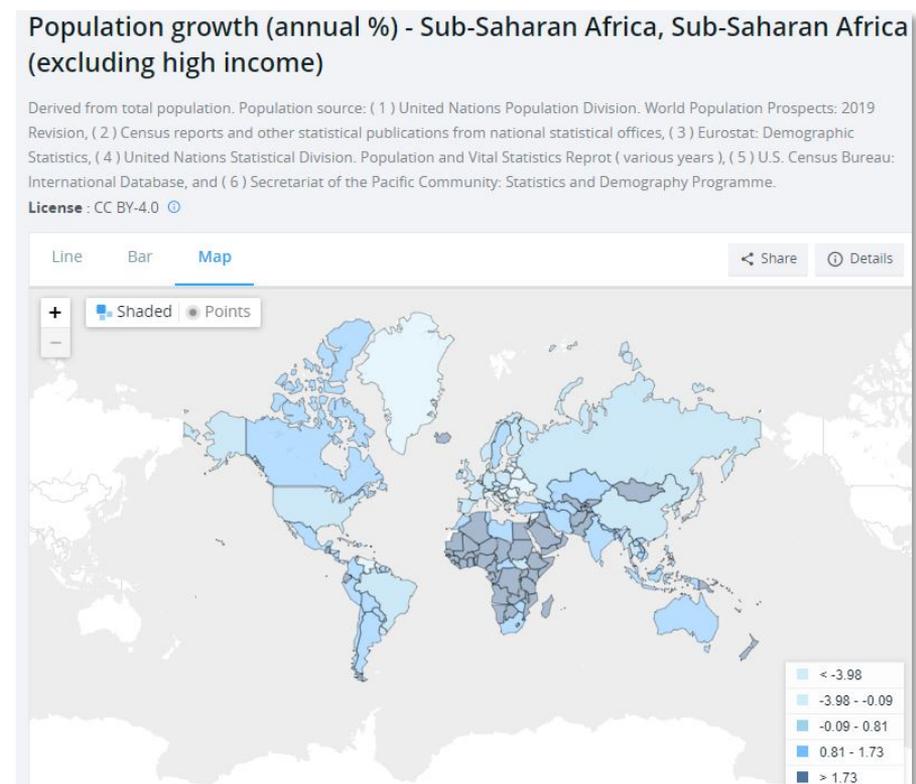


Image: World Bank Open Data <https://data.worldbank.org/indicator/SP.POP.GROW?end=2018&locations=ZG-ZF&start=2018&view=map>

Check your understanding

1. **Complete** the glossary entry for *vulnerability*.
2. **List** three types of people most at risk of contracting malaria and reasons for their increased vulnerability.

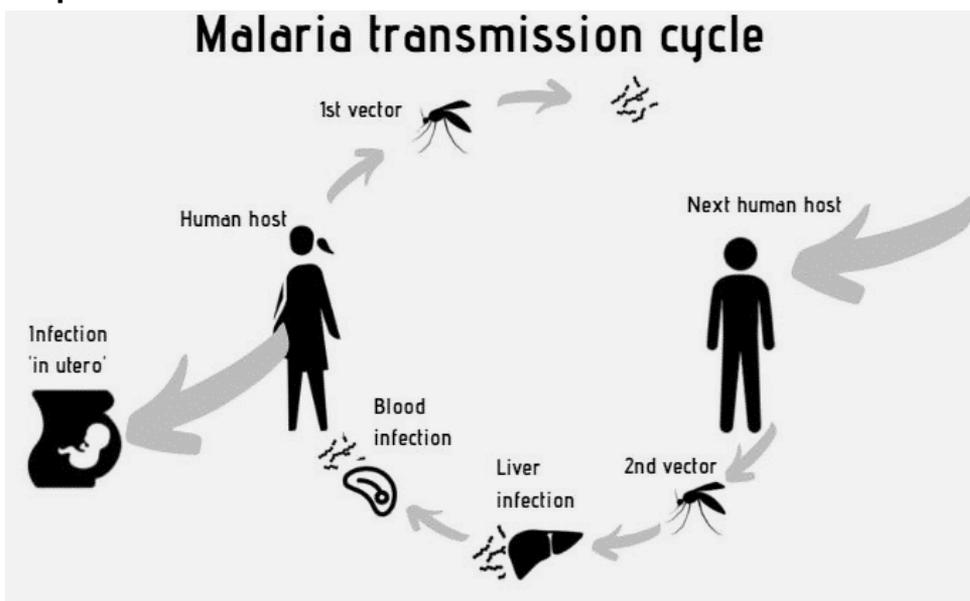
Type	Reasons for vulnerability

3. With references to Sources 1 and 2 and your reading, **explain** why malaria is often called the 'epidemic of the poor'.

Create one possible short answer question on the topic of vulnerability of people and places to malaria and briefly **outline** your answer.

Short answer question:
Reply outline (key points):

6. Spread of infection



How does malaria spread?

- Mostly through bites of the female Anopheles mosquito.
- Rarely spread through blood transfusions or needle sharing.
- Can be spread 'in utero' during pregnancy from the mother to the unborn child.
- With global movement due to increased air travel and transport malaria infected mosquitoes.
- Increased urbanisation and development of tropical and equatorial areas has assisted the spread of malaria to greater population numbers.
- Through dam construction in tropical areas as this increases the breeding areas for Anopheles mosquitoes.

Read section 5.5 ‘Human activities that can intensify the impacts of malaria’ in your textbook, pages 108 and 109.

Check your understanding

1. **Complete** the glossary entry for *in utero*.
2. Use the diagram above and your reading to **outline** at least three ways malaria is spread and three human factors that contribute to the spread.

Ways of spreading malaria

Human factors contributing to the spread

3. **Explain**, with examples, why is it important to understanding the mechanism for the spread of malaria.

--

7. Impact on the natural environment to reduce the cause of malaria

What is the impact of malaria on the natural environment?

In developed countries such as Australia, the big reductions in mortality rates were due to improvements in nutrition, housing and hygiene rather than the development of medicines. These are closely linked to the overall condition of the environment. The condition of the environment is directly and indirectly linked to human health. Any deterioration in environmental conditions is considered to be a major factor contributing to poor health and poor quality of life.

In less developed countries such as those in Africa, parts of South East Asia and South America unregulated urban development, industrial, mining and farming activities have the potential to bring about environmental harm which in turn can add to the risk of malaria. Polluted air and water can add to the threat of malaria.

To reduce the threat of malaria, especially in countries in Africa, the natural environment has been changed to reduce the risk of malaria. This has been evident through strategies such as:

- draining of natural, stagnant water bodies so mosquitoes can't breed
- spraying of water bodies to kill mosquito larva.
- developing and implementing engineering solutions on rivers, streams and other natural water bodies to ensure communities have access to clean safe water supplies.

Source 1



Image: Prefeitura da Olinda <https://www.flickr.com/photos/prefeituradeolinda/3586132293>

Source 2



Image: Prefeitura da Olinda <https://www.flickr.com/photos/prefeituradeolinda/3586867200/>

The series of images from which these two sources are from, is accompanied by the following text by the council of the town of Olinda in Brazil:

“The revitalisation of the Malaria Channel included lining the gutter, cleaning and dredging the ditch. As a result, the obstruction caused by the accumulation of sand and garbage was reduced, improving the circulation of water. The actions were directly reflected in the reduction of flooding in dozens of communities. The canal is one kilometre long and runs from the mouth of the Beberibe River, on Maruim Island, to Largo do Varadouro.” (Prefeitura da Olinda, 2005)

Read the textbook on pages 106 – 109 and find further examples of impacts of malaria on the *natural environment*

Check your understanding

1. **Complete** the glossary entry for *unregulated*.
2. **Identify** three ways in which changes to natural environment increase the spread of malaria and three ways that decrease the spread of malaria.

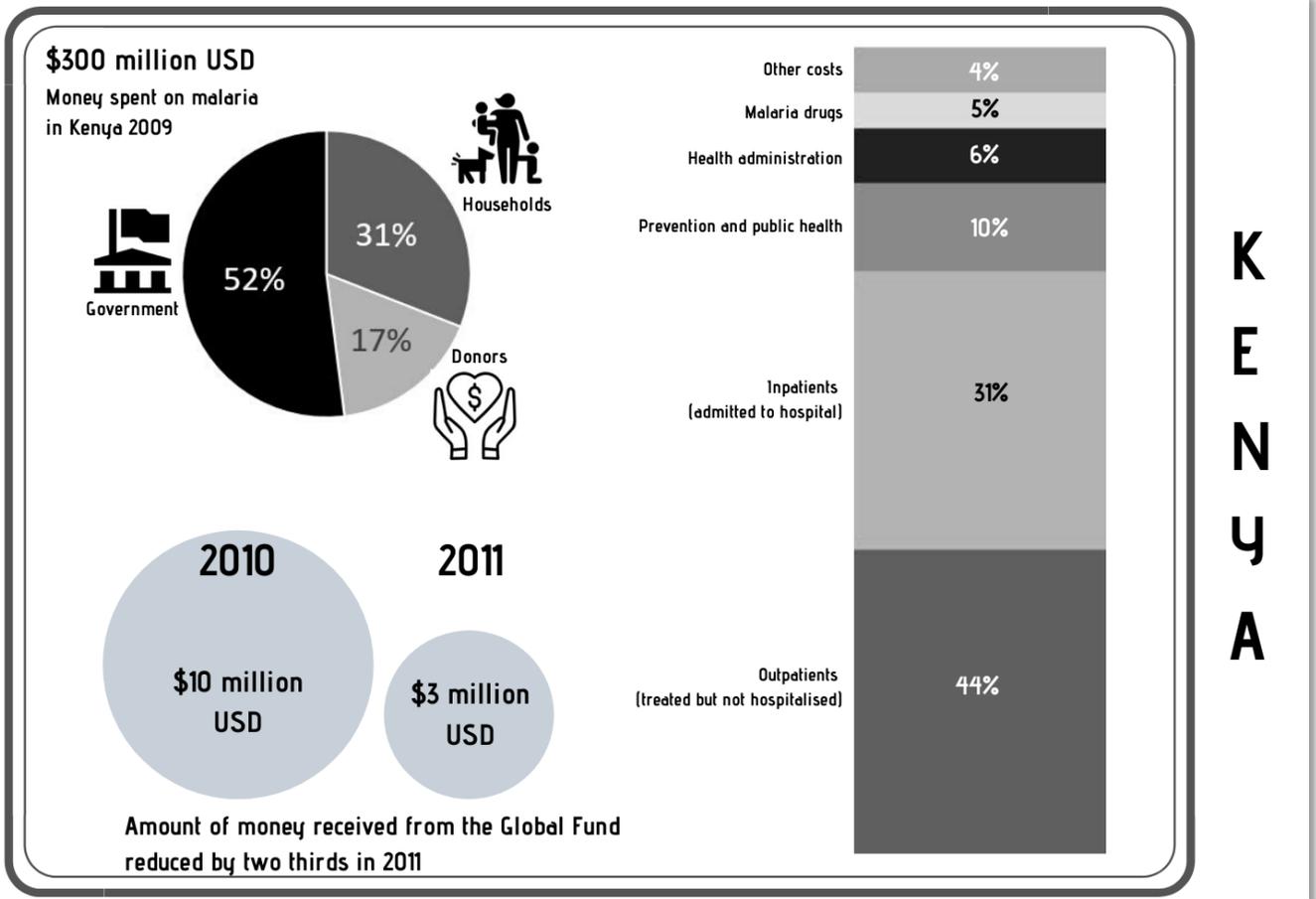
3. **Outline** the link between degradation or improvement of natural environment and malaria control.

4. Using one example, write a paragraph to **justify** the need for at least one strategy to change the natural environment to reduce the risk of spread and impact of malaria.

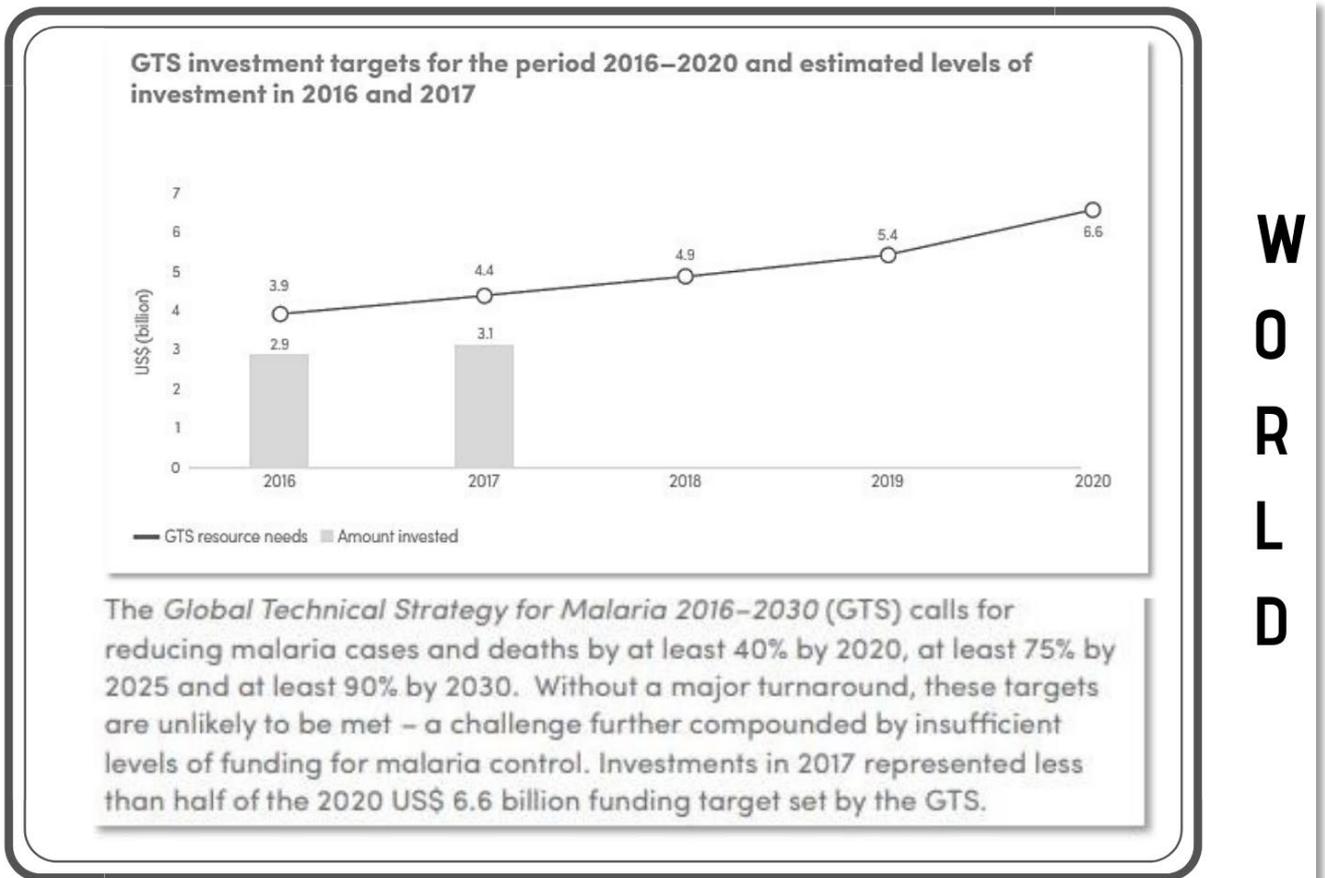
8. Economic impacts of malaria

WHO estimated that last year alone, the economic cost of malaria across African countries was \$30 billion US dollars (approximately \$50 billion Australian dollars). These are massive costs, considering the size of most the economies in the region affected by malaria. Where malaria is endemic, the per capita incomes of the population is low and economic growth is lower than in developed countries such as Australia. The disease causes not only lower productivity, higher medical costs and lower investment but also affects birth rates, population growth and life expectancy.

Source 1



Information source: Internews. <https://internews.org>



Information source: WHO High burden to high impact strategy. <https://apps.who.int/iris/bitstream/handle/10665/275868/WHO-CDS-GMP-2018.25-eng.pdf>

creativecommons.org/licenses/by-nc-sa/3.0/igo/

Source 2

“A MASSIVE WAKE-UP CALL”  creativecommons.org/licenses/by-nc-sa/3.0/igo/

Since the turn of the century, the global fight against malaria has been marked by a steady series of advances resulting in millions of cases averted and millions of lives saved. The effort represents one of public health’s greatest triumphs: mortality caused by the disease plummeted by nearly 60%.

But that downward trend has come to an end. In 2017, WHO reported that the number of malaria cases had levelled off. Now, for a second consecutive year, the battle – on a global scale – has failed to make new gains; and in some places, mainly in sub-Saharan Africa, it has lost ground.

According to the World malaria report 2018, there were 219 million cases of the disease in 2017, compared to 217 million the year before. Of particular concern is the report’s finding that, among the 10 highest burden African countries, there were 3.5 million more cases in 2017 over the previous year.

Source: WHO, *High burden to high impact - a targeted malaria response*, <https://www.who.int/malaria/publications/atoz/high-impact-response/en/>

Read the section ‘Cost of implementation, mitigation and adaptation of global initiatives’ on pages 113 – 114 of your textbook and see the Figure 5.7.2 Investments in malaria control and elimination.

Check your understanding

1. **Complete** the glossary entry for *economic impact*.
2. **Identify** the following:
 - a. sources of funding for fighting malaria, both in Kenya and globally
 - b. where funding for malaria is spent, both in Kenya and globally
 - c. trends in funding, both in Kenya and globally.

a.
b.
c.

3. “Should developed countries increase, decrease or maintain the current level of funding to fight malaria around the world?” **Justify** your answer with examples and evidence.

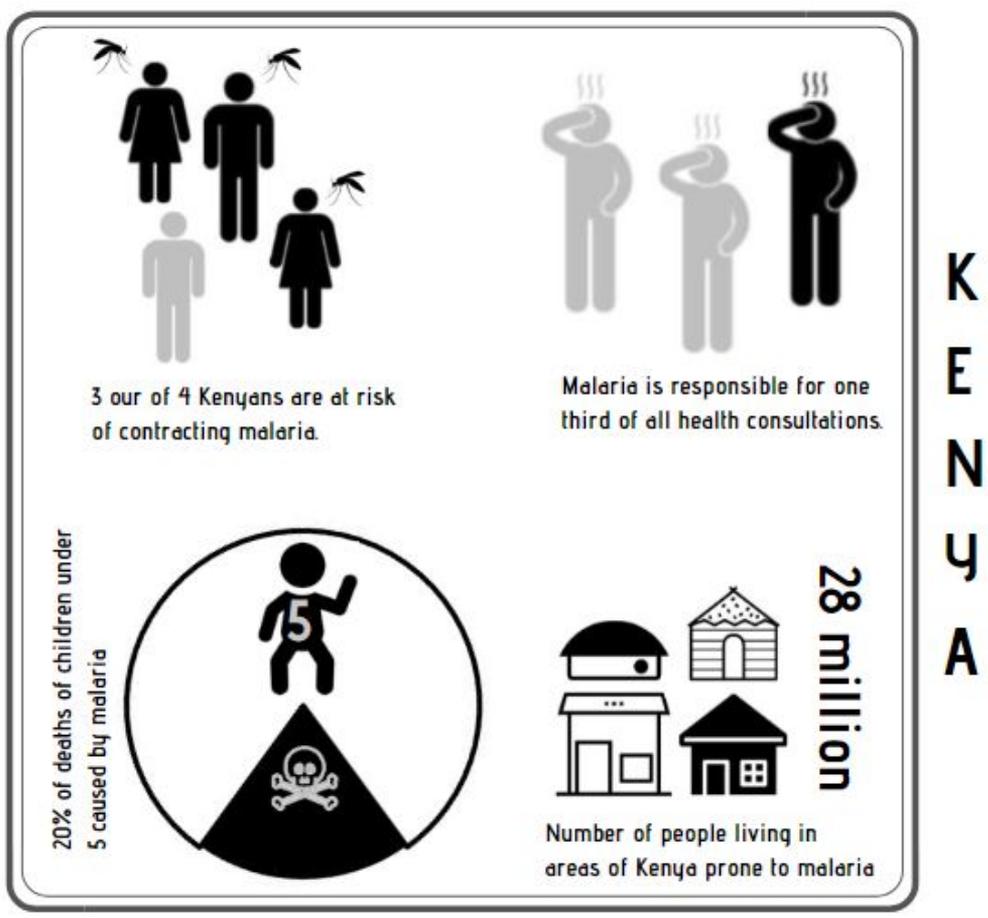
9. Social impacts of malaria

Malaria affects birth rates, population growth, worker productivity, life expectancy and medical costs. Poverty and vulnerability to malaria are closely linked. Immunity is the ability to resist an infection by the action of antibodies present in our body. The most vulnerable persons are those with little or no immunity to the disease and are weakened by malnutrition.

The most vulnerable groups are:

- young children who have yet to develop partial immunity to the disease
- pregnant women whose immunity is decreased by pregnancy
- people infected with HIV or other illnesses that affect the immune system
- people who suffer from malnutrition (inadequate amount and quality of food)
- travellers or migrants who lack immunity, coming from areas with little or no transmission (for example Australia).

Source 1



Information source: Internews. <https://internews.org>

Read Section 5.6 ‘The impact of malaria in Nigeria and Australia’ on pages 110 – 112 of your textbook.

Check your understanding

Activities: Social impacts of malaria.

1. **Complete** the glossary entry for *malnutrition, immunity*.
2. **Create two short answer questions** relating to social impacts of malaria on individuals, families and communities with reference to at least one example from a country or a region. Answer ONE of your questions with a well-constructed paragraph.

Question 1:
Question 2:
Answer to either Question 1 or 2 (paragraph):

3. **Outline** AT LEAST FOUR key differences in the environmental, economic and social impact of malaria in one less economically developed country compared to a more economically developed country (for example, 'nutrition', 'poverty' ...). Please make sure you keep referring to the topic of malaria, not making a mere general comparison.

Less economically developed country LEDC	More economically developed country MEDC

10. Risk management policies

As stated by WHO in their High Burden to High Impact (2019) strategy “since the turn of the century, the global fight against malaria has been marked by a steady series of advances resulting in millions of cases averted and millions of lives saved. The effort represents one of public health’s greatest triumphs: mortality caused by the disease plummeted by nearly 60%.” (WHO, 2019)

The High Burden to High Impact strategy outline can be accessed at <https://apps.who.int/iris/bitstream/handle/10665/275868/WHO-CDS-GMP-2018.25-eng.pdf>

Read Section 5.7 and 5.8 in your textbook about the efforts of various stakeholders to manage the risk of malaria and sustainability of the policies.

The resources below visually complement the material read, all sourced from the WHO campaigns. For more and curated, freely available images please visit WHO’s ‘Facts in pictures’ page <https://www.who.int/news-room/facts-in-pictures/detail/malaria>



Images: <https://www.who.int/news-room/campaigns/world-malaria-day/world-malaria-day-2019/campaign-materials>

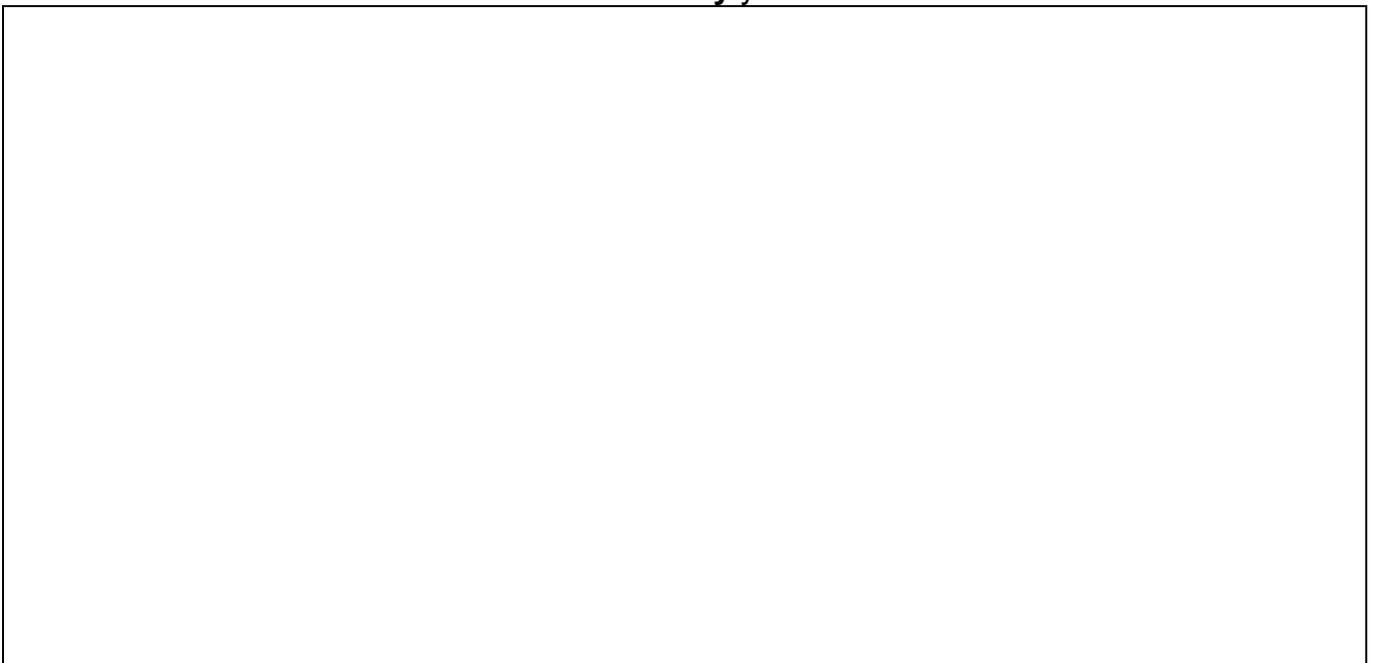


Check your understanding

1. **Complete** the glossary entries for *vector control*, *chemoprevention*, *Roll Back Malaria*, *LLIN*.
2. **Sketch** an infographic that outlines the policies and practices used to minimise or reduce the risk from malaria.



3. Are Australians at risk from malaria? **Justify** your answer.



11. Stakeholders

Who are the stakeholders with an interest in the issue of malaria?

There broadly two groups of stakeholders affected by malaria.

- Stakeholders affected by malaria directly or indirectly.
- Stakeholders involved in malaria management - policy, practices and/or procedures.



Source: Image created by Julia Freeman using Smart Art Graphics

Revisit Sections 5.7 and 5.8 and look for evidence stakeholders have had in the management of malaria.

Activities: Stakeholders

1. **Complete** the glossary entry on *stakeholders*.
2. **Identify** and **describe** the role of three stakeholders in the management of malaria. Be specific to the selected country/ region.

Stakeholders	Country/region	Their role in management of malaria

12. Exam practice questions

The following past examination questions and marking guidelines are published with permission of the Geographical Association of Western Australia (GAWA).

These questions are useful as revision preparation. Preparing a draft plan and short / extended responses for your teacher to provide you with feedback, is an effective method of exam preparation.

Past examination questions related to an ecological hazard.

- The following questions are past examination questions.
- Note how a question will not refer directly to malaria rather as an "ecological hazard you have studied."
- Be familiar with the meaning of each of the directive terms (as highlighted in the question).
- You must answer the question as instructed by the question.

Short response questions

- **Describe** the nature of ecological hazards with reference to examples. (3 marks)
- **Explain** the concept of the magnitude of an ecological hazard. (2 marks)
- For an ecological hazard you have studied, give one example of a stakeholder and **describe** their viewpoint on adaptation to future occurrences of the hazard. (3 marks)
- **Explain** the concept of Mitigation and prevention in relation to a type of ecological hazard you have studied. (4 marks)

Extended response questions

- (a) **Describe** the magnitude, duration, frequency and scale of spatial impact of an ecological hazard you have studied. (8 marks)
- (a) **Describe** the nature of the risks to be managed for an ecological hazard you have studied. (8 marks)
- (a) **Explain** how variations in hazard and vulnerability characteristics affect the level of risk. For an ecological hazard describe two factors that increase risk level. (10 marks)
- (a) Determine the level of risk for an ecological hazard. **Describe** two factors that impact on the intensity and probability of this hazard. (10 marks)
- (b) **Discuss** how human actions can intensify the impacts of an ecological hazard that you have studied in a less developed country. (10 marks)
- (b) **Discuss** the impact and risk management for an ecological hazard in a developed country you have studied. (10 marks)
- (b) **Assess** the extent to which human activities and structures can intensify the impacts of an ecological hazard you have studied. (12 marks)
- (b) **Identify** two (2) groups of stakeholders affected by an ecological hazard and explain their values and viewpoints on adaptation to future hazard events. (12 marks)

Use a planning framework to plan these questions with consideration of the guidelines provided.

Question 1

With reference to an ecological hazard (malaria) that you have studied, discuss its economic and social impact on a less developed country or region. (8 marks)

Marking Guide for an A grade response:

A detailed and comprehensive discussion is given. Integrated information about the **social and economic impacts of an ecological hazard** event that has occurred in a less developed country, identifying **social cost** is the cost society/ communities and security to a community and **economic costs** can have a significant economic impact due to short term and long term costs of the ecological hazard on business activities.

A wide range of **appropriate supporting evidence** is used to develop and strengthen the description. The accurate use of **relevant geographical terminology and concepts** helps to develop a **cohesive, concise and articulate answer**, with well-developed sentences and paragraphs in an extended answer format.

Question 2

Evaluate the sustainability of risk management policies, procedures and/or practices, both short and long term, that have been developed in response to an ecological hazard (malaria) that has occurred in a less developed country. (12 marks)

Glossary:

Sustainability: meeting the needs of current and future generations through simultaneous environmental, social and economic adaptations and improvements.

Risk management: the forecasting and evaluation of risks together with the identification of procedures to avoid or minimise their future impact.

Assess: *evaluate or discuss the effectiveness* of risk management policy, procedures and practises.

Marking Guide for an A grade response:

For full marks, assess the sustainability of a risk management policy, procedures and/or practises designed to reduce the impacts of their chosen ecological hazard, in both the short and long term.

A **detailed and comprehensive assessment** of the sustainability of a risk management policy, procedures and/ or practises. Integrated information is provided about the effectiveness of the policy, procedures and/or practices in reducing both short and long term impacts from an ecological hazard. A wide range of appropriate supporting evidence is used to develop and strengthen the assessment.

The accurate use of **relevant geographical terminology and concepts** helps to develop a **cohesive, concise and articulate answer**, with well-developed sentences and paragraphs in an extended answer format.

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