Chapter 15
Climate Change and Health: The Malaysia Scenario

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Abstract Malaysia, located in Southeast Asia, has a tropical climate and abundant rainfall (2000–4000 mm annually). Malaysia faces weather-related disasters such as floods, landslides and tropical storm attributed to the cyclical monsoon seasons, which cause heavy and regular downpours. Storms, floods and droughts lead to the rise and emergence of climate-sensitive diseases due to contamination of water, environment and creation of breeding sites for disease-carrying vector mosquitoes. The effect of climate change on health is an area of substantial concern in Malaysia. This chapter examines the trends of six prominent climate-sensitive diseases in Malaysia, namely, cholera, typhoid, hepatitis A, malaria, dengue and chikungunya followed by the environmental and public health policies, programmes and plans to battle the impact on health from the climate change.

Keywords Climate change • Food- and water-borne diseases • Vector-borne diseases • Environmental health • Public health policies • Malaysia

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15.1 Introduction

The world is experiencing climate change. The earth is warming due to greenhouse gasses emission resulting from human activity. Temperature rises contribute to melting of glaciers, increasing average sea levels and changing of precipitation patterns. Extreme weather events are occurring at increasing frequencies and intensities. This can have serious impacts on the environment and human health, as essential necessities for good health such as clean air and water, adequate food and shelter will be affected. Increased temperatures and humidity and shifting rainfall patterns lead to weather-related catastrophes, namely, heat waves, floods, droughts and storms which cause loss of agriculture and homes. These climate events also increase health risks such as climate-sensitive vector-borne and food- and-water-borne diarrhoeal diseases, which currently account for mortality of 1.1 million people and 2.2 million people a year, respectively (WHO 2008). Increases in population numbers and current trends in energy use and development further aggravate the effects of climate change (WHO 2009). The Asia-Pacific region holds the highest number of countries most vulnerable to climate change, namely, Bangladesh, India, Nepal, the Philippines, Afghanistan and Myanmar (Asian Development Bank and International Food Policy Research Institute 2009). Malaysia is also vulnerable to the adverse impacts of climate change and is no exception.

15.2 Demography of Malaysia

Malaysia, located in the Asia-Pacific region, has a total land area of 329,733 km^2. Malaysia is composed of Peninsular Malaysia and East Malaysia (Sabah and Sarawak) that is separated by the South China Sea (Fig. 15.1). Peninsular Malaysia, in the west, has an area of 131,573 km^2, while East Malaysia covers about 198,068 km^2 (Ministry of Science Technology and the Environment Malaysia 2000). Peninsular Malaysia consists of 11 states (Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Penang, Perak, Perlis, Selangor, Terengganu) and 2 federal territories (Wilayah Persekutuan and Putrajaya), while East Malaysia consists of 2 states (Sabah and Sarawak) and Federal Territory of Labuan. Kuala Lumpur is the federal capital of Malaysia.

Malaysia's population comprises of 28.33 million people, including 8.2 % non-citizens. The majority (22.56 million people) reside in Peninsular Malaysia while East Malaysia has a population of 5.77 million people. The population density is 86 inhabitants per square kilometre. The average annual population growth rate (year 2000–2010) is 2.0 % (Department of Statistics Malaysia 2010). The proportion of Malaysia's population by the age of 0–14 years is 27.63 %, 15–64 years is 67.33 % and above 64 years is 5.04 %. While Malaysia has a relatively young population, however, the age structure is moving towards an ageing population (Department of Statistics Malaysia 2010) (Fig. 15.2).

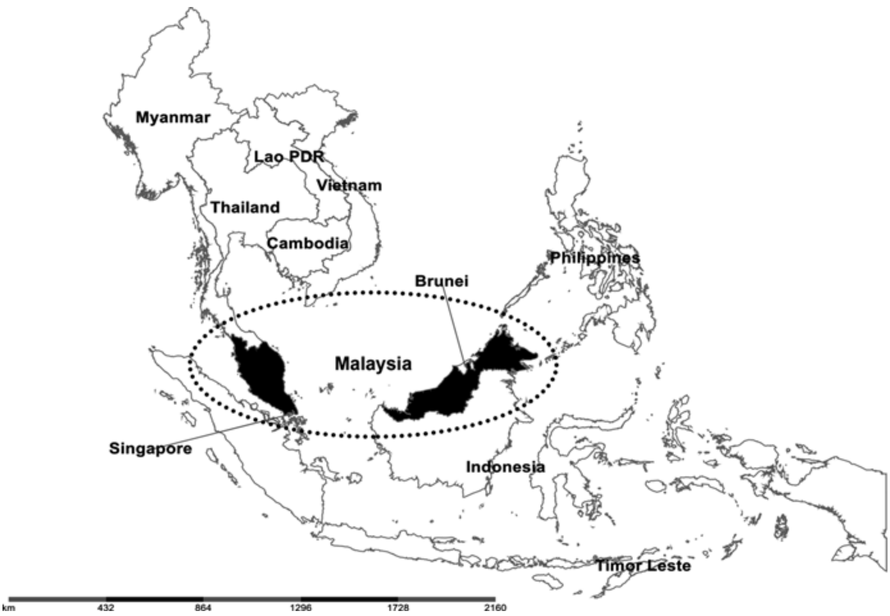

Fig. 15.1 Map of Malaysia

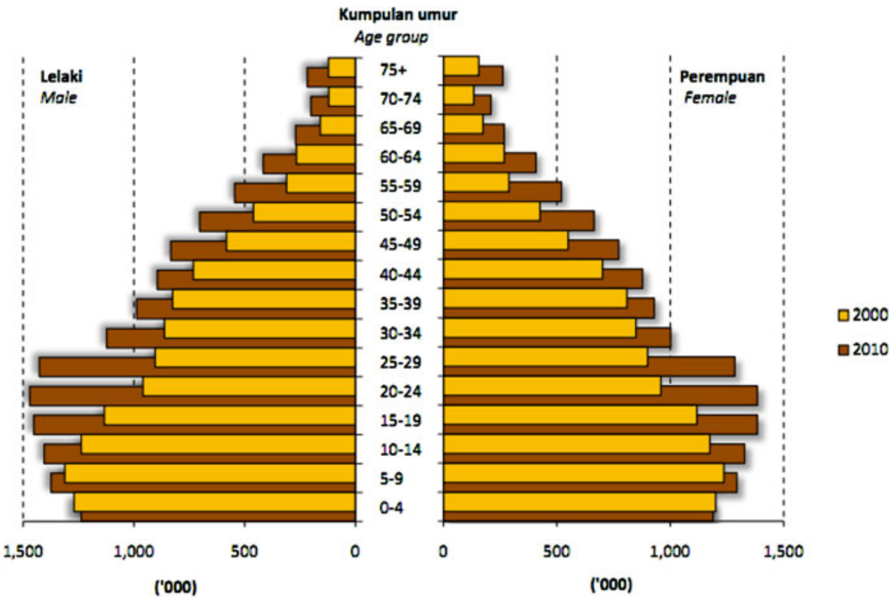

Fig. 15.2 Number of population by sex and age group, Malaysia, 2000 and 2010 (Source: Department of Statistics Malaysia 2010, Population and Housing Census of Malaysia 2010)

Malaysia is a multi-cultural country, with a majority being Bumiputera (67.4 %), followed by 24.6 % Chinese, 7.3 % Indians and 0.7 % other races. East Malaysia is distinct from the Peninsular Malaysia in terms of ethnic composition of its people with a diverse of indigenous residents, which also are part of the Bumiputera group. The largest indigenous group in Sabah is the Kadazan/Dusun ethnic group, which is made up of 24.5 % of the population, while in Sarawak, the largest ethnic group is the Ibans which accounts for 30.3 % of the total citizens in Sarawak (Department of Statistics Malaysia 2010).

Malaysia is a country that is rapidly advancing and has made tremendous progress in socio-economic development since its independence in 1957. Initially, agriculture and mining were the main economic drivers for the country during the post-independence period, but now, Malaysia's economic industry exhibits a multi-sectorial diversification including rubber and oil palm processing and manufacturing, light manufacturing, pharmaceuticals, medical technology, electronics, tin mining and smelting, logging, timber processing, agriculture processing and petroleum production and refining. From 2005 to 2013, Malaysia's gross domestic product (GDP) saw a growth of 4.7 % (Department of Statistics Malaysia 2014a), with a total income value of RM986.7 billion (USD 274.7 billion) in 2013 (Department of Statistics Malaysia 2014b). The World Bank places Malaysia as an upper middle-income country (The World Bank 2014). The level of urbanization is parallel with the country's rapid development whereby all states except Kelantan have an urban population of more than 50 % (Department of Statistics Malaysia 2010).

Malaysia lies at the coordinates of 2°30′N 112°30E which is near the equatorial line. It has a tropical climate with a relatively uniform temperature all year round at 26–28 °C (Ministry of Natural Resources and Environment Malaysia 2011) and abundant rainfall of 2,000–4,000 mm annually (Ministry of Natural Resources and Environment Malaysia 2011). The distribution of rainfall is largely determined by the wind flow patterns and topographic features of the land. The months of November to March experience the Northeast monsoon which carries winds with speeds of 15–50 km/h that bring heavy downpours on some areas along the east coast of Peninsular Malaysia, western Sarawak and the northeast coast of Sabah. From May to August, the west coastal areas of Peninsular Malaysia are affected by the early morning 'Sumatras' during the southwest monsoon. The inland areas covered by mountain ranges are relatively sheltered from monsoon rain influences and receive rainfall of less than 1,780 mm per year. There are also two brief inter-monsoon seasons which bring rain and thunderstorms due to convection currents (Ministry of Science Technology and the Environment Malaysia 2000).

The common weather-related disasters that occur in Malaysia are such as floods, landslides, mudslide and tropical storm, and most of these disasters are attributed to heavy rainfalls (Ibrahim Mohamed Shaluf and Fakhru'l-Razi Ahmadun 2006). Malaysia regularly (almost annually) experiences the occurrence of floods due to the cyclical monsoon seasons, which causes heavy and regular downpours usually in October to March. However, in December 2006, the anomalous event of floods in

Johor Bahru (Southern Peninsular Malaysia), which is located out of the monsoon affected zone, suggests that it could be due to the effects of global warming (Chang 2010).

15.3 Climate Change Trend in Malaysia

Malaysia has recorded a rise in the average temperature since 1951 (Ministry of Science Technology and the Environment Malaysia 2000). Analysis of different regional annual mean temperatures records in various parts of Malaysia indicated warming trends. Generally, the overall correlation analysis of annual mean temperatures over the low land areas has the largest trend over Southern and Central Peninsular Malaysia while the lowest trend is in Sarawak. The rates of increase are about 1.5–2.7 °C per 100 years. The only highland area, Cameron Highland has relatively weak positive correlation as shown in Fig. 15.3. There is strong evidence to link the local warming trends to urbanization process as for Southern and Central Peninsula and also global trends although there is insufficient length of climate data.

The latest data of annual rainfall trend from years of 1951 till year 2013 for different regions in Malaysia shows no overall clear trend of rainfall for the country unless high variability of rainfall probably due to tropical climate. The spatial variability of rainfall lacks the regularity that is generally found with temperature. Therefore, the standardised rainfall anomaly average is used to analyse the rainfall pattern for Malaysia as shown in Fig. 15.4 (Malaysian Meteorological Department (MetMalaysia) 2014). Increase in average temperature can cause rainfall fluctuations that may result in variation of climatic events such as floods, droughts and storms.

These climatic events can have a negative impact on Malaysia's key economic sectors such as agriculture, forestry, water resources, coastal resources, energy and public health. Floods, droughts and storms increase the risk of health diseases due to contamination of water and creation of breeding sites for disease-carrying vector mosquitoes. Environmental hygiene, sanitation and water supply contributed to the spread of these diseases. The effect of climate change on health is an area of substantial concern in Malaysia (Commonwealth Secretariat 2009) particularly with regard to the emergence and rise of climate-sensitive diseases such as food- and waterborne- and vector-borne diseases. These climate-sensitive diseases in Malaysia are much influenced by the climate change variations and Malaysia has developed public health policies of which some were successful while others failed in battling them. This chapter describes the trends of six prominent climate-sensitive diseases in Malaysia, namely, cholera, typhoid, hepatitis A, malaria, dengue and chikungunya followed by the public health policies, programmes and plans to battle the impact on health from the climate change.

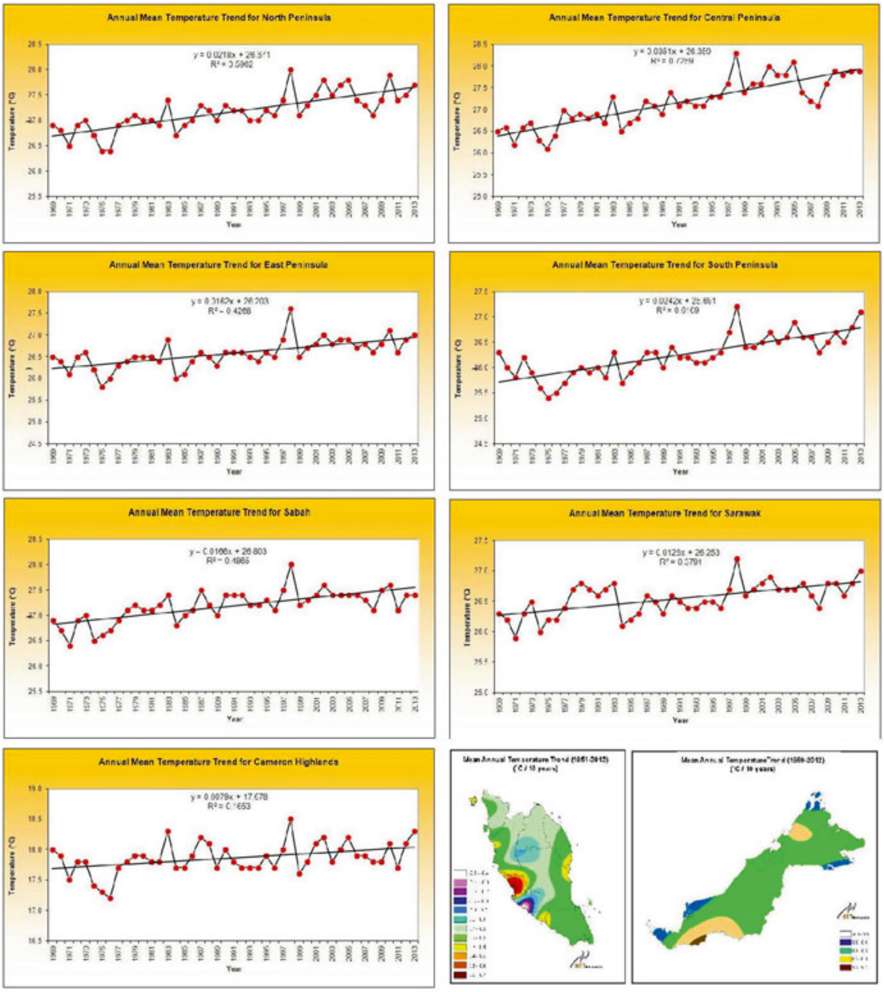

Fig. 15.3 Annual temperature trend for Malaysia 1969 to 2013 (Source: Malaysian Meteorological Department (MetMalaysia) 2014)

15.4 Effects of Climate Changes on Diseases Trends

Before the discovery of the role of infectious agents in the transmission of infectious diseases in the late nineteenth century, human beings have known that climatic conditions affect epidemic diseases. Roman aristocrats retreated to hill resorts each summer to avoid malaria. South Asians learnt early that, in high summer, strongly spiced foods were less likely to cause diarrhoea. Climate change is likely to increase the severity of the weather in which some areas will experience an increase in temperatures, rainfall and flood risk, while other midlatitude areas will experience more

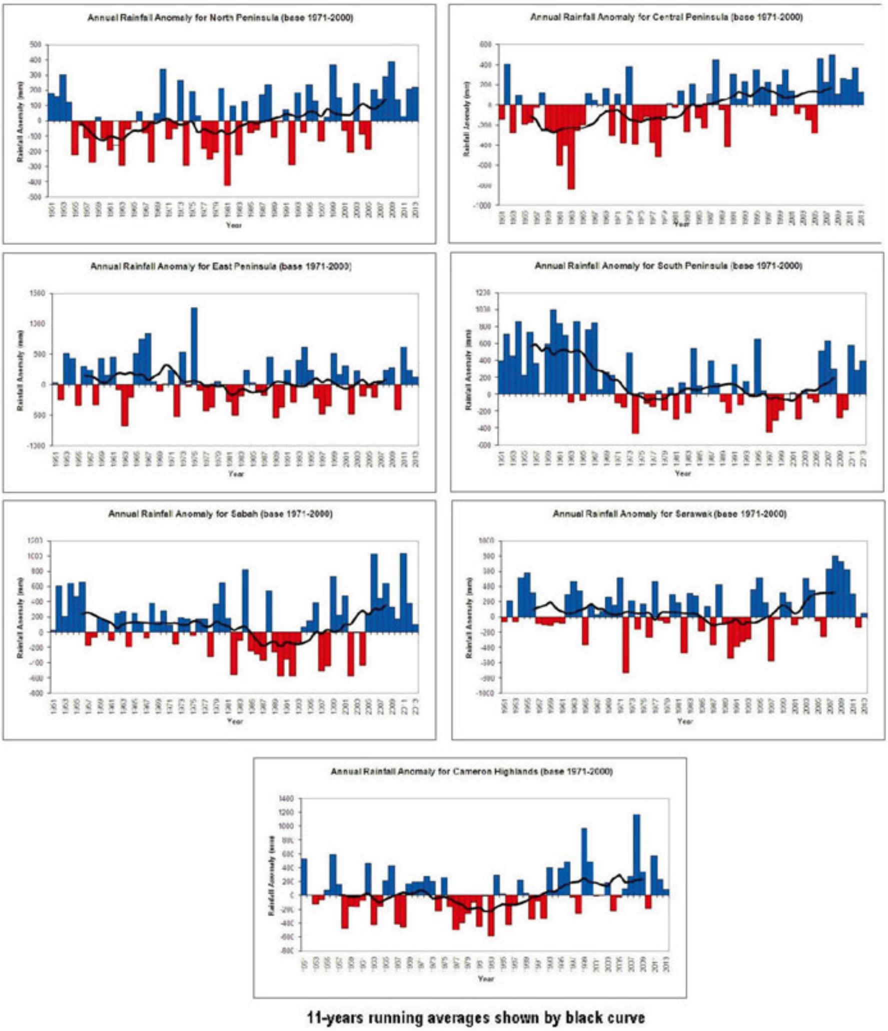

Fig. 15.4 Standardised rainfall anomaly average for Malaysia 1961 to 2013 (Source: Malaysian Meteorological Department (MetMalaysia) 2014)

droughts. Climate change accelerates the spread of several diseases mainly due to warmer global temperatures resulting in an increase of global average rainfall. Increased precipitation caused by global warming may increase flooding in some areas, which could lead to contamination of drinking water with the possibility of a rise of waterborne disease incidence. Furthermore, rainfall can promote transmission of vector-borne diseases by creating ground pools and other breeding sites for the vectors. Climate-sensitive diseases are among the largest causes of morbidity and mortality globally, including diarrhoea, malaria and other water- and vector-borne infections.

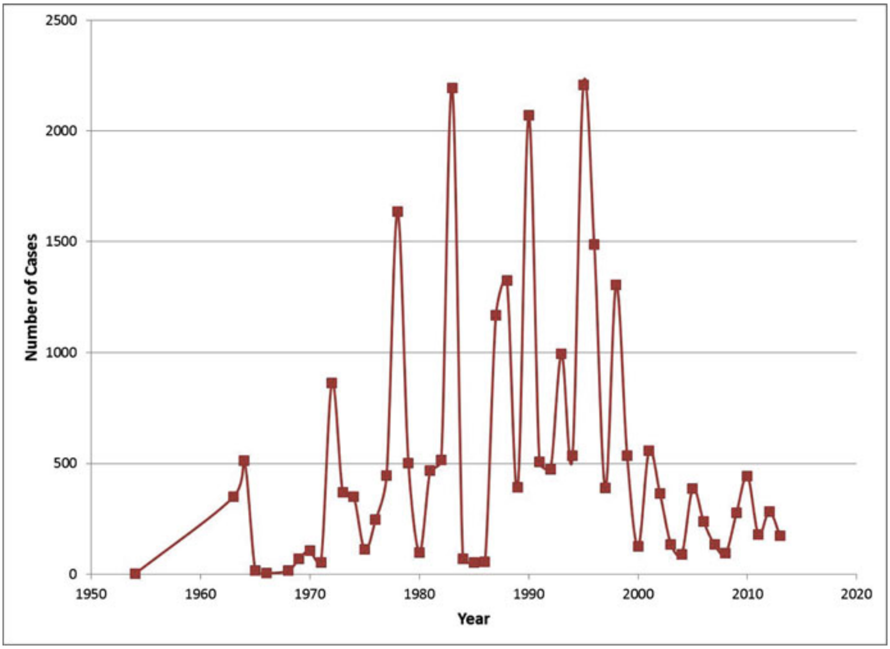

Fig. 15.5 Changes in reported cholera cases in Malaysia from 1954 to 2013 (Sources: WHO (2014). Global Health Observatory (GHO), Ministry of Health Malaysia (2014), Health Facts (2014))

15.5 Food- and Waterborne Diseases

In Malaysia, typhoid fever, cholera, dysentery and hepatitis A are the major waterborne diseases with incidence rates of 0.73, 0.58, 0.28 and 0.41 per 100,000 population (Ministry of Health Malaysia 2014). The spread of these climate-sensitive diseases has been attributed to water crises such as floods and droughts (due to contaminated water) and coupled with improper sewage disposal, personal hygiene and low environmental sanitation standards. In the last century, diarrhoeal diseases such as cholera, typhoid and dysentery were very common in Malaysia due to lack of infrastructure such as inadequate clean water supply and latrines coupled with poor sanitation and hygiene (Engku Azman 2011; Rozlan Ishak 2007) especially in the rural and suburban areas. These infectious diseases are predominantly spread through contaminated water.

To date, these water-borne diseases remain endemic although there has been a significant decline in the last two decades as shown in Figs. 15.5, 15.6 and 15.7. In 2009, the reported cases showed a low incidence of typhoid, cholera and hepatitis A virus (HAV): typhoid cases, 303; cholera cases, 276; and HAV cases, 40. These diseases usually occur as sporadic outbreaks and the incidence by state is closely associated with the coverage of clean water supply. For example, the incidence of typhoid is highest among the states with the lowest coverage of treated water supply as shown in Fig. 15.8.

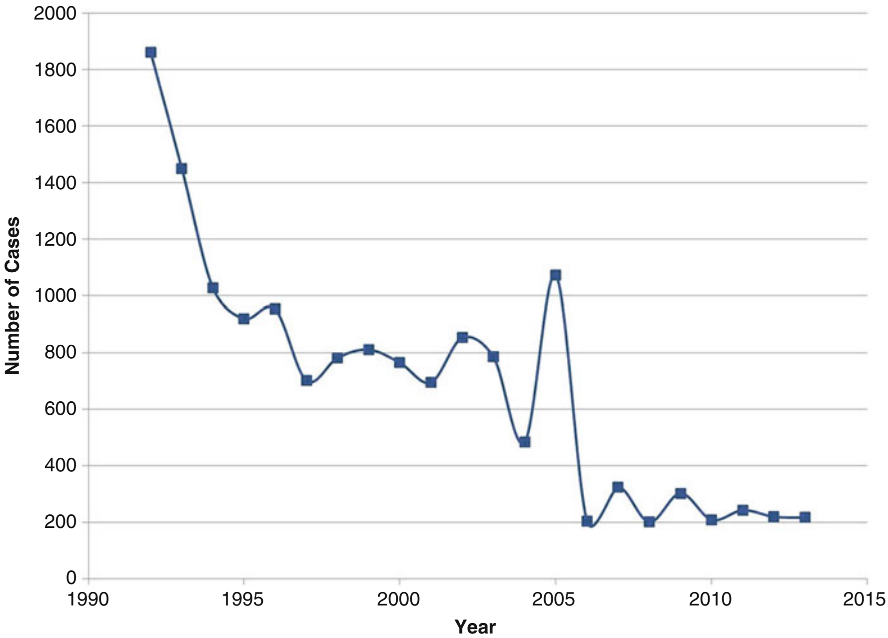

Fig. 15.6 Number of reported cases of typhoid fever in Malaysia from 1992 to 2013 (Sources: Ministry of Health Malaysia (2010). Number of notifiable communicable diseases in Malaysia for 1998–2009, Ministry of Health Malaysia (1992–1999). Annual reports. Ministry of Health Malaysia (2007–2014). Health Facts (2006–2014))

The association between drought and cholera epidemics has been reported in Malaysia (Chen 1970; Khoo 1994; Benjamen 2006; Kin 2007) as the outbreaks have tended to occur in the dry season (May to July) when many are forced to use river water. Thus, the severe drought is considered as one of the main risk factor of cholera epidemics because it affects the water supply. The main affected areas are the coastal and riverine communities especially those with poor environmental sanitation, poor water supply, poor waste disposal and inadequate personal hygiene (Chen 1970; Singh 1972; Yadav and Chee 1990; Khoo 1994; Kin 2007; Benjamen 2006).

15.6 Vector-Borne Diseases

15.6.1 Malaria

Malaria is caused by one of the four species of ***Plasmodium*** parasite and transmitted by the ***Anopheles*** mosquito that exhibits definite seasonal prevalence. Although malaria remains the most common vector-borne disease in the world, the number of malaria cases in Malaysia has declined in the last decade. Public health data showed that the number of malaria cases detected in the country has dropped significantly

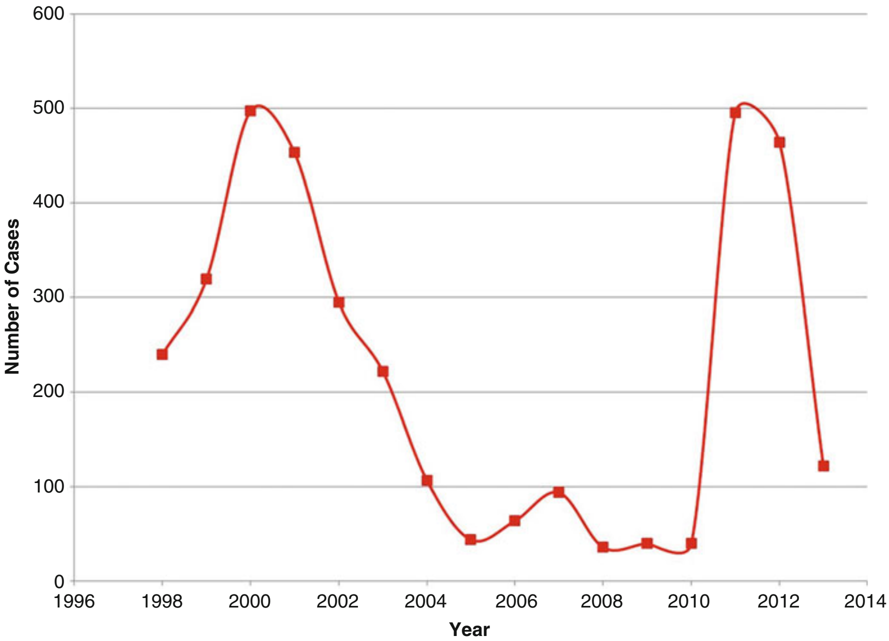

Fig. 15.7 Number of reported cases of hepatitis A in Malaysia from 1998 to 2013 (Sources: Ministry of Health Malaysia (2010). Number of notifiable communicable diseases in Malaysia for 1998–2009, Ministry of Health Malaysia (2007–2014), Health Facts (2006–2014))

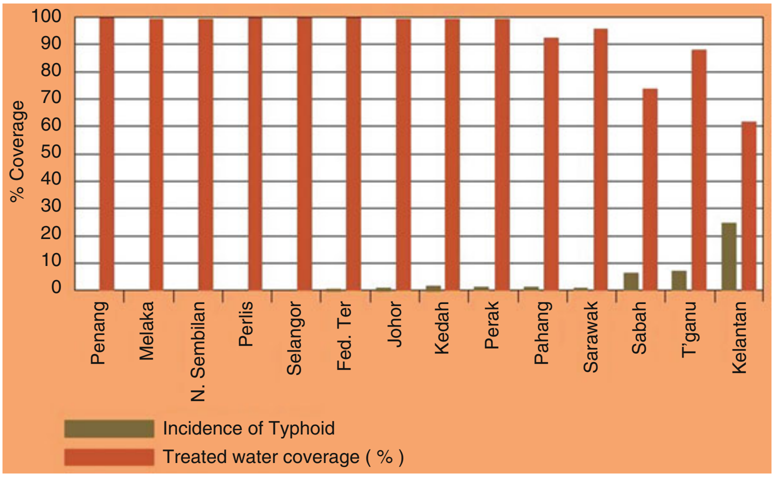

Fig. 15.8 Incidence of typhoid in relation to percentage coverage of treated water supply in the different states in Malaysia (Source: Ministry of Natural Resources and Environment Malaysia (2011). Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC))

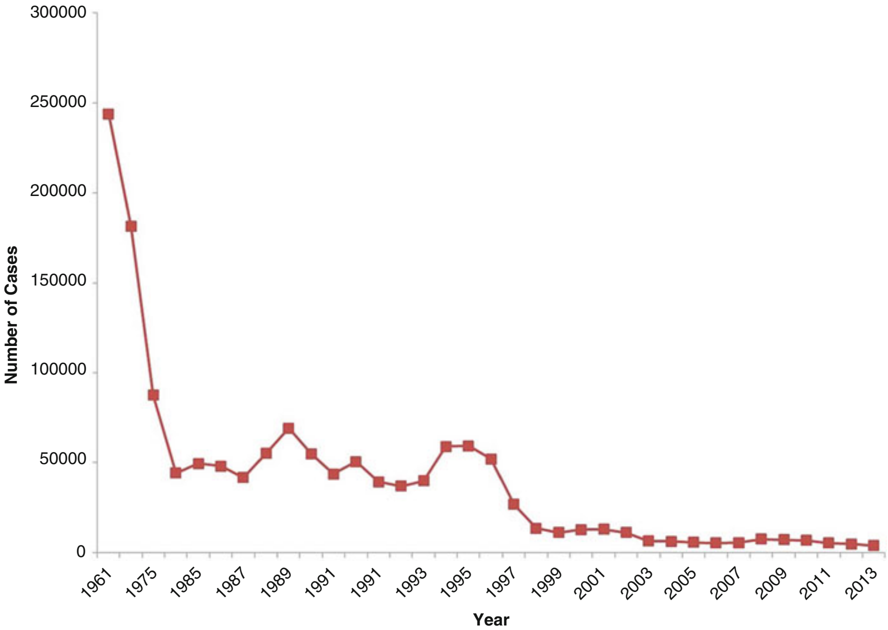

Fig. 15.9 Changes in reported malaria cases in Malaysia from 1961 to 2013 (Sources: Tee (2000). Malaria control in Malaysia, Ministry of Health Malaysia (2010). Number of notifiable communicable diseases in Malaysia for 1998–2009. WHO (2011). World Malaria Report 2011, WHO (2014). Global Health Observatory (GHO), Ministry of Health Malaysia (2007–2014). Health Facts (2006–2014))

from 243,870 in 1961 to 3,851 in 2013 as shown in Fig. 15.9. This decline resulted from effective control measures that applied in the country since 1961 with the opportunities to shift the current control programme into a total elimination programme. Figure 15.10 shows the progressive reduction of malaria incidence in Peninsular Malaysia.

Changes in climate factors such as temperature, rainfall and humidity affect the reproduction, development, behaviour and population dynamics of malaria (Gage et al. 2008). Increased temperature induces the multiplication rate and development of the malaria parasite in the mosquito vector (Ambu et al. 2002). Both, the mosquito vector and malaria parasite are sensitive to changes in temperature and the elevation of ambient temperature of 2 and 4 °C due to climate change will lead to increase in the capacity of the mosquito vectors to transmit malaria by 20 to 30 %, respectively. Thus, the number of malarial cases can be estimated to increase by 15 % if an expected increase of 1.5 °C in ambient temperature in 2050 is observed (Ambu et al. 2002). Furthermore, increased rainfall leads to increase in the number and quality of breeding sites for mosquito's vectors and the increased humidity enhances survival and vectorial capacity of the vectors and hereafter the transmission of the parasites (Ambu et al. 2002). Increases in temperature and rainfall would undoubtedly allow mosquito vectors to survive in areas closely surrounding their current dissemination

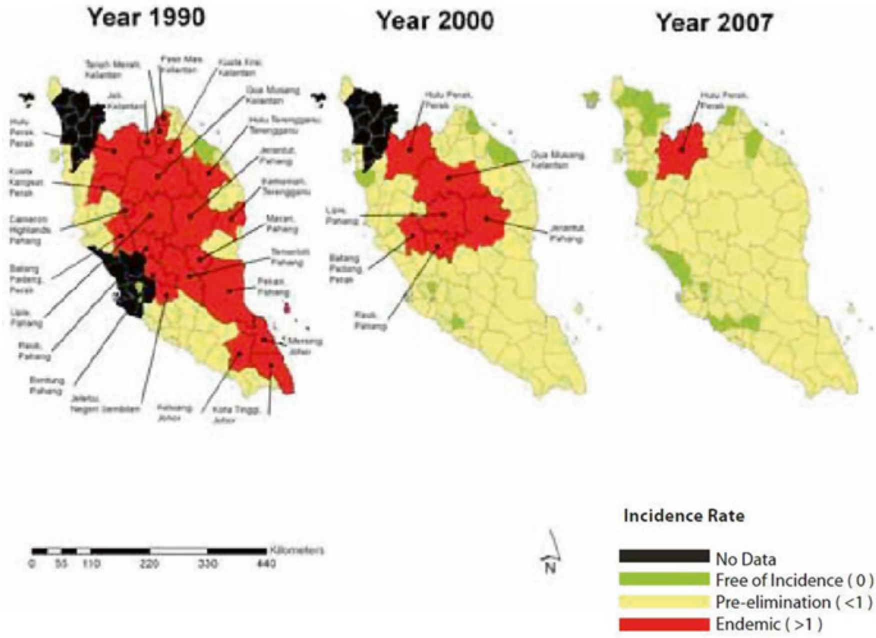

Fig. 15.10 Changes in malaria incidence rate (per 1,000 population) in districts of Peninsular Malaysia according to WHO classification (Source: Ministry of Natural Resources and Environment Malaysia (2011). Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC))

limits. How far these areas are extended would depend on the magnitude of the change in climate. Also, salt-water intrusion into freshwater of coastal areas can extend breeding sites for malaria vectors and enhance transmission of the disease such as in case of ***Anopheles sundaicus*** which breeds in brackish water in the coastal areas of Peninsular Malaysia (Ambu et al. 2002; Mia et al. 2011). These changes and the different climate factors resulted in slight increase in the recorded cases of malaria in the last 5 years as shown in Fig. 15.9.

There is a variation in the distribution of the infection between the different districts of the country, for example, in 2006, 57.2 % of the cases were from Sabah, 26.7 % from Sarawak and the remaining 16.1 % from Peninsular Malaysia (Ministry of Natural Resources and Environment Malaysia 2011). In areas where malaria is seasonal, a dramatic increase in disease prevalence occurs in all age groups during the annual transmission season because previously acquired immunity in the host is lost in the non-transmission season. Potential extension or curbing of the vector breeding season may lead to shifts in malaria incidence and prevalence. Similarly, climate changes can result in increasing the incidence of malaria infection in endemic areas due to the improvement of the vector-breeding conditions.

15.6.2 *Dengue Fever (DF) and Dengue Haemorrhagic Fever (DHF)*

In terms of human morbidity and mortality, dengue has become an important public health problem and the most important arthropod-borne viral diseases in Malaysia. Dengue is transmitted by the *Aedes* mosquitoes (***A. aegypti*** and ***A. albopictus***), which are highly sensitive to environmental conditions. Temperature, precipitation and humidity are critical to survival, reproduction and development of the mosquito and these can influence mosquito presence and intensity. Furthermore, warmer temperatures can enhance the disease transmission possibly by allowing the mosquito vector to reach maturity much faster than in colder climate. Also these environmental conditions can then shorten the extrinsic incubation period of dengue virus by reducing the time required for the virus to replicate and disseminate in the mosquito. The extrinsic incubation period is necessary for virus to reach the mosquito salivary glands and transmit to humans (Githeko et al. 2000).

Dengue affects tropical and subtropical regions around the world, mainly in urban and semi urban areas. Climate change might expand the distribution of vector-borne pathogens in both time and space, thereby exposing host populations to longer transmission seasons and immunologically naive populations to newly introduced pathogens (Patz and Reisen 2001). It is possible to accelerate the dissemination of dengue viruses worldwide. Like many vector-borne diseases, dengue fever shows a clear weather-related pattern: rainfall and temperatures affect both the spread of mosquito vectors and the likelihood that they will transmit virus from one human to another. In a cool climate, the virus takes so long to replicate inside the mosquito that most likely would die before it actually has a chance to transmit the virus to another person (Resurgence 2008). Several studies have predicted that global climate change could increase the likelihood of dengue epidemics. One of these studies published an empirical model of worldwide dengue distribution. In this model they use the annual average vapour pressure (a measure of humidity) as a single climate factor to predicted future dengue fever distribution. If humidity were to remain at 1990 levels into the next century, a projected 3.5 billion people would be at risk of dengue infection in 2085, but assuming humidity increases as projected by the Intergovernmental Panel on Climate Change, the authors estimate that in fact 5.2 billion could be at risk (Hales et al. 2002). Other reports have showed correlations between dengue infection and climate variables such as El Niño, temperature, rainfall and cloud cover concluding that climate change could increase the number of people at risk of dengue infection (Haines et al. 2006).

The number of reported dengue fever (DF) and dengue haemorrhagic fever (DHF) cases in Malaysia shows an increasing trend as shown in Fig. 15.7. The recorded number of infected population shows an upward trend from 6,621 cases with incidence rate of 36.4/100,000 population in 1991 to 46,171 case with incidence rate of 148.73/100,000 population in 2010 (Fig. 15.11). This incidence rate exceeds the national target for DF and DHF, which is less than 50 cases/100,000 population. Since 2000, dengue incidence continues to increase unabated. It is

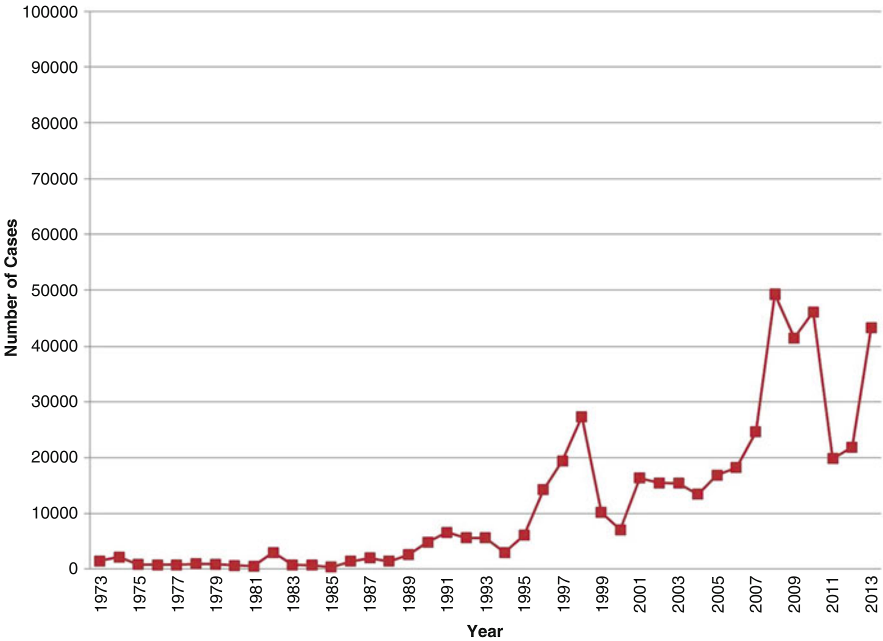

Fig. 15.11 Changes in reported dengue cases in Malaysia from 1973 to 2013 (Sources: Lam (1993). Two Decades of Dengue in Malaysia, Ministry of Health Malaysia (2010). Number of notifiable communicable diseases in Malaysia for 1998–2009. Ang and Satwant (2001). Epidemiology and New Initiatives in the Prevention and Control of Dengue in Malaysia, Director General of Health Malaysia (2011b). Press statement: Current situation of Dengue Fever in Malaysia for week 52/2011(25–31 December 2011), Director General of Health Malaysia (2012a). Current situation of Dengue Fever in Malaysia for week 52/2012, Director General of Health Malaysia (2012b). Press statement: Increased of Mortality of Dengue Cases in Malaysia, Director General of Health Malaysia (2013). Current situation of Dengue Fever in Malaysia for week 52/2013)

prevalent throughout the country with the highest incidence among the most developed and densely populated territories and states. Clinical and laboratory confirmed cases showed that all age groups are affected, with the most vulnerable among school going children and young adults (Mia et al. 2013).

The recorded climate changes in Malaysia showed the increasing rainfall time per year and the ambient temperature provides optimal conditions for mosquitoes to multiply and then spread dengue viruses. *Aedes* mosquito prefers to lay its eggs around human habitation in stagnant clear water in artificial containers rather than natural areas. Even when the containers dry up, the eggs can withstand dryness for about nine months. When exposed to favourable conditions of water and food, the eggs can hatch within a day and emerge as adults within a week. Mosquitoes normally acquire the virus when sucking infected blood from an infected human and it then transmits the virus to others. *Aedes* mosquito has the capacity to sustain the virus in the environment through the transovarial transmission of the virus for up to five generations. Thus, it is generally accepted that changes in precipitation, ambient temperature and humidity may influence the abundance and distribution of the mosquito vectors and by this means increase the ability to spread the infection. A previous study in Malaysia has shown a positive relationship between rainfall and dengue (Li et al. 1985; Hopp and Foley 2003). The study conducted in Jinjang, Selangor, a dengue-prone area found that there was a 120 % increase in the number of dengue cases when the monthly rainfall was 300 mm or more. This may be due to creation of more *A. aegypti* breeding sites due to the rainfall. On the other hand, the extremely heavy rainfall may flush mosquito larvae away or kill them altogether (Promprou et al. 2005). Preliminary findings of an on-going study to develop a climate model for dengue showed that the mean and minimum temperatures were positively associated with the *Aedes* population in Kulim, Kedah. As the minimum temperature increased, the larvae densities also increased leading to increase in the endemicity of the disease (Patz et al. 1998).

15.6.3 Chikungunya

Chikungunya is a reemerging mosquito-borne viral infection. It is caused by a mosquito-borne togavirus belonging to the genus ***Alphavirus***. Many countries neighbouring Malaysia have reported human infections with chikungunya virus. Evidence of presence of chikungunya in Peninsular Malaysia was proved by serological survey of 4384 specimens collected between 1965 and 1969. These results showed that human infection with chikungunya virus appears to be at a low level of activity but is widespread and it is more prevalent in the northern part of the country (Marchette et al. 1980). However, although the serological evidence was present in Malaysia, chikungunya virus has not been known to be associated with clinical illness in the country before 1998. Malaysia experienced the first outbreak of chikungunya when 51 infected subjects were reported in Klang-Selangor between December 1998 and February 1999 (Lam et al. 2001). The majority of the cases were adults, and the clinical presentation was similar to classical chikungunya infections. Chikungunya is among those infectious diseases that extended their occurrence and range as temperatures increase. During the last decade, chikungunya virus has reemerged and caused new epidemics in Malaysia. This emergence may be attributed to the impact of climate change, but also several other factors may be involved such as urbanization, commercial transportation, workers movement, increasing human travel and vector density increase. However, local climatic fluctuations may have exerted a transient impact on chikungunya virus epidemics.

In the last six years, Malaysia has had three outbreaks of chikungunya virus infection. The first two occurred in Perak in 2006, and the third began in Johor in early 2008 until 2009 (Fig. 15.12). Since the reemergence of chikungunya at the end of 2006, Malaysia has been experiencing increasing number of chikungunya cases involving about 10,942 recorded cases until the end of 2010 as shown in Fig. 15.8 (Director General of Health Malaysia 2011a). In the earlier outbreaks, local

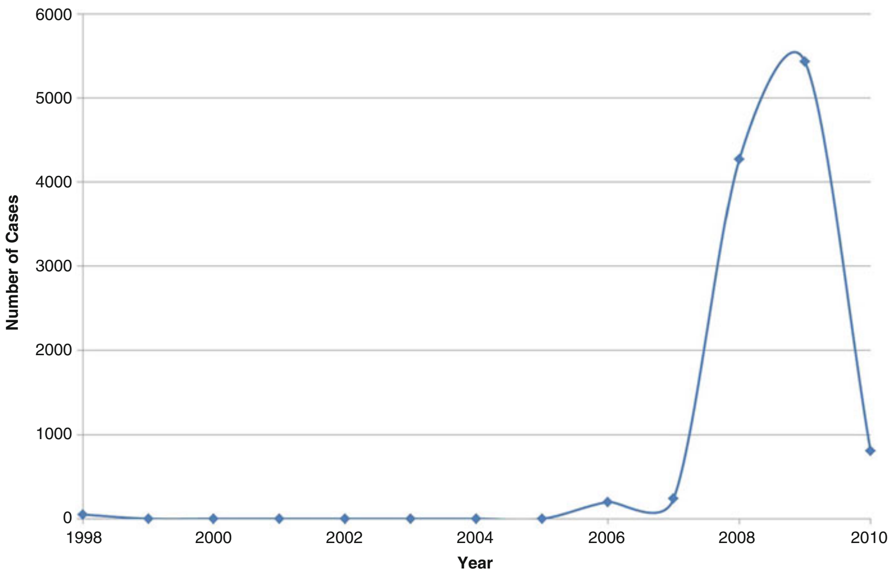

Fig. 15.12 Changes in reported chikungunya cases in Malaysia from 1998 to 2010 (Sources: Lam et al. (2001). Chikungunya infection–an emerging disease in Malaysia, Chua (2010). Epidemiology of Chikungunya in Malaysia: 2006–2009. Director General of Health Malaysia (2011a). Press statement: Current situation of Dengue Fever and Chikungunya in Malaysia for week 52/2010(26/12/2010-31/12/2011))

transmission of the disease has been curtailed, and the disease has not become endemic. Dissimilar to Africa where the primate hosts are the primary reservoirs of the virus, in Malaysia there are no such animal hosts but the necessary mosquito vectors, ***A. aegypti*** and ***A. albopictus***, are present abundantly. That means if a sufficient number of human hosts continue to transmit and perpetuate the virus as is the case for the dengue viruses, chikungunya infection can become endemic. Similar to dengue virus, climate changes in Malaysia such as increasing the ambient temperatures, precipitation and humidity will increase the intensity and activity of the mosquito's vector to transmit the virus (Meason and Paterson 2014; Fischer et al. 2013; Rezza 2008).

In summary, climate changes could play an important role in the endemicity of the common communicable diseases such as dengue, chikungunya, malaria and other diseases that are sensitive to climate and are endemic in Malaysia. The health pattern will be affected due to the climate change such as exposure to high or low temperature, level and duration of raining, contamination of water sources and abundances of the disease-transmitting vectors. Changes in various vector-borne infectious diseases may lead to the expansion of the endemic areas of certain diseases such as malaria and dengue. However, these changes will not affect only the incidence of infectious diseases, but also other risks will arise in both developing and developed countries such as that due to floods and drought. Thus, the risks associated with climate changes will increase over time. Public health policies and programmes will then need to be implemented to handle these climate-sensitive diseases that affect the health.

15.7 Programmes and Public Health Policies on Climate Change and Health

Malaysia's endeavour in addressing climate change is evident since 1970s. The nation's development plans, policies and laws which were formed are related to climate change scenarios so that sustainable development can be achieved. This principle is incorporated in the country development plan, namely, Third Malaysia Plan (1976–1980), the Ninth Malaysia Plan (2001–2005) Vision 2020 and the Third Outline Perspective Plan (OPP-3) (2001–2010). Various environmental-related policies, legislations and plans are formed so that the national developments works are carried out within the environmental standards to ensure the nation's development and environment balance one another. Among them are the Third National Agriculture Policy (1998–2010), National Energy Policy (1979), Fuel Diversification Policy (1981), Environment Quality Act 1974, EQ (Clear Air) Regulation 1978, EQ (Prescribed Activities) (EIA) Order 1987, National Forestry Act 1984, Fisheries Act 1985, Fisheries Maritime Regulations, 1967, Petroleum Mining Act 1986, Petroleum Development Act 1974, Land Conservation Act 1960, National Parks Act 1980 and many others.

Malaysia adopts the 'precautionary principle' or the 'no regret' policy which allows measures to be taken to adapt or mitigate effects of climate change even though it is unsure if the climate change effects will come true (Ministry of Natural Resources and Environment Malaysia 2011). The Malaysian government is receptive towards foreign support on the use of cleaner and environmentally sound technology and encourages other sectors' involvement in such programmes to increase their awareness on global activities in improving the quality of the environment (Lu 2006). Many national programmes and projects were conducted to reduce or mitigate greenhouse gas emissions such as Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP), Clean Development Mechanism (CDM), Malaysia Building Integrated Photovoltaic, etc. and studies have been actively carried out to assess climate and environment interactions and impact of climate change such as National Coastal Vulnerability Index Study and National Study for Effective Implementation of Integrated Water Resources Management (IWRM) in Malaysia, to name a few (WHO 2006). In recent times, two policies were formulated to address climate change more holistically, specifically the National Policy on Climate Change and the National Green Technology Policy to cater for a climate-resilient development, to promote a low carbon economy and to promote green technology (Ministry of Natural Resources and Environment Malaysia 2011).

Malaysia's commitments in addressing climate change also can be seen from its active participation in the national and international arena on multilateral dialogues and collaborations, information sharing and networking. In 1994, the National Steering Committee on Climate Change (NSCCC) was set up and comprised of members from various ministries in the government such as Ministry of Science, Technology and Environment, Ministry of Finance, Ministry of Energy, Communications and Multimedia, Malaysian Meteorological Service and many others which function to formulate and implement policies to address and adapt climate change. Also in the same year, Malaysia ratified a signatory agreement with the United Nations Framework Convention on Climate Change (UNFCC) and its commitment includes preparation of a document which entails the National Greenhouse Gas (GHG) Inventory and reports on actions that has been taken to tackle the issue of climate change. To date, two reports have been submitted to UNFCC, Initial National Communication in 2000 (INC) (Ministry of Science Technology and the Environment Malaysia 2000) and Malaysia Second National Communication to the UNFCC in 2011 (Ministry of Natural Resources and Environment Malaysia 2011) which detailed situation of climate change in Malaysia and strategies that has been carried out and which will be continued and improved to address the causes and impact of the climate impact scenarios. Malaysia is also engaged in various international conventions such as Vienna Convention for the Protection of the Ozone Layer (Montreal Protocol) and ASEAN Agreement on Transboundary Haze Pollution (2002) and even organised the Asia-Pacific Health Ministers' Conference on Climate Change and Health in Kuala Lumpur in 2008.

In 2008, the Cabinet Committee on Climate Change was instituted with the role of determining policy direction and strategies in tackling climate change issues whereby Ministry of Health is one of the members (Commonwealth Secretariat 2009). Provision of proper infrastructures, disease surveillance, investigation and emphasis on research and development were among initiatives undertaken to address the impact of climate change on health. There are already many existing policies and programmes within the country that address climate-sensitive diseases and health conditions such as the vector-borne and food- and water-borne control programmes under the Disease Control Division, Public Health Department, Malaysia (Ministry of Health Malaysia 1999). In terms of provision of healthcare in response to the impact of climate change, comprehensive healthcare service in Malaysia has been successfully extended throughout the country when the goal 'Health for All' was achieved in the year 2000 (Commonwealth Secretariat 2009).

Malaysia has taken a unique approach to climate change adaptation which was coined as 'adaptation through climate change mitigation'. This approach involves action by affected entities, requiring national-, state-, local- and community-level responses. Accordingly, much of Malaysia's adaptation responses come in the form of improved ecosystem management, water resource management and secure agricultural production – each with a backdrop of doing so to improve productivity, efficiency in resource use and optimised economic benefit for the state to the individual. For Malaysia, the health sector also figures prominently into the 'climate change' efforts. Focus is on larval and insecticide controls which are already in

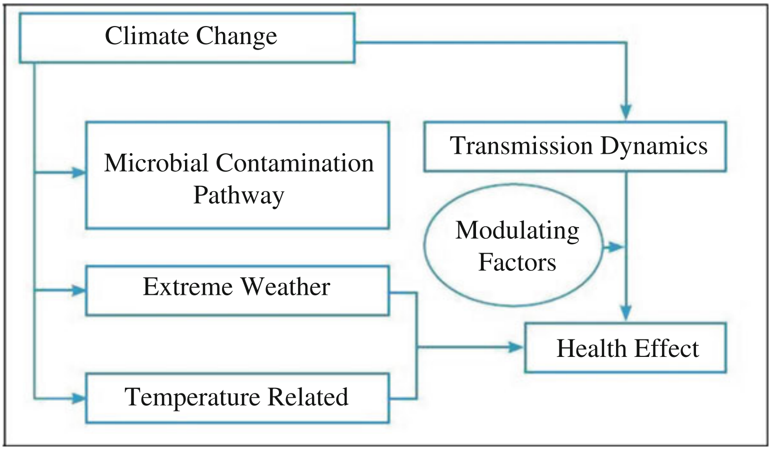

Fig. 15.13 Perception of climate change connection to health-related pathways, dynamics, and modulation in Malaysia. (Source: Solar (2011). Scoping assessment on climate change adaptation in Malaysia Summary October 2011)

place as part of the Health Ministry's Vector-Borne Disease Control Programme. Standard operating procedures for emergency and disaster management are also incorporated at all levels of the national health infrastructure. However, it is still unclear if these actions are adaptive in nature or reactive to current situations (Fig. 15.13).

The Vector-Borne Disease Control Programme is currently in the process of developing the control programme into an elimination programme. Among the key approaches being undertaken include strengthening and improving current strategies by changing the drug regimen to a more effective artemisinin-based combination therapy (ACT) as suggested by the World Health Organization to address the problem of drug-resistant virus, strengthening the surveillance programme particularly in malaria-free but prone areas to prevent reintroduction of the infection and occurrence of outbreaks and improving the case detection mechanism and approaches, including screening of migrant workers. Current and expected programmes and activities for adaptation to both current and projected climate-related health burdens involve the following (Ministry of Natural Resources and Environment Malaysia 2011):

- Emphasis to be placed on entomological surveillance with the recruitment of entomologists at the district level
- Established a Rapid Response Command Centre and incorporated the Centre for Disease Control and Prevention in the 9th Malaysian Plan
- Continued investment in health infrastructures, human resources and research
- Network of public health laboratories and constant vigilance on infectious diseases and strengthening surveillance system and disaster preparedness and response

Next, various policies related to each disease are described.

15.8 Food- and Waterborne Diseases

In controlling food- and waterborne diseases, in 1968, a pilot Rural Environmental Sanitation Programme was conducted in 11 states in Peninsular Malaysia (one per state) with the aim to improve sanitation by provision of clean water supply, building of latrines or sanitary toilets, improvement of environment sanitation by encouraging proper rubbish and sewage disposal and overall cleanliness of rural environment through community efforts '***gotong-royong***'. In 1973, this programme was designed for long term and aimed to cover 80 % of rural population by 1980 (Economic Planning Unit 1976). The target of the programme was to reduce incidences of communicable diseases. Various measures were adopted which involved rural community participation such as promotion of sanitary hygiene practice, building of proper sanitation and usage of sanitation facilities such as clean water supply system and sanitary latrines to ensure proper waste disposal. Identification and priorities were given to water-related diseases areas and encourage involvement of state governmental agencies and voluntary organisation into the programme (Ministry of Health Malaysia 1985). In 1978, the events of drought caused a major cholera outbreak in Peninsular Malaysia. This is due to unavailability of clean water supply to household and people had to obtained water from rivers and wells. At the time, interventions that were carried out to control the epidemic were chlorination of wells, disinfection and constructions of latrines. Also, patients with cholera were treated with tetracycline and immunisation against cholera was carried out (Ministry of Health Malaysia 1980). Since 1983, the oral rehydration salt therapy was introduced nationwide for treatment of cholera. In 1998, the Prevention and Control of Infectious Disease Act (Act 342) was enforced; five food- and waterborne diseases, cholera, typhoid, food poisoning, hepatitis A and dysentery, were made notifiable. Also, the Communicable Disease ControlInformation System (CDCIS), an electronic reporting system, was set up so that data on diseases can be shared at all levels of management for prompting diseases prevention, control and forecast on future outbreaks (Ministry of Health Malaysia 1985). Provision of clean water and environmental sanitation, effective treatment against diseases and mass vaccination for diseases prevention has proven to be effective with evidence of declining trends of the diseases over the years. The Rural Environmental Sanitation and Clean water Supply Programme currently provides 96.36 % coverage of safe water supply to rural community (Ministry of Health Malaysia 2009) and is aiming to give 100 % coverage of sanitary waste disposal and clean water supply in rural areas by 2015 (Commonwealth Secretariat 2009). Currently, cholera, typhoid and other diseases are lowly endemic and only occur as sporadic outbreaks.

In May 2007, the National Crisis Preparedness and Response Centre (CPRC) was established. Equipped with standard operating procedures for emergency and disaster management, the centre is responsible for management of disease outbreak information and coordinating outbreak response activities. This has led to improved registration and reporting system of infectious diseases outbreak with more disease cases being registered (Ministry of Health Malaysia 2009).

In addition, the setting of the Centre for Communicable Disease (CDC) will also improve surveillance, investigation and management of emerging and re-emerging diseases so that there will be instant case notification and prompt actions can be taken in time. Epidemiological investigation will be improved with complete medical staffing and adequate laboratory support for case diagnosis and early confirmation (Commonwealth Secretariat 2009).

15.9 Vector-Borne Diseases

15.9.1 Malaria

Prior to 1967, there were more than 300,000 cases of Malaria in the country annually. At that time, antimalaria drainage and usage of 'antimalaria oil' for larvaciding were measures taken to keep towns in malaria-free Peninsular Malaysia (Ministry of Health Malaysia 1980). In 1967, Malaria Eradication Programme was established with the aim to eradicate malaria by 1982. Among the measures taken in the eradication era were geographical investigation, DDT house spraying, case detection, laboratory diagnosis, registration of malaria cases, chemotherapy, case investigation and follow-up and entomological surveillance (Ministry of Health Malaysia 1980). The success of the programme has led to a significant drop in malaria cases to 44,226 cases in 1980 (Tee 2000). However, because of the difficulty to eradicate Malaria due to land development and migrations of people from one place to another, the vertical programme was changed to 'control' programme and was integrated into health services in the 1980s. In 1986, the malaria control programme was incorporated into the Vector-Borne Disease Control Programme, which is also responsible for 7 other vector-borne diseases, namely, dengue fever and dengue hemorrhagic fever, filariasis, typhus, Japanese encephalitis and scrub, yellow fever and plague. This programme places focus on the control of the diseases with the aim to reduce the impact of vector-borne diseases mortality and morbidity and its recurrence. Among other antimalaria strategies that were also adopted were focal spraying in localities with outbreaks, active case detection and use of insecticide-impregnated bed nets to replace DDT residual spraying (Sirajoon and Yadav 2008). However, the emergence of the resistance to the drug chloroquine has prompted the government to launch the National Anti-Malarial Drug Response Surveillance Programme in 2003 to monitor drug resistance.

Currently, Malaysia has the potential to eliminate malaria completely and is diverting the malaria control programme to an elimination programme (Ministry of Natural Resources and Environment Malaysia 2011) as many areas have been declared as malaria-free. However, there are concerns of the reintroduction and resurgence of malaria due to climate change. Increase in temperature and rainfall will increase the malaria vectors' presence, survival and vectorial capability. In addition, rainfall will cause changes in streamflows and rising of sea levels may lead to creation of more brackish water which will affect the spread of malaria vectors population around the coastal areas. Besides that, the absence of malaria in malaria-free areas is feared to cause lower of natural immunity and reintroduction of malaria. Recognising all factors above, the Vector-Borne Disease Control Programme is currently improving its strategies such as addressing the drug-resistant virus by switching to use of artemisinin-based combination therapy (ACT) and enhancement of the surveillance programme including and improving case detection approaches (Ministry of Natural Resources and Environment Malaysia 2011). In addition to that, research is also being carried out to formulate new insecticide with prolonged residual effects to address the current insecticide, which has a fast diminishing effect. The need for area mapping is important for vulnerability assessment and remote sensing data is currently being investigated to cater to this need (Ministry of Natural Resources and Environment Malaysia 2011).

15.9.2 Dengue Fever (DF) and Dengue Haemorrhagic Fever (DHF)

Following a major DHF outbreak in 1973, a series of actions was implemented to control the outbreak including case detection, case treatments, space spraying of insecticides and regular vector surveillance of the virus host, *Aedes* **.** In 1975, the Destruction of Disease-Bearing Insects Act (DDBIA) was introduced in which the relevant authority was included in the control of the disease through imposition of penalties to careless and indifferent householders whose compounds were found to have mosquito breeding sites (Tham 2001). This act also necessitates DF and DHF to be reported within 24 h to health authority when it was made a notifiable disease under the act. This is to ensure that dengue control activities will get public support so as to reduce dengue source. The enactment of the Prevention and Control of Infectious Diseases Act 1988 further enhanced the control of dengue under Section 18(d) whereby closure of compound harbouring disease-bearing insects can be done under the legislation. Legislation control of dengue was seen to have a positive impact on the reduction of dengue cases from 10,146 cases in 1999 to 7,118 cases in 2000 (Tham 2001). In 2001, the DDBIA 1975 was amended with heavier penalties.

Human plays the most important role in ensuring our environment is clean and free of dengue vector breeding sites to halt transmission of dengue. Recognising this, disease control through community awareness and participation was intensified through campaigns and programmes such as National Cleanliness and Anti-Mosquito Campaign (1999) which aim to increase awareness of cleanliness in the environment to control the breeding of vector mosquitoes (Ministry of Health Malaysia 2000), the Dengue-Free Schools programme to educate school children and the Communication for Behavioural Impact (COMBI) programme in 2001 (Mohd Raili et al. 2004) and 'Promotion of a Healthy Environment' campaign in 2002 (Abu Bakar and Jegathesan 2001) for prevention and control of dengue.

However, until today, dengue still remains as a major public health problem in Malaysia and myriad of reasons contributed to incessant rise of this indomitable disease. The biological nature of the virus host (Rohani et al. 2008; Lindsay and Mackenzie 1997), increased population growth and disorganised urbanization, poor sanitation and improper waste disposal system and increased rural urban migrations and international travels produce epidemiological environments which can increase viral transmission potential of the mosquito vector, ***Aedes Aegypti*** (Gubler 1998), thus posing difficulties for vector control. Changes in public health policy in the late 1990s, specifically integration of the vertical organisational structure of the Vector-Borne Disease Control Programme into general health services, caused loss of expertise and funding targeted for vector control. This resulted in the control of vector-borne diseases to be placed under respective local governments in 2000 where there was lack of expertise, resources and political will (Kumarasamy 2006). In December 2010, a drastic measure was undertaken by Malaysia government to curb DF and DHF, that is, the release of 6,000 genetically modified male mosquitoes in an unhabited forested area in Pahang, which is designed to disrupt ***Aedes aegypti*** mosquito fertility by passing on a gene that would kill the mosquito at its larval stage. This move has raised concerns among environmentalists and experts on possible disruption of the balance ecosystem and emergence of new species of mutated mosquitoes which might introduce new diseases (CBS 2011).

15.9.3 Chikungunya

Chikungunya is a virus, which shares the same host as dengue virus, that is the Aedes mosquitoes (especially Aedes aegypti) (Turell et al. 1992; Thonnon et al. 1999). Thus the policies and programmes related to epidemic control of Chikungunya were similar to dengue, which includes public health education, active case detection, fogging and disease source reduction (Lam et al. 2001).

15.10 Conclusions

Patterns of food and water-borne diseases as well as vector-borne diseases are changing due to climate change and these inevitably affect the population and the surrounding environment. Malaysia is proactive in addressing the various health hazards related to climate change. Public health policies and programmes have been instituted and implemented to deal with these infectious diseases that are affected by climate change with evidence of increasing rates and distribution. It is not only the health risks that must be addressed but also the associated social, economic and demographic consequences. The future public health consequences of climate change for people in Malaysia remain uncertain. Thus, climate change adaptation and disaster preparedness for dealing with the climate change adversities should be the utmost priority for human health and well-being.

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