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title **Impacts of climate change on public health in Australia: Recommendations for new policies and practices for adaptation within the public health sector**

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Executive summary

This Issues Brief provides information, opinions and recommendations relevant to assessing the potential impacts of climate change on public health in Australia, as well as guidelines for decision-making in responding to these impacts.

It aims to:

- draw attention to the potential impacts of climate change on health in Australia;
- discuss the policies and issues related to the impacts of climate change on health;
- present prioritised recommendations to decision-makers on policies and practices which may assist mitigation of and adaptation to the most serious of the identified impacts;
- provide guidance which will assist appropriate people and agencies to allocate resources to the highest priority problems; and
- provide a comprehensive list of references which provide reliable evidence about the potential impacts of climate change on health in Australia.

The immediate and longer-term impacts of climate change have the potential to affect Australian health and social environments seriously, and as such, demand and deserve attention by Federal and State Governments and agencies within the Australian public health sector.

Policymakers are faced with pressing issues of funding and delivering health services for an ageing society with an ever increasing burden of chronic disease and expectations of access to high-technology, high cost interventions. However, the impacts of future climate change on public health may potentially generate very large healthcare costs if current strategies for healthcare are inadequate.

Successful advocacy of new policies and practices by credible and influential groups must use language which can be understood by the people who are to be influenced. This advocacy must be supported by reliable evidence.

Climate-related catastrophes (droughts, floods, cyclones, other storms, bush fires) occur frequently in Australia. The demonstrably high variability in the incidence and severity of such phenomena present a challenge to scientists to discover and demonstrate any correlations between the catastrophes and the slow changes of climatic indices due to climate change.

Public health organisations must start to develop alternative, more effective, practices to manage the complex issues related to climate change while continuing to implement their traditional primary, secondary and tertiary preventive models.

A new approach, based on ecological principles, will be required to navigate through the complex and interrelating health causes. The public health sector must strengthen existing approaches for effective climate change adaptation strategies, including assessing regional health risks to identify vulnerable and resilient populations, collecting enhanced surveillance data and developing monitoring indicators.

This approach must be based on:

- providing sound scientific evidence for predicting the likely outcomes and thus to take preventive or responsive action; and
- reorienting the public health sector towards greater comprehension and use of ecological understandings and approaches.

Recommendations

Politicians, health bureaucrats and other interested parties must formulate comprehensive, coherent policies to address the direct and indirect impacts of climate change on public health, including allocation of appropriate financial resources as part of a National Plan for Health in Responding to Climate Change.

The National Health and Medical Research Council should be tasked with ensuring coordinated, comprehensive funding to support research into the health impacts of climate change.

Research organisations and health institutions must collaborate to develop cost-effective, long-term, longitudinal studies on the impacts of climate change on the physical, biological and social environments that will affect Australian's public health.

Advocates must develop proposals which demonstrate cost savings to government over three to six years, or one or two electoral cycles. Little will be achieved in the current fiscal environment if proposed policies and practices will incur significant new budgetary expenses to governments or their agencies.

Managing the impacts of climate change on public health will also involve several other sectors, such as water, planning, building, housing and transport infrastructure. Appropriate institutions should work towards a multi-level, interdisciplinary and integrated response to raise the importance of the impacts of climate change on public health.

A comprehensive surveillance system would monitor the inter-relationship of environmental, social and health factors. Observational studies are important to monitor recent and present disease patterns and incidence to inform modelling of future disease patterns. They could also provide baselines for environmental health indicators, which can periodically be monitored and measured in order to inform program evaluation.

The public health sector must integrate planned, evidence-based adaptations into existing preventive activities. Useful methodologies might include:

- a risk assessment approach such as Health Impact Assessment (HIA);
- an appropriate range of Environmental Health Indicators (EHIs);
- a "Driving force-Pressure-State-Exposure-Effect-Action (DPSEEA) framework"; and
- a systematic ecological health framework.

The opposite of vulnerability is resilience – our capacity to respond to challenging or new circumstances. The factors which encourage resilience needs to be better understood. The public health sector must communicate concepts of risk, and develop strategies to encourage greater resilience.

To understand how we can minimise vulnerability of individuals and communities to climate change we must identify those populations which are most at risk, including those for whom climate change will act as a stress multiplier for existing public health problems.

The health sector must communicate climate change as a human health issue rather than just an “environmental problem”. The focus should be on effective, realistic and sustainable solutions rather than problems characterised as bleak and unresolvable.

Introduction

The concept of 'Do No Harm' has guided health service delivery and medical practice as they have evolved over many years. This is particularly relevant as we face new environmental challenges, including those which result from climate change. Equally as important is the concept that people are at the heart of health care, because personal and public health both involve our social, mental, spiritual and physical well-being.

Our physical and social environments influence our health and importantly, our ability both as individuals and society to meet and adapt to the challenges we encounter. Our housing, our ability to access clean water, our food security, our safety from environmental dangers such as bushfires, floods, cyclones, heatwaves and other catastrophes are all critical factors in our ability as humans to survive, and to live long and healthy lives.

There is significant evidence that there is a socio-economic gradient in good health. The more underprivileged are less likely to experience good health and a long life due to lack of clean water, food insecurity, sanitation issues, localised environmental problems and other problems. This is widely acknowledged and serious attempts are made to address socio-economic factors underpinning health. Unfortunately, the media and public discussion can lead to a perception that environmental impacts on health are (and will be) largely confined to those with disadvantages. However, those seeking to influence the debate about climate change and health must emphasise its broad public impact. The problems really concern all of us, not just some unseen group of unfortunate people.

Most of us care about our good health, so health considerations should be an important driver in changing attitudes towards climate change. While a reported pattern of increased temperatures may fail to convince a climate change sceptic, personal experiences of illness related to heatwaves or skin cancer or the rising prevalence of vector-borne diseases such as dengue fever may provide the emotive stimulus for improved awareness of the impacts of climate change.

The general aim of this Issues Brief is to clarify the issues related to the probable impacts of current and imminent climate change on the health of Australians. It makes recommendations about policies and practices within the public health system which may reduce these impacts.

Those who advocate new public policies and practices in relation to the impacts of climate change on public health must realise that very little will be achieved in the current fiscal environment unless proposals demonstrate cost savings to government over three to six years, or one or two electoral cycles.

Aims

This Issues Brief aims to:

- draw attention to the potential impacts of climate change on health in Australia;
- discuss the policies and issues related to the impacts of climate change on health;

- present prioritised recommendations to decision-makers on policies and practices which may assist mitigation of and adaptation to the most serious of the identified impacts;
- provide guidance which will assist appropriate people and agencies to allocate resources to the highest priority problems; and
- provide a comprehensive list of references which provide reliable evidence about the potential impacts of climate change on health in Australia.

Policy context

There appears to be few policies at Federal and State levels which specifically address management of the impacts of climate change on Australia's public health. While much has been written and discussed, few practical policies have been formulated or adopted.

The health sector has generally been slow to recognise the impacts that global climate change might have on human health.^{1 2} For example, there were no submissions by any health agencies to the 2012 Productivity Commission Inquiry into Barriers to Effective Climate Change Adaptation.

The lack of attention by Federal and State Governments on the probable impacts of climate change on public health is potentially placing Australian populations at an unnecessary risk.⁴ Public health adaptation requires higher levels of government effort, particularly public health policies on climate change adaptation. The Commonwealth can provide useful stewardship and leadership. Governments on all levels must listen to and respond to the concerns of vulnerable communities.⁵ Policy leadership from the Commonwealth Government should initially be addressed by a National Plan for Health in Responding to Climate Change.³

There are numerous barriers to formulation and adoption of potentially effective policies. Many can be overcome with sufficient political will, social support, adequate resources and effort.⁶ The public health sector must provide leadership, strategic thinking, resourcefulness, creativity, collaboration, and effective communication.⁶ Leadership is important at every stage in the adaptation process, especially initiating the adaptation process and sustaining momentum into the future.

The impacts of future climate change on public health have the potential to generate very large health care costs if current strategies are inadequate and ineffective.⁷⁻⁹ However, the National Health and Medical Research Council has allocated almost no funding on climate related projects to date.³ Sustained funding is required to support the understanding of climate change policies in particular health vulnerabilities and the development of surveillance and monitoring tools.^{10 11} The development of a comprehensive funding strategy is required for public health adaptation. Managing the impacts of climate change on public health will also involve several other sectors, such as water, planning, building, housing and transport infrastructure. Therefore, a multi-level, interdisciplinary, and integrated response is necessary to raise the importance of health in those sectors.^{5 7 12 13}

Climate change in Australia

There is wide acknowledgement throughout the scientific community that the increasing atmospheric concentrations of greenhouse gases from human activities are causing global warming and other climatic changes.¹⁴ According to the Intergovernmental Panel on Climate Change, the global average surface temperature has increased by approximately 0.6°C, mainly since the mid-1970s, and may rise further by about 5.4°C by 2100.¹⁵

A recent report by the Australian Bureau of Meteorology details many aspects of the changing climates in Australia:¹⁶

- Australia's climate has warmed by 0.9°C since 1910, and the frequency of extreme weather has changed, with more extreme heat and fewer cool extremes.
- Temperatures are projected to increase, with more extremely hot days and fewer extremely cool days in Australia.
- The duration, frequency and intensity of heat waves have increased across large parts of Australia since 1950.
- Extreme fire weather has increased and the fire season has lengthened across large parts of Australia since the 1970s.
- Rainfall averaged across Australia has slightly increased since 1900, with the largest increases in the northwest since 1970.
- Rainfall has declined since 1970 in the southwest, dominated by reduced winter rainfall. Autumn and early winter rainfall has mostly been below average in the southeast since 1990.
- Average rainfall in southern Australia is projected to decrease, and heavy rainfall is projected to increase over most parts of Australia.
- Global mean sea levels rose at a rate of 3.2 mm per year during the last 20 years.

Future climatic scenarios may include¹⁶:

- Australian temperatures are projected to continue to increase, with more hot days and fewer cool days.
- A further increase in the number of extreme fire-weather days is expected in southern and eastern Australia, with a longer fire season in these regions.
- Average rainfall in southern Australia is projected to decrease, with a likely increase in drought frequency and severity.
- The frequency and intensity of extreme daily rainfall is projected to increase.
- Tropical cyclones are projected to decrease in number but increase in intensity.
- Projected sea level rise will increase the frequency of extreme sea level events.

Impacts and problems related to climate change

Global and local warming has been linked with both direct and indirect serious impacts on human health.¹⁷ Climate change has been identified as one of the major threats to global health and societies must develop strategies to manage the projected impacts.⁵

The impacts on public health in Australia of the climatic changes outlined above can be categorised as follows:

- probable increases in the frequency and severity of severe weather-related events (floods, droughts, bushfires, severe storm systems and prolonged periods of extreme heat) which expose communities to the threat of an unusually high incidence of mortality or morbidity, as well as increasing mental health disorders;⁵
- increased incidence and severity of climate-sensitive diseases such as heat-related illness, infectious diseases, migratory vector-borne diseases and diarrhoeal disease from contaminated food or water supplies;¹⁸
- rising air temperatures may alter the chemical reactions of some air pollutants such as ozone and particulate matter¹⁹ and could increase ground level exposure to air pollution or allergens while potentially aggravating pre-existing respiratory and cardiovascular diseases;¹⁹ and
- there may be more complex pathways of adverse health impacts from climate change such as social dislocation, unusual levels of migration of populations forced by sea level rise and increased food insecurity arising from broad changes to local environments.²⁰

Probable impacts on health

It is reasonable to expect that increasing temperatures will affect the geographical distribution of insect disease vectors, such as mosquitoes. Therefore the incidence and severity of specific vector-borne health problems such as Ross River fever, dengue fever and Murray Valley encephalitis is expected to increase. The introduction of new vector-borne diseases to Australia is likely especially with the close proximity of Papua New Guinea to northern Australia.

There appears to be little epidemiological evidence from reliable studies which specifically links any increased incidence and severity of other climate-sensitive infectious diseases, such as diarrhoeal diseases from contaminated food or water supplies.¹⁸ More short-term and long-term research is required.

A similar observation can be made about the lack of any reliable research which specifically correlates present and probable increases in the frequency and severity of severe weather-related events (floods, droughts, bushfires, severe storm systems and prolonged periods of extreme heat) with climate change. These events expose communities to the threat of unusually high incidences of mortality or morbidity, as well as increasing mental health disorders and heat-related illnesses, especially among babies and the aged.¹⁹

It is possible that rising air temperatures may alter the chemical reactions of some air pollutants such as ozone and particulate matter.¹⁹ This could increase ground level exposure to air pollution or allergens while potentially aggravating pre-existing respiratory and cardiovascular diseases.¹⁹ Again, reliable research is required.

There may be more complex pathways of adverse health impacts from climate change, such as social dislocation and increased food insecurity arising from broad changes to local environments. For example, severe social dislocation may result from forced migration to evade rising sea levels in some South Pacific countries, which could have implications for some communities in Australia.

Climatic change may exacerbate food insecurity. For example, the impact of severe cyclones on food availability and prices is well demonstrated by much higher banana prices in Eastern Australia following the devastation of plantations during Cyclone Yasi. The impacts of droughts on food production in Australia are well known and climate change is likely to increase the frequency and severity of droughts. For those living in remote Australian communities, the loss of a major food product from climate-related catastrophes can have huge implications for finances, health and ultimately for survival.

Climate change skeptics frequently observe that these types of climatic catastrophes (droughts, floods, cyclones, other storms) have “always occurred” in Australia and cannot be attributed to climate change. The demonstrably high variability in the incidence and severity of such phenomena present a challenge to scientists to discover and demonstrate any correlations between the catastrophes and the slow changes of climatic indices due to climate change.

Validity and reliability of indicators

Health agencies in all parts of Australia already routinely collect a wide range of statistics (“indicators”) on the occurrence of numerous diseases, medical conditions and medical interventions. Researchers should design longitudinal studies which capitalise on the availability of this information in order to link the occurrence and severity of certain conditions with selected indicators of climate change. Importantly, such studies need to discover and assess the validity and reliability of the selected indicators of diseases related to climate change, so that long-term studies can be proved to be valid over many decades.

The recording of health problems in the wider community, as opposed to hospital records, relies partly upon assessing reports from primary health practitioners widely scattered around Australia. There can be considerable unintentional delays and gaps in such reporting and analysis. Research is underway, both in Australia and internationally, to explore possibilities for innovative use of social media to track the spread of various health problems. However for this to be useful, it must be undertaken in collaboration with health professionals to provide context to the data patterns that might emerge through social media monitoring.

Estimates of the rates of change and geographical spread

The possibility of estimating the rates of geographic spread of medical problems from existing data already exists. However, any links to climate change (especially increased temperatures) have yet to be established by appropriate research. For example, it might be possible to establish correlations between some indicators of climate change (such as maximum and minimum temperatures and other parameters) and the occurrence and severity of dengue fever if it is observed to be spreading southwards along coastal Eastern Australia at detectable rates.

Monitoring priorities

Researchers must select a limited number of indicators of health relating to climate change and monitor these within well-designed, adequately-resourced, longitudinal studies. The degrees of urgency and priority in monitoring these and other impacts should be discussed among professionals of relevant institutions.

Estimates of financial implications

The probable financial implications of any impacts of climate change on personal households, communities and state and federal agencies needs discussion. While much information about the costs of many aspects of public health is already available, there is virtually no reliable information which links these statistics with components of climate change. The financial impacts of climate change on health must be discussed, together with the provision of resources to undertake the necessary studies.

Monitoring the indicators

Preventative frameworks in public health

What actions are, and should be, taken by the public health sector (and other government and non-government agencies) to monitor the indicators of climate change and related health risks? Are the present systems dealing adequately with monitoring, reporting and education? Critical assessments of the current systems indicate that they are not robust enough. Satisfactory monitoring of public health issues over the coming decades is required. These include suitable human and financial resources, policies and practices to address the problems and impacts of climate change.

The monitoring of health status, followed by identifying, investigating and explaining health problems at a population level, are traditional public health responsibilities.⁷ Climate change health problems can be investigated using classical disease prevention principles of public health (primary, secondary and tertiary prevention).^{1, 7, 12, 13, 19-23} Primary prevention is intended to prevent disease, harm or exposure from ever occurring.¹³ Secondary prevention aims to prevent disease from happening once an individual is exposed to a hazard.¹³ Tertiary prevention is the implementation of measures to prevent a disease from worsening and to reduce the suffering caused by the disease.¹³

Traditional public health science is heavily dependent on reductionist approaches by identifying factors and reducing these interactions in maintaining human health.²⁴ Reductionism is an effective approach for understanding disease causal paths and has provided interventions to improve human well-being.²⁴ However, reductionism may not be an adequate mechanism in the future to manage unusual incidences or severities of health problems attributable to climate change.

Meeting the new challenges: Requirements for the public health sector

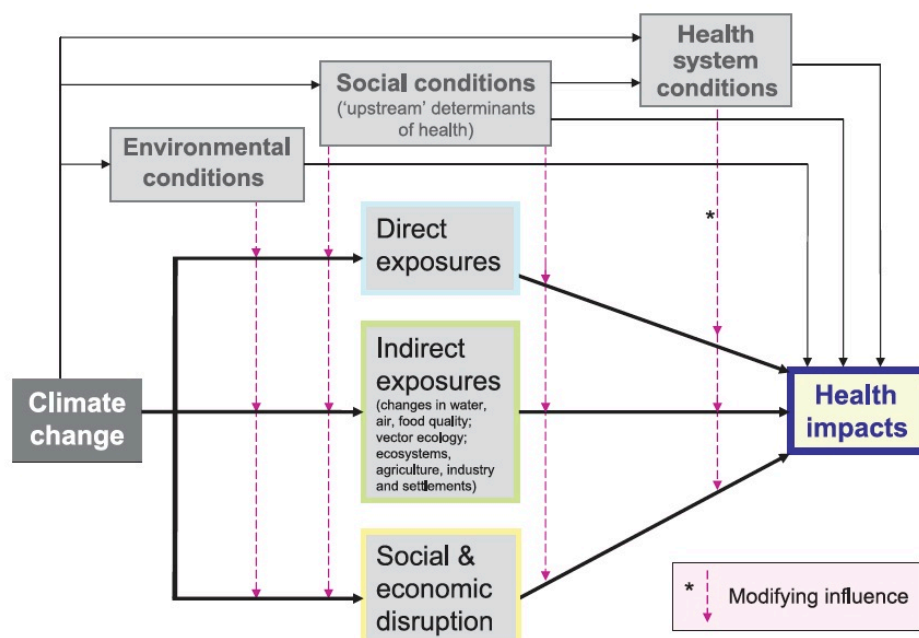
The need for human adaptation to climate change is not new. This may well have been the driver for innovations as the early humans lessened the impact of intense cold with fires and improved housing. In general, Australia's ability to plan for possible events is also well established. For example, risk management strategies, hospitals, emergency services and activation of Disaster Management Plans are some key planning strategies for unusual events.

While the challenges are generally not new, Australians are likely to face amplified current public health problems. This means that the public health sector must go beyond reactive strategies and integrate planned, evidence-based adaptations into existing preventive activities to effectively reduce health risks of climate change.

However, the classic public health framework does have some limitations.²⁴ The complex natural and man-made systems within which we live cannot always be readily explained by simply reducing issues to individual components.²⁴ The complex array of ecological relationships which may affect human health needs to be better understood.²⁴ Humans must recognise that good health is dependent fundamentally on the vitality of nature's life support system.²³ This underpins a requirement for the health sector to communicate climate change as a human health issue impacting everybody rather than as a somewhat distant environmental problem.^{7 13 25 26} Individuals are significantly more likely to support climate policy responses when they understand that climate change can be directly harmful to their health.^{26 27} Furthermore, available research suggests that communications which focus on solutions are accepted more positively than those which present the challenges of climate change as a bleak, unresolvable problem.²⁸

Does the current public health approach fully take into account the profound implications and consequences of the connections between climate change and human health?²³ Climate change presents impacts and challenges quite different from previous challenges.¹⁸ These risks not only demand interventions to reduce specific health vulnerabilities but also require the involvement of social, cultural, environmental, political, and economic interrelations.¹⁸ (Figure 1). Clearly, the public health sector requires a new paradigm to navigate through the turbulent present and uncertain future, as traditional approaches cannot deliver progress on the scale and with the speed required.^{24 29}

Figure 1. Some pathways by which climate change affects health through environmental, social, and health system factors³⁰



Adapted from Intergovernmental Panel on Climate Change. (2007) Working Group II Fourth Assessment Report – Impacts, adaptation and vulnerability.

Current monitoring of indicators and health risks by the public health sector

So what is required to progress this thinking? Firstly, to strengthen our ability to respond to climate change we need to harness the power of “big data”. Disease information is used by the health sector to:

- monitor population health,
- determine when interventions are needed,
- model future disease patterns,
- evaluate the efficacy of health programs and
- provide baselines for indicators.

A simple example is the reporting of the incidence of dengue fever in a community, followed by interventions to manage an outbreak and subsequent evaluation of those activities.

Comprehensive surveillance systems would monitor the inter-relationship of environmental, social and health factors, recognising that these are not necessarily linear. A responsive and effective public health sector requires considerable amounts of accurate information.¹⁵ Traditionally, surveillance data is used to track the health of a population to generate effective responses and then to evaluate the effectiveness of health interventions.^{7 31 32} Adequate surveillance data also provides an early indication if the rate of illness is increasing or spreading in certain areas.³²

The current disease surveillance strategies must be strengthened to assist in understanding how illnesses are altering with climate variability.^{7 8 22 33 34} For example, a comprehensive surveillance system is urgently required to address the complex interrelation of environmental, social, human health and vulnerability factors to better monitor human health outcomes.^{8 22 34 35} While much climate change health research focuses on future risk, it is also important to examine disease patterns.³⁶ Observing the recent past and the present is required to develop reliable baselines for assessing future changes in disease patterns and their impacts.³⁶

Understanding vulnerability

Vulnerability to climate change is defined by the ability of an individual or community to anticipate, manage, resist, and recover from climate change health impacts.^{21 37 38} Therefore, any assessment of potential health impacts from climatic variability requires an understanding of both human vulnerability and the capacity of individuals, communities and health agencies to respond to new conditions.³⁹

The assessment begins by determining the current ability of individuals, communities and agencies to minimise future health impacts.⁴⁰ This is necessary to determine current vulnerability and to plan appropriate adaptation strategies for those most at risk.⁴⁰ As previously mentioned, climate change will act as a stress multiplier for existing public health problems which are already occurring within the community.¹³

The impacts of climate change on human health will place all Australians at some level of vulnerability.¹⁷ Common examples include the impacts of extreme weather events, such as cyclones.¹⁷ The most vulnerable groups are generally lower socioeconomic groups, those already suffering with pre-existing health conditions, Indigenous populations, the young and the elderly.^{13 23 35 41} Climate change is expected to affect both environmental and socioeconomic conditions for vulnerable populations.¹³ However, there is much that is unknown about the vulnerability of such groups and the severity of impacts on them.¹³

The opposite of vulnerability is resilience – our capacity to respond to challenging or new circumstances. To understand how we can minimise vulnerability of individuals and communities to climate change we must assess the risk levels of various population groups. These will include those for whom climate change will act as a stress multiplier for existing public health problems and those who appear resilient in the face of health problems. The factors which encourage resilience need to be better understood, and the public health sector must develop strategies to encourage greater resilience.

Communicating risk

Risk management principles promoting resilience are evolving as an essential component of public health responses to climate change.⁴² Perceptions of the risks and impacts of climate change have been identified as critical in assisting decision-makers to plan adaptations and for communicating the risks to the public and policy-makers.^{13 25 41}

Risk assessment approaches which include disease estimation are essential to implement adaptive strategies.^{31 33} Frameworks useful in undertaking this process are discussed in the academic literature. Health Impact Assessment (HIA) is generally the agreed tool for developing appropriate adapting strategies for climate change.^{10 36 41 43} HIA is defined as “a combination of procedures, methods, and tools by which a policy, program or project may be judged as to its potential effects on the health of a population and the distribution of those effects within the population”.⁴³

The World Health Organisation has encouraged the use of HIA as an important methodology in determining climate change health risks and measuring adaptation benefits.⁴³ The process identifies and examines both the positive and negative health impacts.⁴⁰ The HIA framework can also systematically assist as a support tool for decision-makers and practitioners for health preventive measures by taking into consideration the implications of policy options.^{7 25 36 43-45} This can raise the ‘health profile’ as part of the necessary process for holding governments and other stakeholders accountable for their future decision making.^{7 10 25 39 43 45 47}

Monitoring and evaluating adaptation

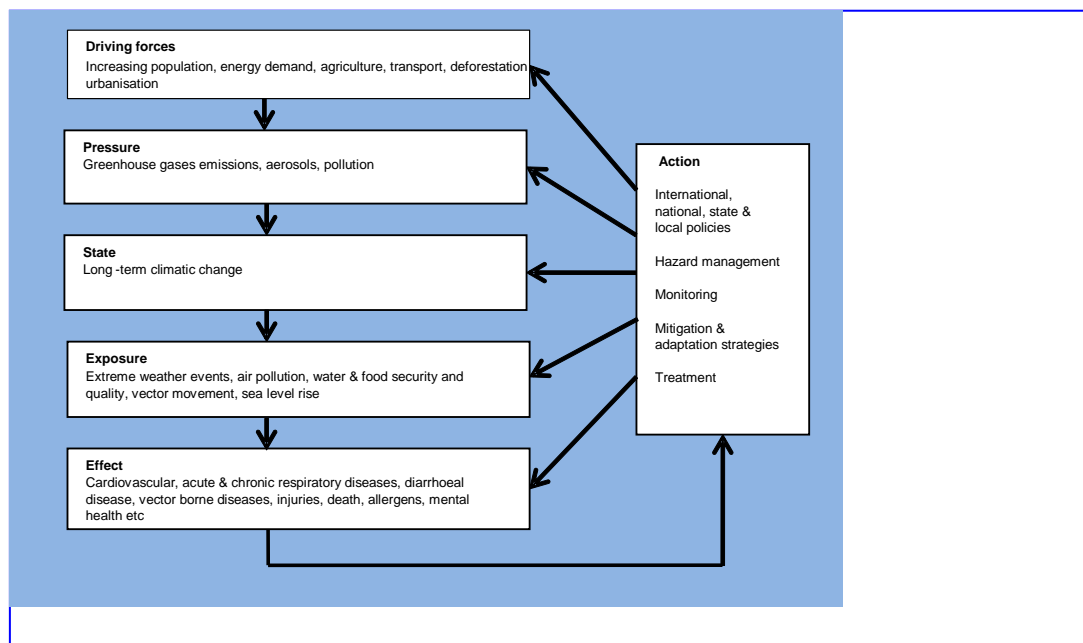
An effective adaptive management approach includes monitoring and evaluating climate change adaptation strategies.³⁹ They provide information for key stakeholders and policy-makers to set priorities, and to select the most appropriate strategy to be used.^{25 38} Further, they also provide baseline information for assessing the variability in time and space of health risks to enable the forecasting of health impact scenarios.^{36 39}

A systematic ecological health framework is important to develop a relevant range of Environmental Health Indicators (EHIs) to allow for consistent monitoring and evaluation of adaptation strategies.³² A ‘Driving force-Pressure-State-Exposure-Effect-Action (DPSEEA) framework’ has been found suitable for the analysis required for complex climate change and health interrelations.^{36 47} The main strength of this framework is that it clearly classifies the various starting points along the causal chain so indicators can be developed at different stages.^{36 47 48} (Figure 2). However, a problem evident in this framework is that it displays a linear order to represent the connections, while in reality the situation is more complex.⁴⁹

Driving forces include social, economic, or political factors at all levels of society which affect the environment.^{36 47} Pressure factors are environmental stressors from driving forces.^{36 47} State factors are the status of the environment.^{36 47} Exposure factors explain the interaction between humans and the environment.^{36 47} Effect factors are human health burden from the exposure to the environmental hazard.^{36 47} Action refers to policy and other interventions intended to protect human health at any stage.^{36 47}

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Figure 2. A simplified example of a Driving force-Pressure-State-Exposure-Effect-Action (DPSEEA) framework applied to climate change³⁶



Adapted from Hambling, T., Weinstein, P. & Slaney, D. (2011) A Review of Frameworks for Developing Environmental Health Indicators for Climate Change and Health. *International Journal of Environmental Research and Public Health*, 8(7), 2854-2875

Reporting, education and communication

Climate change and its probable impacts on health are complex issues. This makes communicating their implications to decision-makers and the general public difficult.^{18 25 41}

The health sector must communicate climate change as a human health issue rather than focusing the discussion as an “environmental problem”.^{7 13 25 26} Many people in the community, including decision-makers, consider climate change as a threat to social, biological and physical environments distant from themselves.⁵⁰ Shifting the climate change focus to an issue of human health and well-being may engage a much broader cross-section of the public.^{26 41}

Research has shown when individuals view climate change as being harmful to themselves and other people they are significantly more likely to support climate policy responses.^{26 41} Communications will be more effective and will generate wider engagement if the focus is on solutions rather than problems.

Human and financial resources, policies and practices for monitoring public health

It is impossible in this Issues Brief to be more specific than to indicate that human and financial resources will have to be made available as the health problems induced by climate change become increasingly

severe. There are many able professionals in the various institutions associated with public health, and more can be trained during the coming decades.

After formulating realistic plans, long-term commitments by politicians, health bureaucrats and health institutions are essential and long-term funding must be assured. This is unlikely in the near future and the problems may have to be addressed in the short to medium term with ingenuity and limited funding. Effective communications by health personnel and the public about their urgent climate change health concerns may pressure governments for some degree of funding priority.

Actions for adaptation

The policy groundwork to address the health challenges related to climate change must be laid now, to anticipate the predicted impacts of climate change on human health. Furthermore, potential health impacts must be identified, a robust evidence base provided, policies developed and action plans implemented in a timely manner. If the “wait and see” approach continues and serious impacts are experienced, it will simply be “too little, too late”.

Both mitigation and adaptation strategies are required. These will be shaped by global attempts to reduce the release of greenhouse gas emissions to minimise future harm. While the academic literature has largely focused on mitigation actions, which are certainly important for overall human health, attention must also be paid to public health adaptation policy.^{52,53}

Defining mitigation and adaptation

Mitigation aims to moderate or make any impact less intense or severe. Adaptation is the process by which populations adapt to new or changing conditions.

Clearly, it is desirable that any problem should be mitigated, minimised or eliminated using practical methods at an acceptable cost. However, if the problem cannot be readily or sustainably mitigated, affected populations have no choice but to adapt themselves to cope with the impacts of the problem.

The two concepts are not mutually exclusive. Immediate and longer-term actions can be taken to minimise the problem while coping strategies can be developed to assist the population in adapting to the adverse impacts. In other words, fix (mitigate) the problem if possible, and while attempting to do so, help societies to adapt to the impacts of the problems and achieve their best possible lives.

What is adaptation?

Adaptation involves designing, implementing, monitoring and evaluating strategies intended to reduce the impacts attributable to climate change.^{7,12,27,43} This is an important strategy to reduce vulnerability, by investigating any adjustments required in natural or human systems.^{6,54}

There are two forms of adaptation:

- preventive action to avoid risk (proactive); or
- immediate action after the impact (reactive).¹⁹

Generally, wealthy countries have lower vulnerability and therefore have greater adaptive capacity to cope than most developing nations.⁶ Although recent attention to adaptive actions might have been focused on poorer countries, developed countries are not immune from the impacts of climate change.⁵⁴

Adaptation and public health

The adaptation approach aligns closely with the conventional “preparedness principles” of public health.¹⁵ These principles have assumed a central role in the public health sector in recent years and appear to be useful in managing the effects of climate change.^{2 7 12 35} Clearly, the public health sector has an important and ethical part in climate change adaptation in preventing adverse human health impacts.^{13 18 21 55 56}

The World Health Organisation describes the “Preparedness Principle” as:

“If an activity raises threats to human health or environmental harm, precautionary measures must be undertaken, even if some cause and effect relationships are not fully scientifically proven”⁵⁷

This is consistent with the mantra of “Do No Harm” that shapes the ethics, practices and behaviour of health professionals.

Some characteristics of climate change adaptation are not new for the public health sector.^{7 53} Human societies have a long history of social adaptation to varying climates, such as preparing disaster management plans to protect human health.¹³ However, several aspects of adapting to climate change are new to some societies, as it is probable that many locations will experience record climatic conditions and at a rate of change unprecedented in modern human history.^{53 58}

Climate change will probably not introduce any new diseases but will alter factors such as the locations and timing of environmental exposures.³¹ This will affect the incidence of morbidity and mortality. Climate change will mainly amplify the current public health problems.⁵⁹ For example, some vector-borne diseases are currently largely confined to the tropical northern parts of Australia. These diseases could well become more prevalent in southern areas as climates warm. Therefore, the public health sector must anticipate these types of change in the incidence of diseases. Importantly, the public health sector must go beyond simply reacting to changing climates by integrating planned adaptations into existing preventative activities to reduce the health risks.³⁵

Mitigation and adaptation action

Mitigation and adaptation strategies for minimising the adverse impacts of climate change must support each other. The public health sector must not make the mistake of accepting one strategy as the only alternative.^{17 52} Therefore, managing the impacts of predicted climate changes will require both mitigation

and adaptation strategies.¹⁷ For instance, inadequate strategies to address adaptation will leave communities poorly equipped to cope with the climatic changes expected over the next few decades.^{4 12} On the other hand, focusing on adaptation alone with limited or ineffective mitigated strategies could result in the problems escalating to the point that human societies may not be able to adapt and survive.¹⁵

It is critical that long-term global mitigation strategies are used by all countries to reduce the absolute amounts and rates of greenhouse gas emissions to reduce the adverse impacts on future climatic conditions.^{4 12 40} Mitigating the atmospheric concentration of greenhouse gas emissions will significantly benefit human health, provided that appropriate and effective policies and practices are introduced.¹⁷

Mitigation has received more attention in academic literature than adaptation.⁵² Despite an urgent requirement for mitigation actions, there are also increasing arguments for the importance of adaptation strategies.⁵² While actions to mitigate the impacts of climate changes are extremely important, they are implementable largely at global and country-wide levels and are thus generally out of the control of locally-based public health agencies. This Issues Brief concentrates on public health adaptation strategies to minimise the probable health impacts on Australian communities.

Constraints on adaptive actions by the public health sector

If the current health systems are not demonstrably robust, how can they and their resources be changed to monitor, mitigate, adapt and communicate? Public health sector capacity must be developed to inform policy-makers and politicians while educating the public to be aware of the risks they may experience.

However, the public health sector is inevitably constrained in its ability to adapt to and minimise the impacts of changing climates. Identifying the most important issues impeding the adaptive ability of the public health sector will assist understanding, decision-making and implementing adaptation strategies.^{6 17} Many constraints may lie outside the direct control of the public health sector, yet have direct impacts on the adaptation process.³⁵

Uncertainties about future climate conditions

Policy making generally happens in uncertain environments and therefore it is rarely possible to have complete knowledge of all the important factors affecting any given topic. The policy-making process must proceed on the basis of the “best available evidence”. There is strong scientific evidence that climates are changing, as corroborated in recent reports from the International Panel on Climate Change, the Australian Bureau of Meteorology and others. Yet, there are still uncertainties about the amounts, directions and rates of change. Several other uncertainties affect the nature of the correlations between the probable severities of climate change and the state of community health. For instance, these include changes in social behaviour and technologies.^{33 35} The public health sector will have to understand and consider numerous uncertainties about the future health impacts to improve and adopt effective policies on adaptation.

Lack of urgency

There is an apparent lack of urgency within the health sector to address the implications of climate change and its impacts on public health. This appears to be common among policy-makers and governments, but also amongst researchers and those who deliver health services. Despite acknowledging the importance of public health in climate change adaptation, there is limited international literature on how the public health sector could implement appropriate policies.⁶⁰ The health sector has generally been slow to recognise the impacts that global climate change could have on human health.^{1,2} For example, there were no submissions by any health agencies to the 2012 Productivity Commission Inquiry into Barriers to Effective Climate Change Adaptation.³ This may suggest to policy-makers that the health sector itself does not consider climate change adaptation as a priority.

Lack of guidance

Despite the work undertaken by organisations such as the Australian Healthcare and Hospitals Association and the Climate and Health Alliance to advance policy debate, the issue appears to be low on the policy agenda. Implementing effective adaptations requires guidance and information about feasible strategies to address climate change impacts.³⁵ Some adaptation recommendations are available for the public health sector but there has been little guidance on developing suitable specific procedures for adaptation in particular locations.^{32,60} Likewise, there has been little guidance as to how this process could increase the resilience of individuals and communities to changes in the incidence of health problems.^{32,60}

Competition with existing health issues and priorities

The increasing number of issues confronting public health today will be a challenge for the sector.¹³ Climate change adaptation is a new priority in the public health agenda. As is the case with all operational matters, priorities will have to be established, possibly at the expense of other programs or investments.^{28,61}

Regions with limited public health infrastructure, such as rural and remote locations, may consider that climate change adaptation should be secondary to strengthening the fundamental health services.⁶⁰ Even in well-developed health infrastructures, climate change adaptation often unsuccessfully competes with other urgent public health concerns.^{8,48,60} These competing issues raise important dilemmas for public health.²⁴

Availability of data

There is a lack of quality long-term data to support understanding of the present complex relationships between environment and health. Baseline datasets are essential for understanding the long-term impacts of climate change on health.^{8,33,39} Obtaining this information is extremely important for evaluation, as the data provides reference points against measured outcomes.⁶²

This is made even more difficult because of disorganised and inefficient approaches to data collection.^{7,44} Even if health surveillance data are available, valid interpretations of the data to explain the impacts of

climate changes are likely to be complicated and difficult.³³ For instance, variations in important health factors change over time, or the way in which diagnoses may be recorded might have changed.^{33 62} Changes in the methods of collection of baseline data over time can be increasingly misleading as the impacts from climate change increase.⁶²

Lack of resources

Policy-makers in the health sector are faced with pressing issues of funding and delivering health services for an ageing society with ever increasing chronic disease burdens and expectations of access to high-technology, high cost, interventions. The situation is likely to become even more constrained, as health budgets become even tighter.

Adequate resources for the public health sector are especially important for forecasting and management phases. Climate change adaptation is heavily reliant on laboratory and field-based science to enable increased adaptive capacity.^{18 62} The necessary resources include assured financial support, technical information, technology and professional expertise.^{6 61}

The lack of resources to address the health impacts of climate change is understandable for developing countries but is also an issue for countries like Australia.³⁵ There has been little evaluation in Australia, but it is clear from international surveys that the lack of adequate resources for assessing the impacts of climate change is a challenge for the public health sector.^{6 63}

Climate change adaptation policies require initial and continuing financial investments which governments may be reluctant to provide.^{19 35} Long-term approaches to adaptation and its complexity will be difficult to achieve because they require secure long-term funding.^{28 35 52 59 60} Public health adaptation strategies interrelate with other sectors making it difficult to measure outcomes, which could contribute towards reluctance by government to make the required investment.⁶⁴ Perhaps the biggest challenge is to balance the costs and benefits of an adaptation strategy that draws on limited financial resources.³⁵

Lastly, public policy advocates will achieve very little in the current budgetary environment if they propose new policies and practices which incur significant expense to governments or their agencies. The most successful approaches will demonstrate short and medium-term cost savings, because governments develop budgets in terms of election cycles which are not much longer than three or six years.

Discussion

Despite some uncertainties, there is a wide agreement that climate change will have direct and indirect impacts on human health, both globally and in Australia. While strategies to mitigate climate change are important to reduce the severity of impacts in the longer term, it is clear that adaptation policies and practices are becoming more urgent.³⁹ The public health sector has an ideal framework within which preventative plans can be used to minimise the human health impacts of climate change..

The capacity of people and institutions in the modern era to understand, predict and control the natural world has brought undoubted benefits in healthcare and material wealth.⁶⁵ However, in a rapidly changing and complex world, the public health sector is witnessing decreasing outcomes from formerly successful interventions.⁶⁶ For example, new epidemics have appeared and increasing inequalities indicate that some interventions have proven to be unsuccessful.⁶⁵ There is also little evidence that individuals are responding positively and are embracing new forms of thinking and behaviours.⁶⁶ Many of the challenges faced by the public health sector remain outside the sector's influence.⁶⁶ The impacts of global climate change indicate that societies are now experiencing unavoidable transformations and that the public health sector appears inadequately prepared to cope.⁶⁷

Advocacy

Communicating the climate change message effectively is critical to ensure the impacts of climate change become an important component of the health policy agenda. Australians must give consideration to the real possibility that climate change will affect their ability to live healthy, productive lives.

Public health advocates, policy-makers and leaders do not need to become climate change experts, but armed with robust evidence they can lead change.¹³ Anecdotes, statements of opinion and misleading and unverified data do impede serious evidence that policy-makers can use to underpin good public policy. The scientific community must provide credible evidence of practical value to health policy-makers.

Advocates need to use language which can be understood and accommodated by those to whom they are advocating. This goes beyond evidence and terminology, requiring realistic political familiarity and sensitivity. In conservative political environments it is particularly challenging to advocate for change. This is particularly relevant in the current political and fiscal environment with its focus on budget savings and devolution of responsibilities from the Commonwealth to the states and territories, and to the private sector. A useful approach is to focus on win-win strategies, deliverable in an affordable manner with demonstrable return on investment.

There is already considerable performance monitoring and reporting in the public health sector. Environmental health indicators and supporting data must be included in this work. This may well be readily achievable even as budgets for health governance are tightened. Agreed environmental health indicators, underpinned by robust baseline information, must be monitored, measured and evaluated periodically. Roundtable meetings hosted by the Australian Healthcare and Hospitals Association and the Climate and Health Alliance have discussed practical examples and strategies for change being implemented by clinicians, policy-makers and researchers in the health sector. The international movements 'Healthier Hospitals' and 'Global Green and Healthy Hospitals', exemplify the leadership being exercised. Health leaders are natural allies in the quest to drive better policy to address climate change as they are scientifically literate.

For advocacy to be successful, it must be supported by 'rational' information, including:

- robust data;
- effective use of health terminology;
- peer-reviewed evidence about the problem;
- a health impact assessment for any proposed program or policy change, which assesses the potential effects on population health, and the distribution of those effects across different population cohorts;
- a plan for evaluation; and
- credible and influential spokespersons to argue the case.

Sustainability

The sustainability concept is a good example of a modern public health problem associated with climate change, and is mainly expressed through two focal issues.⁶⁶

Sound scientific evidence is required to predict likely outcomes and thus to take appropriate preventive or responsive action.⁶⁷ It also provides influential support for major and contentious proposals.⁶⁷ However, this approach has some flaws, as radical adjustments in the behaviour of individuals and societies are unlikely to occur if based solely on scientific evidence.⁶⁷

The second focus is to reorient the public health sector towards greater comprehension of ecological understandings and approaches.⁶⁷ Ecological public health identifies the limits of natural systems and appreciates health as a process engaging social, mental, spiritual and physical well-being. This would also move public health to a more environmental and social approach in seeking to change some of the emerging 'risk patterns' of society, such as dependence on fossil fuels.⁶⁷

New approaches to public health

To address the health impacts of climate change, the attention of policy-makers and health leaders must be shifted beyond the familiar preventative public health model.²³ If major public health goals of global sustainability, equity and human health are to be achieved, then a new approach will be required.^{24 68-71} Future public health approaches must have an ecological framework to assist in making sense of the complex systems that influence human health.^{23 24 29 68-71} The public health sector must view climate change as an opportunity to strengthen and encourage its role in achieving environmentally sustainable and equitable health.^{9 21 23} It is also important to stress that this approach does not replace earlier public health models but should be inclusive and superior.⁶⁶

The public health sector must communicate the climate change message as a concern about population health rather than just a vague environmental problem.⁵⁰ Public health professionals must use credible scientific evidence and opinions to communicate the importance of climate change to health.¹³ It is vital that policy-makers, the public and other stakeholders are correctly informed of the probable health impacts to enable the acceptance of adaptive measures.^{7 52}

When planning adaptive strategies, public health professionals must recognise that specific populations in some communities will become more vulnerable to different climate-sensitive outcomes.^{13 38} Identifying those at greater risk can assist in mapping vulnerabilities and identifying areas for priority attention to public health preparedness.^{13 28 42 60} However, considerably more information is required on the complex pathways by which climate change can affect the health of vulnerable and resilience of some populations.

Health impact assessment

Policy-making will depend on structured assessments of the health risks, which in turn require reliable information on the probable impacts.³⁹ The Health Impact Assessment (HIA) is an ideal tool for developing appropriate strategies for adapting to climate change and can be used by appropriate agencies for future decision-making.^{10 13 43} However, the HIA findings must be presented with as few limitations as possible, such as uncertainty and changing of conditions.⁴⁵ Policy-makers who rely on fixed norms about diseases, causality and their implications for health service delivery will not comprehend the climate-relevant issues if they are surrounded by qualifications and uncertainties.⁶⁵ Health risks will vary over time and location, requiring adaptation to be flexible and capable of responding to a continual process of changing hazards.⁴ The assessment of climate change health risks is a complex process as multiple uncertainties must be considered for better understanding.^{4 39 74} Regardless, the public health sector must plan to protect human health from risks associated with climate change irrespective of the future uncertainty.^{35 41}

The public health sector already has existing preventive programs in place, but these were not designed with climate change in mind.⁶³ The existing programs such as surveillance data must be strengthened so that they are adequate to monitor the effects of climate change on health.^{10 13 20}

Adaptation strategies

Adaptation strategies for health impacts must aim to be cost-effective in terms of lives saved and illness avoided.³⁹ Adding some carefully selected adaptation measures into existing public health programs may not be overly costly, for example, monitoring vector distribution to determine if a vector or their associated disease is expanding or contracting from the already established dispersal range.³⁹

Environmental Health Indicators (EHIs) summarise complex information to assist in identifying trends, establishing priorities, monitoring and evaluating adaptation plans in a format that is easily interpreted.^{28 36 38 47 75} An important feature of EHIs is that they provide the necessary understanding of scientifically based linkages between the environment and health.³⁶ However, it may be possible to misinterpret indicators, as they may not fully reflect the environmental health system and may obscure details.⁴⁷ While no single framework can fully represent the complex interactions involved, the DPSEEA framework discussed earlier in this Issues Brief may be helpful in understanding environmental and human health outcomes.³⁶

Barriers to adaptation

Examining potential barriers is essential to understand issues which will hinder adaptation.⁶ Many barriers can be overcome with sufficient political will, social support, adequate resources and effort.⁶ To assist in overcoming the barriers, the public health sector must provide leadership, strategic thinking, resourcefulness, creativity, collaboration and effective communication.⁶ Leadership is important, especially for initiating the adaptation process and sustaining momentum in the future.⁶

Strengthening understanding within the public health sector about the significance of climate change adaptation is an important initial step.^{7 50} This step cannot be taken unless the sector knows what it should do differently because of climate change.⁷³ Therefore, research is required to determine the level of understanding amongst the public health sector and what resources are necessary to deliver responses to climate impacts.^{3 72} A well-informed workforce is fundamental if the health system is to respond adequately to the challenges of climate change.⁷

Despite the scale and nature of climate change, the National Health and Medical Research Council has to date allocated almost no funding to climate-related projects.³ A comprehensive funding strategy is needed to support the development of climate change policies. In particular, understanding health vulnerability and resilience and the development of surveillance and monitoring tools are crucial.^{10 11}

Managing the impacts of climate change on public health will involve several sectors. Many decisions within non-health sectors will have impacts, both adverse and beneficial, on public health outcomes.⁴⁰ Therefore, a multilevel, interdisciplinary, and integrated response is necessary to raise the importance of health in other sectors.^{5 7 12 13} Sectors such as water, planning, building, housing and transport infrastructure should already be developing climate change adaptation strategies, regardless of present uncertainties.²¹ Unfortunately, the public health sector is often not included in such analyses, despite the health impacts being closely linked to these sectors.^{21 38}

The lack of attention from the Commonwealth Government on the probable impacts of climate change on public health is placing Australian populations at an unnecessary risk.⁴ Public health adaptation requires higher levels of government effort, particularly public health policies on climate change adaptation. This requires continued support from the Commonwealth, but governments on all levels must listen to and respond to the vulnerable communities in ways that have not been previously achieved.^{5 10} The major gap in policy leadership from the Commonwealth Government must be addressed by a National Plan for Health in Responding to Climate Change.³

Recommendations

Politicians, health bureaucrats and other interested parties must formulate comprehensive, coherent policies to address the direct and indirect impacts of climate change on public health, including allocation of appropriate financial resources as part of a National Plan for Health in Responding to Climate Change.

The National Health and Medical Research Council should be tasked with ensuring coordinated, comprehensive funding to support research into the health impacts of climate change.

Research organisations and health institutions must collaborate to develop cost-effective, long-term, longitudinal studies on the impacts of climate change on the physical, biological and social environments that will affect Australian's public health.

Advocates must develop proposals which demonstrate cost savings to government over three to six years, or one or two electoral cycles. Little will be achieved in the current fiscal environment if proposed policies and practices will incur significant new budgetary expenses to governments or their agencies.

Managing the impacts of climate change on public health will also involve several other sectors, such as water, planning, building, housing and transport infrastructure. Appropriate institutions should work towards a multi-level, interdisciplinary and integrated response to raise the importance of the impacts of climate change on public health.

A comprehensive surveillance system would monitor the inter-relationship of environmental, social and health factors. Observational studies are important to monitor recent and present disease patterns and incidence to inform modelling of future disease patterns. They could also provide baselines for environmental health indicators, which can periodically be monitored and measured in order to inform program evaluation.

The public health sector must integrate planned, evidence-based adaptations into existing preventive activities. Useful methodologies might include:

- a risk assessment approach such as Health Impact Assessment (HIA);
- an appropriate range of Environmental Health Indicators (EHIs);
- a "Driving force-Pressure-State-Exposure-Effect-Action (DPSEEA) framework"; and
- a systematic ecological health framework.

The opposite of vulnerability is resilience – our capacity to respond to challenging or new circumstances. The factors which encourage resilience needs to be better understood. The public health sector must communicate concepts of risk, and develop strategies to encourage greater resilience.

To understand how we can minimise vulnerability of individuals and communities to climate change we must identify those populations which are most at risk, including those for whom climate change will act as a stress multiplier for existing public health problems.

The health sector must communicate climate change as a human health issue rather than just an "environmental problem". The focus should be on effective, realistic and sustainable solutions rather than problems characterised as bleak and unresolvable.

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