POLICY BRIEF

LOWY INSTITUTE
FOR INTERNATIONAL POLICY

NOVEMBER 2008

SARAH POTTER
spotter@med.usyd.edu.au

THE STING OF CLIMATE CHANGE:
MALARIA AND DENGUE FEVER IN MARITIME SOUTHEAST ASIA AND THE PACIFIC ISLANDS

WHAT IS THE PROBLEM?

Global climate change will intensify the already significant malaria and dengue problems in maritime Southeast Asia and the Pacific Islands. Those countries with the fewest resources and poor public health infrastructure are likely to feel the impact of increasing disease the most acutely. Australia itself is a 'fringe country' to the expanding endemic zone of mosquito-borne diseases to its north. Climate change may well make more of northern Australia more vulnerable to malaria and dengue outbreaks.

WHAT SHOULD BE DONE?

Australia should strengthen regional efforts in maritime Southeast Asia and the Pacific Islands for the better quantification of the effects of climate change on the spread of mosquito-borne diseases between and within susceptible countries. Australia's own risk assessments for malaria and dengue should be updated.

AusAID's increased budget allocations for climate change and public health should be leveraged to enhance impact-based research, public education and health care training programs in malaria and dengue-prone areas, especially previously unaffected ones.

Within Australia, quarantine procedures need to be re-evaluated. The Northern Territory policy of screening and treatment of immigrants from malaria-infected areas should be extended to other states, particularly Queensland and Western Australia. Consideration should be given to a similar screening and isolation program for dengue.

LOWY INSTITUTE FOR
INTERNATIONAL POLICY
31 Bligh Street
Sydney NSW 2000
Tel: +61 2 8238 9000
Fax: +612 8238 9005
www.lowyinstitute.org

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Lowy Institute Policy Briefs are designed to address a particular, current policy issue and to suggest solutions. They are deliberately prescriptive, specifically addressing two questions: What is the problem? What should be done?

Dealing with the ramifications of climate change is today's most vexing international and domestic policy question. From the global *realpolitik* of negotiating a successor to the Kyoto Protocol to the everyday choices on what light bulb to use, climate change is affecting our daily lives and placing new demands on governments to work collectively. As with so many of the world's most difficult challenges, the impacts of climate change are being felt the quickest and the most sharply by the poorer and less prepared countries.

One area where the negative impacts of climate change are already being felt, and felt most sharply in the Indonesian archipelago and the small island states of the South Pacific, is in the spread of the deadly mosquito-borne diseases, malaria and dengue. Each year there are up to half a billion new cases of malaria and as many as two million deaths globally, mostly children.[1] Dengue is also a significant health problem, with an estimated 50-100 million cases of dengue fever annually and approximately 25,000 deaths.[2] Experts agree that this number is rising every year.

Unfortunately, mosquitoes are very sensitive to changes in climate. Warmer conditions allow the mosquitoes and the malaria parasite itself to develop and grow more quickly, while wetter conditions let mosquitoes live longer and breed more prolifically. The sting of climate change is an international public health crisis being felt on Australia's tropical doorstep. It may soon be pressing on Australia's northern shores as well.

Fortunately, the international community and the Australian government are responding to the twin challenges of communicable diseases and climate change. The World Health Organization has recently set aside $10 million for advocacy programs for individuals and governments on the public health dangers of climate change. The Global Fund to Fight Aids, Tuberculosis and Malaria has signed up to the milestones of a malaria-free Solomon Islands and Vanuatu by 2015, with Bali, Java and Aceh in Indonesia and Papua New Guinea to follow by 2025.[3] Since it was established in 2002, the Global Fund has allocated more than $2 billion dollars to the global fight against malaria, focusing on the financing of new effective malaria medicines and the distribution of insecticide-treated mosquito nets.[4]

Achieving better public health outcomes is also a focus of the 2006 White Paper on Australian aid that committed to doubling Australia's aid budget in nominal terms by 2010. Since the publication of the White Paper, the new Rudd government has committed to providing even more public funds to AusAID, and this new aid money is being rolled out. In the 2007-2008 budget, the Government announced plans for an additional $530.8 million over a four-year period to improve health systems, including a focus on malaria and other deadly diseases in the Asia Pacific. In 2007-08, AusAID is prepared to spend $55.2 million on international programs to deliver better health. By 2010-11 this is budgeted to rise to $225.1 million.

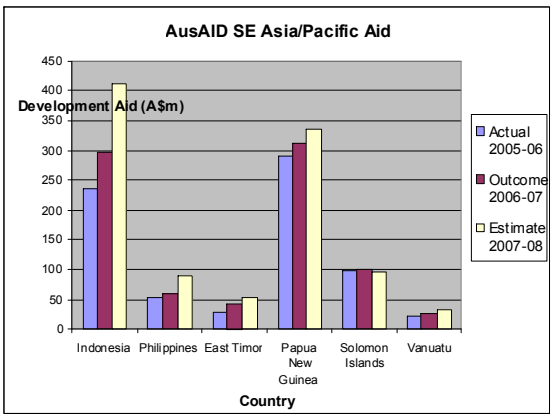
In this same budget, an additional $86.9 million has been allocated for 2007-08 towards multilateral initiatives on climate change and improved health standards in the region. Domestically, the Department of Health and Ageing is strengthening its national bio-security initiatives including border health protocols,

though this is mainly targeted at emerging infectious diseases such as SARS and pandemic influenza.

This greater international and Australian focus on the lethal intersection between climate change and communicable diseases means that the policy recommendations contained in this brief do not need to take the well-beaten path of demanding much greater funding or the establishment of new institutions. Rather, they suggest better ways of fighting malaria and dengue using existing funding streams and policy actions.

The current situation

Malaria is a major public health problem for Indonesia, the Philippines, East Timor, Papua New Guinea, Solomon Islands and Vanuatu, countries that all featured heavily in the 2006 White Paper on aid and all countries (except Solomon Islands) whose allocations of AusAID funding are increasing.



Source: 2007-2008 Foreign Affairs and Trade (AusAID) Budget, 'Appendix – AusAID Country and Global Programs'

Unfortunately, these six most vulnerable countries face an increasing disease burden at the same time as their governments and health systems are finding it more and more difficult to prioritise a growing list of public health concerns. The rapid spread of drug-resistant malaria strains is not helping.

Table 1: Malaria's bite[5]

Country	Population	Estimated annual number of clinical cases of malaria	Malaria incidence per 1000 people/year
Indonesia	227,000,000	6-15 million (2005)	27-68
PNG	6,100,000	1,800,000 (2002)	295
Solomon Islands	580,000	150,000 (2005)	311
East Timor	1,015,100	136,000 (2005)	134
Vanuatu	221,900	9,000 (2005)	41

Sources: Refer to [6]

From 1996 to 2000, the number of confirmed cases of malaria in central Java (the third most populated province in Indonesia with over 30 million people) increased more than tenfold from 4 to 45 cases per 1000.[7] This resurgence of malaria in Indonesia has been aggravated by the fiscal fallout from the 1997-98 financial crisis, which led to significant cutbacks in promising malaria control programs (as well as in many other areas of the health care sector). Today, close to one half of Indonesia's total population of over 225 million people are at risk from malaria. Malaria is now the number one public health issue in many parts of the

archipelago and is responsible for the majority of childhood deaths in several island regions.[8]

Malaria is the main cause of morbidity in the Papua New Guinean lowlands and it is increasing in both geographical range and incidence in the Western Highlands region. In this emerging zone of malaria transmission, only 638 cases of malaria were reported in 2000. Five years later, this had increased almost eightfold to 4986.[9]

The Solomons' recent severe social and governance problems that led to the Australian-led Regional Assistance Mission to Solomon Islands (RAMSI) intervention in 2003 have also contributed to a growing malaria problem in the last five to seven years. In 2003 alone, the World Health Organization reported over 90,000 cases of malaria in the Solomons.[10] This upsurge came after the country achieved low and rapidly declining levels of malaria in the 1990s. In the Solomons and East Timor, malaria is highly endemic and transmitted all year round. In the Philippines, recent cases of malaria have been documented in 65 of the country's 79 provinces.[11]

The current dengue situation is also of increasing concern. Globally, more than three billion people live in areas where they are at risk of dengue and the number of dengue cases as a proportion of the world's population is growing. Dengue usually presents itself as a mild-to-moderate flu-like illness, but infection can result in the much more serious syndrome known as dengue hemorrhagic fever (DHF), with mortality rates as high as 40 per cent if patients are left untreated. The World Health Organization has recently declared a dengue pandemic in the Pacific Islands.[12]

However, attempts to eradicate dengue-carrying mosquitoes in Southeast Asia have proven to be of limited benefit. Despite significant resources and determined effort on the part of the government, even highly developed and geographically compact Singapore has failed to eradicate these mosquitoes. This is partly because there is no cure for dengue, so it cannot be removed from the human population, and partly because the mosquitoes that carry dengue have become so adept at cohabitating with humans in urban environments.

Even worse news comes from a recent controversial study in Thailand.[13] It suggests that deficient or incomplete dengue eradication attempts may actually be causing more cases of dengue hemorrhagic fever. If this initial study proves to be correct, there will be serious public health consequences to be considered in the design of future control and eradication programs.

Inside Australia

Mainland Australia is currently malaria-free, with the last major epidemic recorded in the Northern Territory in 1962. Even though the climate of northern mainland Australia is malaria-friendly, the population density and number of infected people is too low to maintain disease transmission. In southern Australia, there are fewer mosquitoes and the cooler climate is less suitable. The National Notifiable Disease Surveillance System recorded 701 reported cases annually between 2000 and 2006, up from 193 per year from 1983 to 1991. The vast majority of these cases, as well as the latest reported cases of malaria on the

mainland, appear to have been imported through disease-carrying visitors from neighbouring countries. Local malaria transmission has been recently documented in Queensland and in some of the islands in the Torres Strait. However, if disease and mosquito surveillance remains vigilant, experts would not consider Australia to be at high risk of a malaria epidemic.

Dengue epidemics have occurred in the Torres Strait Islands, where the dengue-carrying Asian Tiger mosquito has infiltrated. Northern Queensland has also recorded recent dengue cases. The National Surveillance System recorded an average of 303 dengue cases yearly between 2000 and 2006, peaking at 861 cases in 2003. Dengue poses a much bigger threat to Australia as once dengue becomes established in an area it appears to be almost impossible to eradicate.

The sting

Projections of the impact of climate change on malaria and dengue are truly eye-opening. Early modeling studies predict that malaria prevalence may be 1.8 to 4.8 times greater in 2050 than 1990.[14] The share of the world's people living in malaria-endemic zones may grow from 45% to 60% by the end of the century, with 'fringe zones' like northern Australia at the forefront of this expansion.[15] By 2085, it is estimated that 52% of the world's population, about 5.2 billion people, will be living in areas at risk of dengue.[16]

Beyond these alarming headline numbers, one of the greatest problems in addressing the intersection of climate change and mosquito-borne diseases is the significant uncertainty over how much and how quickly climates will change and how much of the observed and predicted increases in malaria and dengue can be directly linked back to climate change. However, many experts agree that early warning signs already exist.

Recent data suggest that since the 1970s climate change has contributed to 150,000 more deaths every year from disease, with over half of these deaths occurring in Asia.[17] In Africa, as well as Papua New Guinea, increases in average temperature have contributed to the spread of malaria into previously malaria-free zones, particularly in highland areas. It has been estimated that in the African highlands a mere half-degree rise in temperature translates into a 30-100% increase in the number of mosquitoes able to transmit malaria.[18]

Climate change and extreme weather events associated with it will increase the number of people displaced by environmental change and disaster. Using mid-range scenarios, climate change models predict that the population at risk from coastal flooding may grow from 75 to 200 million people by 2080.[19] The number of 'environmental refugees' as a whole may reach 50 million by 2010, with small, low-lying island populations at the greatest risk.[20] Displaced people from lowland areas could well provide the human reservoir for the spread of malaria and dengue. Displaced groups are particularly vulnerable to increased disease and higher mortality rates. Refugee groups in the tropics have experienced a sevenfold increase in the risk of malaria transmission.[21]

Closer to home, in Asia and the Pacific, outbreaks of dengue have been correlated with

the Southern Oscillation Index, a component of the El Nino phenomenon.[22] Region-specific modeling shows that dengue fever could increase by 20-30% in Fiji due to climate change.[23] The population at risk from malaria in Papua New Guinea could increase by 2 million people due to rising temperatures.[24] In Indonesia, climate change is predicted to increase annual rainfall by 2-3% which will be concentrated into shorter seasons that could increase the frequency of malaria and dengue-spreading flooding and droughts.[25] Droughts kill off some of the most important mosquito predators, including dragonflies, frogs and lacewings.

In Australia

More and more specific models have been used to predict the effects of climate change on mosquito-borne diseases in Australia. The Australian-developed CLIMEX model predicts that a 1.5 degree increase in temperature and a 10% increase in annual rainfall could lead to malaria spreading down as far south as Gladstone, Queensland (550 kilometres north of Brisbane) by 2030.[26] Another modeling study suggests that the range of dengue-carrying mosquitoes could expand southwards as far as Carnarvon, Western Australia in the west and Rockhampton, Queensland in the east. (Please see the map in appendix 1.)

Australia's largest challenge though will likely come from the spread of dengue and malaria in and between the countries to the north, and the greater number of people carrying these diseases entering Australia.

What should be done?

1) Improve predictive modeling capacity

One of the biggest problems facing the six countries neighbouring Australia under study here is the dearth of information on current disease incidence, let alone specific information or modeling on the future spread of malaria and dengue owing to climate change. Unlike for Australia, there is only limited information on the present distribution of malaria and dengue-carrying mosquito populations in the most affected countries in the region. Improved malaria and dengue prediction is essential, yet few predictive models have been applied to these six countries to better gauge where and by how much malaria and dengue will spread because of climate change.

Using Australian aid dollars and scientific expertise in cooperation with these six countries to develop climate, disease and mosquito surveillance systems, and to carry out country-specific modeling would provide an invaluable basis for all other policy interventions. It would provide the means over time to improve the models themselves and a better early warning system to predict outbreaks in specific locations in the affected countries. This would have obvious benefits for prioritising government health and development strategies. In line with this, Australia should update its own risk assessments of malaria and dengue based on the latest climate change modeling and information about the geographical distribution of the relevant mosquito species.

2) *Prepare the affected health systems*

In line with AusAID's efforts to tackle malaria in all six countries under study here, more emphasis in the short term should be placed on preparing local health care facilities and populations in new malaria and dengue-sensitive areas to address the prevention and management of these diseases.[27] There should be a focus on local impact-based research to determine the best strategies for prevention, treatment and management of the disease. This would be cheaper and more immediately achievable than attempts to eliminate mosquito populations. The recent SARS and avian influenza experiences reinforced the difficulties of effective pandemic planning and how poor adaptive capabilities hamstrung effective local responses.

In the longer term, the development of a sustainable health facility north of the Torres Strait border would provide a centre for prevention training and monitoring programs, as well as having an important role in improving biosecurity by acting as a first-line facility during epidemics.

3) *Tighten quarantine and screening processes*

As the areas potentially vulnerable to malaria and dengue in northern Australia expand, effective border screening will become even more crucial. Stringent screening was a central component of the highly effective malaria control program on Aneityum, Vanuatu in the early 1990s.[28] The Northern Territory screens for malaria all visitors who are considered to be in high-risk groups, including illegal fisher-people from Indonesia, refugees, and students from Solomon Islands and Papua New Guinea. This should also become practice in Queensland and Western Australia, with the potential for expansion into the rest of Australia. The diagnostic tests and treatment for malaria are straightforward and relatively inexpensive, especially in comparison to the costs of an outbreak response. Although more problematic, tests for dengue should also be considered for these same at-risk groups given the greater threat of an epidemic posed by dengue.

The majority of refugees to Australia from Africa are screened and treated for malaria before their departure. However, these tests are not 100% accurate, and many are performed days, if not weeks, before departure, allowing time for reinfection. Data from health refugee services showed prevalence of malaria of 5% and 16% respectively in the two groups of refugees who were sampled.[29] More stringent testing should reduce these relatively high failure rates and the related risk of local malaria outbreaks in Australia.

NOTES

[1] World Health Organization (WHO) Regional Office for the Western Pacific, *Malaria annual data: Malaria morbidity and mortality*. Manila, WHO, 2005; R. W. Snow, C. A. Guerra, A. M. Noor, H. Y. Myint and S. I. Hay, The global distribution of clinical episodes of Plasmodium falciparum malaria. *Nature* 434 (7030) 2005.

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[4] http://www.theglobalfund.org/en/apply/current/ (visited on 11 November 2008).

[5] These numbers are indicative only and likely underestimate the burden. Due to the lack of health services and demographic information in many areas, a number of deaths and disease incidences go unreported or undiagnosed.

[6] For Indonesia, P. Dale, N. Sipe, S. Anto, B. Hutajulu, E. Ndoen, M. Papayungan, A. Saikhu and Y. T. Prabowa, Malaria in Indonesia: a summary of recent research into its environmental relationships. *Southeast Asian Journal of Tropical Medicine and Public Health* 36 (1) 2005 & WHO/SEARO data; for East Timor, WHO/SEARO data; for Solomon Islands and Vanuata, WHO/WPRO data; for PNG, I. Mueller, M. Bockarie, M. Alpers and T. Smith, The epidemiology of malaria in Papua New Guinea. *Trends in Parasitology* 19 (6) 2003 and WHO/SEARO data.

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[9] Charles J. Hanley, As world warms and mosquitoes thrive, malaria climbs into New Guinea highlands. *Associated Press*, 10 December 2007.

[10] WHO, *Solomon Islands country profile*. Roll back malaria monitoring and evaluation, 27 April 2005.

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[12] WHO warns of Pacific dengue pandemic. *One News, New Zealand*, 1 November 2008.

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[21] J. Kolaczinski and J. Webster, Malaria control in complex emergencies: the example of East Timor. *Tropical Medicine & International Health* 8 (1) 2003.

[22] This index measures the strength and direction of the Southern Oscillation, a major air pressure shift between the Asian and east Pacific regions. The best known extremes of this are the El Nino events. The index is calculated from the monthly and seasonal in the air pressure difference between Darwin and Tahiti. (www.bom.gov.au/climate/glossary/elnino/elnino.shtml, last visited on 27 October, 2008). For correlations, please see S. Edwards, S. J. Hales, and R. S. Kovats, Impacts on health of climate extremes, in *Climate change and human health: Risks and Responses* ed. A. J. McMichael, D. H. Campbell-Lendrum, C. F. Corvalán, K. L. Ebi, A. Githeko, J. D. Scheraga and A. Woodward. Geneva, World Health Organisation, 2003; and A. K. Githeko, S. W. Lindsay, U. E. Confalonieri and J. A. Patz, Climate change and vector-borne diseases: a regional analysis. *Bulletin of the World Health Organization* 78 (9) 2000.

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[25] Sanjana, Barcus, Bangs, Ompusunggu, Elyazar, Marwoto, Tuti, Sururi, Tjokrosonto and Baird, Survey of community knowledge, attitudes, and practices during a malaria epidemic in central Java, Indonesia.

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[27] Prevention and eradication programs targeting malaria and dengue should, in theory, have the side benefit of reducing the risk of other mosquito-borne diseases like chikungunya. Indian Ocean countries have experienced recent outbreaks on this deadly disease and Australia and the Pacifife Islands could face a chikungunya threat in the future.

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APPENDIX 1.


Melville I.
Darwin
Arnhem Land
Katherine
Cape York
Great Barrier Reef
Wyndham
Kimberley
NORTHERN TERRITORY
Broome
Halls Creek
Cairns
Tennant Creek
Port Hedland
Mount Isa
Townsville
Mackay
AUSTRALIA
QUEENSLAND
North West Cape
Alice Springs
Tropic of Capricorn
Rockhampton
Longreach
Uluru (Ayers Rock)
Carnarvon
WESTERN AUSTRALIA
Charleville
Sunshine Coast
Brisbane
Coober Pedy
Lake Eyre
Cooper Ck
Geraldton
Gold Coast
SOUTH AUSTRALIA
Kalgoorlie
Bourke
Port Macquarie
Port Augusta
Broken Hill
NEW SOUTH WALES
Perth
Fremantle
Esperance
Port Lincoln
Newcastle
Sydney
Wollongong
Albany
Adelaide
Kangaroo I.
CANBERRA
AUSTRALIAN CAPITAL TERRITORY
VICTORIA
Geelong
Melbourne
Launceston
TASMANIA
Hobart

ABOUT THE AUTHOR

Dr Sarah Potter
BA; BSc (Hons); MIPH; PhD (Medicine)

Sarah Potter worked as a malaria research scientist at the University of Sydney, Australia, and at the Institut Cochin, France focusing on the immunopathology of cerebral malaria, as an INSERM Postdoctoral Research Fellow. In 2006, she joined the Health Policy Division at the George Institute for International Health, where she contributed to *The Malaria Product Pipeline: Planning for the Future* policy report on the clinical development of malaria drugs and vaccines. Sarah also completed her Masters degree in International Public Health in 2003, and was awarded the University Medal by the University of Sydney in 2000. Sarah is currently based at the Environmental Health Branch, NSW Department of Health.

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