

# Adaptation Education of Climate Change on Human Health in Taiwan



## Plans for Climate Change Adaptation Strategies and Core Competencies for Adaptation

The effects of global climate change are steadily growing in severity. Taiwan is facing even severer impacts. In 2012 the Taiwan National Development Council released its *Adaptation Strategy to Climate Change in Taiwan* in order to enhance Taiwan's ability to adapt to climate change and reduce the overall risk of and vulnerability to climate change's impacts. The entirety of the Executive Yuan develops action plans for this adaptation within the framework of this strategy and set forth eight sectors for adaptation and the policies required. These eight sectors include disasters, infrastructure, water resources, land use, coastal zones, energy supply and industry, agricultural production and biodiversity, and health. These sectors are then managed by different organizations. In the health sector, the primary goal is to effectively improve the environment and systems for aggregating health information to improve the health of all people in Taiwan. Seven items for this adaptation strategy were laid out in the hopes of reducing deaths related to climate change.

1. Enforcing the laws and regulations on public health.
2. Improving the productivity and work division of environmental and public health agencies.
3. Every government department should arrange drills for natural disasters and the prevention of epidemics.
4. Improving the general public's knowledge of climate change and post-disaster epidemic preventative measures.
5. Conducting an ongoing assessment of the impact and adaptation of health issues.
6. Expanding the compilation of databases with disease-related assessments.
7. Strengthening the monitoring system's formation and maintenance.

The Executive Yuan passed the Adaptation Action Plan for Climate Change in Taiwan in 2014, transforming the adaptation strategy into an action plan. The plan set out comprehensive and actionable policies for each adaptation sector. This shift allows all government departments to have a concrete basis for implementing future adaptation efforts. Of these policies, the health sector's action plan is derived from the seven strategic adaptive policies laid out *Adaptation Strategy for Climate Change in Taiwan* and includes 34 adaptive measures.

Taiwan currently does not possess a high-temperature warning system; however, the Ministry of Labor (MOL) in 2016 promoted an information platform for laborers working outside in high temperatures. This platform utilized temperature readings and graphs showing values produced by sensor equipment to provide up-to-date reports regarding the harm stemming working in hot environments along with warning recommendations. The form of labor in Taiwan is divided into three levels: light labor (operating equipment by hand in a seated or standing position), medium labor (work requiring the lifting or pushing objects of a certain weight while also moving), and heavy labor (requiring the use of the whole body for shoveling, digging, or pushing). There are four grades for the warning recommendations:

1. Green Level: Environmental temperature is below the human body's temperature. The speed of air flow can be increased to lower the temperature. Besides requiring an ample amount of water, laborers will also need to be aware of heat-related states including heat stroke, heat exhaustion, heat cramps, and fainting due to heat. Laborers should also monitor each other for any of these states.
2. Yellow Level: Wear cotton or linen clothing that is as light in color as possible. Clothes should be loose and breathable to avoid absorbing too much UV rays. Laborers should also drink plenty of water and consume salt to reduce the possibility of heat-related diseases occurring. When the temperatures of the environment exceed the temperature of human skin, it is recommended to use cooling fans.
3. Orange Level: Water and salt should be replenished every 10 to 15 minutes. Clothing should follow the guidelines above. Facilities should be equipped with cooling fans and shaded rest areas. When working in such environment over a continued period time, appropriate amounts of rest time must be scheduled. Work should be done in rotation to ensure the safety of workers.
4. Red Level: The same as orange level. However, work sites must post the telephone number of the nearest medical facility and times for avoiding operations. When required, operations must stop. Taipei City was the first county/city to establish a heatwave and high-temperature warning, which was officially implemented in 2016. The Taipei City Government worked in conjunction with local weather companies. In the event that the temperature for a given day reaches 38°C or remains at 37°C over a three-day period, the Taiwan Environmental Protection Administration (EPA) will announce a heat wave warning. Each EPA department will initiate response measures to reduce the potential harm associated with heatwaves.

The EPA will spray water on the streets to lower temperatures. The MOL will implement "outdoor labor operations inspections during high temperature days". The Department of Social Welfare will hold activities to care for those living alone. The MOE plans to produce educational materials that feature health in relation to climate change as its core component. (Table 1)

## Conclusion

Climate warming is an accepted scientific fact. The resulting weather phenomenon, such as extreme high temperatures, sharp increases in rainfall, and the rising sea level as well as the acidification of ocean waters: all have direct and indirect impacts on human health. Taiwan has already laid out plans for adaptation policies in response to climate change. The government's primary goals are to reduce the emission of greenhouse gases and mitigate the effects of climate change. The climate change adaptation strategy laid out by the government features eight sectors involving health. Local governments will use the climate change adaptation action plan as a basis for their work, while also taking unique local circumstances into consideration. These steps are taken in order to mitigate climate change and its impact.

The adaptation strategy includes plans at the national, local, and individual levels. The government installed warning systems as well as sensors for monitoring health conditions as means to reduce the effects of climate change on individuals' health. The planned core competencies will teach people to increase their individual ability to respond to the negative impacts of climate change

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Regarding the matter of rainfall, no overt change in Taiwan's annual amount of rain has been seen, yet the total number of rain days has shown a decline. There has been four fewer rain days every decade over a hundred-year period. When looking at the past 30 years, the rate of decrease changes to six fewer rain days every ten years. The number of heavy rain days in Taiwan show signs of change over a period of 50 60 years; however, in the past 50 and particularly the last 30 years there have been larger changes. Additionally, the number of light rain days declined sharply. The trend of 100 years is two fewer days every decade. In the past 30 years that changed to four fewer days each decade. These trends highlight the fact that the total amount of rain days as a whole decreased yet the strength of the rainfall has increased.

In addition to temperature changes, Taiwan has experienced an increase in the effect of typhoons. There has been an increase in the number of typhoons that have affected Taiwan since the 1990s, when compared to typhoon seasons in 1961-1989. Beginning in 2000 there was a discernible increase in the number of typhoons. This increase is closely related to the fact that typhoons forming over the northwestern Pacific Ocean follow paths that tend to track northward. Furthermore, the ratio of typhoons to hit Taiwan that reach the level of a strong typhoon also show evident signs of increase after 1980 (Figure 3).

## The Health Impacts of Climate Change in Taiwan

The impact of climate change on one's health is not limited to any one particular factor. Instead it is linked to several kinds of weather changes and the side effects stemming from the complexities of the socio-economic system. Climate warming and incidents of extreme weather have gradually risen due to the increase in greenhouse gases. These two factors have produced various direct impacts depending on the environmental conditions of different areas resulting in harm brought about by flooding, damage from drought, and diseases tied to the heat. Natural ecosystems are also indirectly impacted as extreme high temperatures produce secondary pollutants, allergens increase, agriculture is damaged, and vector-borne diseases occur. Such unstable environments consequently affect people's psychological health and society's development. The main health impacts of climate change in Taiwan are described below.

### 1. The Effects of Infectious Diseases

Through research into the relationship between Taiwan's regional weather conditions and the occurrence of infectious diseases, a connection has been steadily proven to exist between the outbreak of these diseases, such as dengue fever and scrub typhus, and warming/extreme weather. Looking at the matter from the number of people contracting diseases in the past, it is clear that dengue fever is the disease most impacted by these environmental changes. The infection area of dengue fever is expected to spread further north as population density increases and temperatures rise (Wu et al., 2007; Chen et al., 2012).

Closer research (Figure 4) indicates that 38 townships belong to the high-risk category based on monthly average temperature estimates as seen in the 2016-2035 IPCC AR5 RCP 8.5 models. The 2046-2065 monthly temperature estimates indicate that 63 townships will become high risk. Estimates for 2081-2100 show a total of 91 areas falling under the high risk category. As temperatures rise, the number of high-risk townships will be 2.6 times higher than the current level by the end of the century. These conclusions highlight the expanding area of townships that are potentially at a high risk of experiencing a dengue fever outbreak.

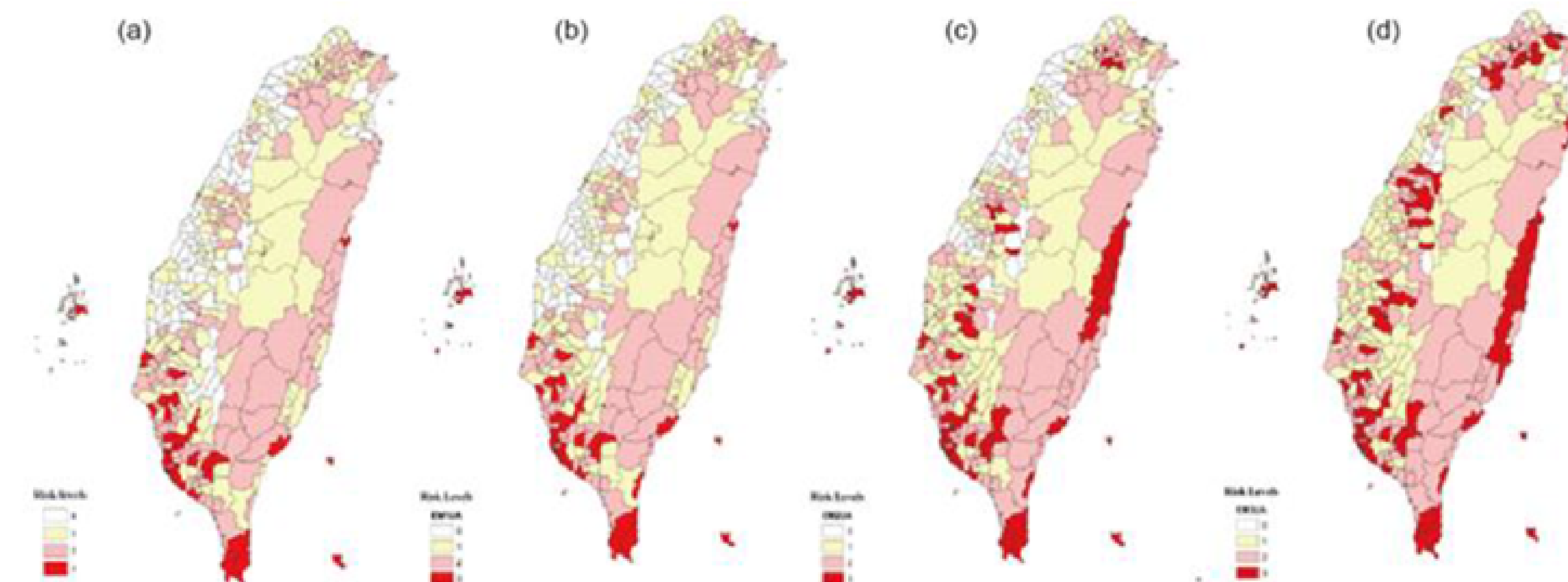


Figure 4 (a) 2003-2013 map displaying the risk levels of dengue fever, (b) 2016-2035 IPCC AR5 RCP8.5 Ensemble model of Dengue fever risk, (c) 2045-2065 IPCC AR5 RCP8.5 Ensemble model of at risk areas for Dengue fever, (d) 2081-2100 IPCC AR5 RCP8.5 Ensemble model of at risk areas for Dengue fever (Source: MOE, 2016)

### 2. The Effects of Secondary pollution

A warming climate and extreme temperatures indirectly produce secondary pollutants, such as ozone and particulate matter. Currently a large body of epidemiology research shows that exposure to air pollutants increases the risk of respiratory and cardiovascular diseases. Depending on the severity of the disease, this will result in increased usage of the medical system (the number of doctor visits or stays in the hospital) and severe cases that could be fatal.

### 3. The Effects of Atmospheric Pollen

Climate change also indirectly affects the growth of plant life as well as its distribution. This can result in an increase in pollen, causing the pollen allergy season to begin early and last longer. The indirect effects increase the concentration of allergens in the air. A higher concentration of pollen will trigger a more severe hay fever, asthma, and allergic diseases. Taiwan's location in the tropical part of Asia means that it experiences high temperatures and humidity throughout the year, providing a hospitable environment for fungi to grow. Based on long-term observations on active fungi concentrations found in residences, office buildings, and outside environments in southern Taiwan, southern areas of the island show higher concentrations of active fungi in the area than other countries, including the US, UK, and Finland (Wu, 2005).

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## Introduction

In order to raise civic literacy and enable citizens to respond to climate change in Taiwan. The Ministry of Education (MOE) determined to create a series of educational materials based around the idea of "health" for people to learn. This article will begin with a description of Taiwan's natural environment as well as the state of climate change on the island. Following this, the article turns its focus to the health risks associated with climate change. This section also details the government's action plan to meet the challenges of climate change. In the final section, the article outlines how the MOE focused on climate change as it developed the health literacy and core competencies people will need.

## Taiwan's Natural Environment and Climate Change

Each season in Taiwan has a distinctive weather system as the island is located in the tropical region of Asia and carries geological features including both high mountains and plains. Its position at the border of the Asian continent and the Pacific Ocean means that weather patterns change rapidly due to the effect of land-sea interactions on the local climate. Taiwan is made up of 75% mountains that are an average of 660 meters above sea level. This feature causes Taiwan's rivers to have sharp slopes and rapid currents. Coupled with the large-scale land development and urbanization in recent years, Taiwan's soil water storage capacity has decreased. The land's ability to withstand abnormal weather patterns such as massive rainfalls and typhoons has weakened. Such conditions increase the vulnerability of Taiwan's environment to the impact and effects of climate change.

A clear sign of climate change in Taiwan comes in the form of rising mean annual temperature over the years in addition to changes in rainfall and the increased number of typhoons. According to a 2011 scientific report on climate change in Taiwan provided by the Taiwan Climate Change Projection and Information Platform (TCCIP), the mean annual temperature in Taiwan has risen 1.4°C from 1911 to 2009. This rate of temperature increase is equal to a 0.14°C every decade. In fact, it is higher than the global average (0.074°C every ten years). In the past 30 years (1980-2009) the increase rate of temperatures in Taiwan has clearly accelerated. Every decade the temperature has risen by 0.29°C over those past three decades. This is nearly double the rate that had been the trend over the past 100 years (Figure 1).

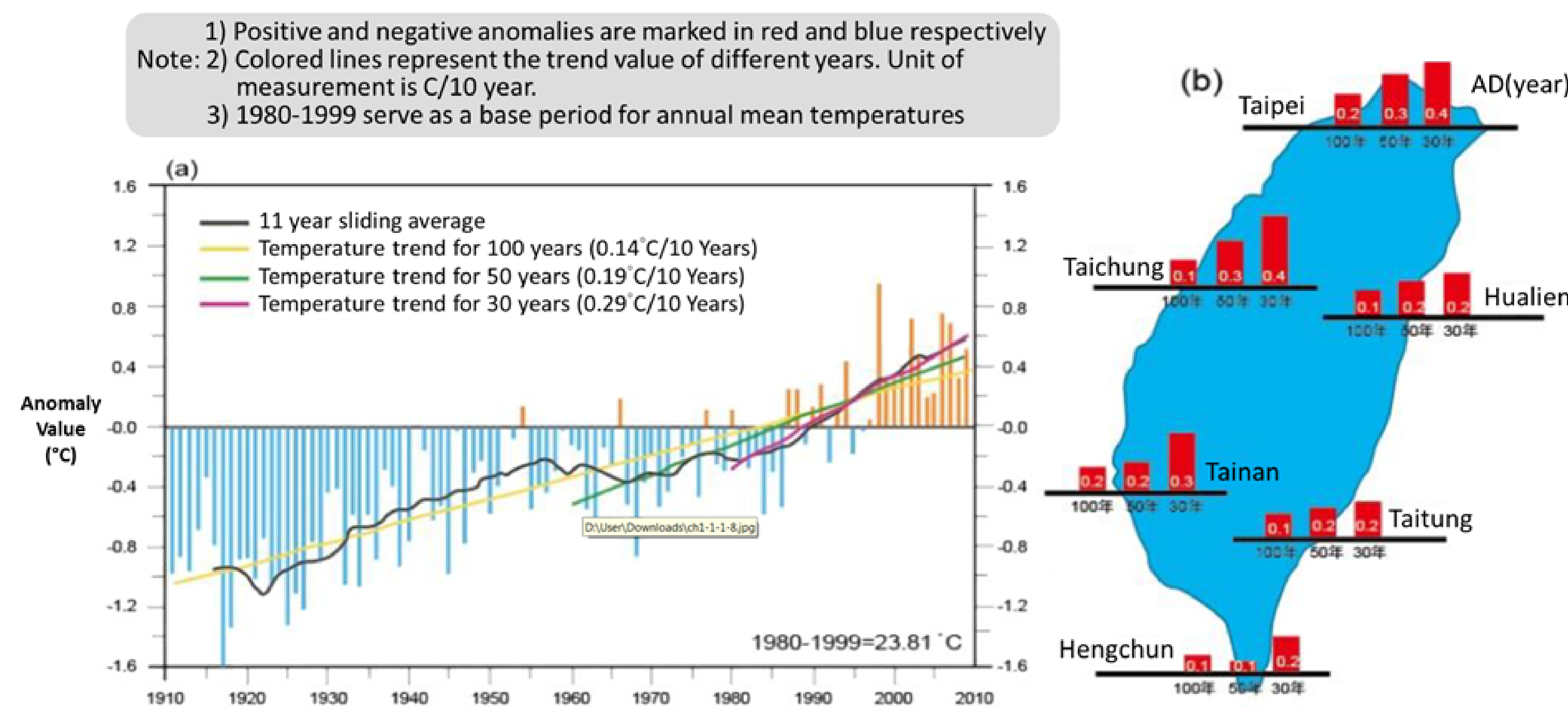


Figure 1. Taiwan mean annual temperature over time (a) and the change in trend (b) (Source: MOE, 2016)

In recent years, much research has indicated that global temperatures are gradually rising. The likelihood of extreme weather phenomenon within this context of global warming thus becomes higher. Additionally, the strength of said phenomenon also increases. The method in which Taiwan calculates the frequency of extreme high temperature incidents (>38°C) defines the threshold value for extreme high temperatures based on the distribution of the cumulative probability during summer months (June-Aug). The threshold value for the highest temperatures reaches a cumulative probability of 90% and is based on the data of each monitoring station over 99 years (1911-2009). Observation data from six monitoring stations (including Taipei, Taichung, Tainan, Hengchun, Taitung) indicate that incidents of high temperatures show a clear increase over the past hundred years, with Taipei's station showing the most significant increase. There is an average of 1.4 high temperature days every ten years. Incidents of extreme cold (<10°C) show a decrease on a linear trend over the past hundred years. These shifts in trends indicate the occurrence of extreme, asymmetrical change (Figure 2).

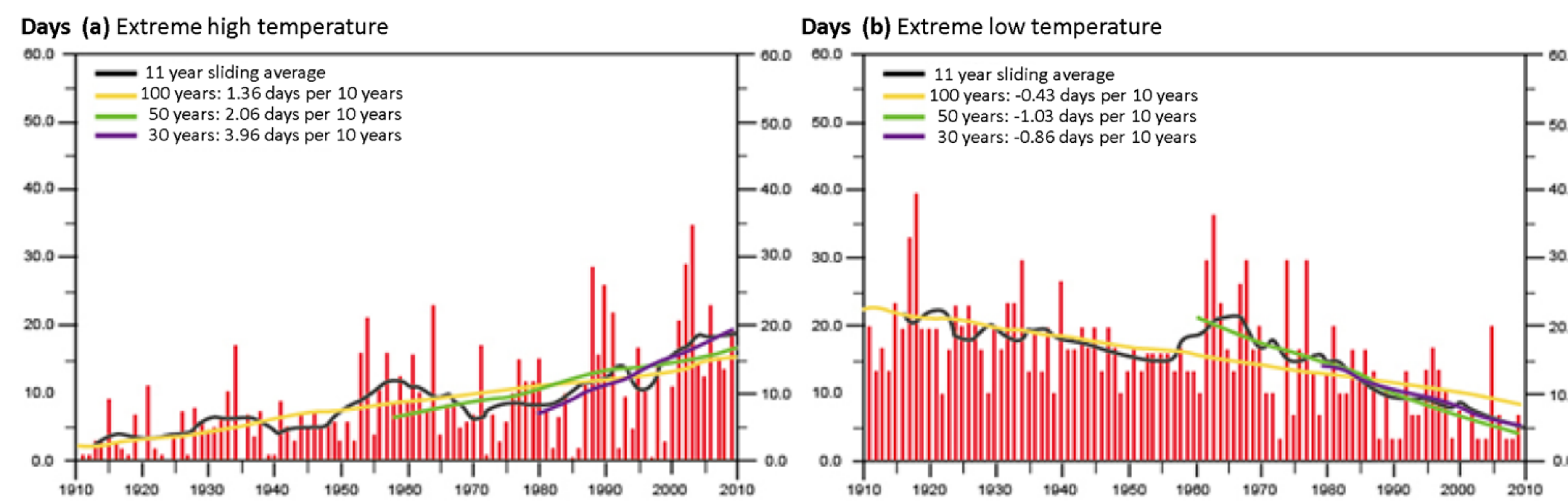


Figure 2. Taipei sensor stations 1911-2009 number of days with extreme temperatures over time and the change in trend. (Source: MOE, 2016)