Papua New Guinea

National Malaria Strategic Plan, 2021-25

Strengthening malaria control, moving towards elimination.

FINAL DRAFT

See filename for date

List of acronyms

ACSM	Advocacy, Communication and Social Mobilization
ACT	Artemisinin-based Combination Therapy
ADB	Asian Development Bank
AL	Artemether-Lumefantrine
AMF	Against Malaria Foundation
AMS	Area Medical Store
An.	*Anopheles*
ANC	Ante-natal Care
API	Annual Parasite Incidence
APLMA	Asia Pacific Leaders' Malaria Alliance
AQ	Amodiaquine
ARI	Acute respiratory tract infection
AROB	Autonomous Region of Bougainville
AUD	Australian dollar
BCC	Behaviour Change Communication
CEO	Chief Executive Officer
CHW	Community Health Worker
COVID-19	Coronavirus disease of 2019
CPHL	Central Public Health Laboratory
CQ	Chloroquine
DAL	Department of Agriculture and Livestock
DCO	Disease Control Office
DDT	Dichlorodiphenyltrichloroethane
DFAT	Australian Agency for International Development
DPM	Department of Personnel Management
DWU	Divine Word University
eNHIS	electronic National Health Information System
EQA	External Quality Assurance
FET-PNG	Field Epidemiology Training in Papua New Guinea
FSAT	Focal Screening And Treatment
G6PD	Glucose 6 Phosphate Dehydrogenase
GDP	Gross Domestic Product
GoPNG	Government of PNG
HIV	Human Immunodeficiency Virus
HMM	Home-based Management of Malaria
HR	Human Resources
HSSDP	Health Services Sector Development Program
iCCM	Integrated Community-based Case Management
IEC	Information, Education and Communication
ILI	Influenza-like illness
IMF	International Monetary Fund
IPC	Inter-Personal Communication

IPTp	Intermittent Presumptive Treatment during pregnancy
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Bednet
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
LLIN	Long Lasting Insecticide-treated Bednet
LNG	Liquefied Natural Gas
M&E	Monitoring and Evaluation
MAP	Malaria Action Plan
MDA	Mass Drug Administration
MEMTI	Malaria Elimination Initiative in Melanesia and Timor Leste
MEP	Malaria Elimination Programme
MIS	Malaria Indicator Surveys
MPR	Malaria Programme Review
MSAT	Mass Screening and Treatment
MSMET	Multi-Sectoral Malaria Elimination Taskforce
MTR	Mid-Term Review
NAQIA	National Agriculture Quarantine and Inspection Authority
NCD	National Capital District
NDC	National Disaster Centre
NDoH	National Department of Health
NEC	National Executive Council
NGO	Non-Governmental Organization
NHP	National Health Plan
NIPMA	New Ireland Provincial Malaria Alliance
NMCP	National Malaria Control Programme
NMSP	National Malaria Strategic Plan
NMTG	National Malaria Treatment Guidelines
OIC	Officer In Charge
P.	*Plasmodium*
PCR	Polymerase Chain Reaction
PHA	Provincial Health Authority
PHIO	Provincial Health Information Officer
PIMI	PNG Industry Malaria Initiative
PMS	Provincial Malaria Supervisor
PMU	Project Management Unit (for selected donor-funded projects)
PNG	Papua New Guinea
PNG-IMR	PNG Institute of Medical Research
PPI	Provincial Pharmacy Inspectors
PPP	Public-Private Partnership
PSI	Population Services International
PSM	Procurement and Supply Management
QA	Quality Assurance

QC	Quality Control
RAM	Rotarians Against Malaria
RDT	Rapid Diagnostic Test
RMC	Regional Malaria Coordinator
RSSH	Resilient and sustainable systems for health
s.l.	*senso lato*
SMO	Specialist Medical Officer
SOP	Standard Operating Procedures
SP	Sulphadoxine-Pyrimethamine
STRIVE	Stronger Surveillance and Systems Support for Rapid Identification and Containı Resurgent or Resistant Vector Borne Pathogens in PNG
TA	Technical Assistance
TES	Therapeutic Efficacy Study
TWG	Technical Working Group
UG	University of Goroka
UNDP	United Nations Development Programme
USD	United States dollar
WHO	World Health Organization

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Strategy at a glance

Vision

A malaria-free Papua New Guinea (PNG) by 2030.

Mission

Improve, transform and provide quality malaria prevention and case management services through innovative approaches supporting primary health care and health system development and good governance at all levels. The malaria control and elimination programme will help to alleviate poverty amongst PNG's most marginalized people.

Goals

- Reduce malaria morbidity by 63 percent by 2025 (i.e. from 66.3 per 1,000 in 2019[1] to ≤ 25.8 per 1,000 in 2025).
- Reduce malaria mortality by 90 percent by 2025 (i.e. from 1.697 per 100,000 [146 deaths] in 2019 to ≤ 0.165 per 100,000 [16 deaths] in 2025).
- Eliminate malaria in the Autonomous Region of Bougainville by the end of 2025 and prevent reestablishment of transmission once malaria-free.[2]

Objectives

1. Malaria vector control and personal protection. Coverage of locally appropriate quality assured strategies for vector control and personal protection optimized nationwide.

2. Malaria case management. Universal access to quality assured early diagnosis and appropriate treatment.

3. Behaviour Change Communication. Community-based support for malaria control and elimination efforts mobilized and utilization of prevention and case management services maximized.

4. Surveillance and response. A strong routine disease surveillance and response system in burden reduction settings and a robust case-based surveillance and response system in elimination and prevention of re-establishment settings.

5. Enabling environment. A strong enabling environment for malaria control and elimination.

Programme priorities

- Immediately augment intensive malaria prevention and case management services targeting
    - populations in PNG's most remote and most endemic communities.
    - PNG's most underserved and marginalized populations in urban settlements.
- Support capacity development for staff involved in malaria related activities especially at district and at provincial level nationwide.

[1] 639,048 confirmed cases in 2019 (NHIS).
[2] NDoH will introduce subnational certification of elimination from 2028 based on zero indigenous cases for 3 consecutive years.

- Accelerate the expansion and use of 'smart systems' data and communication systems to improve supply and demand side planning and management of malaria commodities and to strengthen implementation of programme activities.
- Rapidly accelerate burden reduction efforts in the two lowland provinces of Madang and Morobe (key sources of malaria infection that threaten epidemic prone highland provinces).
- Rapidly accelerate burden reduction efforts and progressively roll-out malaria elimination activities in selected provinces/islands embarking on elimination.
- Ensure safe radical cure of *Plasmodium vivax* by all qualified service providers.
- Raise the profile of malaria and increase multisectoral engagement to support malaria control and elimination efforts much more widely.

Targeting by province

1. All provinces continue to provide an essential package of vector control and personal protection services and case management services as well as behaviour change communication.
2. Capacity development support for all provinces and districts.
3. Accelerated burden reduction in Madang and Morobe Provinces to protect epidemic prone highland provinces.
4. Phased roll-out of accelerated burden reduction and elimination in selected provinces/islands embarking on elimination.

Timelines and key targets

Figures for annual parasite incidence (API) and malaria mortality presented in Table 1 are modelled based on actual reported figures for 2019 and on the goal of ending indigenous transmission during 2030 (Figure 11).

Table 1. Timelines and key targets for the National Malaria Control Programme (NMCP) 2021-30[3].

	2021	2022	2023	2024	2025	2030
National API (cases/1,000 pop)	≤ 61.7	≤ 55.6	≤ 47.2	≤ 35.4	≤ 24.8	≤ 0.5
National mortality (cases/100,000 pop)	≤ 1.80	≤ 1.41	≤ 0.83	≤ 0.40	≤ 0.20	≤ 0.0

Key interventions

1. Malaria vector control and personal protection

[3] N.B. Improvements in malaria case reporting resulting from the roll-out of eNHIS and associated capacity development may result initially in an anomalous increase in reported API.

1.1 Implement rolling three-yearly mass distribution of long-lasting insecticide treated bednets (LLIN) to achieve universal coverage in target areas.

1.2 Implement continuous LLIN distribution to maintain universal coverage amongst vulnerable and key risk populations.

1.3 Re-introduce high-quality indoor residual spraying (IRS) to rapidly reduce incidence in selected high burden areas and to maintain malaria control in areas where LLIN utilization is low[4].

1.4 Implement supplemental vector control tools and personal protection measures as appropriate.

1.5 Support multisectoral involvement in the provision of vector control and personal protection measures.

1.6 Implement focal responsive vector control interventions in response to outbreaks in burden reduction settings and confirmed transmission foci in elimination settings.

2. Malaria case management

2.1 Ensure early and accurate diagnosis.

- Expand and maintain quality assured rapid diagnostic test (RDT)-based diagnostic services.
- Maintain and strengthen quality assured malaria specific microscopy-based diagnostic services down to district level.
- Support the PCR[5] facility at the Central Public Health Laboratory (CPHL).
- Introduce routine G6PD[6] testing to support safe radical treatment for vivax malaria cases.

2.2 Ensure effective rational treatment.

- Provide case management, including the management of severe malaria in public sector health facilities.
- Provide community-based[7] case management for malaria in areas beyond reasonable reach of health facilities.
- Strengthen private sector case management services.
- Provide intermittent preventive treatment (IPTp) for malaria during pregnancy in areas below 1,600 metres.
- Conduct mass drug administration (MDA) in specific circumstances[8].
- Conduct routine mass screening and treatment (MSAT) for boarding school children.

2.3 Address the issue of sub-standard and falsified antimalarials.

[4] Re-introduction dependent on the outcome of trials.
[5] Polymerase chain reaction - a method used widely in molecular biology to amplify sections of genetic code from cells.
[6] Glucose 6 Phosphate Dehydrogenase (G6PD) is a critical 'housekeeping' enzyme in red blood cells that intervenes against oxidative challenge. G6PD deficiency has a slight protective effect against malaria but results in increased susceptibility to haemolysis for patients treated with primaquine and other similar drugs.
[7] Covering villages, schools and refugee camps.
[8] MDA may be used to eliminate the parasite reservoir and interrupt transmission at a rapid pace in elimination settings or to rapidly reduce burden in transmission hotspots in higher burden settings, depending on the outcome of operational research.

3. Behaviour Change Communication (BCC)

3.1 Implement health promotion activities to support the enabling environment for malaria control and elimination, to strengthen knowledge, attitudes and practices amongst populations at risk, and to promote community led engagement.

4. Surveillance and response.

4.1 Strengthen capacity for epidemiological analysis to support policy-related decision making at national level and data analysis to support decision making for appropriate action at the peripheral level.

4.2 Accelerate the expansion and strengthening of the electronic National Health Information System (eNHIS) and the workforce's capacity to utilise it.

4.3 Incorporate private sector case reporting into eNHIS.

4.4 Update malaria risk stratification every two years.

4.5 Expand and strengthen outbreak surveillance and timely response for epidemic prone areas.

4.6 Establish case-based surveillance and response for areas targeted for malaria elimination and prevention of parasite re-establishment.

4.7 Maintain national level sentinel site surveillance and expand to sub-national level.

4.8 Conduct malaria indicator surveys three yearly.

4.9 Conduct health facility surveys three yearly.

4.10 Conduct mini-prevalence surveys in remote villages in suspected high burden areas to inform the roll-out of community-based case management services as per guidelines.

4.11 Conduct periodic school surveys.

4.12 Monitor drug resistance through therapeutic efficacy studies and molecular surveillance.

4.13 Establish and maintain a system of essential entomological surveillance, including insecticide resistance monitoring.

4.14 Conduct operational research to inform national policy.

4.15 Conduct annual review of research.

5. Enabling environment.

5.1 Develop and maintain strong malaria programme management at all levels.

5.2 Implement robust programmatic supervision and monitoring and evaluation (M&E)

5.3 Implement robust procurement and supply management (PSM)

5.4 Conduct periodic policy review, strategy development and programme planning.

5.5 Ensure adequate and sustainable infrastructure and capacity for NMCP, CPHL and the PNG Institute of Medical Research (PNG-IMR).

5.6 Strengthen leadership and governance regionally, nationally and sub-nationally.

5.7 Strengthen political commitment regionally, nationally and sub-nationally.

5.8 Ensure adequate financial support.

5.9 Develop and enhance multisectoral partnerships for action

5.10 Support continued active coordination between the National Department of Health (NDoH) and malaria stakeholders in PNG.

5.11 Support active international technical collaboration.

5.12 Develop cross-border collaboration with neighboring countries in preparation for elimination.

1. Background.

The background section of this National Malaria Strategic Plan (NMSP) draws on the country context provided by PNG's NMSP 2014-20 and on the background provided in the 2013 Malaria Programme Review (MPR) report, the 2016 Mid-Term Review (MTR) report and the 2019 MPR report. Details have been updated where appropriate.

1.1 Contextual information.

1.1.1 Political environment.

PNG has had an unbroken record of democratic continuity since independence in 1975. The Head of State is the Governor General and Executive Power is exercised by the National Executive Council (NEC) Cabinet chaired by the Prime Minister. There are 111 elective seats (89 open constituencies and 22 provincial constituencies).

1.1.2 Economic situation.

PNG is richly endowed with natural resources, but exploitation has been hampered by rugged terrain, land tenure issues, and the high cost of developing infrastructure. The economy has a small formal sector, focused mainly on the export of those natural resources, and an informal sector, employing the majority of the population. Subsistence agriculture supports a livelihood for approximately 85 percent of the people.

Mineral deposits, including copper, gold and oil, account for nearly two-thirds of export earnings. In 2017 natural gas reserves amounted to an estimated 141 billion cubic meters. Following construction of a $19 billion liquefied natural gas (LNG) project, PNG LNG, a consortium led by ExxonMobil, began exporting liquefied natural gas to Asian markets in May 2014. The success of the project has encouraged other companies to look at similar LNG projects. French supermajor Total hopes to begin construction on the Papua LNG project by 2020. Due to lower global commodity prices, resource revenues of all types have fallen dramatically. PNG's government has recently been forced to adjust spending levels downward.

Numerous challenges still face the government, including providing physical security for foreign investors, regaining investor confidence, restoring integrity to state institutions, promoting economic efficiency by privatizing moribund state institutions, and maintaining good relations with overseas governments.

PNG's medium-term economic outlook was optimistic, underpinned by further large-scale resource projects. Real gross domestic product (GDP) growth is estimated to have rebounded to 5.6 percent in2019 (from –0.8 percent in 2018), primarily driven by a return to full annual production in the extractives sector following recovery from the 2017 earthquake. However, this masks slower growth of the non-resources economy.

Growth was then expected to ease to 3-4 percent a year, pending planned investments in LNG and mining projects. Future large-scale investment in the resource sector appear likely, with plans to double LNG production and develop new gold, copper and silver reserves. However, the emergence of the COVID-19 pandemic and recent escalation of a new 'oil price war' – coupled with delays in finalizing agreements and launching implementation of large new resource projects – mean the outlook for growth and national budgets seem grim.[9] A rapid $US2 billion 'bail out' for PNG involving the International Monetary Fund (IMF) and direct Australian funding and the prospects of a slowing

[9] World Bank. 2020. *East Asia and Pacific in the Time of COVID-19*. East Asia and Pacific Economic Update (April), World Bank, Washington, DC.

global economy in a COVID-19 environment are all likely to squeeze Government of PNG (GoPNG) revenues further.

1.1.3 Social situation.

PNG continues to face development challenges. About 85 percent of PNG's population relies on subsistence agriculture and fishing for survival, sometimes in some of the most isolated and inaccessible locations on the planet. These communities receive little benefit from mineral and petroleum exports, and PNG remains one of the least developed nations on earth. The United Nations Development Programme's (UNDP's) 2019 Human Development Index ranked PNG 155th of 189 countries surveyed[10], lower than any other country in the Pacific. Life expectancy at birth in PNG is 64.3 years. Only 61.6 percent of people 15 years old or over are literate.

Priority issues faced by PNG in developing the country include health, education, transport and public infrastructures and services, ensuring effective and transparent governance, law and order problems and difficult land ownership and access issues. Law and order issues continue to pose high risks, and gender-based violence, especially violence against women and girls in PNG is extreme.

1.2 Health system.[11]

Service delivery in PNG is mainly provided at government and church health facilities, funded by a mix of government tax revenues, out-of-pocket payments and donor funds. The central government is responsible for the national referral hospital and one specialist, 4 regional and 16 provincial public hospitals. The majority of health service delivery is carried out by provincial and local governments in rural health services, including rural hospitals, health centres, health sub-centres, and aid posts. All of these services offer a mix of public health and primary and community care.

Health care in PNG has a hierarchical structure of 7 levels with level 1 as the least complex: basic health services provided through aid posts and community health posts, and level 7 as the most complex set of health services provided at the national referral hospital.

Government-subsidized church health services are an integral part of the national health system, particularly in the most hard-to-reach areas of the country where they provide almost 50 percent of ambulatory services. Not-for-profit and organized under the Churches Medical Council, they manage their own plans and staffing, but are highly subsidized with over 80 percent of the service costs financed by the government, without any formal contractual arrangement. In principle churches are part of the local planning and decision-making process under the coordination of provincial and district authorities but in practice, participation is limited. Church organizations also run 6 of the 9 nursing schools and all 14 of the community health worker training schools.

Private sector organizations include for-profit enterprise-based services or employment-related health care programs, small for-profit private sector organizations, women's and youth organizations, non-governmental organizations (NGO) and an undocumented number of unregulated traditional healers. Some newer services are dependent upon external financial support and may not be well established in the community, while more well-known and long-established services receive strong community support.

People living in remote rural areas face significant financial and non-financial barriers to accessing basic health services. The main problem is transport. PNG's transport infrastructure is poorly

[10] http://hdr.undp.org/en/countries/profiles/PNG

[11] From: Grundy J, Dakulala P, Wai K, Maalsen A, Whittaker M. Papua New Guinea Health System Review. Vol. 9 No. 1. New Delhi: World Health Organization, Regional Office for South-East Asia; 2019.

developed, with a limited road network that is not well maintained. Only 3 percent of the country's roads are paved and many villages can only be reached on foot. In some areas, planes and trekking are the only mode of transport. Most provincial capitals can only be accessed from Port Moresby by air. PNG has 22 airports plus about 600 rural airstrips but many of the rural airstrips no longer operate due to poor maintenance and other reasons making access to many remote areas extremely difficult. The country also lacks adequate public water-based transport between islands and coastal areas. Seventeen small commercial ports and innumerable small wharfs, jetties and beach landings provide the basic infrastructure for maritime services, but the majority of this infrastructure is in poor condition and carries very little traffic. As a result of these issues, the cost of transport is very high. With many rural areas relatively inaccessible, a significant proportion of the rural population does not have easy access to basic services, such as health and education, safe drinking water, and modern sanitation.

There are significant inequities in access to primary health care and the World Health Organization (WHO)-defined essential package of services. Coverage of these services is low and has stagnated, or in some cases declined, in recent years. Non-communicable diseases are on the rise. The legislated mandate for decentralization, with the roll-out of Provincial Health Authorities (PHA), forms the backdrop for service delivery. Provincial and district-level governments have the primary responsibility for the majority of the funding and for delivery of health-care services but are inadequately resourced and do not have the human resource capacity to manage these responsibilities effectively.

The Government is the main financing agent of the health-care sector. There is a tight fiscal context for health-care investment, and the country is transitioning in eligibility for international development assistance. Addressing the human resources for health and infrastructure gaps and maldistribution, particularly at the primary level of care in rural and remote locations in PNG, are significant policy priorities. These combinations of resourcing shortfalls have contributed to the closure of some peripheral facilities, the continued use of user fees in some locations (although not supported by national policy) to address operational funding shortfalls, and inequities in the subnational coverage of priority interventions.

Several reform measures are proposed by the Government of PNG. These include getting 'back-to-basics' (rural and primary health care), finalizing the roll-out of the decentralized model of governance through the PHA Framework, and reintroduction of a policy of free primary health care. Under consideration are options of direct facility financing, closer linkages between planning and budgeting at the subnational level, and a scale-up of investment in the health workforce, particularly for rural and remote areas.

Health policy and planning challenges in PNG support the case for the back-to-basics approach adopted by the Government. This will entail investment in human resources for health and infrastructure across the country for improved access to primary health care, particularly in rural and remote areas. This back-to-basics approach will need to be reinforced by improved provincial and district health management capacity, and timely availability of operational financing. Systems to support supervision of the services provided and operational referral pathways will need to be in place. The convergence of these reforms will, if achieved, support the transition towards universal health coverage of an acceptable quality and cost-effective primary care services.

1.3 Malaria in Papua New Guinea.

Malaria is one of the most important public health problems in PNG.

1.3.1 Epidemiology.

Müller et al., (2003) provides a broad overview of the epidemiology of malaria in PNG which is summarized below:

PNG is a patchwork of different ecological zones (ranging from coral atolls and coastal swamps to rainforests and high mountains) inhabited by human populations of exceptional cultural and linguistic diversity (800 different language groups). This degree of diversity is reflected in the remarkable complexity of malaria epidemiology in the country. Malaria is the main cause of morbidity in many health facilities in lowland areas and is responsible for epidemics in the highlands (considered malaria free until recently). In some low-lying areas falciparum malaria reaches holoendemic levels that are rarely found outside sub-Saharan Africa.

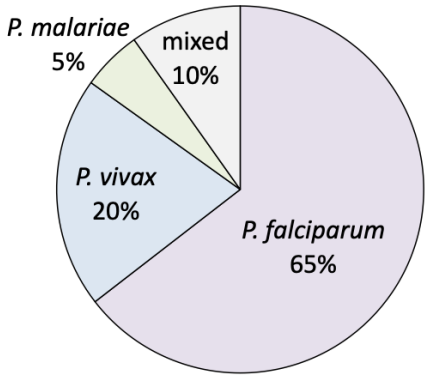
Population density: Population density is highest in the highland areas between 1,600 and 2,400 metres (31.1 people per km^2). In the lowlands population density ranges from 3.9 people per km^2 in the interior to 6.5 people per km^2 along the coast. Increased mobility in recent years has contributed to increased malaria transmission (especially falciparum malaria) in the highlands through frequent introduction of infections from the lowlands.

Influence of climate, altitude and other factors: The main climatic determinant of malaria endemicity in PNG is temperature, and because the country is located close to the equator, temperatures do not show much seasonal variation and depend mainly on altitude. In most parts of the lowlands there is perennial transmission, with only limited seasonality. Transmission is less intense on some of the islands and in some drier areas along the south coast (including Port Moresby). These south coast areas are the only ones that exhibit marked seasonality, with transmission virtually stopping during the dry season. As altitude increases, transmission decreases significantly becoming unstable at an altitude of 1,200–1,600 metres. Intense transmission is then limited to local epidemics, which generally coincide with the end of the rains and start of the dry season (April–July) and can be associated with a high incidence of relatively severe morbidity. Above 2,000 metres temperatures are generally considered to be too low for local malaria transmission. Global warming is thought to be a key factor involved in the recent alarming increases in transmission at higher altitudes.

Substantial heterogeneities in malaria epidemiology are found not only along broad environmental gradients, but also between villages only a few kilometres apart and even between different clusters of houses within the same villages. Some of this variation is accounted for by drug and bednet usage patterns and nutritional differences could also play a role. Local heterogeneity in the spectrum of vectors present and in their densities is also a significant determining factor. In the highlands, one village can have endemic malaria, while a neighbouring village is malaria free, and epidemics tend to be localized rather than affecting large areas.

Parasites species composition (Figure 1): Four species of human malaria exist in PNG but the two main species are *P. falciparum* and *P. vivax*. *P. falciparum* is now predominant everywhere except in West Sepik and less endemic highland areas where *P. vivax* is more common. The distribution of *Plasmodium malariae* is patchy. According to 2019 eNHIS microscopy data its relative abundance overall was 5.3 percent but in Western Province it accounted for 15.6 percent of cases. *Plasmodium ovale* is reported only occasionally.

Figure 1. *Plasmodium* species composition in PNG based on nationwide microscopy results for 2019 (N=39,271).



Drug resistance: Although chloroquine (CQ)-resistant *P. vivax* has been present in PNG since the late 1980s, it is far less frequent than CQ-resistant *P. falciparum*, which was first noted in 1976. By the early 1990s, the effectiveness of CQ or amodiaquine (AQ) was greatly reduced; however, these remained the first-line treatments until combination therapy with CQ or AQ plus sulphadoxine-pyrimethamine (SP) was introduced in 2000. Since the introduction of AQ a significant increase in SP resistance has been observed resulting in the introduction of artemisinin-based combination therapies (ACTs) in 2009. Therapeutic efficacy studies (TES) with the current first-line ACT - artemether-lumefantrine (AL) - are now being conducted regularly at selected sentinel sites.

Burden of malaria: Malaria is the most frequent outpatient diagnosis and the second leading cause of admissions in health facilities in many endemic areas. In the lowlands, both prevalence of malaria infection and incidence of morbidity are highest in young children and pregnant women.

Studies on malaria during pregnancy in Madang revealed peripheral parasitaemia rates reached 34 percent in the first, 30 percent in the second and 19 percent in the third or subsequent pregnancy resulting in high levels of severe maternal anaemia (17 percent had a haemoglobin level less than 7 g/dL) and low birthweight. However, in low-endemic or epidemic areas such as the highlands, malaria infections are commonly symptomatic in all age groups.

Severe malaria and malaria mortality are less frequent in PNG than in areas of comparable endemicity in Africa[12]. Verbal autopsies conducted in two lowland areas (Madang and Maprik) indicated that malaria was responsible for between 4 and 17 percent of child mortality. Co-infection with *P. vivax* probably significantly lowers the risk of severe malaria and appears to cross-protect against simple *P. falciparum* morbidity in PNG. Genetic factors also contribute to reduced morbidity and mortality: A great variety of red blood cell traits are found in PNG including a number of different variants of G6PD deficiencies, three different α-thalassaemia gene rearrangements, patchy distributions of both β-thalassaemia and Gerbich negative blood group phenotype, ovalocytosis, and several haemaglobinothapies. This wide variety of protective traits suggests independent evolution aided by the relative isolation of PNG populations.

Relevant key and/or vulnerable populations: The key populations at elevated risk of malaria in PNG are: Mobile populations traveling from low endemic (or predominantly vivax malaria endemic) and epidemic prone areas in the highlands to (and from) highly endemic lowland areas, especially urban settlements in Madang and Morobe; People of all age groups living in epidemic-prone highland provinces during epidemic years; Pregnant women and young children (particularly those who are

[12] Manning L, Laman M, Law I, Bona C, Aipit S, Teine D, et al. (2011) Features and Prognosis of Severe Malaria Caused by *Plasmodium falciparum*, *Plasmodium vivax* and Mixed *Plasmodium* Species in Papua New Guinean Children. PLoS ONE 6(12): e29203. https://doi.org/10.1371/journal.pone.0029203

malnourished) living in highly endemic lowland areas; People living in large squatter 'settlements' (slums), many of which are highly endemic for malaria particularly in the lowlands.

The scale-up of activities in the mining and petroleum sectors has also had important consequences for controlling malaria, with a large mobile population of both national and international staff that tend to work on a fly in fly out basis. There is a heightened risk of non-immune populations being exposed to malaria, especially for workers moving between the highly endemic coastal areas and the highlands provinces.

Increasing levels of population movement are taking place between lowland and coastal areas and the highlands and island regions for farming/logging/agricultural/educational/business reasons and for migrant labour into plantations and mining areas. This can trigger local outbreaks of malaria, due to the importation of malaria cases from higher transmission areas.

Until recently the Regional Refugee Processing Centre in Manus, which held refugees seeking asylum in Australia, was an important concern as it was filled with migrant populations many of whom lacked immunity to malaria, however this has now closed.

Vector mosquitoes: The principal malaria vectors in PNG are members of the *Anopheles punctulatus* group of mosquitoes which comprises at least 11 species. The different species vary in habits and in vectorial capacity. This diversity contributes to the micro-heterogeneity in transmission rates in PNG and means that for maximum effect vector control strategies need to be tailored to local vector profiles. *Anopheles farauti s.l.* (made up of eight morphologically identical sibling species)[13] is most common in coastal villages. It can breed in fresh or brackish water and larvae are found in permanent swamps, temporary pools and in streams near the coast. *Anopheles koliensis* is most common in lowland areas more than 2 km from the coast. Larvae are generally found in temporary pools in grasslands and in pools around the edges of forests. *Anopheles punctulatus* is most common in the hills. It breeds in sunlit water, road ruts and drains. All of these vector species are anthropophilic and anthropophagic, but also opportunistic and feeding on humans is reduced dramatically by the local availability of other hosts. *An. farauti* tend to bite mostly during the early hours of the evening, females tend to return to feed shortly after oviposition, and the peak of biting occurs before midnight. In the case of *An. punctulatus* and *An. koliensis*, biting occurs mainly after midnight with peak activity taking place in the early hours of the morning. One would expect this early biting by *An. farauti* to limit the effectiveness of ITNs in coastal areas however this may not be the case: Recent research has shown that due to the high frequency of feeding there is a strong likelihood that these vectors would have a lethal contact with an ITN before becoming infectious, and furthermore, within the species older potentially infective mosquitoes tend to bite later than younger uninfected ones[14].

1.3.2 History of malaria in PNG.

In 1957, PNG joined the Global Malaria Eradication Programme. The National Malaria Elimination Programme (MEP) was based on countrywide IRS with dichlorodiphenyltrichloroethane (DDT) and dieldrin together with MDA using chloroquine. It was the single biggest programme within the NDoH and was managed through four regional malaria control units.

By the late 1970s, it became clear that eradication would not be achieved. The Global Malaria Eradication Programme was abandoned, the national spray programme wound down, and MDA halted.

[13] https://malariaatlas.org/bionomics/anopheles-farauti/

[14] Russell TL, Beebe NW, Bugoro H, et al. Frequent blood feeding enables insecticide-treated nets to reduce transmission by mosquitoes that bite predominately outdoors. *Malar J*. 2016;15:156. Published 2016 Mar 10. doi:10.1186/s12936-016-1195-8

In 1976 the first cases of chloroquine-resistant malaria were reported.

Following a review of PNG's Malaria Programme in 1975 spraying was limited to specific areas and responsibilities for implementing programme activities were integrated into the responsibilities of the provincial health services. Untreated bednets were introduced for malaria control for the first time.

In 1983 NDoH-supported IRS stopped altogether.

In 1995, the 'Organic Law' was introduced leading to near complete decentralization. This was a result of the Bougainville Crisis of the 1990s, which forced the government to relinquish some administrative and budgetary autonomy to Bougainville. This set a precedent, and other provinces followed Bougainville's example, establishing provincial governments and lobbying for more control over their administration. This resulted in the decentralization of service organization. As a consequence, malaria control lost its priority status and multiple gaps – administrative, financial and human resources related – were created within the government structure. The NMCP's network of microscopy, its entomology capacity and its training facilities were all severely undermined.

National level retained responsibility for setting policy standards and monitoring and provision of training and support to provincial level, while the regional Disease Control Offices (DCO) and provinces took on the role of providing technical support to districts. Health Centre and Aid Post health staff fell under district administration while hospitals developed their own separate administrations, hampering communication between health staff at different levels.

In 1986, PNG led the world with the launch of the first trial of insecticide treated bednets (ITN) for malaria control. This trial demonstrated the effects of ITNs both on mosquito populations and on the prevalence and incidence of falciparum malaria in children.

In 1989, an ITN programme (incorporating a revolving fund) was established.

In 1992 the examination of blood films and associated quality assurance (QA) was halted. Malaria case classification in the National Health Information System was changed to distinguish between three categories: severe malaria, treatment failure malaria and uncomplicated malaria.

In 1994, the Health Administration Act was passed resulting in the closure of regional DCOs. Malaria control (including the distribution of ITNs) became an entirely provincial function. At central level there was just one Specialist Medical Officer (SMO) responsible for overseeing the NMCP.

In 1998, Rotarians Against Malaria (RAM) was established in PNG and started importing bednets and insecticide and delivering them to provinces and districts at near cost price.

In 2000, the national treatment guidelines for malaria were changed from first line CQ or AQ to CQ and SP. Artemether and SP combination therapy was adopted as the second-line treatment and the use of quinine was shelved except for use during pregnancy.

In 2001, the National Health Plan (NHP) 2001-2010 was approved. During the same year the PNG-IMR completed mapping malaria risk in the highlands.

In 2004 increasing resistance of malaria parasites to the most commonly used drugs became evident. This progressed rapidly to widespread resistance of *P. falciparum*, and to a slightly lesser extent *P. vivax*, to CQ, AQ and SP. In studies conducted between 2003 and 2005, even combination regimens of these drugs faced up to 29 percent resistance with *P. falciparum*.

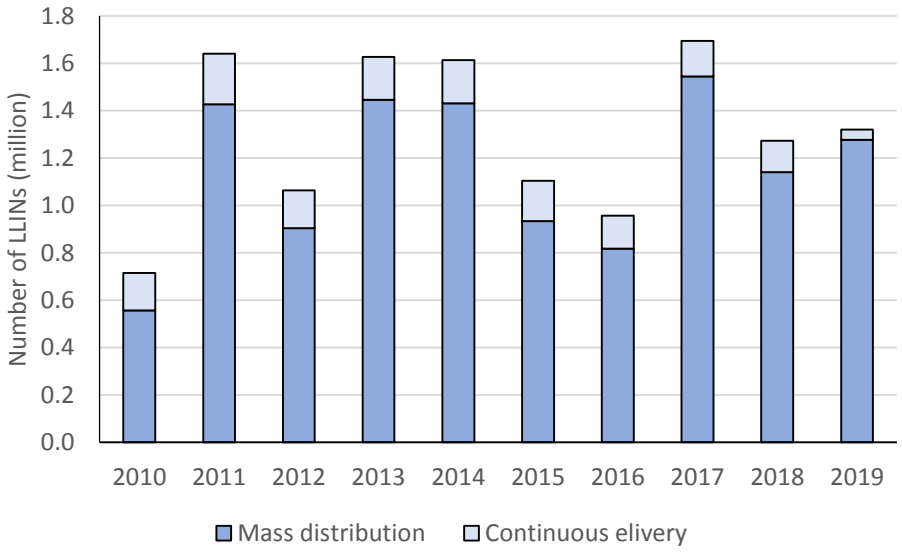
The reinvigoration of the malaria control programme began again in 2003 with the introduction of the Global Fund round 3 grant. From 2005 to 2009 the malaria programme delivered about 2.3 million nets throughout the country at a rate of one net for every 2.5 people. The delivery of nets was under the provincial health authorities and reached most parts of the country. However, while the programme was very successful in some areas it was not so successful in others. Problems included slow release of funds from central to provincial level, some provinces not following

technical guidelines resulting in some areas not being covered, and weak technical and financial reporting in many of the provinces. With the Global Fund round 8 grant, it was elected that RAM, an NGO, would take over the coordination of the LLIN programme which has led to better movement of funds and clear technical and financial reporting in all provinces. Since January 2010 and up until 2020, RAM has coordinated the distribution of about 13 million nets to household level and to vulnerable groups, particularly women receiving antenatal care.

Global Fund round 8 also saw the introduction of artemether-lumefantrine branded as Mala-1 and IPTp. Under that grant, the international NGO Population Services International (PSI) joined PNG's malaria team to improve mass communication and behaviour change through interpersonal communication (IPC) programs. In 2012, in order to expand access to testing and treatment in the remotest communities, PSI and NDoH launched the home-based management of malaria (HMM) programme. Through this HMM programme community-based volunteers (called community-based distributors) were trained and equipped to provide malaria testing and treatment (where applicable) for uncomplicated malaria and referral where appropriate. The HMM programme ran from 2013 to 2015 in three provinces: East New Britain, East Sepik and West Sepik (Sandaun).

Just over 2 million LLINs were distributed under Global Fund round 3, 6.6 million under Global Fund round 8, 3.2 million under the Global Fund NFM (2015-17). A further 1.2 million LLINs were delivered in 2018 (Figure 2). Household surveys conducted by PNG-IMR in 2009 and 2014 indicate an increase in the proportion of households with at least two LLINs, from 38 percent to 82 percent. The percentage of the population sleeping under an LLIN the night before the surveys increased from 33 percent to 54 percent during the same period. This rapid increase in LLIN coverage has resulted in most of the population having access to nets and initially at least, appeared to result in significant decreases in malaria throughout PNG.

Figure 2. Long-lasting insecticidal net distributions in PNG from 2010-2019 (mass distribution to household level and continuous delivery through ante-natal care (ANC) facilities).



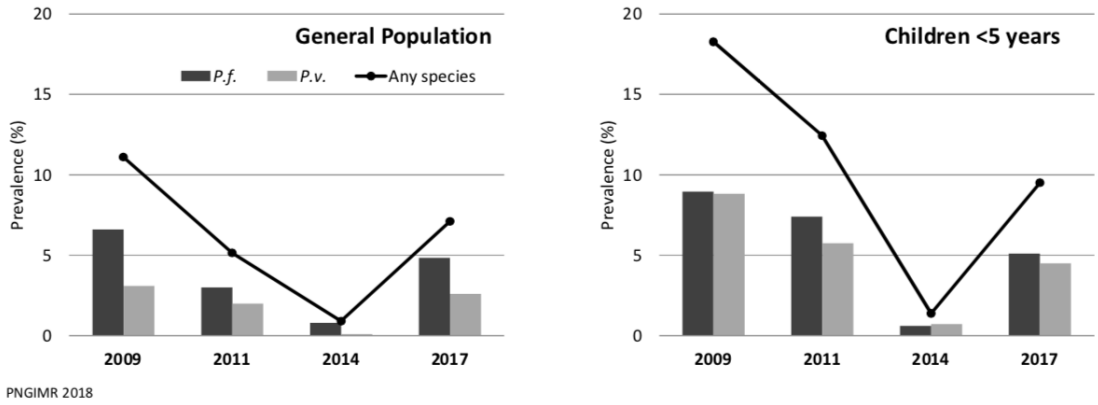
The LLIN distribution programme for 2015-2016 was sub-optimal due to reduced funding resulting in many areas in the Highlands and Port Moresby only having distributions for children under five. This changed only after Against Malaria Foundation (AMF) started giving nets in 2017.

1.3.3 Recent trends in disease burden.

With major budget support from the Global Fund, PNG made significant progress in malaria control between 2004 and 2014 leading to an unprecedented decline in malaria. Prevalence below the altitude 1,600 metres decreased from 11 percent in 2008/09 to <1 percent in 2013/14 (Figure 3). The largest decline was in the 5-14 years age group (the age group that experienced the largest increase in LLIN coverage). In recognition of its achievement, the country was highlighted in the 2012 World Malaria Report as a success story for scale-up of LLIN coverage and associated declines in parasitaemia.

However, malaria prevalence across PNG increased by an estimated 8.6 times between the 2013/14 and the 2016-17 surveys. As a result, the target of less than 2 percent prevalence in children under five years of age has not been reached on a national or regional level in areas below an altitude of 1,600 metres (where malaria conditions are favourable for transmission). On a provincial level, the target was met in all provinces in the Highlands Region, in 3 of 6 provinces in Southern Region (Western, Central, National Capital District (NCD)), and in 1 of 4 provinces in the Islands Region (Autonomous Region of Bougainville - AROB).

Figure 3. Country-wide malaria parasite prevalence in the general population and in children under five years of age (less than 1,600 metres altitude) [PNG-IMR 2018].



Based on eNHIS data from 2000 to the end of 2018, the number of reported malaria cases and deaths have fallen from 1.78 million to 1.01 million (43 percent) and from 699 to 216 (69 percent) respectively. Corresponding incidence rates and mortality rates are presented in Figure 4. Prevalence and incidence data together suggest a real drop in transmission and cases between 2008 and 2013/14. The figures for the period 2011-2012 are however difficult to interpret as starting late in 2011, RDTs were scaled-up across PNG (Figure 5) and there was a reduction in the number of clinical cases reported (Figure 6). The drop is most probably a reflection of the combination of more testing and not yet very accurate reporting of test-confirmed cases.

Figure 4. Reported incidence of malaria (clinical and confirmed) and malaria mortality rate in PNG from 2000-2019.

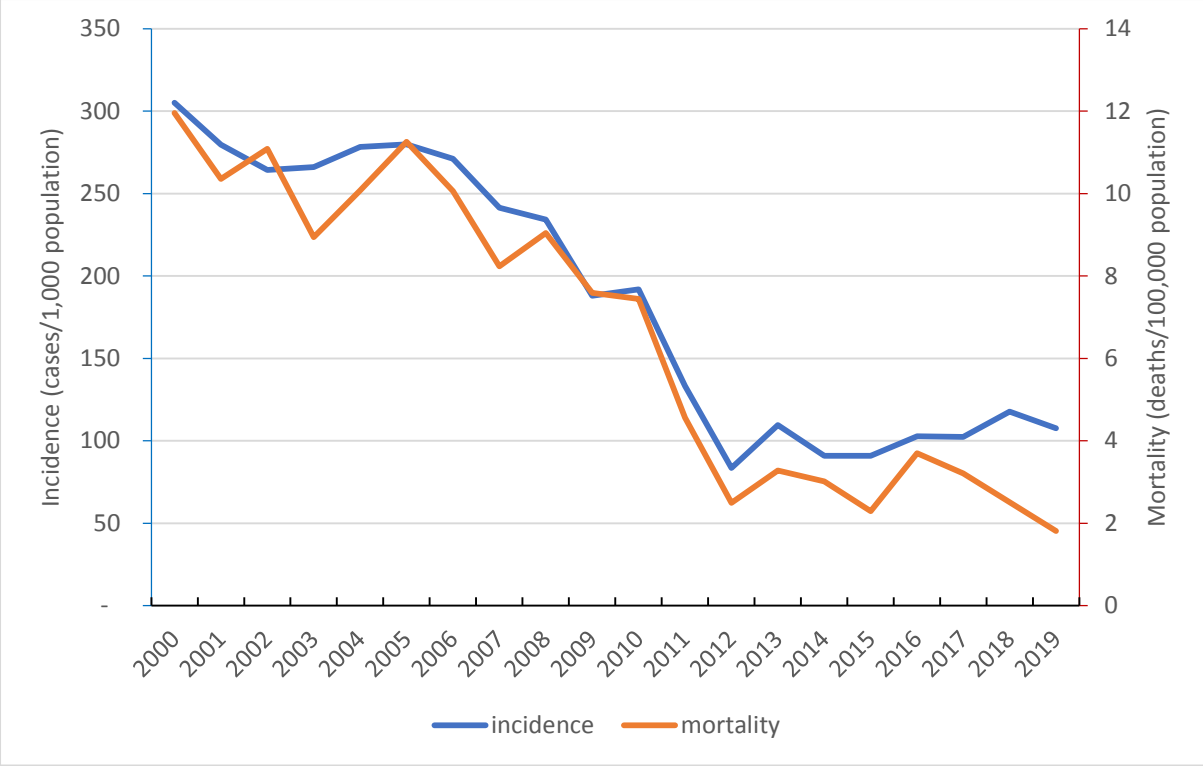


Figure 5. Number of patients tested with Rapid Diagnostic Tests for malaria in PNG by month since 2011 (from eNHIS data).

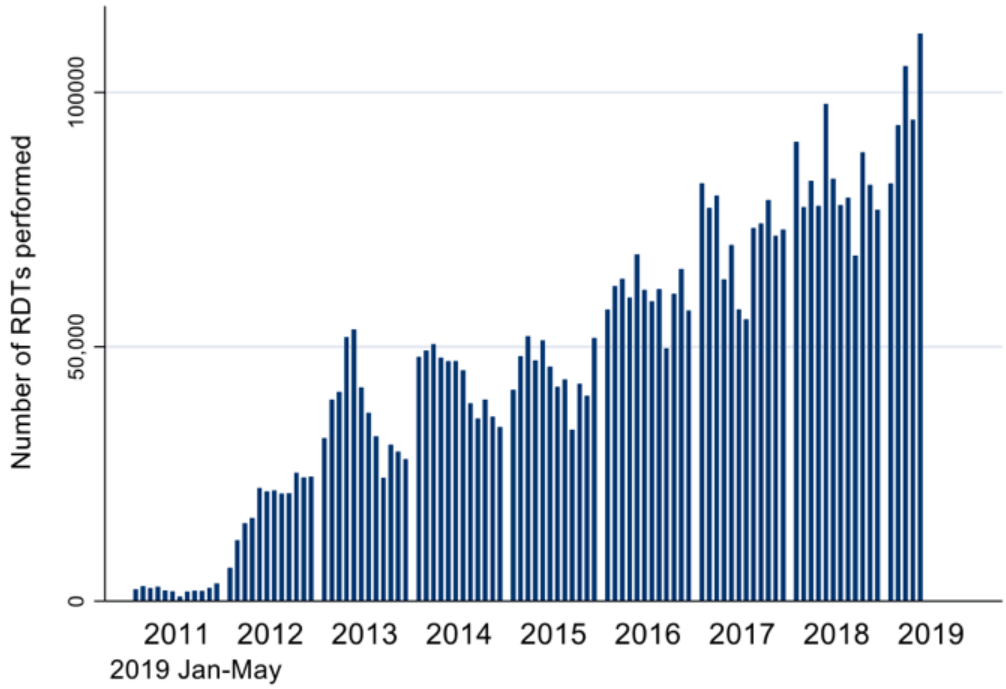
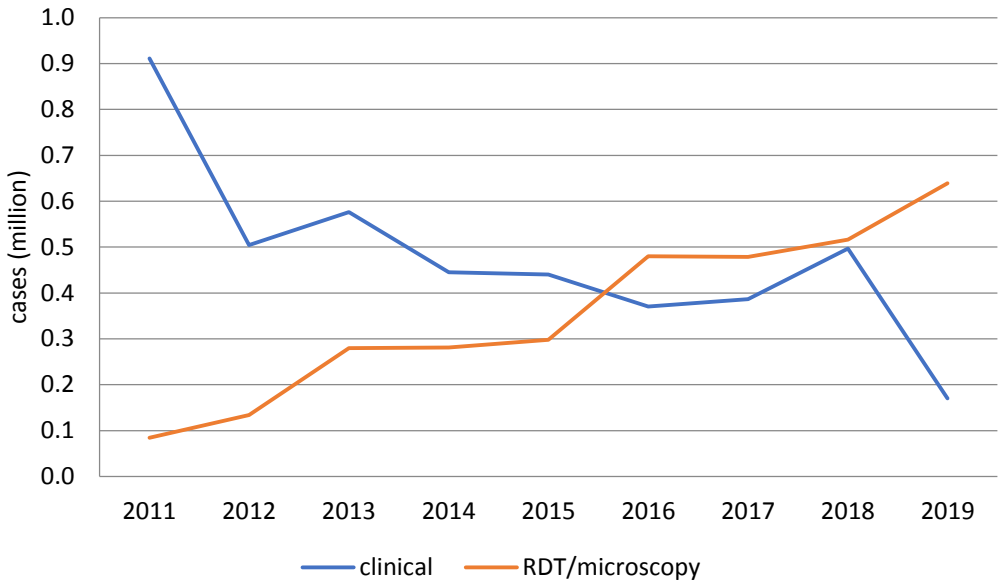


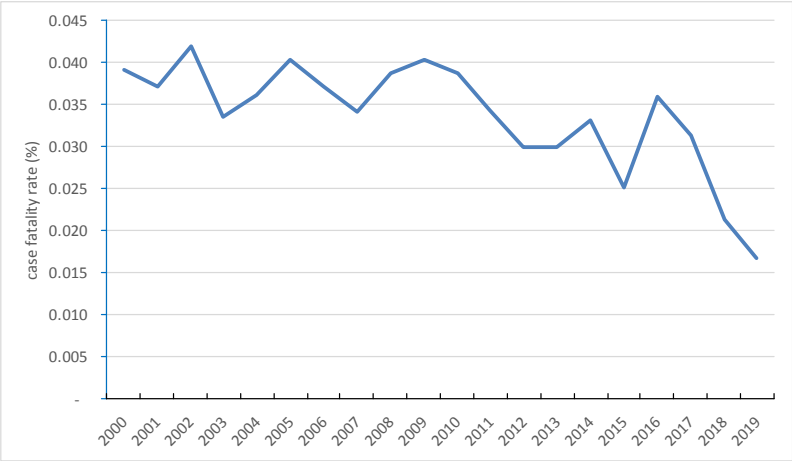
Figure 6. Change in malaria diagnostic approach in PNG since 2011.



Since 2014 there appears to have been a slow but steady increase in reported annual incidence (Figure 4) but again, given the recent roll-out of RDTs (Figures 5 and 6), this passive case detection data from the eNHIS is difficult to interpret.

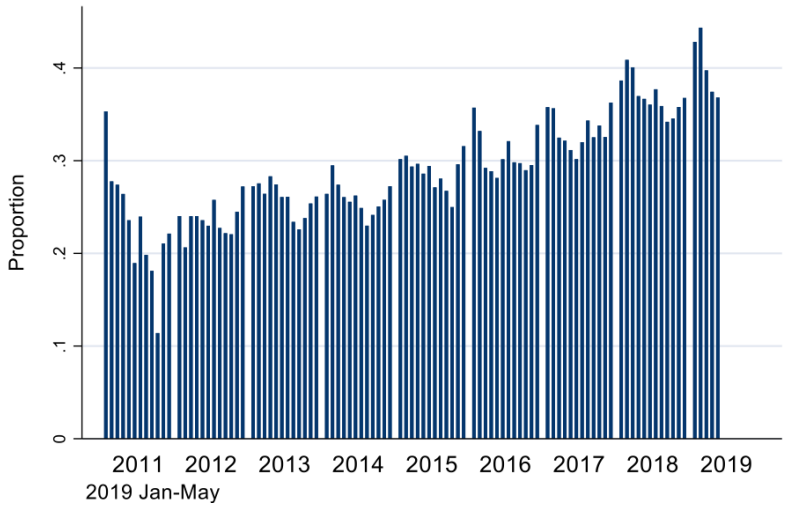
Since 2014, the number of reported deaths has fluctuated between 186 and 306 with no clear trend. It seems highly likely that a large number of malaria deaths go unreported, especially in the most inaccessible areas of PNG. From 2010 there has been a significant but erratic drop in the malaria case fatality rate (Figure 7). This can likely be attributed to the introduction of ACT and prereferral treatment, better access to services and a better trained heath workforce.

Figure 7. Malaria case fatality rates in PNG by year since 2000 (from NHIS data)



There has been a steady increase in the RDT positivity rate (albeit with seasonal fluctuations), at least since 2012 (Figure 8), which in passive case detection data at National level is normally indicative of increasing incidence. An analysis of RDT positivity by region, revealed recent progressive increases, particularly in Southern, Highlands and Islands.

Figure 8. Rapid diagnostic test positivity by month since 2011 (from NHIS data).



The NHIS data presented here broadly corroborates the data from prevalence surveys conducted by the PNG-IMR as part of the program's periodic malaria indicator surveys presented in Figure 3 above.

1.4 National malaria control implementers.

1.4.1 The National Malaria Control Programme.

The NMCP, led by the Program Manager, is responsible for the coordination of activities for malaria and other vector borne diseases in the country. The Program Manager, together with a team based in Port Moresby, provide policy direction, coordination and technical assistance for the implementation of activities across the whole of PNG. The nationally based team includes four Regional Malaria Coordinators (RMC), who have a strong focus on M&E and providing technical support to provincial partners.

At the provincial level, the Provincial Malaria Supervisors (PMS) work closely with the Provincial Disease Control Officers and staff at health facility level to monitor, measure and improve malaria control activities (e.g. diagnostic services, treatment and routine reporting). The NMCP is not a vertical program, and the planning, implementation, coordination and monitoring of control activities are integrated into the health systems at all levels.

1.4.2 Implementing partners.

Beyond the NDoH there are a broad range of non-governmental stakeholders involved in the implementation of the national malaria control strategies. The Church Medical Council oversees primary, secondary and tertiary level health services provided by church groups of various denominations. These faith-based services work in cooperation with governmental services providing healthcare for approximately 50 percent of the population. The government provides an operational budget for these services. As well as providing routine diagnostic and treatment services for malaria, the church-based health services coordinate and support the distribution of LLINs in their catchment areas.

A number of NGOs also play an important role in the national malaria control effort:

RAM takes the lead in importing and distributing LLINs. The majority of these nets are supported by the Global Fund (and since 2017 increasingly by AMF) and are provided free of charge through rolling three-yearly mass bednet distribution campaigns but some additional LLINs procured directly with RAM's own 'Chasing Malaria' funds are sold at cost price to other groups involved in bednet distribution such as NGOs and private sector mining and plantation companies. RAM is also

supporting the supply and supervision of health workers in the periphery as well as BCC efforts. RMCs are assigned to deliver RDT/ACT/PQ to health facility staff on a quarterly basis, they provide on job training to health facility staff on how to use RDTs and how to stress the importance of adherence to national malaria treatment protocol during IPC. In addition, they train officers in charge (OIC) how to report malaria data using the monthly eNHIS form. In 2018-19, RMCs visited 592 road and boat accessible health facilities out of total 825 health facilities. These visits are jointly done in collaboration with the local PMS.

A number of corporate groups working in PNG support their employees, their employees' dependents and communities surrounding their facilities. Some gold mines, oil fields and oil palm plantations provide high quality health services in-line with NDoH guidelines. In the best examples, staff accommodation is screened against mosquitoes and sprayed with insecticide and LLINs are provided for all occupants. This is not however universal.

Academic institutions such as the Divine Word University (DWU) played a key role in training health workers under the round 8 Global Fund grant. PNG-IMR, which was established through an act of Parliament to conduct medical research, has been a key partner for the NMCP, responsible for the independent evaluation of the interventions it implements. It is a leading research establishment with a long and distinguished history of academic research in the field of malaria. The University of PNG and the University of Goroka (UG) also provide additional support for training, quality assurance and operational research.

A number of training institutions in PNG have specific health related training programs leading to diploma and degree level qualifications. These include the University of PNG, Pacific Adventist University, UG, and the DWU as well as Nursing and Community Health Worker Schools. Community health workers, including village health volunteers and village birth attendants are trained primarily by the various church health agencies.

Professional societies: The PNG Medical Society, Nurses' Association, Health Extension Officers' Association and the Pharmacy Society all play vital roles in enhancing the quality of malaria related training especially in terms of malaria diagnosis and treatment.

WHO provides technical support for the NMCP including one full time malaria advisor and short-term technical assistance (TA) when needs arise. In the past it has also supported the procurement of equipment and commodities on request. WHO's Western Pacific Regional Office provides technical backstopping support and regional coordination. The Australian Department of Foreign Affairs and Trade (DFAT) also provides substantial technical support to the NMCP and the broader NDoH.

The Australia-China-Papua New Guinea Pilot Cooperation on Malaria Control (the 'Trilateral Malaria Project') is an inter-governmental partnership that commenced in December 2015 and was the first substantial trilateral collaboration in the Asia Pacific region aimed at combatting the disease. Since 2016 the three countries have been working to improve malaria diagnosis within PNG by strengthening laboratory diagnostic services and operational research, in line with several priorities outlined in this strategic plan. The three countries have committed to continued collaboration in malaria and health security for the next 10 years (2020 to 2029), with the second phase of collaboration running from 2020 to 2023.

In 2018-19, an assessment of mass drug administration using Artequick (artemisisnin and piperaquine) was conducted by a team from the University of Guangzhou in partnership with local health authorities. Unfortunately, this study lacked a robust baseline. Nevertheless, PNG-IMR is now assessing the intervention's long-term effectiveness. So far the findings have not been promising however as high prevalence of sub-microscopic infections has been found even after the 3rd round of treatment (57 percent in 1 community). The preliminary conclusion from this study is that MDA programs must have a strong surveillance and response component if MDA is to be implemented

successfully. The 2019 MPR report recommended that only WHO pre-qualified drugs should be used in future MDA programs in PNG.

There are also several private sector pilot elimination projects under planning in the country including: the Lihir Malaria Elimination Project (2016-2018) and New Ireland Provincial Malaria Alliance (NIPMA; a joint partnership between the New Ireland Provincial Government and the private sector).

1.4.3 Community engagement.

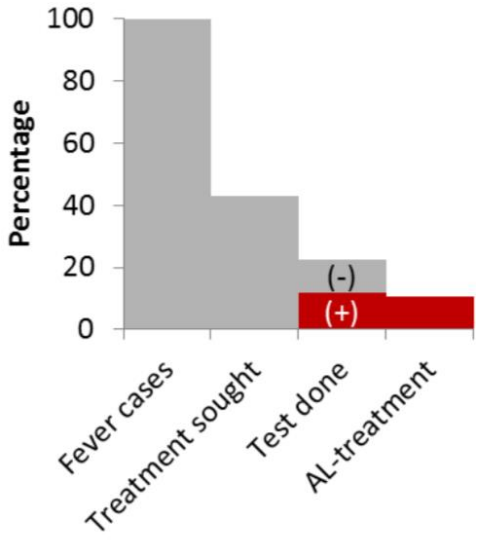
Community engagement in malaria treatment and control still remains relatively low except in areas with HMM where community volunteers test and treat malaria. There have been other small projects such as the 'Chasing Malaria Project' in Central Province which works with schoolteachers and school children in malaria control at community level. Healthy Village malaria volunteers have also helped with knowledge, compliance and vector control.

1.5 Challenges facing the national malaria control and elimination effort at present.

The implementation of the 2014-2020 National Malaria Strategic Plan (NMSP) has been hampered by financial constraints as well as human resource capacity and management constraints. While, despite the constraints, a great deal of progress has been made in many programme areas, in some programme areas the funding cuts and other issues have resulted in stagnation and slippage. Nonetheless, many useful lessons have been learnt during this period.

Treatment seeking behaviour and case management practices. The target of 65 percent of children with a fever in the past two days seeking advice or treatment has not been reached on a national or regional level (sub-national numbers are difficult to interpret due to small sample size). The percentage of fever cases brought to a health facility for treatment has remained almost constant and below 50 percent since 2009. While the testing rate has steadily increased, still only about half of all suspected malaria cases that attend a health facility are tested (PNG-IMR household surveys, 2016-17). The proportion of test-positive cases receiving the first-line treatment has further increased yet remains below 100 percent. Together, low health facility attendance and low testing rates lead to about three quarters of all potential malaria cases in the community missing the opportunity of a proper diagnosis and treatment (Figure 9).

Figure 9. Percentage of fever cases for whom treatment was sought outside home, and who were tested and treated with artemether-lumefantrine (AL) in case of a positive test [PNG-IMR 2018].



LLINs. Household surveys conducted by the PNG-IMR in 2016-17 revealed that across PNG, 80 percent of all households owned at least one long-lasting insecticidal net (LLIN). The target of 85 percent for this indicator was not reached on a national level but it was reached in 11 out of 18 provinces surveyed. A total of 51 percent of the household members slept under an LLIN the night before the survey. Among children less than five years old and pregnant women in households that owned at least one LLIN, this figure rose to 72.0 percent and 70.5 percent respectively. Utilization rates still however fall below PNG's ambitious national targets of 80 percent.

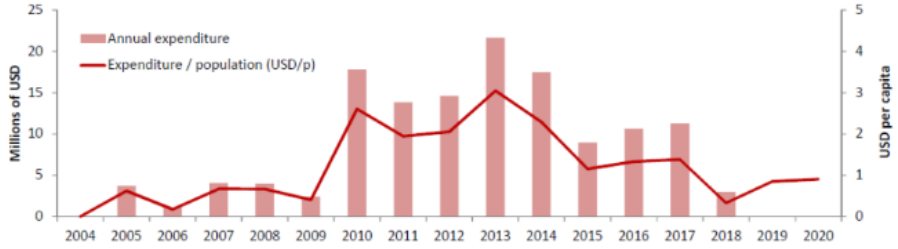
Despite the high level of LLIN coverage achieved through rolling three-yearly mass distributions over the last five years, the malaria burden has increased significantly since 2014. Malaria prevalence across PNG increased by an estimated 8.6 times between the 2013/14 and the 2016-17 surveys (Figure 3). As a result, the target of less than 2 percent prevalence in children under five years of age has not been reached on a national or regional level in areas below an altitude of 1,600 metres.

Fluctuations in funding. Funding, both external and domestic, has fluctuated very considerably over the last decade or so (Figure 10).

Figure 10. Fluctuations in external and domestic funding 2004-2019.

Global Fund funding

Source: GFATM



PNG Government funding (in PGK)

Source: GoPNG

Hetzel et al. 2019 (manuscript in preparation)

Given the impact that the COVID-19 pandemic has already had on the global economy and international aid budgets, there are now very few prospects that donors would provide significant additional new funding for malaria; this effect is expected to last the full five years' duration of the present NMSP. Investments in COVID-19 preparedness and response linked to primary health care, surveillance and PSM represent the only possibilities to leverage new donor resources until global economic conditions stabilise and improve.

Malaria resurgence. The start of the resurgence in malaria in 2015 coincided with: a reduction in the Global Fund support to the PNG malaria control programme after 2013; a simultaneous decline in PNG public expenditure in the health sector; and a decrease in the availability of ACT and RDTs across PNG, including extended stock-outs in many places. At the same time, entomological studies conducted by PNG-IMR have confirmed frequent outdoor biting of local Anopheles species and a shift in peak biting to earlier times in the evening. Both behavioural features may contribute to reducing the effectiveness of LLIN. Further investigations mounted by NMCP in partnership with RAM and PNG-IMR have revealed that very low bio-efficacy of LLINs procured from 2014 onwards may have been a significant factor in the malaria resurgence. Insecticide resistance, another major threat to the effectiveness of LLINs, has not yet been detected in PNG. Preliminary studies have detected artemisinin resistance in certain parts of the country but the full extent of the situation is yet to be fully understood. Investigations are continuing.

Natural disasters and extreme weather events. PNG's location on the seismic 'Rim of Fire' and its exposure to extreme climatic events in the Pacific make it one of the most vulnerable countries to natural disasters in the Asia-Pacific region, including due to earthquakes, volcanic activity and tropical cyclones.[15] Extreme weather and environmental events may have a direct impact on health and malaria programme implementation through damage to health facilities, disruption of supply chains and blockage of programme access to communities. Climate change and climate variability are likely to increase the frequency and severity of extreme weather events in PNG and the Pacific.

Implementation quality. The quality of implementation remains poor in many areas of operation, often due to broader health system issues and the difficult accessibility of remote locations. Ill-committed workers and corruption are also challenges hampering implementation.

[15] National Disaster Centre, 2017. *PNG National Disaster Risk Reduction Framework, 2017-2030*.

1.6 Planned mitigation measures to address the challenges currently facing the national malaria control and elimination effort.

The remarkable progress achieved by PNG's NMCP in recent years has suffered a major setback. As a consequence, the first part of the PNG Department of Health's vision of 'a substantial and sustained reduction in the burden of malaria in the near term (2014-2018) and mid-term (2019-2024)' has clearly not been achieved, and the longer-term goal of malaria elimination by 2030 is less likely now than it was at the time the NMSP 2014-2018 was drafted.

An immediate and concerted effort is required from all stakeholders to ensure that malaria control efforts are brought back on track and intensified, so that the aim of regional malaria elimination by 2030, which the political leaders of the Asia Pacific Region have committed to through Asia Pacific Leaders' Malaria Alliance (APLMA), does not become an unreachable goal. For this to happen, a substantial increase in funding will be required for PNG's malaria elimination effort and for health system strengthening more generally.

Emphasis now needs to be placed on an innovative approach to tackling health system strengthening and improving the quality of services delivered by the NMCP and its implementing partners.

The programme will work with PHAs to develop committed driven teams at provincial and district levels, trained and involved to increase the quality and sustainability of activities. PHAs need to do more. Burden reduction or elimination of malaria in respective provinces will be made a KPI in order to urge Chief Executive Officers (CEOs) into action. The programme and its partners will also place emphasis on strengthening district health management teams to rejuvenate the national malaria response. This will include recruiting and training 28 district malaria officers (one for each district) to bolster the malaria response.

The expansion and use of 'smart systems' data and communication systems will be accelerated to improve supply and demand side planning and management of malaria commodities and to strengthen implementation of programme activities.

The programme will implement 'system methods and tools' to improve diagnosis and treatment, build competencies and promote provision of quality care.

PHA's must develop the capacity to deliver their own supplies through their PMS, logistics officers, ancillary staff and through the development of a network of pharmacy assistants. Making these improvements will take time, but the approach will result in major cost savings over the current private sector model (a push system). Although at present the principal recipient (RAM) is working primarily with Area Medical Stores to strengthen supply, its longer-term goal will be capability development within the PHA supply chain to enable them to take over distribution of malaria commodities. RAM's support will be holistic and integrated into routine supportive supervision.

The programme will seek support from DFAT, the Japan International Cooperation Agency (JICA) or other appropriate agencies for the placement of experienced professional volunteers within PHA Offices in poorly performing provinces to work alongside NDoH staff providing day-to-day technical support for management, planning and operations and thereby bolster implementation.

Much more will be done to engage with PNG's wealthy private sector to support malaria control and elimination efforts more widely. There will be much more emphasis on raising the profile of malaria and a suitably qualified individual (or group) will be formally tasked with this role. The leadership role of NMCP will also be strengthened to ensure that, in future, it is responsible for all decisions affecting national malaria control and elimination efforts.

Depending on the outcome of bio-efficacy tests on recently distributed LLINs, the NMCP may need to replace all existing LLINs with new fully functional LLINs as a matter of urgency.

IRS acceptability assessments and small-scale efficacy trials will be conducted to support the development of a roadmap to guide the re-introduction of IRS (if deemed appropriate based on assessment outcomes).

The programme will enhance health worker performance by incorporating broader febrile case management training into RDT training; where possible and appropriate, this approach will leverage funds and collaborative training opportunities for integrated surveillance of fever, acute respiratory tract infection (ARI) and influenza-like illness (ILI) as part of evolving COVID-19 preparedness and response. It will also take advantage of the current revision of Nurse and Community Health Worker (CHW) curricula, to update the malaria component. Further revisions to the health worker training approach may be required following the 2019-20 MIS, TES and the forthcoming review of the National Malaria Treatment Guidelines (NMTG).

The CPHL's recently established External Quality Assurance (EQA) scheme for microscopy will be rolled-out to all high level health facilities with microscopy.

Given the problems supplying the four different weight-group-specific ACT blister packs in the correct quantities, health workers will continue to be trained and supported to improvise use of alternative blister packs when particular weight-group packs become unavailable (by cutting-up higher weight-group blisters or combining lower weight-group blisters). The possibility of introducing other packaging/blister solutions will be explored.

Injectable artesunate is the first-line treatment for severe malaria in PNG and the drug of choice. Its supply and use will be ensured through regular training on proper preparation and administration. Training will place further emphasis on restricting the use of injectables for the treatment of *severe* malaria only.

PHAs will adopt and roll-out community-based malaria case management services to all high burden communities beyond reasonable reach of a functioning health facility with minimal possible delay. Priority will be given to the most endemic, remote and inaccessible communities. Services for ARI and diarrhea will be included at a later stage, once the capacity to integrate these add-on interventions smoothly has been established or as part of expanded COVID-19 preparedness and response.

IPTp will be further strengthened in collaboration with Family Health Services Branch. Stock issues will be addressed so stocks of SP in health facilities throughout the country are maintained at all times.

The programme will conduct an urgent expert review of its NMTGs. Special consideration will be given to the guidelines for the radical treatment of relapsing malarias.

The periodic school surveys currently supported by NMCP, RAM and WHO will continue but will be adjusted and strengthened to ensure that they are technically robust and that they meet the required ethical standards and serve a clearly defined purpose.

Every effort will be made to ensure that adequate resources are allocated both for operations research and for the regular scientifically sound surveillance required to monitor programmatic progress at outcome and impact levels and guide strategy and policy formulation.

The programme will develop a robust mechanism for malaria outbreak preparedness, detection and response, incorporating closer collaboration with the national Disaster Centre.

The national communications strategy will build on the branding, messaging and tools already developed for health workers ('Prevent, Test, Treat, Track.'), school children and for community engagement.

1.7 Malaria risk stratification

Malaria is a focal and sometimes sporadic disease and it is thus essential in malaria control and elimination to identify the areas and populations at high risk, which must be prioritized for targeted interventions and mobilization of limited resources.

PNG has developed a number of standardized approaches to monitor the malaria situation with the aim of informing evidence-based decision making: there is the NHIS that covers clinical cases country wide; there is the extended eNHIS with individual-level tablet-based data collection in a number of pilot provinces; and, there are the country wide Malaria Indicator Surveys (the 5th round of which was completed in early 2020). In addition, on a smaller scale, there are sentinel sites run by the PNG-IMR and school malaria surveys in the Highlands also run by the PNG-IMR specifically intended to inform the stratification of malaria risk in the highlands and highlands fringe areas thereby complementing and validating the routine NHIS and MIS data.

PNG-IMR is in the process of reviewing the appropriateness of the current altitude-based approach to stratification which assumes that:

- Malaria is endemic and stable up to 1,200 metres.
- Malaria is epidemic prone between 1,200 and 1,600 metres.
- Only *P. vivax* is transmitted above 1,600 metres.
- There is no malaria transmission above 2,000 metres.

In order to do this the institute is:

- Using eNHIS monthly reports from health facilities to update detailed incidence risk maps.
- Improving incidence estimates at health facility catchment area level for different demographic groups using spatial analyses tools.
- Incorporating other data sources including malaria register, MIS, prevalence studies and expert feedback in the stratification exercise.
- Estimating disease burden in different strata including pre-elimination, high burden and special zones.
- Modelling impact of interventions at different strata using a combination of scenarios based on deliverables and deployment.
- Pilot testing modelled scenarios at specific sites to improve the model framework and optimize the targeting of interventions.
- Producing annual reports of risk strata and modelled interventions specific to each province to improve decision making on allocation of antimalarial commodities.

Under this NMSP, intervention thresholds will vary according to the intervention in question: Any health facility catchment area below 2,000 metres will be targeted for mass distribution of LLINs (or IRS if IRS proves acceptable and LLIN use is low); Any village more than three hours walk from the nearest functional health facility that has malaria prevalence amongst children greater than a set threshold (to be decided) will be targeted to receive community-based case-management services (with communities prioritized on the basis of prevalence and degree of remoteness); Any health facility catchment area with an API less than 1 in a designated elimination setting will be targeted for case-based surveillance for elimination (immediate case reporting, investigation and classification followed for any suspected foci by focus investigation, classification and, where appropriate, active focus response within seven days).

The stratification will continue to be updated by the NMCP, PNG-IMR and other technical partners annually immediately prior to the annual review meeting and activities will be targeted or retargeted accordingly. Continued flexibility on the part of funding partners will be required to accommodate

this retargeting. This approach will allow the programme to re-focus Global Fund support on a regular basis in a way that will maximize the cost-effectiveness of the interventions that it funds.

1.8 Programme priorities

The remarkable progress achieved by PNG's NMCP during the first part of the last decade has suffered a major setback recently and an immediate and concerted effort will be required from all stakeholders to ensure that malaria control efforts are brought back on track and intensified, so that the aim of regional malaria elimination by 2030 does not become an unreachable goal. Emphasis now needs to be placed on an innovative approach to tackling health system strengthening and improving the quality of services delivered by the NMCP and its implementing partners.

Programme priorities include:

- Immediately augmenting intensive malaria prevention and case management services targeting
    - populations in PNG's most remote and most endemic communities.
    - PNG's most disadvantaged populations in urban settlements[16].
- Supporting capacity development especially at district and at provincial level nationwide, including through the deployment of experienced public health volunteers in weaker provinces.
- Accelerating the expansion and use of 'smart systems' data and communication systems to improve supply and demand side planning and management of malaria commodities and to strengthen implementation of programme activities.
- Rapidly accelerating burden reduction efforts in the two lowland provinces of Madang and Morobe which are key sources of malaria infection that threaten epidemic prone highland provinces.
- Rapidly accelerating burden reduction efforts and progressively rolling-out malaria elimination activities in selected provinces or islands embarking on elimination.
- Ensuring safe radical cure of *P. vivax* by qualified service providers.
- Raising the profile of malaria and increasing multisectoral engagement to support malaria control and elimination efforts much more widely.

1.9 Interventions targeted by province

The targeting of accelerated burden reduction and/or elimination in selected provinces presented here was developed in order to take advantage of the Malaria Elimination Initiative in Melanesia and Timor Leste (MEMTI), a new funding stream introduced by the Global Fund for the 2021-23 funding period. The approach has been informed by a malaria-focused health system 'landscape' analysis and impact modelling, and a MEMTI financing scoping exercise – both commissioned by the Global Fund.[17,18] The MEMTI approach is designed to:

- Significantly accelerate the elimination of malaria in eligible countries. [19]
- Move away from a 'business as usual approach'.
- Work within a broader health system strengthening approach, avoiding a vertical disease 'silo' approach.

[16] Many urban centres in PNG have large squatter settlements (slums), many of which are highly endemic for malaria particularly in the lowlands.

[17] Malaria Elimination Initiative (University of California, San Francisco), Nossal Institute for Global Health (University Of Melbourne), 2020. *A landscape analysis to assess the technical, operational and financial feasibility of malaria elimination in Papua New Guinea, Solomon Islands, Timor-Leste and Vanuatu*

[18] Ian Anderson, Manuel Hetzel, and Luis Segura. MEMTI discussions in PNG: findings and key recommendations. 31 March 2020.

[19] i.e. Papua New Guinea, Solomon Islands, Timor-Leste and Vanuatu

- Act as a catalyst or lever for new investment in malaria and malaria-relevant health system interventions, or synergistically with existing investments , public-private-philanthropic partnerships and future programmes (be they malaria specific or broader health system strengthening related).

The *Landscape Analysis* identified a number of high priority health system barriers to malaria elimination, and modelled what might be achieved if interventions could be put in place to address them. They include:

- PHAs providing a more effective organizational platform to deliver quality health services (and working to effectively integrate malaria control and elimination strategies into broader service delivery)
- Unblocking financial flows to facilities to allow effective and regular outreach, particularly to remote and difficult to access areas
- Supporting efforts to improve the quality, production and management of the health workforce, including though supervisory outreach to facility level to strengthen quality of care
- Further development and roll-out of the eNHIS malaria surveillance module
- Ensuring provision of essential medical supplies to health facilities (if necessary, using parallel systems) pending strengthening of Government PSM systems
- A more research-informed understanding of the drivers of health-seeking behaviour in relation to malaria (and health service utilisation more broadly), to develop and implement a better-targeted Social and Behavioural Change Communication strategy
- Continuing to support the PNG-IMR and other PNG institutions to produce high quality and timely research and analysis of malaria-relevant health service performance.

These recommendations will be addressed through a combination of within-programme approaches and partnerships with other Government- and partner-supported activities and interventions addressing health system performance at national and – particularly – provincial level. The targeting under this NMSP also takes into consideration GoPNG priorities as well as feasibility and affordability:

1. All provinces will continue to provide an essential package of vector control and personal protection services and case management services as well as behaviour change communication. The latter will aim to maximize the utilization of these services.
2. All provinces and districts will benefit from a range of innovative capacity development measures.
3. Madang and Morobe Provinces will implement accelerated burden reduction in order to protect the epidemic prone highlands, by reducing infection risk for migrants and mobile populations returning from these provinces to the highlands.
4. In addition, there will be a phased roll-out of accelerated burden reduction and elimination in selected provinces or islands. These provinces or islands will act as pilot or demonstration projects which will generate lessons and encouragement for a broader national roll-out of elimination measures later on during the current decade. Provinces will be selected based on a range of criteria including the strength of their PHA, the drug resistance profile of malaria parasites locally, their strategic significance in terms of forming an elimination buffer zone between PNG and its malaria endemic neighbours, availability of significant co-financing, presence of active private or philanthropic health partnerships with the public sector, vulnerability to reintroduction of parasites and the likelihood of reestablishment of transmission in the event of reintroduction of parasites. The number of provinces and islands selected with take into consideration overall financial feasibility.

1.10 NMSP development process

This NMSP was developed by the NMCP in consultation with WHO and other technical and implementing partners. The development process included extensive country dialogue with stakeholders and experts. The strategy is in-line with WHO's 'Regional Action Framework for Malaria Control and Elimination in the Western Pacific: 2016-20', 'Global Technical Strategy for Malaria 2016-2030', and 'A framework for Malaria Elimination (2017)' and takes into account lessons learned from implementation of malaria control efforts in PNG during the past decade. Its development was informed by recent MPR and MTR reports and by the 2020 MEMTI analysis.

The document will serve as reference for all institutions working on malaria elimination in order to ensure that their efforts are aligned with those of the NMCP.

2. Strategic framework.

2.1 Vision

A malaria-free Papua New Guinea by 2030.

2.2 Mission

Improve, transform, and provide quality malaria prevention and case management services through innovative approaches supporting primary health care and health system development and good governance at all levels. The malaria control and elimination programme will help to alleviate poverty amongst PNG's most marginalized people.

2.3 Goals

- Reduce malaria morbidity by 63 percent by 2025 (i.e. from 66.3 per 1,000 in 2019[20] to ≤ 25.8 per 1,000 in 2025).
- Reduce malaria mortality by 90 percent by 2025 (i.e. from 1.697 per 100,000 [146 deaths] in 2019 to ≤ 0.165 per 100,000 [16 deaths] in 2025).
- Eliminate malaria in the Autonomous Region of Bougainville by the end of 2025 and prevent reestablishment of transmission once malaria-free.[21]

2.4 Objectives

1. Malaria vector control and personal protection. Coverage of locally appropriate quality assured strategies for vector control and personal protection optimized nationwide.

2. Malaria case management. Universal access to quality assured early diagnosis and appropriate treatment.

3. Behaviour Change Communication. Community-based support for malaria control and elimination efforts mobilized and utilization of prevention and case management services maximized.

[20] 639,048 confirmed cases in 2019 (NHIS).
[21] NDoH will introduce subnational certification of elimination from 2028 based on zero indigenous cases for 3 consecutive years.

4. Surveillance and response. A strong routine disease surveillance and response system in burden reduction settings and a robust case-based surveillance and response system in elimination and prevention of re-establishment settings.

5. Enabling environment. A strong enabling environment for malaria control and elimination.

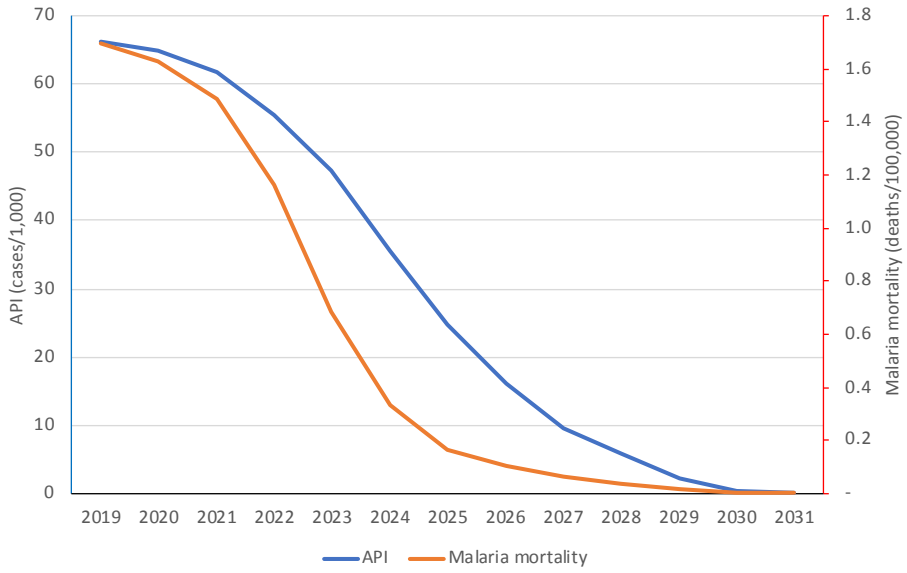
2.5 Timelines and targets

Figures for annual parasite incidence (API) and malaria mortality presented in Table 1 were modelled by NMCP with support from WHO based on actual reported figures for 2019 and on the goal of ending indigenous transmission during 2030 (Figure 11). A full set of indicators and targets is presented in Table 2 (section 4).

Table 1. Timelines and key targets for the National Malaria Control Programme (NMCP) 2020-30[22].

	2021	2022	2023	2024	2025	2030
National API (cases/1,000 pop)	≤ 61.7	≤ 55.6	≤ 47.2	≤ 35.4	≤ 24.8	≤ 0.5
National mortality (cases/100,000 pop)	≤ 1.80	≤ 1.41	≤ 0.83	≤ 0.40	≤ 0.20	≤ 0.0

Figure 11. Projected API and malaria mortality for PNG from 2020-2030 (2019 figures actual reported).



[22] N.B. Improvements in malaria case reporting resulting from the roll-out of eNHIS and associated capacity development may result initially in an anomalous increase in reported API.

3. Key interventions and activities.

3.1. Malaria vector control and personal protection.

ITNs/LLINs and IRS are core interventions for reducing the human biting rate and vector survival, which significantly reduce vectorial capacity and transmission. ITNs/LLINs provide protection for the occupants of houses against biting malaria mosquitoes by acting as a physical barrier and more importantly killing them before they can take a blood meal, whereas IRS kills mosquitoes that rest indoors after they have taken a blood meal.

Implementation will be in-line with WHO's 'Global vector control response 2017–2030' to ensure optimal use of resources. Selection and use of insecticidal interventions will follow technical recommendations provided in WHO's 'Global plan for insecticide resistance management in malaria vectors'. Core vector control interventions will include achieving high levels of personal protection using LLINs, and the use of IRS with long-lasting non-pyrethroid insecticides in selected areas to accelerate the reduction in malaria transmission. Where appropriate, larval source management and other vector control measures may be added as supplementary interventions in specific areas.

The programme will work towards more evidence-based targeting of locally appropriate vector control and personal protection interventions. Stratification will increasingly guide mass distribution of LLIN targeting burden reduction settings, while case-based surveillance will guide focal responsive measures in elimination settings.

At present the public sector does not have the robust management and financial mechanisms to deal with the large sums of money involved in Global Fund funded LLIN delivery at provincial and district levels. In the short-term the management of the LLIN project will therefore continue to be outsourced to a suitably qualified external agency. This agency will ensure that the robust approach to financial management and micro planning developed over the last several years continues. Emphasis will however be placed on building the capacity of NMCP and PHAs to manage all vector control and personal protection interventions internally in the future. The agency managing the LLIN project will be tasked with building the capacity of malaria staff at central, provincial and district levels to take over the management of the project, initiating progressively staged handover of implementation of mass LLIN distribution by the end of 2025. From the outset PHA staff in the periphery will be involved in the analysis of net coverage and distribution data and in the broader planning process.

Entomology teams from NDoH and PNG-IMR will be responsible for evidence-based coordination and monitoring of vector control efforts. They will monitor the coverage and quality of interventions, including the 'within village' and 'within house' coverage of IRS, the physical condition of LLINs, and the residual efficacy of insecticides on LLINs and on walls and ceilings with time. LLIN utilization and perceived usefulness will also be assessed.

3.1.1 Implement rolling three-yearly mass distribution of LLINs to achieve universal coverage in target areas.

Free LLINs will be provided for all populations at risk under the altitude of 2,000 metres, to achieve universal coverage.

In order to minimize logistical constraints these LLINs will be delivered through regular 'rolling' mass distributions whereby approximately one-third of provinces will be targeted annually (the 3-yearly periodicity of these mass distributions is based on the expected effective lifespan of the polyester LLINs currently procured).

The target coverage rate for these mass distributions will be 1.8 people per net in-line with WHO standards to achieve 100 percent coverage.

Immediately before each distribution campaign, PHA teams under the guidance of LLIN coordination staff and the project management team (NMCP staff and staff from the agency managing the LLIN project), will conduct a micro-level planning exercise. This micro-level planning will take into consideration which members of each household share a sleeping space in order to ensure 100 percent coverage of LLINs without wastage.

Under the guidance of the project management team, the PMS and their multiskilled district malaria officers[23] will then prepare and organize their teams according to standard operating procedures (SOP) for LLIN distribution. Generally, each team will comprise of one or two local health staff (where available) and village level volunteers. LLINs will be delivered directly to household level or at least to village level wherever possible. All mass distribution operations will be coordinated and monitored by the PMS.

The programme will investigate options for external assessors (e.g. schoolteachers) to conduct LLIN coverage assessments immediately after distribution campaigns in a representative random sample of targeted sites as a component of programmatic quality assurance.

In the event of disasters, outbreaks and confirmed transmission foci, LLINs will be provided to anyone who does not already have access to one. A five percent buffer stock of LLINs will be procured in 2021 and stored at national level to ensure that the programme is adequately prepared to react rapidly in the immediate aftermath of a disaster while the NDC, Provincial Disaster Authorities and donors mobilise resources for an at-scale response; the buffer stock will be maintained at 2-5% of annual orders, depending on rates of utilisation. Stock rotation with LLINs for routine distribution will ensure that these buffer LLINs do not expire. Additional stocks will be procured using emergency relief funding in the event of larger scale disasters.

Given the low bio-efficacy of LLINs distributed in PNG since 2014 the schedule for mass distributions will be changed to ensure that new efficacious LLINs will be delivered to the most endemic areas first (starting in 2020).

3.1.2 Implement continuous LLIN distribution to maintain universal coverage amongst vulnerable and key risk populations.

In addition to these mass distribution channels, continuous distribution channels will be established in order to address population growth plus any LLIN attrition in-between mass distributions. LLIN stockpiles will be established at provincial level and at health facilities to supply these continuous distribution channels. These LLINs will be provided to:

- Every pregnant woman attending ANC services (one net per pregnancy). As well as maximizing LLIN coverage for infants, this approach reportedly has a positive impact on ANC attendance levels.
- Anyone indicating they have lost or damaged their net.
- All confirmed cases, in case they do not already have access to an LLIN.
- Malnourished children (through Maternal and Child Health).
- People living with HIV and TB.
- Prisoners.
- Students at boarding institutions.
- Police.
- Military (LLINs provided by the Australian Defence Force).

[23] 28 new district malaria officers will be recruited (one for each district) to support PMO under this NMSP.

All of those involved in LLIN distribution, whether it be through mass distribution channels or through continuous distribution channels, will use NMCP's standardized recording and reporting tools to ensure that accurate records are kept of all LLINs distributed, in-line with requirements for performance-based funding.

Quantification of LLIN procurement requirements will be overseen by NDoH with technical inputs by WHO and relevant development partners.

Wherever possible, procurement of LLINs will be through the Global Fund's Voluntary Pooled Procurement mechanism. In-country supply management will use the existing inventory system and sub-national storage depots. An assessment will be carried out to verify if there are any gaps in supply chain management and storage facilities for vector control tools and measures will be put in place to improve the system as necessary such as through the construction of additional storage facilities.

All distributions of LLINs will be coupled with intensified locally appropriate BCC to promote community mobilization and maximize high and correct LLIN utilization and care. BCC will also include advice on the use of old LLINs (e.g. for screening windows and doors or for weaving into ropes or sleeping mats and pillows). BCC will also cover other personal protection measures beyond just LLINs. BCC will be an important component of follow-on surveys by community representatives (e.g. Village Councillors and Village Magistrates). All of these BCC efforts will be overseen by BCC Officers.

The operational success of this intervention will be measured by periodic household surveys either through the forthcoming Demographic and Health Survey or through multiple indicator cluster surveys. Outcome targets will be set to at least 90 percent access and 80 percent utilization at the population level.

3.1.3 Re-introduce high-quality IRS with long-lasting non-pyrethroid insecticide to rapidly reduce incidence in high burden areas or to maintain malaria control in areas where LLIN utilization is low (re-introduction dependent on the outcome of trials).

As with LLINs, the effectiveness of spraying the walls and ceilings of houses and animal sheds with residual insecticides is likely to be somewhat constrained by the early outdoor biting habit of *An. farauti*. As with LLINs, IRS can still be expected to have a significant impact on malaria transmission provided that the construction of houses is sufficiently solid to provide enough sprayable surfaces. Although there is no categorical epidemiological evidence (from well-organized randomized-controlled trials) to demonstrate the effectiveness of IRS for malaria control in areas where *An. farauti* is the primary vector, there is ample entomological, circumstantial and anecdotal evidence to indicate that the approach is likely to be highly effective.

IRS, using a long-lasting non-pyrethroid insecticide (to avoid exerting pressure for the selection of pyrethroid resistant vectors that could undermine the effectiveness of LLINs), will be applied in high burden areas (including boarding schools where appropriate) in order to quickly reduce transmission in support of the elimination effort. Improved application equipment and management systems will be introduced as appropriate. One cycle per year for up to three years may be applied in any given target area to reduce API to manageable levels but where there is compelling evidence that transmission has been interrupted, spraying will not be repeated. Therefore, it is expected that in some situations, one cycle per year for one or two years will be sufficient.

The NMCP will also conduct one-off focal responsive IRS in the event of outbreaks in burden reduction settings or in the event of persistent transmission foci in elimination settings. IRS may also be used routinely as an alternative to LLINs in settings where LLIN utilization is low due to behavioural challenges or due to the presence of transient populations (as found in some urban settlements) if objective assessment indicates limited prospects for an optimised bed net programme.

To be effective IRS requires a well-organized operation. Quality implementation requires skilled spray-staff supported by strong field supervisors. Improved compression sprayers with integrated technology to guide spray operators in delivering correct doses have been developed and will be used wherever possible. These systems improve quality of spray and also significantly reduce the training required to build quality spray teams. Training will be rolled-out as required. Provincial-level teams (led by PMS) will be strengthened accordingly and spray-staff will be recruited and trained as required. As with LLINs, IRS operations require careful planning at both the macro and the micro levels (including geographic reconnaissance to ensure the suitability of house construction in target areas). The latest digital technology will be used to improve efficiency and accuracy of ground reconnaissance operations and to strengthen post spray monitoring and evaluation and coverage tracking. Improved planning will allow capacity established in one province to be leveraged for application in another province.

As with LLINs, community mobilization and BCC will be a key component of IRS operations. Volunteer networks will assist in this regard. This is essential to ensure that spray teams have adequate access to homes in order to achieve the high level of coverage (>80 percent) required to maximize impact. Emphasis will be placed on strengthening logistics in order to ensure timely and adequate supplies of consumables, equipment (spray pumps, replacement parts, personal protective equipment etc.) and transport.

Attention will also be given to strengthening coverage assessments and documentation of IRS operations.

In accordance with the national policy the choice of insecticide will take into account safety, efficacy, cost, availability, existing insecticide susceptibility of vectors, and likely effect on susceptibility of vectors. Guidelines on the management, monitoring and correct use of insecticides (including annual reporting and mapping of insecticide usage for public health and agriculture and safe disposal of expired insecticide) will be developed and implemented.

3.1.4 Implement supplemental vector control tools and personal protection measures as appropriate among at-risk, high-exposure populations (implementation dependent on the outcome of trials).

Alternative strategies for vector control and personal protection such as house screening, larval source management, topical and spatial repellents, attractive targeted sugar baits and ivermectin as an endectocide for example will be evaluated for use in special high-risk settings, and particularly high population density areas such as urban settlements. Interventions will then be scaled-up where appropriate in close coordination with efforts to promote the Healthy Islands Concept.

3.1.5 Support multisectoral involvement in the provision of vector control and personal protection measures.

Multiskilled district malaria officers will work with PMSs to facilitate stakeholder meetings at national, provincial and district levels. Companies will be encouraged to support NMCP's vector control and personal protection measures as a public good. Larger corporations with large workforces in highly endemic settings will be encouraged to provide staff with insecticide treated clothing.

3.1.6 Implement focal responsive vector control interventions in response to outbreaks in burden reduction settings and confirmed transmission foci in elimination settings.

The programme will provide a tailored vector control and personal protection response to outbreaks in burden reduction settings and to active transmission foci in elimination settings. The responses may include any of the interventions described above, either alone or in combination. Each response will be developed based on an in-depth situation assessment by staff from district, provincial and national level as appropriate.

3.2 Malaria case management.

Providing universal and timely malaria case management is a key component of malaria control and elimination strategies. Quality assured diagnosis by RDT or microscopy and prompt, effective treatment of all malaria cases according to updated NMTGs will remain a high priority, supported by proper training and supportive supervision of healthcare providers. The programme will implement 'system methods and tools' to improve diagnosis and treatment, build competencies and promote provision of quality care in the public sector.

3.2.1 Ensure early and accurate diagnosis.

Ensuring universal diagnostic testing will reduce the over-use of ACTs and reduce drug resistance selection pressure on parasites. The detection of malaria infections will be based primarily on blood examination by RDTs or microscopy. Diagnostic methods with a higher sensitivity than RDTs and microscopy, such as PCR or other molecular-based techniques may be used in specific settings and to support operational research. Malaria diagnostic testing, using either RDTs or microscopy, needs to be readily available at all health facilities throughout PNG (both public and private) and at community level.

Case management training and supervision will continue to stress the importance of timely detection of all possible malaria cases, in high-burden as well as in elimination and prevention of re-establishment areas. Any individual presenting with a fever or history of fever must be suspected as a case of malaria and be promptly tested, regardless of any other known or suspected febrile illness; this rationale will be integrated with COVID-19 based surveillance for ARI and ILI. If the malaria test is negative, malaria treatment should not be administered to the patient unless other possible causes of illness have been adequately considered and ruled out (with patient referral to a higher-level health facility if appropriate).[24]

Microscope-based diagnosis remains the gold standard where staff are highly skilled and adequately supported. In these settings microscopy is more sensitive than RDTs and can be used to quantify parasitaemia and give species-specific diagnoses both of which are beneficial for clinical management. However, where microscopy support systems are weak RDTs are generally far more sensitive and specific than microscopy. In line with the diagnostic algorithm for malaria approved by Senior Executive Management in 2016, microscopy will be strengthened at Level 4 (higher level primary care) health facilities and above. At levels 1-3, hospital outpatients departments and emergency services the programme will focus on improving RDT-based diagnostic services.

In elimination settings (and later in prevention of reestablishment settings) the programme will continue to support malaria testing to maintain an annual blood examination rate (ABER) at or above 16 percent.

3.2.1.1 Access to quality assured RDT-based diagnostic services will be expanded and maintained. The RDT-based diagnostic skills of healthcare providers in the public-, community- and private-sectors will be strengthened through procurement, quality assurance, supply, outreach, training and supportive supervision and needs-based refresher training. This support will be integrated into broader programme activities relating to training and supervision wherever possible.

3.2.1.2 Access to quality assured malaria specific microscopy-based diagnostic services down to district level health facilities strengthened and maintained. High-quality microscopy services will be maintained at hospital level, where microscopy is required to monitor the severity of disease and the response to treatment of inpatients suffering from severe malaria.

[24] A small proportion of RDTs can give false negative results and so treatment can be given based on clinical judgment in case differential diagnosis fails to identify an alternative cause of illness.

Microscopes and spares will be procured through international competitive tender and supplied through the routine supply chain. Procurement of microscopy consumables will be centralized to avoid the quality issues that have undermined microscopy performance in PNG in the past. The NMCP will work to strengthen the capacity of the CPHL to manage microscopy QA and training services. Laboratories will be refurbished and equipped and on-site certification will be introduced for facilities upgrading to provide microscopy services.

CPHL will provide malaria microscopy training, routine supportive supervision and EQA for all public sector microscopists nationwide. This will be linked to needs-based refresher training conducted by the provincially based National Core Group of malaria microscopists. CPHL will also establish and operationalize a slide bank facility for maintaining the skills of microscopists, especially in elimination settings. This may be superseded by an online slide bank facility once one becomes available.

External Competency Assessments will be conducted for all microscopy trainers and assessors (national and provincial level) while National Competency Assessments will be rolled-out for lower level microscopists (district level).

A malaria microscopy database containing details of all microscopy related trainings and assessments will be established and maintained by CPHL and NMCP.

Once public sector services are on track, CPHL will consider training and certification for private sector microscopists.

eNHIS microscopy reporting requirements are currently overly burdensome and much of the data collected is not useful at central level. These reporting requirements will therefore be reviewed and rationalized.

3.2.1.3 Support operation of a fully functional PCR facility at CPHL. A PCR facility has been established at CPHL. This will allow specialists to resolve discordant results from microscopy QA, to distinguish between recrudesce and reinfection during TES, to support molecular surveillance for drug resistance markers and studies as required and to support development of the slide bank. It will not be used for routine diagnosis but may be used for screening specific populations in elimination settings if deemed appropriate based on studies of the transmission-significance of asymptomatic cases.

3.2.1.4 Introduce G6PD testing to support safe radical treatment for vivax malaria cases. Primaquine is used for the elimination of the liver stages of vivax malaria (hypnozoites), which cause relapse of malaria in the months following initial infection. Unfortunately, primaquine can cause mild to severe and potentially life-threatening haemolysis in patients who are G6PD deficient. Point-of-care G6PD deficiency tests have recently been developed and their usefulness in the support of safe radical treatment of vivax malaria is being assessed in various countries. Depending on the outcome of these assessments, routine G6PD testing may be adopted in PNG.

3.2.2 Ensure effective rational treatment nationwide according to NMTGs.

Ensuring prompt provision of effective treatment for all confirmed cases of malaria according to the latest NMTGs is essential, not only to secure rapid clinical recovery in infected individuals, but also to reduce onwards transmission within the population. The use of ACT is essential for schizontozidal treatment for all *Plasmodium* species. In addition, it is important to provide primaquine treatment (single dose) for *P. falciparum* cases as a means of targeting gametocytes and hence reducing onwards transmission, and to provide primaquine treatment (14-day or 8-week regimen) for *P. vivax* cases to target sporozoites and to ensure radical cure by targeting relapsing hypnozoite parasite stages.

3.2.2.1 Provide case management, including the management of severe malaria in public sector health facilities. Antimalarials will be procured and supplied. Case management training and

refresher training will be provided for all public sector health staff covering differential diagnosis, management of uncomplicated, severe malaria, referral and malaria case reporting. There will be special emphasis on safe radical treatment of relapsing *P. vivax* malaria (including with short course treatment where appropriate). The training will also incorporate a module on IPC aimed at providing malaria knowledge on symptoms, free diagnosis and free treatment, improving patient compliance with malaria treatment regimens and improving other malaria related risk behaviour such as personal protection and prompt treatment seeking (IPC materials will be developed for this purpose). Special training will be provided to provincial level doctors on the treatment of severe malaria.

The training will be conducted by PHA Malaria Officers trained as trainers (a recruitment drive will ensure that every PHA has a Malaria Officer) under the supervision of the NMCP.

PHA Malaria Officers will carry-out supervisory visits to all health facilities on a quarterly basis to ensure high quality malaria case management at all levels.

3.2.2.2 Provide community-based case management for malaria in areas beyond reasonable reach of health facilities. Community-based malaria case-management providers (e.g. HMM)[25] will be rolled-out to all endemic communities beyond reasonable reach of a health facility (three hours walk) in collaboration with the PHA, district level health facilities, faith-based organizations, NGOs, the Education Department and the private sector. They will substantially complement and extend the reach of public health services, particularly in rural and remote areas, where health infrastructure tends to be weak or absent and malaria transmission tends to be highest. Community-based providers will also cover schools and refugee camps wherever alternative services are lacking. A detailed blueprint for the roll-out will be developed by the NMCP in consultation with implementing partners. This will take into consideration the many valuable lessons-learned from several years of implementation under the current and previous Global Fund grants. Prior to roll-out, a detailed mapping will be carried out to identify all communities still in need of these services. Priority will be given to the most endemic remote and inaccessible communities as identified as a result of mini-prevalence surveys, which are planned in all remote communities.

Community-based providers will be trained on febrile case management, RDT-based diagnosis, treatment of uncomplicated malaria with ACT, referral and reporting requirements. They will meet on a monthly basis (quarterly if too remote) at their nearest health facility with other community-based providers to discuss the previous month's cases and case numbers, receive updates and training, deliver reports and collect supplies.

3.2.2.3. Ensure private sector case management services adhere to NMTGs and submit reports to eNHIS. The NMCP will provide training based on latest NMTGs (febrile case management, uncomplicated malaria, referral and reporting requirements) to private practitioners (mainly urban-based) to enable them to prescribe quality-assured treatment on the basis of a positive RDT result, in return for reporting positive cases to the national malaria reporting system. Supervision will be carried out on a quarterly basis by the PHA Malaria Officer with the support of district level health staff.

3.2.2.4 Provide intermittent preventive treatment for malaria during pregnancy through ante-natal care services in burden reduction settings. The NMCP will support the provision of IPTp at antenatal clinics as part of the ANC package in collaboration with the family health services. The aim will be to provide women attending ANC with 3 doses of SP at least one month apart from the second trimester of their pregnancies. Training on the administration of IPTp will target all ANC clinics. In order to minimize transaction costs and maximize cost effectiveness this training will be integrated

[25] Services for acute respiratory tract infections and diarrhoea will be included at a later stage once the capacity to integrate these add-on interventions smoothly has been established.

into the NMCP's yearly clinical refresher training. When feasible, the Family Health Tally Sheet used at ANC facilities will be amended to support the monitoring of IPTp activities.

3.2.2.5 Conduct MDA to rapidly reduce malaria burden in certain specific circumstances. Targeted MDA interventions may be used to eliminate the parasite reservoir and interrupt transmission at a rapid pace in elimination settings or to rapidly reduce burden in transmission hotspots in higher burden settings. Introduction of MDA will depend on the outcome of operational research (learning by doing). As more sensitive diagnostic tools become available, there may be an opportunity to replace MDA with proactive case detection through MSAT or focal screening and treatment (FSAT) as an approach to accelerate malaria elimination and burden reduction. Trials will be conducted and SOPs will be developed. These SOPs will clearly define the circumstances in which these interventions should be used.

3.2.2.6 Conduct mass screening and treatment for boarding school children in high burden settings. Proactive case detection (MSAT) will be conducted routinely in boarding schools in high burden areas at the start of each term in order to minimize disease burden. This intervention will form part of the 'School Health' approach, which will include larviciding and other source reduction interventions as well as BCC. SOPs will be developed to ensure that PHAs adopt a robust and unified approach.

3.2.3 Address the issue of sub-standard and falsified antimalarials.

Functional and robust QA and quality control systems (QC) are critical for ensuring selection and procurement of quality assured products and for monitoring product quality throughout the supply chain and for detecting sub-quality products in private sector outlets.

3.2.3.1 Monitor source and quality of antimalarial drugs and RDTs in the private sector. SOPs for QA/QC for antimalarial drugs and RDTs have been developed and approved by the malaria technical working group (TWG). Associated activities will be incorporated into the terms of reference for Provincial Pharmacy Inspectors (PPI). NMCP will work with PHAs and PMSs to ensure that the PPIs are suitably motivated and empowered to conduct regular and robust QA/QC, focusing especially on private sector clinics and pharmacies.

The programme will procure Minilabs® and consumables and train staff at the Medicines Quality Control Laboratory on their use. Monitoring missions will be carried out every 6 months, both in sentinel sites and in additional spot-check sites. Confirmatory tests of selected samples will be carried out at central level. The NDoH decision banning the distribution and sale of sub-standard and falsified antimalarials or diagnostics will be enforced in partnership with the police. Legal action will be taken where appropriate.

The programme will also take steps to address any leeching of supplies from the public sector. Products available in the private sector will be sampled and batch numbers cross-checked with those procured for the programme. Stocks will be confiscated where appropriate in partnership with the police and legal action may be taken against those responsible for misappropriation of public sector supplies.

In recent years inappropriate antimalarials have been donated to the NDoH on a number of occasions. In future, all notifications of donations of antimalarials or diagnostics will be reviewed for suitability (WHO pre-qualified and in-line with NMTG) by NMCP prior to authorisation.

Considering the risk of adverse events arising from substandard or falsified antimalarials, and also the risk of adverse events following PQ treatment in patients with G6PD[26] deficiency, NMCP will advocate for NDoH to establish some minimum pharmacovigilance monitoring standards and functions in PNG, not only for antimalarials but for all pharmaceuticals. The programme will support

[26] Glucose-6-phosphate dehydrogenase.

training on adverse drug reaction reporting. Programme staff and technical partners will also work on pharmacovigilance related process mapping (especially the reporting and feedback pathway) and response procedures. Any malaria related adverse event reports will be reviewed and responded to as appropriate.

3.3. Behaviour Change Communication.

3.3.1 Implement health promotion activities to support the enabling environment for malaria control and elimination, to strengthen knowledge, attitudes and practices amongst populations at risk, and to promote community led engagement.

Malaria prevention must go hand in hand with community participation. Unless individuals in communities see the merits of preventing the illness, even the best-designed prevention strategies might not be used. The NMCP will provide support for malaria control and elimination efforts through comprehensive BCC, community mobilization and advocacy. The NMCP's BCC sub-committee of the Malaria-TWG, led by the NDoH Health Promotion Unit will work with health authorities and implementing partners to educate the various target populations on malaria and its prevention.

The BCC-TWG will review advances in Information, Education and Communication (IEC)/BCC approaches elsewhere in the region and beyond and work towards developing a more holistic and intersectoral approach to strengthening the impact of malaria elimination efforts through the synergies that can be achieved by combining IEC/BCC with integrated vector management, community development and income generation schemes.

Where appropriate attendance at BCC sessions will be maximized through the use of non-monetary incentives.

3.3.1.1 Provide national coordination of IEC/BCC. The IEC/BCC technical working group will hold two meetings per year (integrated into routine NMCP review meetings) and ad hoc meetings as necessary. BCC activities will be coordinated with other health programmes.

3.3.1.2 Train BCC implementers. Train PMS, provincial health promotion officers, environmental health officers and HMM officers to strengthen capacity. These staff will be responsible for the effective management and smooth implementation of IEC/BCC efforts at provincial and district levels and in the periphery.

3.3.1.3 Review, update and develop standardised IEC/BCC messaging. Every three years the NMCP will conduct an assessment of IEC/BCC materials and methodology and revise as appropriate.

3.3.1.4 Identify and prioritize key malaria advocates. The programme will work closely with church groups, the private sector and NGOs to maximize the reach and impact of IEC/BCC efforts. It will also use politicians and sportspersons (e.g. 'The Mosquitoes' football team) to champion the malaria cause and ensure that it remains a high profile health priority until elimination has been achieved.

3.3.1.5 Develop standardised IEC/BCC messaging. The programme will work to develop messaging that is standardised where possible, but always locally appropriate, to ensure that communication materials are clear, relevant and likely to achieve high impact. As there are around 800 languages in PNG the emphasis will be on 'Tok Pisin', which is known universally.

Different messages will be required for burden reduction, elimination and prevention of reestablishment settings. Messages need to be age-group specific and culturally sensitive. The programme will work with PMSs to identify and prioritise target groups and develop evidence based key messages for advocacy, communication and social mobilization (ACSM) interventions using nationally developed guidelines. Messages are likely to cover: care of LLINs and washing practices; the importance of sleeping under an LLIN; the importance of LLINs; the dangers of sub-standard and

falsified antimalarials; the importance of compliance with the full course of treatment; availability of services (advertising the location of and services provided by community-based case management providers etc.); and, the importance to the community of all cases being tested and receiving appropriate treatment in an elimination setting.

3.3.1.6 Develop innovative IEC/BCC mixed-media materials that are able to be locally adapted. The NMCP will work to develop target group specific and locally appropriate IEC/BCC materials and methodologies. Full use will be made of the many IEC/BCCs materials developed with the support of PSI during 2015-2017, which will be updated and contextualized as required.

Materials are likely to include tablet-based tools, IPC aids, audio and video sketches/presentations, billboards, messages on fun run T-shirts, bottles etc., posters, brochures, articles and pamphlets. The approach will be tailored to the specific requirements of the target groups and to the specific requirements of burden reduction and elimination. Products will be developed using a bottom-up approach whereby the programme's target groups are themselves engaged in the process of problem solving through IEC/BCC. The NMCP will advocate to align the messaging with the Standard Health Literacy Promotion Booklet published by Ministry of Health and Sports. Where appropriate work will be carried out in partnership with a commercial advertising agency.

3.3.1.8 Produce IEC/BCC materials. Production of IEC materials will be carried out in-house if possible but where necessary it will be outsourced to a commercial design agency.

3.3.1.9 Support robust IPC by healthcare providers. An IPC-based IEC/BCC programme will be delivered by health staff at every level, community-based case management providers and selected communicators (e.g. community leaders, etc.). All health practitioners trained by the programme will be trained on malaria specific IPC skills (integrated into clinical training). Flip charts and other materials will be designed to support this.

3.3.1.10 Implement school-based IEC/BCC. School based IEC/BCC will target children especially in high burden areas. Malaria modules targeting different age groups will be developed for incorporation into the teaching curriculum. Malaria leaders will be recruited from amongst the pupils tasked with peer-to-peer education. This approach will be developed in close collaboration with the Department of Education.

3.3.1.11 Implement village-based IEC/BCC. Village based IEC/BCC will be delivered through engagement with churches, community-based organizations and NGOs.

3.3.1.12 Implement IEC/BCC through other innovative means. IEC/BCC efforts will also be supported through a range of additional innovative means including sports campaigns, drama groups, social media, text messaging and mass media as well as through integration of IEC/BCC messaging and activities into the 'Healthy Islands' approach.

3.3.1.13 Manage 'World Malaria Day' events at national, provincial and district levels. Every year a large-scale community mobilization event will be held on World Malaria Day (25 April). This is an important opportunity for high level advocacy as it is normally attended by both the Minister for Health and the Health Secretary.

3.3.1.14 Support socialization of malaria elimination through strategic advocacy. Socialization of malaria will be supported by encouraging religious, civil-social, charitable organizations, NGOs and village leaders to be fully involved in malaria elimination. A focal person for malaria socialization will be appointed in each province or island embarking on elimination. In association with community leaders at each level, presentations will be made at least annually to key community groups (during their own scheduled meetings) to update them on malaria elimination related issues and gain their support for programme activities where necessary. The NMCP will work similarly to encourage the private sector, private enterprises and professional associations to actively participate. Provincial health promotion officers will coordinate these efforts under the guidance of NMCP.

3.4. Surveillance and response.

3.4.1 Strengthen capacity for epidemiological analysis to support policy-related decision making at national level and data analysis to support decision making for appropriate action at peripheral level.

With the exception of PNG-IMR, national capacity for epidemiological analysis is extremely limited. The programme and many of its partners lack epidemiological capacity. At provincial level evidence-based decision making for malaria is largely non-existent and many provinces have little data-supported knowledge of the malaria situation.

The NMCP will therefore recruit a senior malaria epidemiologist and health information system (HIS) technical expert to support training workshops and on-the-job training of programme advisors and NDoH M&E officers (NMCP and Performance Monitoring and Evaluation Branch) at national level, and Provincial Health Information Officers (PHIO) and PMSs at province level and to develop a locally appropriate approach to supportive supervision of other malaria related staff at province and district levels. A trickle-down training approach will be developed and integrated into supportive supervision to ensure that staff at health facility level are able to make better use of the data available to them through the use of simple tables, graphs, charts and maps to identify malaria hotspots and monitor trends. This skill-set will be enhanced by provincial and district level staff participating in Field Epidemiology Training in PNG (FET-PNG) whenever places on that CDC- and DFAT-supported programme are available and suitable candidates identified.

The technical expert will also be tasked with simplifying and standardizing the eNHIS reporting format (for both microscopy, RDT and treatment) to ease the associated reporting burden and thereby improve the quality of data entered into the system. This work will link with the malaria-focused 'knowledge hub' that will be established by the Trilateral Malaria Project within the NDoH to synthesise, analyse, interpret and disseminate malaria data. The expert will also supervise, coach and mentor any FET-PNG candidates working on malaria data or within the programme at provincial or district level.

Vector control specialists at PNG-IMR and NMCP will work with international modellers to develop skills and build malaria transmission models based on local data in order to better predict the epidemiological impact of various vector control tools.

3.4.2 Accelerate the expansion and strengthening of the national health information system (eNHIS) and the workforce's capacity to utilise it.

eNHIS contains all of the information a province or district needs to run a successful malaria programme but unfortunately, very few people are using it, even at national level. Use of the eNHIS will be encouraged at national, provincial and district levels through capacity development. The NMCP and the malaria epidemiologist / HIS technical expert will work closely with the Asian Development Bank (ADB) Health Services Sector Development Program (HSSDP) to enhance and quality-assure the format of the malaria module within the eNHIS.

Continuous supportive supervision by the NMCP M&E team and PHIOs and PMSs will be provided until the system is fully functional and fully and effectively utilized for targeting programme activities. PHIOs and PMSs will be supported to collaborate on a monthly basis on the analysis of malaria data and assessment of trends and anomalies to identify and target facilities in need of extra support.

Data quality audits will be carried-out consistently as part of routine supervision.

3.4.3 Incorporate private sector case reporting into eNHIS.

The programme will progressively incorporate private sector reporting into the eNHIS. Large companies in high burden areas and all providers in elimination settings will be provided with

prioritized access to the eNHIS – either through direct data entry or submission of returns to the PMS or PHIO; this will ensure that all malaria cases are captured in the system as the country moves into the last years prior to achieving elimination.

3.4.4 Update malaria risk stratification every two years.

With the increased efforts described in this new intensified NMSP the situation is expected to evolve rapidly and so, in order to ensure that the cost-effectiveness of operations are optimised, the malaria risk stratification will be updated every two years.

3.4.5 Expand and strengthen outbreak surveillance and timely response for epidemic prone areas.

Outbreak preparedness will be maintained in higher burden areas and in outbreak prone parts of the highlands through training and through the provision of equipment and supplies. As noted above, a 2–5 percent buffer stock of LLINs, insecticide, RDTs and drugs will be maintained at national and provincial levels to deal with outbreaks and natural disasters (stock rotation will be applied with routine supplies to minimize expiry); see also disaster response at Section 3.1.1, above.

As with case-based surveillance in elimination/prevention of re-establishment settings, the timeliness of the response is key, and so a '1-7' approach will be adopted. This will require malaria outbreaks to be reported within one day (based on caseload exceeding the threshold of mean monthly caseload for the last 3 years plus 2 standard deviations[27]) and full outbreak investigation and response actions to be taken as early as possible, but within seven days.

A comprehensive outbreak response will be developed based on SOPs and tailored to the specific circumstances of the outbreak area. Key interventions will include focal or mass screening and treatment and may include setting-up a community-based case management provider, providing LLIN top-ups, providing focal IRS and any other vector control and personal protection measures deemed appropriate (see 2.1.6). Where feasible and appropriate, this response will be harmonised with surveillance and response systems for COVID-19 and other febrile illnesses.

3.4.6 Establish case-based surveillance and response for areas targeted for malaria elimination and for prevention of parasite re-establishment.

A transmission focus detection system for elimination and prevention of re-establishment of malaria transmission will be developed and rolled-out progressively to new health facility catchment areas as they transition from burden reduction to elimination. This will be achieved through training and supportive supervision for staff at province, district and health facility levels.

As with outbreak response, the timeliness of the response is key, and so PNG is adopting a '1-7 approach' whereby case reporting, case investigation and case classification will all be completed on day one at the point of care and focus investigation (at the expected site of transmission) and the response to confirmed new active transmission foci will both be conducted as early as possible, but within seven days. Performance will be monitored against this 1-7 benchmark.

The investigation of suspected foci will include focal screening and treatment and mapping according to SOPs and may include entomological assessments where capacity exists and where deemed necessary.

In the event of an active focus of transmission being confirmed, a comprehensive transmission focus response will be developed based on SOPs and tailored to the specific circumstances of the area. As with outbreak responses, key interventions will include focal or mass screening and treatment and may include setting-up a community-based case management provider, providing LLIN top-ups, and

[27] Automated outbreak detection algorithms have been integrated into eNHIS.

providing focal IRS as well as any other vector control and personal protection measures deemed appropriate (see 3.1.6).

Where feasible 28-day follow-up will be carried out by healthcare workers or community-based malaria case management providers to detect any secondary cases.

In order to maximize case detection as a result of the reactive active case detection associated with focus investigation, the programme will support teams to overnight at investigation sites where necessary.

3.4.7 Maintain national level sentinel site surveillance and expand to sub-national level.

PNG-IMR will continue to collect laboratory-confirmed (RDT and microscopy) malaria incidence data in sentinel health facilities across PNG in order to complement and validate the NMCP's routine eNHIS and MIS data. Sentinel site surveillance will also be expanded to support progress monitoring for accelerated sub-national malaria burden reduction and malaria elimination initiatives. In non-IMR-supported sites, this work will also draw on data from other sentinel sites that have been established through the *Stronger Surveillance and Systems Support for Rapid Identification and Containment of Resurgent or Resistant Vector Borne Pathogens in PNG* project (STRIVE).

3.4.8 Conduct malaria indicator surveys three yearly.

A malaria indicator survey will be carried-out every 3 years until disease burden drops to a level at which these are no longer justified. The surveys will focus on: LLIN coverage and usage; treatment seeking practices; and national malaria prevalence.

3.4.9 Conduct health facility surveys three yearly.

Surveys will be carried out in a random representative sample of health facilities countrywide every 3 years to evaluate the outcome of the NMSP on resource availability and health worker practice.

3.4.10 Conduct mini-prevalence surveys in remote villages in suspected high burden areas to inform the roll-out of community-based case management services as per guidelines.

The malaria situation in many remote communities in PNG is a complete unknown. In order to address this important knowledge gap and thereby ensure that these communities are adequately catered for in terms of malaria prevention and case management services, the programme will conduct mini-prevalence surveys (RDTs and blood smears for 20 children) in every community beyond three hours walk from the nearest functional health facility. Where possible these surveys will be incorporated into mass LLIN distribution campaigns to minimize logistical costs. All confirmed cases will be treated according to NMTGs. The resulting data will be consolidated, stratified and mapped and used to target malaria interventions including community-based case management services.

3.4.11 Conduct periodic school surveys in high burden areas.

PHAs will conduct *ad hoc* malaria prevalence surveys in schools in order to develop a better understanding of the malaria situation in their provinces. All confirmed cases will be treated according to NMTGs. The school surveys will also be used for behaviour change communication as well as for community mobilization. As for the routine boarding school surveys, SOPs will be developed to ensure that PHAs adopt a robust and unified approach.

3.4.12 Monitor drug resistance.

NMCP will work with PNG-IMR to monitor antimalarial drug resistance in-line with the latest WHO guidelines and with technical support from WHO. First-line treatment efficacy will be monitored through TES conducted initially in two sentinel sites annually, in selected health facilities across the country. The number of TES sites may be increased over time, depending on capacity. Monitoring drug resistance in *P. vivax* will be carried out in parallel where feasible. Staff will be hired and trained, and equipment procured as necessary.

Blood samples will be collected from hospitals nationwide for molecular monitoring of parasite populations (genetic epidemiology and to detect and monitor markers of artemisinin resistance).

The programme will also prepare for the introduction of Integrated Drug Efficacy Surveillance in areas targeted for elimination.

3.4.13 Establish and maintain a system of essential entomological surveillance, including insecticide resistance monitoring.

Routine surveillance of insecticide resistance will be carried-out at sentinel sites by NMCP in partnership with PNG-IMR and according to WHO's Global Plan for Insecticide Resistance Management. Epidemiological events such as outbreaks and persistent transmission foci will also trigger entomological investigations, the nature and scale of which will be adjusted according to the situation. These investigations may include vector incrimination, monitoring of essential entomological indicators and/or insecticide resistance profiling as appropriate.

A fully equipped entomology laboratory and insectary will be maintained at PNG-IMR. Standard kits for insecticide susceptibility testing will be procured from WHO.

Annual consultation meetings will be held with entomology counterparts at the Department of Agriculture and Livestock (DAL), National Agriculture Quarantine and Inspection Authority (NAQIA) and other technical partners.

3.4.14 Conduct research of high operational significance.

A comprehensive package of needs-based operational research will be supported as far as funding permits. NMCP will work in collaboration with national and international experts and institutes to develop research capacity and improve the quality and relevance of research outputs. Research will aim to addresses bottlenecks in operations and find innovative ways to effectively deliver services to hard-to-reach populations. Research will only be carried-out following the approval of PNG's Ethics Review Committee.

Research priorities will be reviewed annually and revised as necessary but initially at least, topics are likely to include the following:

- Conduct operations research in collaboration with technical partners to optimize the impact and cost-effectiveness of existing and new interventions and strategies (i.e. 'learning by doing').
- Investigate the use of G6PD testing to support safe radical treatment for vivax malaria cases.
- Investigate the causes of residual transmission.[28]
- Pilot new tools, technologies and approaches for malaria control and elimination e.g. spatial repellents (e.g. metofluthrin), topical repellents (e.g. DEET[29]), ivermectin as an endectocide, insecticide treated livestock, attractive targeted sugar baits, etc.
- Investigate population movements between highlands and lowlands, assess associated malaria risks and develop mitigation measures if appropriate e.g. prophylaxis, vector control and personal protection measures for mobile populations, focal responsive LLINs/IRS in the highlands.
- Investigate and develop locally appropriate uses for old LLINs.
- Assess the effectiveness of mass drug administration to rapidly reduce malaria burden in different settings.
- Effectiveness of a peer group education approach for BCC in specific populations.
- Efficacy of prophylaxis for hyper-splenomegaly in children.

[28] The transmission that persists even after achieving universal coverage of effective LLINs and/or maximal coverage of IRS with insecticides containing active ingredients to which the local vector populations are fully susceptible.
[29] DEET – diethyltoluamide.

- Conduct economic research investigating the impact of different factors on malaria.
- Conduct non-malaria fever illness study in selected hypo/mesoendmic areas

3.4.15 Conduct annual review of research.

NMCP and relevant partners will conduct an annual review of research findings to ensure a coordinated national approach.

3.5. Enabling environment.

3.5.1 Develop and maintain strong malaria programme management at all levels.

3.5.1.1 Strengthen capacity of the health system with special emphasis on PHAs. In order to ensure dynamic and responsive implementation of interventions the programme will ensure that appropriate skill sets are available at every level of the health network. Where appropriate malaria related responsibilities will be integrated into the roles of non-malaria-specific staff; this will be facilitated, where appropriate, through the World Bank's *IMPACT Health* project in East New Britain (and eventually extending to other elimination or enhanced control provinces) and the ADB's HSSDP – both of which focus on strengthening key health system inputs like digital health, drug supply and financing, and outputs like supervisory outreach and coverage of essential primary care interventions. The programme will develop innovative service delivery mechanisms such as community-based malaria case management and integrated community case management (iCCM) where appropriate.

The NDoH will work in partnership with the Department of Personnel Management (DPM) to conduct an in-depth malaria-specific human resource (HR) review covering PHAs and peripheral health services. The review will include district level 'malaria readiness' assessments. The review team will then work with NMCP to produce an HR development plan designed to attract, motivate and retain key skilled staff at PHA level and beyond if necessary.

As part of the mandate of PHAs, funding will be prioritized to re-establish adequately staffed provincial level Malaria Units to support the implementation of malaria related activities at both health facility and community levels. Emphasis will be placed on developing the skills of PMSs and PHIOs as well as Officers in Charge. Wherever possible the support required will be integrated into routine supportive supervision.

Performance management measures will be put in place to ensure that the activities and outputs of the newly formed Malaria Units meet the NMCP's requirements in an effective and efficient manner.

Management support for malaria control and elimination activities at provincial level by NMCP will be strengthened so that the NMCP is in a position to give clear and consistent guidance and support for coordination of implementation by PHAs. The NMCP will also provide PHAs with robust support for enforcement of legislation.

3.5.1.2 Develop and implement an approach to attract, motivate, strengthen and retain key skilled staff at central level. The NDoH-DPM review of malaria-specific HR needs will include NMCP, CPHL and PNG-IMR; it will produce an HR development plan designed to attract, motivate and retain key skilled staff for those departments and institutions. Each of the three agencies will ensure that any additional essential staff needed are recruited and trained as required. Existing staff will also be retrained as necessary, in accordance with the HR development plan. Wherever possible the agencies will make use of the free certified training courses available online from WHO-TDR.

3.5.1.3 Introduce a malaria risk management approach. The NMCP will work with other government departments (DAL, Department of Defence, etc.) both at central and regional/provincial levels to ensure that it is fully informed regarding actual or expected population movements (including larger

scale international travel) and on major construction/development projects likely to impact on the malaria situation.

NMCP will advise government bodies reviewing impact assessments for major projects in endemic areas. National contingency plans will be drawn-up in accordance with the most likely risk scenarios. These will specify the channels to be used to transfer emergency funding to ensure speedy mobilization of the necessary resources.

3.5.1.4 Ensure adequate technical assistance - National level. PNG benefits from the support of a number of technical and implementing partners across the country, and this support, including long-term advisors and short-term consultants to deal with specific issues, will continue as required.

3.5.1.5 Ensure adequate technical assistance - Provincial level. The programme will request DFAT, JICA, WHO and any other relevant partners for volunteer-based technical support for poorly performing provinces. Professional volunteers will be placed within PHA offices to work alongside NDoH staff to bolster implementation. The volunteers will be tasked with providing day-to-day technical support for management, planning and operations.

3.5.1.6 Establish a vector control stakeholder group. The NMCP will establish a national level vector control stakeholder group to review vector control practices and provide independent, strategic advice on all policy areas relating to vector control. The group will also assess the public health value of new interventions for vector control and personal protection and provide advice to NMCP as necessary.

3.5.1.7 Establish a case management stakeholder group. The NMCP will establish a national level malaria case management stakeholder group to review case management practices and provide independent, strategic advice on all policy areas relating to malaria case management. The group will be responsible for periodic review of NMTGs in partnership with technical specialists from WHO.

3.5.2 Implement robust programmatic supervision and monitoring and evaluation (M&E).

3.5.2.1 Conduct supportive supervision and monitoring and evaluation. Ensure regular supportive supervision and monitoring and evaluation for all programme activities at all levels, especially at peripheral and community levels. Where capacity to plan or implement supervisory outreach is lacking, the NMCP will harmonise with and draw on the expertise of the World Bank *IMPACT Health* project (either through the national Project Management Unit (PMU) or in specific supported provinces). To further optimize use of limited resources, these visits will be integrated rather than disease specific wherever possible.

3.5.2.2 Conduct annual financial audits. The NMCP will be subjected to an annual financial audit by the Global Fund's Local Fund Agent to ensure continued sound financial management.

3.5.2.3 Conduct data quality audits. Data quality audits will be built into routine supportive supervision to ensure that data entry standards are strengthened and maintained. In addition, every two years the Global Fund's Local Fund Agent will conduct an independent data quality audit using new simplified data collection and reporting formats.

3.5.2.4 Establish province specific malaria targets as key performance indicator (KPI) for PHAs. The programme will work closely with PHAs to develop committed driven provincial level teams, trained and involved to increase the quality and sustainability of activities. Province specific burden reduction or elimination related targets will become (or be adopted as) a KPI in order to ensure that PHA CEOs take all necessary actions to accelerate programmatic progress. Subject to satisfactory harmonisation with *IMPACT Health* in supported provinces, one or two KPIs may be linked to supplementary performance-based financing (e.g. as disbursement-linked indicators under that project). Performance dashboards for PHAs will be introduced at the outset and monitored by NMCP on at least a quarterly basis.

3.5.3 Implement robust procurement and supply management (PSM).

PNG currently has a number of parallel PSM pathways and this is resulting in overlaps in drug procurement, uncertainty regarding what drugs are being distributed, when and by whom, and whether they are reaching their intended destination. PSM strengthening has long been identified by GoPNG as a priority area but to date progress has been slow.

3.5.3.1 Strengthen capacity for forecasting, procurement and supply. Despite strengthening measures, including the roll-out of the 'Msupply' system down to transit stores at provincial level, stockouts in the periphery have been very common at least until recently. There is no stock control at the majority of health facilities and this is making bottom-up planning impossible, hampering quantification of needs and affecting supply.

The NMCP will redouble efforts to strengthen the roles of the PMS, Area Medical Stores (AMS) and Transit Stores; it will also work closely with the ADB and World Bank PMUs to ensure it is drawing appropriately on PSM-related system strengthening resources and expertise available through those projects. PHAs will be supported to develop the capacity to deliver their own supplies through the 'pull system' using PMSs and their network of pharmacy assistants and ancillary staff. This approach is expected to result in major cost savings over the ineffective multiple contractor, private sector model that is being used at present.

mSupply and mSupply-mobile will be further rolled-out to health facility level and the pharmacy assistant network will be expanded. Staff at AMSs and provincial transit stores will be trained to use mSupply and staff at health facility level will be trained on stock management (use of stock cards and mSupply-mobile). Once mSupply is fully functional an mSupply module will support robust quantification of commodity requirements. Until such a time, quantification of commodity requirements will be carried out by NMCP specialists with the support of WHO.

The timing of RAM logistics support through the 'push system' will be aligned to support capacity development within the supply chain, including: bi-monthly rather than tri-monthly monitoring; and, top-up of supply as soon as possible after scheduled bi-monthly delivery through the 'pull-system'. In future the capacity will be built for holistic support for malaria logistics, covering all aspects of malaria related supply, including PQ and SP. This supply management support will be integrated with routine supervision. Using this approach RAM will build capacity and increase the sustainability of PSM in the long term.

The programme will support instant text/phone/VHF radio communication by facilities to the PMS in the event of any stock-out. Stocks will be routinely redistributed between health facilities to minimize both stock-outs and stock expiry.

Procurement may be outsourced nationally incorporating an appropriate oversight mechanism. Major Global Fund supported procurements will continue to go through the Global Fund's Voluntary Pooled Procurement mechanism. The NMCP will participate actively in all aspects of the malaria related procurement process including tender evaluation to ensure that all products procured are fully appropriate to the needs of the programme.

3.5.3.2 Quality assurance (QA) for programme commodities. The NMCP and its partners will work towards strengthening in-country regulatory processes and having robust post-delivery inspection of products. QA will be managed according to SOPs. Samples will be taken from all batches of insecticide and insecticide treated materials both post-production and on receipt. Bioassays will be carried out in-house (with capacity development as required) and samples will be sent for chemical testing at WHO collaborating centres prior to deployment to ensure that they are within the specifications set-out in the manufacturer's product documentation. Sub-standard products will be rejected and returned to the supplier.

'On receipt lot testing' for RDTs and antimalarials will be carried out. Initially all samples will be sent for testing at WHO collaborating centres prior to deployment to ensure that they are within the

specifications set-out in the manufacturer's product documentation. Sub-standard products will be rejected and returned to the supplier.

Over the next five years the programme will work to establish capacity at CPHL for 'on receipt lot testing' for rapid diagnostic tests and to establish the capacity at the Medicines Quality Control Laboratory for 'on receipt lot testing' for antimalarials. Laboratories will be upgraded as required and staff will be trained as necessary.

As well as 'on receipt lot testing' for RDT and antimalarials, once in-house capacity has been established the programme will implement follow-up testing of RDT and antimalarial samples retrieved from a representative sample of field settings.

The programme will also implement 'on receipt lot testing' for insecticides and insecticidal materials (chemical and biological assays) as well as pre- and post-wash assays for LLINs. These tests will be conducted by PNG-IMR. As with RDTs and antimalarials, follow-up testing of samples of insecticides and insecticidal materials retrieved from a representative sample of field settings will also be carried out.

3.5.4 Conduct periodic policy review, strategy development and programme planning.

There will be regular sessions of policy review, strategy development and programme planning with increased emphasis on a bottom-up design. The programme will promote a strong participatory approach with clear roles and responsibilities for all of the partners concerned. Partners' annual plans will be reviewed and quarterly meetings will be held to exchange information and support consultations between WHO, partners and the NMCP. This is expected to result in better coordination of malaria control and elimination efforts and to facilitate resource mobilization.

3.5.4.1 Conduct periodic malaria programme reviews. WHO and NMCP will support an external/joint MTR in 2022 followed by a larger MPR in 2024. The former will inform the development of the next Global Fund funding application and the latter will inform the development of the next NMSP.

3.5.4.2 Update strategies, guidelines and SOPs as required. There will be an annual NMCP meeting for all stakeholders for information sharing and review, covering every component of the programme. Challenges will be discussed and mitigation measures developed. Strategies, guidelines and SOPs will be reviewed periodically in light of surveillance data and research findings (from both PNG and beyond) and taking into consideration any changes in normative guidance. Documents will be revised as appropriate. NMTG will be reviewed and revised as necessary at least every 5 years or whenever TES or other evidence indicates[30]. Epidemiological surveillance regulations (and related SOPs for supervision and M&E) and SOPs for elimination will be revised as required. The NMCP will support an annual entomological review workshop. The insecticide resistance status of malaria vectors will be reviewed and action plans developed as necessary. Where appropriate, components of other public health programmes will be integrated into malaria control/elimination and vice versa, maximizing synergies where possible (e.g. through super-imposing iCCM on community based malaria case management).

3.5.4.3 Develop annual Malaria Action Plans (MAP). National and provincial MAPs will be developed every year in-line with the national strategy.

3.5.4.4 Develop National Malaria Strategic Plan (NMSP). An NMSP will be developed every five years in consultation with a broad range of stakeholders.

[30] Current NMTGs were developed in 2010 and urgently need updating to incorporate the 'Test, Treat, Track' initiative.

3.5.5 Ensure adequate infrastructure (integrated where feasible) and capacity for NMCP, CPHL and PNG-IMR.

Infrastructure strengthening and maintenance will be supported. Buildings, vehicles (cars and motorbikes) and equipment will be insured and maintained and their running costs at central level and in the periphery will be supported. Opportunities for integration will be sought wherever possible.

There will be a special package of support for strengthening the capacity of CPHL including increasing laboratory space and functionality at central (establishment of a molecular facility), regional and provincial levels. This will be implemented in partnership with the upcoming second phase of the Trilateral Malaria Project.

Vehicles, equipment, commodities and consumables will be procured as required. High-speed internet access will be supported wherever possible. All procurement will be carried out in strict accordance with national guidelines. A nationwide integrated procurement management system, incorporating details regarding all procurements irrespective of funding source, will be developed to allow managers to review procurement status of all products. PHAs will be responsible for management of infrastructure at provincial level. National stock review meetings will be held on a monthly basis.

3.5.6 Strengthen leadership and governance regionally, nationally and sub-nationally.

3.5.6.1 Strengthen the National Multi-Sectoral Malaria Elimination Taskforce (MSMET). In-line with APLMA guidance, the programme will support the strengthening of MSMET, a Secretary and Director level taskforce which was established in 2019 to provide oversight of the national malaria elimination effort and more specifically to:

- Ensure follow through on priority actions and delivery of the resources required to achieve them;
- Harmonize policy across government so that all agencies are pulling in the same direction;
- Effectively coordinate different stakeholders in the public, non-government and private sectors;
- Identify and take forward necessary bilateral, sub-regional and regional cooperation activities.

MSMET is not a technical taskforce. It is a group of people who can make decisions, provide funding ideas and advocate for the malaria elimination effort. Its membership will be extended to include DFAT, the Department of Education, the Secretary for the DPM and other parties that have the capacity to assist with strengthening implementation. The MSMET will meet quarterly or on an *ad hoc* basis as required. Innovative measures will be put in place to optimize attendance.

3.5.6.2 Establish provincial malaria elimination committee. As provinces progressively embark on elimination, the NMCP will work with PHAs and provincial partners to establish provincial malaria elimination committees to oversee elimination efforts and to ensure that malaria remains firmly on provincial agendas as caseloads fall and throughout the elimination and prevention of reestablishment stages. Lessons will be learnt from New Ireland Province, which established its provincial elimination taskforce in 2019, and from other provinces and islands progressing towards elimination early on.

3.5.7 Strengthen political commitment regionally, nationally and sub-nationally.

There is already strong political commitment at national and international levels, but commitment at province, district and Local Level Government levels needs to be strengthened. The NMCP and its partners will develop a mechanism to keep the elimination agenda on the map at peripheral level both from a technical perspective and from a broader population-centred perspective through awareness campaigns and high-level advocacy.

3.5.7.1 Develop Malaria Road Map. A 'Malaria Road Map' will be developed as an advocacy tool. The aim will be to maintain political support and leverage funding, both domestic and international

3.5.7.2 Engage with international malaria partners. The programme will engage with APLMA, Asia-Pacific Malaria Elimination Network, Civil Society for Malaria Elimination (CS4ME) and WHO to raise the profile of malaria and advocate for support including funding for malaria elimination.

3.5.7.3 Provide regular briefings to government ministers and opinion leaders. NMCP representatives will provide regular briefings to government ministers and opinion leaders.

3.5.7.4 Strengthen PHA ownership of Public-Private Partnerships (PPP). NMCP will work to strengthen PHA ownership of PPPs to improve their functionality and sustainability, including by strengthening the linkage between NDoH and PHAs.

3.5.8 Ensure adequate domestic and external financial support.

3.5.8.1 Strengthen advocacy. Advocacy will be strengthened by appointing a dedicated focal person from within the elimination taskforce to ensure that malaria elimination becomes a national goal with full public and development partner support. A broad-based advocacy package targeting decision makers and community leaders at international, national, regional and provincial levels will be developed to foster inter-sectoral collaboration, continuous monitoring and timely collective action. NMCP experiences, best practices, successes and lessons learnt will be documented and consolidated and disseminated amongst stakeholders. NMCP representatives will provide regular briefings to government ministers and opinion leaders. Efforts will be made to leverage financial support from District Service Improvement Programmes and Provincial Service Improvement Programmes - Members of Parliaments' local funds - for malaria elimination and health system strengthening, and to integrate malaria-relevant health system improvements into the work of other partner-supported health system strengthening activities.

3.5.8.2 Maximize the cost effectiveness of programme activities. The programme will place increased emphasis on improving its cost-effectiveness (e.g. through integration and through use of stratification for improved targeting of interventions) to mitigate financial constraints. In addition, the programme will endeavour to increase the efficiency of resource usage: higher health and malaria budgets can contribute to better outcomes, but so can improvements in health spending efficiency (both national release and provincial utilisation of funds) – this can help to ensure that resources are available in a timely manner, and will reduce cost pressures at a time when resource availability in the medium- to longer-term is increasingly uncertain.[31]

3.5.9 Develop and enhance multisectoral partnerships for action.

3.5.9.1 Revitalize and relaunch the PNG Industry Malaria Initiative (PIMI). PIMI will be relaunched to support major resource operators (energy, mining and agribusiness) and other private sector entities to create or reactivate PPPs with their host provinces to support malaria control and accelerate progress towards elimination.

3.5.9.2 Promote 'One Health' concept. The NMCP's advocacy focal point (5.9.1) will be charged with promoting 'One Health', an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes. For example: Wildlife conservation team medics in PNG already provide healthcare for all in need encountered during field visits; and, NAQIA has entomological capabilities in all provinces and it may be possible to leverage their support for malaria related entomological surveillance. FETP alumni in all provinces have been increasingly exposed to 'One Health' concepts and inter-sectoral collaboration during their training.

[31] World Bank, 2017. *Health Financing System Assessment, Papua New Guinea*

3.5.9.3 Pressure the private sector to support malaria initiatives as a public good. The NMCP's advocacy focal point (5.9.1) will lobby GoPNG and key influencers to exert political and social pressure on the private sector to support malaria initiatives as a public good. Some resource companies cover large areas and populations (e.g. oil palm plantations, logging, mining, pharmacies) and efforts will be made to engage all of these to support malaria control and elimination efforts much more widely. NMCP will work with partners to develop guidelines on how the private sector can engage with the malaria elimination effort (based on the New Ireland Province Malaria Alliance model - which provides a robust example of a Public-Private-Philanthropic Partnership – and others).

3.5.9.4 Support mapping and partnership building. NMCP will support mapping and partnership building (civil society/non-government sector/UNFPA/UNICEF) by PHAs to support the development of scalable community-based interventions, especially iCCM.

3.5.10 Support continued active coordination between the National Department of Health (NDoH) and malaria stakeholders in PNG.

The NDoH will hold regular coordination meetings with the various stakeholders implementing malaria related activities to ensure that all are working in accordance with the NMSP and that their activities are aligned with national malaria control strategies, guidelines, systems and standards. All of these stakeholders, both NGO and private, will be required to submit annual operational plans for scrutiny prior to implementation.

3.5.11 Support active international technical collaboration.

The programme will support capacity building for staff through participation in international workshops, meetings and conferences and by promoting and expanding opportunities for staff to collaborate with national and international centres of excellence for malaria related research. Emphasis will be on research that builds the technical capacity of national scientists and supports the development of locally appropriate strategies for accelerated burden reduction and elimination in PNG.

3.5.12 Develop cross-border collaboration in preparation for elimination.

The NMCP will conduct routine cross-border meetings in West Papua, Solomon Islands, Timor-Leste and AROB designed to promote sharing of data and lessons learned on malaria control and elimination among border provinces/districts, including data relating to population movements to or from high risk areas. Engagement with Solomon Islands will be particularly relevant due to the focus under this NMSP on malaria elimination in the Islands Region and concurrent efforts to eliminate malaria from the adjacent Solomon Islands provinces of Choiseul, Western and Isobel (potentially creating an 'elimination corridor' spanning the international border zone.

The meetings will promote immediate notification in case of any unusual increase in cases in districts/provinces with shared borders. The collaboration will involve key NMCP/NDoH staff (central, provincial and/or district level) along with any implementing and development partners working on extending access to prevention tools and case management services amongst border crossers.

4. Performance assessment

Assessment of programmatic performance is described in detail in the National Malaria Monitoring and Evaluation Plan, 2021-25. Table 2 summarizes the key programmatic indicators and targets in this plan.

Table 2. Key programmatic indicators and targets for 2021-25.

	Baseline	Baseline year	2021	2022	2023	2024	2025
IMPACT							
Malaria I-1(M) Reported malaria cases (presumed and confirmed)	808,869	2019	712,976	655,337	567,456	434,103	310,200
Malaria I-2.1 Confirmed malaria cases (microscopy or RDT): rate per 1000 persons per year	72.8	2019	61.7	55.6	47.2	35.4	24.8
Malaria I-3.1(M) Inpatient malaria deaths per year: rate per 100,000 persons per year	2.05	2019	1.80	1.41	0.83	0.40	0.20
Malaria I-4 Malaria test positivity rate	49.0%	2019	38.6%	31.8%	26.2%	19.1%	13.1%
Malaria I-5 Malaria parasite prevalence: Proportion of children aged 6-59 months with malaria infection	9.5%	2017			8.7%		
Malaria I-6 All-cause under-5 mortality rate per 1000 live births	49.0	2018			44.1		
OUTCOME							
Malaria O-1a Proportion of population that slept under an insecticide-treated net the previous night	51.1%	2017			60%		
Malaria O-1b Proportion of children under five years old who slept under an insecticide-treated net the previous night	59.5%	2017			65%		
Malaria O-1c Proportion of pregnant women who slept under an insecticide-treated net the previous night	59.6%	2017			65%		
Malaria O-2 Proportion of population with access to an ITN within their household	66.7%	2017			90%		
Malaria O-3 Proportion of population using an insecticide-treated net among those with access to an insecticide-treated net	76.6%	2017			80%		
Malaria O-4 Proportion of households with at least one insecticide-treated net for every two people and/or sprayed by IRS within the last 12 months	64.6%	2017			80%		
Malaria O-9(M) Annual blood examination rate: per 100 population per year (Elimination settings)	14.9%	2019	16.0%	17.5%	18.0%	18.5%	19.0%
COVERAGE							
VC-1(M) Number of long-lasting insecticidal nets distributed to at-risk populations through mass campaigns	1,276,634	2019	1,100,752	1,171,752	1,278,293	1,168,127	1,243,490
CM-1a(M) Proportion of suspected malaria cases that receive a parasitological test at public sector health facilities	88%	2019	90%	90%	90%	90%	90%
CM-2a(M) Proportion of confirmed malaria cases that received first-line antimalarial treatment at public sector health facilities	72.1%	2019	90%	92%	94%	96%	98%
CM-3a Proportion of malaria cases (presumed and confirmed) that received first line antimalarial treatment at public sector health facilities	92.0%	2019	88%	90%	92%	94%	96%
M&E-2b Timeliness of facility reporting: Percentage of submitted facility monthly reports (for the reporting period) that are received on time per the national guidelines	56.6%	2019	60%	65%	70%	80%	90%
M&E-2a Completeness of facility reporting: Percentage of expected facility monthly reports (for the reporting period) that are actually received	94.7%	2019	85%	90%	95%	95%	95%
VC-3(M) Number of long-lasting insecticidal nets distributed to targeted risk groups through continuous distribution	43,030	2019	194,691	120,555	122,966	201,966	127,934
CM-1b(M) Proportion of suspected malaria cases that receive a parasitological test in the community			90%	92%	94%	96%	98%
CM-2b(M) Proportion of confirmed malaria cases that received first-line antimalarial treatment in the community			90%	95%	98%	98%	98%
CM-3b Proportion of malaria cases (presumed and confirmed) that received first line antimalarial treatment in the community			90%	90%	90%	90%	90%

5. Budget and financing

5.1 Budget for the NMSP 2021-25

The Programme has undertaken a detailed costing and budget prioritisation exercise in relation to the NMSP. The budget assumptions are as described in the relevant areas of the Plan (Sections 3.1–3.5)

The overall budget for the five-year period 2021-2025 is estimated at USD 112,675,162 including salaries (USD 95,820,260 excluding salaries). For the first three years of the Plan, the budget is estimated at USD 66,209,702 including salaries (USD 56,195,374 excluding salaries).[32]

Table 3, below, summarises the budget breakdown by Objective and principal activities (Strategy) by year. Figure 12 shows the proportionate allocation to each Objective for the full five years of the Plan.

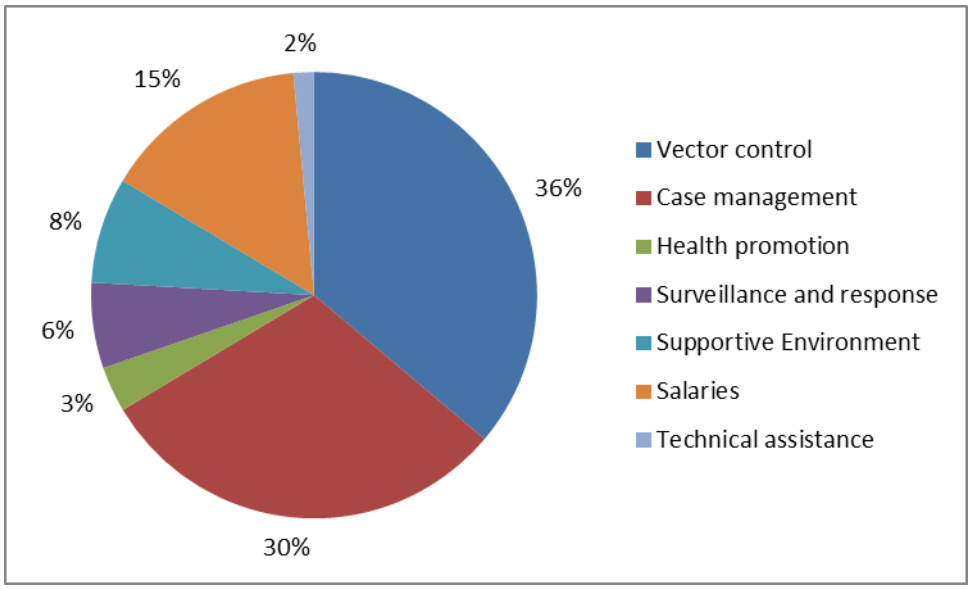
[32] These budget estimates exclude any cost recovery associated with Principal Recipient functions under the Global Fund. However, these costs are included in the Total row and under Objective 5 in Table 3.

Table 3. Budget by Objective, Strategy and Year, National Malaria Strategic Plan, Papua New Guinea, 2021-25.

Level	#	Row Title	Year					
			2021	2022	2023	2024	2025	Total
Total			$21,263,479	$21,958,964	$24,675,257	$23,797,596	$22,667,863	$114,363,160
Objective	1	Malaria vector control and personal protection - Ensure that all people at risk of malaria infection are covered with appropriate and effective vector control measures	$6,144,202	$6,691,576	$9,850,951	$9,102,528	$9,013,847	$40,803,105
Strategy	1.1	Implement rolling three-yearly mass distribution of LLINs to achieve universal coverage in target areas	$4,932,031	$5,245,629	$5,716,026	$5,229,549	$5,562,342	$26,685,578
Strategy	1.2	Implement continuous LLIN distribution to maintain universal coverage amongst vulnerable and key risk populations (including provision to pregnant women through ante-natal care services, malnourished children through MCH, to PLWH, prisoners, students at boarding institutions, police and military)	$702,084	$434,739	$443,434	$728,172	$461,348	$2,769,776
Strategy	1.3	Re-introduce high-quality IRS with non-pyrethroid insecticide to rapidly reduce incidence in high burden areas or to maintain malaria control in areas where LLIN utilization is low (re-introduction dependent on the outcome of trials)	$128,549	$629,670	$3,309,953	$3,144,807	$2,990,157	$10,203,136
Strategy	1.4	Implement alternative vector control tools and personal protection measures as appropriate among at-risk, high-exposure populations (implementation dependent on the outcome of trials)	$381,538	$381,538	$381,538	$0	$0	$1,144,614
Strategy	1.5	Support multisectoral involvement in the provision of vector control and personal protection measures	$0	$0	$0	$0	$0	$0
Strategy	1.6	Implement focal responsive vector control interventions in response to outbreaks in burden reduction settings and confirmed transmission foci in elimination settings	$0	$0	$0	$0	$0	$0
Objective	2	Malaria case management. Universal access to quality assured early diagnosis and appropriate treatment	$6,790,431	$7,181,241	$6,702,156	$7,184,478	$6,287,370	$34,145,676
Strategy	2.1	Ensure early and accurate diagnosis	$3,651,969	$4,516,154	$4,293,831	$5,286,711	$4,771,657	$22,520,322
Strategy	2.2	Ensure effective rational treatment nationwide according to National Malaria Treatment Guidelines (NMTGs)	$2,983,545	$2,621,019	$2,320,118	$1,809,002	$1,437,895	$11,171,580
Strategy	2.3	Address the issue of sub-standard and falsified antimalarials	$154,916	$44,068	$88,207	$88,765	$77,818	$453,773
Objective	3	Behaviour Change Communication. Community-based support for malaria control and elimination efforts mobilized and utilization of prevention and case management services maximized	$776,811	$728,033	$739,479	$753,919	$728,033	$3,726,276
Strategy	3.1	Implement health promotion activities to support the enabling environment for malaria control and elimination, to strengthen knowledge, attitudes and practices amongst populations at risk, and to promote community led engagement	$758,505	$728,033	$728,033	$735,613	$728,033	$3,678,217
Strategy	3.2	Supervision and Monitoring for IEC/BCC activities	$18,306	$0	$11,446	$18,306	$0	$48,059

Objective	4	Surveillance and response. A strong routine disease surveillance and response system in burden reduction settings and a robust case-based surveillance and response system in elimination and prevention of re-establishment settings	$1,553,014	$1,294,310	$1,485,889	$1,357,836	$1,305,898	$6,996,947
Strategy	4.1	Strengthen capacity for epidemiological analysis for policy and decision making at all levels	$107,940	$57,521	$82,409	$57,521	$58,974	$364,366
Strategy	4.2	Accelerate the expansion and strengthening of the national health information system (eNHIS) and the workforce's capacity to utilize it.	$125,441	$0	$0	$56,764	$0	$182,205
Strategy	4.3	Incorporate private sector case reporting into eNHIS	$0	$0	$0	$0	$0	$0
Strategy	4.4	Update malaria risk stratification every 2 years	$9,822	$9,822	$9,822	$9,822	$9,822	$49,108
Strategy	4.5	Expand and strengthen outbreak surveillance and timely response for burden reduction settings	$68,903	$103,291	$77,886	$72,312	$106,919	$429,310
Strategy	4.6	Establish case-based surveillance and response for areas targeted for malaria elimination and for prevention of re-establishment	$422,894	$356,089	$381,279	$386,602	$464,344	$2,011,207
Strategy	4.7	Maintain sentinel site surveillance	$70,438	$70,438	$70,438	$70,438	$70,438	$352,189
Strategy	4.8	Conduct malaria indicator surveys	$0	$421,268	$421,268	$0	$0	$842,537
Strategy	4.9	Conduct health facility surveys.	$293,491	$0	$0	$293,491	$0	$586,982
Strategy	4.10	Conduct mini-prevalence surveys in remote villages	$0	$0	$0	$0	$0	$0
Strategy	4.11	Conduct periodic school surveys in high burden areas	$0	$0	$0	$0	$0	$0
Strategy	4.12	Monitor drug resistance	$205,444	$205,444	$205,444	$410,887	$410,887	$1,438,105
Strategy	4.13	Monitor vector bionomics and insecticide resistance	$195,814	$0	$184,515	$0	$184,515	$564,844
Strategy	4.14	Conduct research of high operational significance	$52,828	$70,438	$52,828	$0	$0	$176,094
Strategy	4.15	Conduct annual review of research	$0	$0	$0	$0	$0	$0
Objective	5	Enabling environment. A strong enabling environment for malaria control and elimination	$5,999,021	$6,063,804	$5,896,782	$5,398,835	$5,332,714	$28,691,156
Strategy	5.1	Develop and maintain strong malaria programme management at all levels.	$191,622	$119,069	$154,997	$121,050	$147,806	$734,544
Strategy	5.2	Implement robust programmatic supervision and monitoring and evaluation (M&E).	$667,668	$666,788	$667,668	$666,788	$667,668	$3,336,579
Strategy	5.3	Implement robust procurement and supply management (PSM)	$89,948	$28,965	$39,859	$28,965	$39,859	$227,595
Strategy	5.4	Conduct periodic policy review, strategy development and programme planning.	$42,219	$75,060	$42,219	$219,487	$42,219	$421,203
Strategy	5.5	Ensure adequate infrastructure (integrated where feasible) for NMCP, CPHL and IMR	$489,455	$389,492	$213,397	$213,397	$213,397	$1,519,138
Strategy	5.6	Strengthen leadership and governance regionally, nationally and sub-nationally.	$34,908	$34,908	$34,908	$34,908	$34,908	$174,539
Strategy	5.7	Strengthen political commitment regionally, nationally and sub-nationally	$0	$0	$0	$0	$0	$0
Strategy	5.8	Ensure adequate domestic and external financial support	$305,283	$305,283	$305,283	$305,283	$305,283	$1,526,413
Strategy	5.9	Develop and enhance multisectoral partnerships for action	$5,408	$5,408	$5,408	$5,408	$5,408	$27,038
Strategy	5.10	Support continued active coordination between the National Department of Health and malaria stakeholders in PNG	$83,263	$83,263	$83,263	$83,263	$83,263	$416,317
Strategy	5.11	Support active international technical collaboration	$0	$19,789	$0	$0	$19,789	$39,577
Strategy	5.12	Develop cross-border collaboration in preparation for elimination	$52,828	$52,828	$66,828	$0	$52,828	$225,313
Strategy	5.13	Salaries	$3,173,755	$3,420,287	$3,420,287	$3,420,287	$3,420,287	$16,854,902
Strategy	5.14	Indirect cost recovery	$562,666	$562,666	$562,666	$0	$0	$1,687,998
Strategy	5.15	Technical Assistance	$300,000	$300,000	$300,000	$300,000	$300,000	$1,499,999

Figure 12. Budget allocation by Objective, National Malaria Strategic Plan, Papua New Guinea, 2021-25.



5.2 Financing strategy for 2021-2023

5.2.1 National financing

The GOPNG has committed to providing an estimated USD 9,813,745 for the first three years of the NSP, i.e. the funding period 2021-2023.

5.2.2 Global Fund allocation

The Global Fund has made a malaria allocation of USD 37,534,289 for the period 2021-2023. Table 4 summarises the distribution of the PNG funding request by year and Global Fund module.

Table 4. Funding request by year and module, Global Fund malaria allocation, Papua New Guinea, 2021-23.

	Funding Request			
	2021	2022	2023	Total
Case management	$2,613,917	$3,386,659	$2,731,919	$8,732,495
Program management	$3,833,421	$3,842,226	$3,833,421	$11,509,069
RSSH: Financial management systems	$0	$0	$0	$0
RSSH: Health management information systems and M&E	$1,082,273	$1,157,350	$1,191,042	$3,430,665
RSSH: Health products management systems	$2,090	$0	$2,090	$4,179
RSSH: Health sector governance and planning	$0	$0	$0	$0
RSSH: Integrated service delivery and quality improvement	$209,029	$320,932	$144,838	$674,798
RSSH: Laboratory systems	$17,169	$17,169	$17,169	$51,508
Specific prevention interventions (SPI)	$697	$697	$697	$2,091
Vector Control	$4,143,135	$4,299,134	$4,687,215	$13,129,484
Total	**$11,901,731**	**$13,024,167**	**$12,608,391**	**$37,534,289**

RSSH = Resilient and sustainable systems for health

5.2.3 Collaborative financing (MEMTI and partner-funded development projects)

As noted above (Section 1.9), the Global Fund may potentially make an additional allocation under the proposed MEMTI funding stream.

MEMTI is an innovative financing mechanism rather than conventional malaria-specific funding. It was designed to potentially leverage additional donor funds and to have a catalytic effect on the NMCP to move away from a 'business as usual' approach to malaria control and elimination.

No up-front MEMTI allocation has yet been made to any of the eligible countries. The Global Fund has said that it will assess the quality of the overall funding requests and the alignment of MEMTI-relevant content in the submission with a number of conditions: a national or sub-national orientation towards malaria elimination; MEMTI funds being used to address health system or other critical barriers to national or sub-national elimination; and the availability of Government or donor co-financing for elimination-relevant aspects of the NMSP or Global Fund funding request.

The GoPNG has not yet made any policy commitments (e.g. raising or borrowing additional funds) in response to the recommendations of the *Landscape Report* or other communications from the Global Fund about MEMTI. Moreover, the *Financing Options* paper concluded that the original MEMTI funding model – especially the mobilisation of additional GoPNG or donor financing alongside MEMTI – was unlikely and probably not feasible, given: the current macro-economic conditions in PNG; the diversion of Government and donor financing to preparedness and response to COVID-19; and the likely impact of the pandemic on domestic finances and therefore aid budgets in donor countries (see also Section 1.1.2). The *Financing Options* paper did, however, identify a number of existing donor-financed projects addressing health systems strengthening or malaria and other vector-borne diseases that are already funded and either about to commence or already under way in PNG, which could potentially be 'leveraged' to ensure sustainable benefit to the NMCP and support for the NMSP.[33]

The NMCP has costed a range of activities within the NMSP as relevant to the overall purpose of MEMTI, and is requesting a total of USD 8,039,721 under this funding stream. These activities are summarised in Table 5, below, and presented in detail in the detailed budget (**Annex 1**).

Table 5. Summary of proposed investments under the MEMTI funding stream during the first three years of the NMSP (2021-23), Papua New Guinea.

	MEMTI			
	2021	2022	2023	Total
Case management	$403,632	$409,461	$667,411	$1,480,504
RSSH: Financial management systems	$0	$0	$0	$0
RSSH: Health management information systems and M&E	$126,094	$53,960	$53,990	$234,043
RSSH: Health sector governance and planning	$68,336	$68,336	$82,336	$219,009
RSSH: Human resources for health, including community health workers	$58,236	$151,079	$151,079	$360,395
RSSH: Integrated service delivery and quality improvement	$208,202	$1,937	$1,937	$212,076
Specific prevention interventions (SPI)	$26,414	$26,414	$26,414	$79,243
Vector Control	$34,978	$629,670	$3,316,815	$3,981,464
Program management	$22,012	$22,012	$22,012	$66,035
Subtotal (specific NMSP activities)	**$947,905**	**$1,362,870**	**$4,321,995**	**$6,632,769**
Unallocated (HSS co-activities in elimination provinces) @ 17.5%	$468,984	$468,984	$468,984	$1,406,951
Subtotal (unallocated MEMTI funds for HSS co-financing)	**$468,984**	**$468,984**	**$468,984**	**$1,406,951**
Total	**$1,416,889**	**$1,831,853**	**$4,790,978**	**$8,039,721**

[33] Anderson *et al* (*op cit*)

The proposed activities include a range of elimination-relevant RSSH investments that will be bolstered by parallel development partner investments in health systems, either nationally or in selected 'pre-elimination' provinces in the Islands Region. The largest allocations within the requested MEMTI funds are for case management (mainly G6PD POC testing commodities in elimination and 'pre-elimination' provinces and districts to support radical cure of vivax malaria) and supplementary vector control activities and commodities (mainly for IRS for managing identified high transmission areas in provinces re-orienting towards elimination: preparatory operational research in Year 1, piloting through the NIPMA in Year 2 and full roll-out to other 'pre-elimination' provinces in Year 3).

An un-earmarked component equivalent to 17.5% of the total requested MEMTI funds is reserved for detailed activity mapping against partner-funded support for malaria-relevant health system improvements in 'pre-elimination' provinces during Year 1, and to provide co-financing for those activities (e.g. in the first part of Table 6, below) – also from as early as Year 1 – where extending the range of the financing agreement would be necessary to strengthen their impact on the national or provincial malaria programme.

Relevant existing donor-financed projects in PNG are summarised in Table 6.

Table 6. Donor co-financed activities either addressing health system barriers to malaria elimination or generating elimination-relevant knowledge during the first three years of the NMSP (2021-23), Papua New Guinea.

Activity Title	Donor	Implementing partner	Geographic focus	Technical focus	Duration	Value (est.)
Broad-based health system strengthening (indirect or potential relevance to malaria)						
HSSDP	ADB, DFAT, others	NDoH, selected PHAs	National and selected provinces	National and PHA public financial management; sub-national planning; PSM; digital health; integrated health service delivery	2019-25	USD 395 million
FET-PNG	DFAT-CHS	University of Newcastle	National and selected provinces	Surveillance, outbreak detection and investigation	2020-22	AUD 925,000
IMPACT Health	World Bank	GoPNG; selected PHAs	Initially East New Britain and Enga with national technical support; extending to up to 4 more PHAs	Community-based service delivery; performance based financing for improved service delivery	2020-26	USD 30 million
PNG-Australia Transition to Health (PATH)	DFAT	To be decided	National and selected PHAs	Rural health care; health security and disease control; sexual and reproductive health	2021-24	AUD 220 million
Tupaia	DFAT-CHS	Beyond Essentials Systems	National and selected PHAs	Data aggregation for improved medicines availability (including roll-out mSupply Mobile), mapping disease outbreaks, disaster response	2020-22	AUD 667,000 (indicative share)
WHO Country Cooperation Strategy	WHO	NDoH with WHO TA	National, selected provinces and districts	Sustainable health outcomes; HSS; health security	2016-20 (to be revised)	As per biennial budgets

Activity Title	Donor	Implementing partner	Geographic focus	Technical focus	Duration	Value (est.)
Malaria programme, systems or technical support; operational research						
APLMA / APMEN	DFAT-CHS	APLMA	National	Financing malaria elimination, access to quality commodities	2020-22	Up to AUD 630,000 (indicative share)
Capacity building for vector surveillance and control	DFAT-CHS	James Cook University	Selected provincial study sites	Capacity development for provincial vector control officers; operational research	2020-22	AUD 425,000
NATNAT	DFAT-CHS	Innovative Vector Control Consortium	Mainly national; selected provincial study sites	New vector control tools and technologies for malaria and arboviruses	2020-22	AUD 5 million
NIPMA	RAM	New Ireland PHA	New Ireland Province	Progressive malaria control and elimination	2020-23	Initially AUD 30,000, potentially increasing towards AUD 100,000
SPARK	DFAT-CHS	Doherty Institute	Mainly national; selected provincial study sites	Modelling the impact of malaria interventions to inform elimination	2020-22	AUD 875,000
STRIVE-PNG	DFAT-CHS	Burnet Institute	Selected provincial study sites	Surveillance innovations for malaria and arboviruses	2018-21	AUD 3 million
Trilateral' Malaria Project (Phase 2a)	DFAT; China and PNG (in kind)	NDoH; Chinese and Australian technical agencies	Mainly national; selected provinces	Provincial malaria system strengthening; management and use of malaria data; laboratory and malaria diagnosis strengthening	2020-23	AUD 6 million

Source: Adapted from Anderson *et al* (2020)

These activities either address health system barriers to elimination or provide additional technical support, quality assurance and operational research to help the country move away from a 'business as usual' approach to malaria interventions.

5.2.4 Financing gap

A residual financing gap of just over USD 8.75 million for the period 2021-23 is currently addressed through a prioritised above-allocation request (PAAR) to the Global Fund.

The NMCP will continue to explore ways to mobilize resources for malaria elimination beyond just relying on increased domestic resources, including through sustainable regional financing options. It will aim for reduced donor dependency by 2026. The NMCP will join forces with members of the corporate sector to tap resources from corporate social responsibility funds and new initiatives like M2030 and – subject to improving macro-economic conditions – a revitalised PIMI.