

# Technical Report

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*Protecting the public  
and minimizing health effects from heat:  
towards the development of a  
Heat-Health Action Framework  
for the Prefecture of Hyogo, Japan*



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## Executive summary

### ***About this report***

The technical report is intended to support efforts by the prefectural government of Hyogo (Japan) towards a comprehensive system for public health prevention of heat disorders. It is the result of an evidence-building process involving relevant stakeholders at the local and national level in Japan. The state of the science regarding public health action on heat waves is reflected only as required by practical purposes, and is based on published scientific literature, as well as the gathering of critical inputs from experts within and outside the World Health Organization (WHO).

### ***Heat and health***

Excessive exposure to environmental heat is a serious risk for health, with possible effects ranging from mild illness to death in both healthy and ill individuals. Heat constitutes a major stress for the human organism, especially for the cardiovascular and respiratory systems. When environmental heat overwhelms the body's thermoregulation, core temperature rises, resulting eventually to heat disorders. Depending on the individual sensitivity, even a slight rise in core body temperature may cause adverse health effects. In the context of public health practice, dangerous exposures to heat are commonly classified as either occupational or environmental. This report focuses on the prevention of health effects from environmental heat exposures, and in particular how the Hyogo prefectural government can move towards the development of a heat-health action framework protecting the public and minimizing public health effects of heat waves.

### ***Preparedness and prevention for heat waves***

While intense heat spells have long been recorded around the world, recent episodes have raised public awareness of their health effects and associated casualties. In particular, the heat waves observed during July and August 2003 throughout most of Europe including Scandinavia and western Russia had dramatic impacts on human health (with an estimated 35,000–70,000 deaths) and kick-started a chain reaction of political and scientific responses.

Local, regional and national governments worldwide have developed and implemented frameworks to address heat exposure, commonly referred to as heat-health action framework or heat-health action plans, to be integrated into their broader emergency management systems. Such systems are credited with successfully reducing heat-related adverse health effects, particularly mortality. The World Health Organization has worked extensively in the field of heat waves and health. Since the 2003 European heat waves, that work has intensified, covering the epidemiology of heat, risk factors and responses, as well as issuing guidance documents to develop, implement and run heat-health action plans.

### ***Heat waves and Japan: history, risk factors and projections***

The coasts of the main islands of Japan (and particularly the Pacific coast of Honshu) are highly urbanized and of temperate climate, and have historically recorded very hot periodical weather spells, although systematic measurements started only in the 1900s. Their effect on public health, however, was not brought to public and scientific attention until the late 1990s, when the epidemiological identification of excess mortality became easier due to data availability and improved analysis capabilities.

Most of the heat-related deaths in Japan have been observed to happen in the largest cities (Tokyo, Osaka and Nagoya), though almost every major city has had a significant number of heat-related deaths. This evidence is consistent with international experience pointing to heat-related disorders as a mainly urban public health issue. High heat-related mortality was registered in 1978, 1983, 1990 and particularly 1994, which were years characterized by markedly hot summers with peak daily temperatures of at least 38.0 °C. Though few studies have been published on heat wave mortality in Japan since then, it is likely that very hot summers, such as the record-breaking one of 2004, have had a significant effect on public health in the major cities.

Many factors have been found to influence the effect of heat waves on public health (WHO 2006) including:

- The timing, frequency, intensity and duration of the excessively hot period;
- The size and the demographic profile of the exposed population;
- Individual risk factors (e.g., chronic diseases, drug treatment);
- Concurrent risk factors, such as air pollution episodes;
- Preventive measures and preparedness arrangements in place; and
- Characteristics of the living and working environment of the population.

Some of these risk factors are widely prevalent in Japan's and Hyogo's cities, specifically: 1) an increasing "heat island" effect derived from a high urbanization rate; 2) episodic peaks of traffic-generated and industrial air pollution; and 3) an ageing population, adding to the pool of individuals at higher risk. Epidemiological evidence supports the thesis of a worsening situation. Research from the National Institute for Environmental Studies (NIES) based on ambulance records in Japan shows an increase in the number of heatstroke patients in the 18 largest cities in the country since 2003.

Therefore, public health risks from heat waves are likely to increase in Japan and in Hyogo. A multi-partner study determined that the number of days over 30 °C in a year will grow almost three-fold on average for the whole country by the end of this century, even if strong action is taken to curb climate change. This increase could be much steeper if greenhouse gas emissions are not adequately curtailed in short order.

### ***A proposed comprehensive Heat-Health Action Framework for Hyogo Prefecture, Japan***

For obvious reasons, it is not within the capacities of public health authorities and practitioners to act on every risk factor for heat wave health effects. However, public health action on the prevention of heat disorders and deaths has proved highly effective when addressed comprehensively and firmly based on intersectoral coordination. Furthermore, based on the information available and climate change projections, preventive and responsive action is justifiable in order to protect the public from the harmful effects of heat in Hyogo Prefecture.

The Hyogo prefectural government has already taken on the challenge of mitigating greenhouse gas (GHG) emissions locally and adapting to climate change impacts. In his opening remarks at the "Workshop on research priorities for climate change and health in urban settings" at WHO Kobe Centre in November 2008, Hyogo Governor Toshizo Ido stressed the commitment of Hyogo to protecting health and the environment from climate impacts, and made a call for WHO Kobe Centre to assist in developing a framework to prevent health effects from heat waves and climate change in the prefecture. The call by the Governor was taken as an opportunity to assess specific health system needs to cope with heat waves in the prefecture in the wake of climate change. WHO Kobe Centre has since liaised with NIES on building an evidence base to inform creation of a heat-health action guide.

Prevention of health effects from heat requires actions at different levels: from health system preparedness coordinated with meteorological early warning systems to timely public and medical advice and improvements to housing and urban planning. Such actions can be integrated into a Heat-health action plan (HHAP). The report is a first step towards a comprehensive HHAP to protect health from heat waves in the prefecture of Hyogo. However, design, development and implementation of HHAPs must be based on a broad, multi-stakeholder process that relies on existing systems and effective communication. Such process will require political commitment, allocation of human and financial resources and, inevitably, time. The resulting plan and associated systems should ideally be based on the principles of sustainability and accountability and subject to periodical monitoring and evaluation.

### ***The bases for action in Hyogo Prefecture, Japan: existing initiatives and infrastructure***

A number of actions are currently being implemented in Hyogo to address the public's exposure to excessive heat. However, there is no comprehensive structure in place to prevent health effects from heat waves as yet. As with any activity related to health emergency management, a HHAP should be built upon existing infrastructure and activities, and be aligned with initiatives developed by relevant

stakeholders across sectors. One example of these building blocks is the “Hyogo Urban Heat Island Countermeasures Plan” under which a number of departments of the Hyogo prefectural government are involved in activities to avoid excessive heat exposure in local urban areas. The actions set forth by this plan would eventually cover most plausible actions for the urban management component of an HHAP.

Other relevant ongoing activities include the research carried out by the Hyogo Institute of Environmental Sciences (HIES) and other research institutions and universities. The prefectural health authorities also have a number of activities and strategies in place to deal with the health effects of heat waves. For instance, nationally-produced health education materials about heat waves are being distributed to the public by health and social care providers. The prefectural plans for healthcare and health promotion also include provisions for elderly care. As of today, such activities lack sufficient integration to fully address health effects from heat waves. However, they constitute a solid foundation for identification, outreach and care of vulnerable population subgroups, and overall for a comprehensive public health management of heat extremes.

### ***HHAP development and implementation: lessons from existing local plans in Japan***

Specific decisions regarding the structure and functionality of HHAP belong ultimately to the implementing agencies, based on their resources and capabilities for risk assessment, as well as organizational, communication and data constraints. However, those decisions can be crucially informed by the options and alternatives adopted by existing systems. In the case of Japan, some local governments have taken action to prevent health effects from heat waves. The most relevant characteristics and attributes of these local systems, summarized in the document, can facilitate the conceptualization of an eventual prefectural plan in Hyogo. But most importantly, the policy lessons derived from local actions on heat waves can constitute important components of the necessary inter-institutional dialogue for the coordination of comprehensive public health responses to heat.

### ***A framework for preventive heat-health action in Hyogo Prefecture, Japan***

While the ultimate goal of a HHAP is to minimize or avoid all public health effects of excessive environmental heat, limiting factors strongly determine how to direct and implement efforts towards that goal. The scarcity of public resources, data availability constraints, institutional cultures and structural considerations are only some of the barriers that need to be overcome in public health actions against heat waves.

Therefore, the approach to building a HHAP needs to be systematic and conceptually robust. Categorizing its elements into a conceptual framework can help strengthen the basis for institutional efforts. In general, preventive actions on heat can be condensed into four main dimensions: prediction, health effects prevention, coordination and information, and long-term planning.

In line with these dimensions, the specific objectives of a Heat-Health Action Framework (HHAF) and/or Heat-Health Action Plan (HHAP) for Hyogo could be proposed as follows:

1. To predict and detect as far as possible, with the available technical means, any potentially hazardous situation and assess risks related to hot weather and heat waves;
2. To avoid or minimize the negative effects of heat on the population, particularly among the most vulnerable population groups;
3. To coordinate actors, resources, measures and procedures to deal with potentially hazardous hot weather; and
4. To promote adequate urban planning and management measures to reduce hazardous exposures to heat.

Work in each of these dimensions should build upon existing arrangements (e.g., for emergency preparedness and response or outreach to vulnerable populations) and use of a multi-sectoral approach. Furthermore, the principles of accountability, transparency and equity should be incorporated as soon as possible in all processes, so as to ensure adequate mainstreaming.

***Recommendations: a road map towards HHAF/HHAP for Hyogo Prefecture, Japan***

If the prefecture of Hyogo, Japan is to establish or strengthen an integrated plan for public health prevention of the effects of heat waves, the mechanism should be similar to that of general disaster planning, with a long-term development and planning phase, an implementation phase including pre-summer preparations and the iteration of the plan during summer, and periodical monitoring and evaluation.

The report will formulate some general recommendations derived from the general status of affairs presented in the text. These recommendations are not exhaustive, nor intended as anything other than suggestions to be scrutinized according to their feasibility and applicability in the local context.

It is hoped that the recommendations will be perceived as useful for officials and technicians in this field within and outside the Hyogo Prefecture, Japan.

## 1. BACKGROUND

### 1.1. Heat exposure as a public health problem

#### *Effects of heat on human health*

Excessive exposure to environmental heat is a serious risk for health, with possible effects ranging from mild illness (e.g., rash and fatigue) to serious disorders (e.g. cramps, heat exhaustion, heat stroke) or even death. Some of these conditions, like heat stroke, can be life-threatening for both healthy and ill individuals. Heat constitutes a major stress for the organism, especially for the cardiovascular system. The human body dissipates heat through a number of natural mechanisms: radiation, convection, conduction and evaporation of sweat. All mechanisms are in turn influenced by a wide range of factors both in healthy and sick individuals in a complex thermoregulation mechanism. If, as in hot weather, the environment is hotter than the skin the most important heat loss mechanism available is evaporation (sweating). Thus any factors that hamper evaporation, such as high ambient humidity, reduced cardiac output, some chronic conditions, high volume to surface ratio, reduced air currents, tight fitting clothes or certain drugs, could result in a dangerous rise of body temperature. When environmental heat overwhelms the body's thermoregulation, core temperature rises, resulting eventually in heat disorders. Depending on the individual sensitivity, even a slight rise in core body temperature may cause adverse health effects (WHO 2009). Yet, it is also known that the adverse health effects of hot weather and heat waves are largely preventable (WHO 2011).

#### *Public health consequences of heat waves*

Excessive and sustained heat exposure - such as that occurring during heat waves - has long been recognized as a threat to human health, particularly in cities of temperate regions of the world. The hazards of occupational exposures to excessive heat are also a significant health problem extensively studied in the scientific literature, but the focus of this technical report is mainly on the environmental exposures to heat and heat waves affecting the general population. While intense heat spells have long been registered throughout the world, only recent episodes have brought the issue of their health effects and associated casualties to public attention. In particular, the heat waves observed during July and August 2003 in Western and Central Europe, including Scandinavia, and western Russia, had dramatic impacts on human health and kick started a chain reaction of political and scientific responses. With an estimated toll between 35,000 and 70,000 excess deaths in one summer, the European 2003 heat waves raised many questions regarding the consequences of heat waves on human health, whether these impacts are preventable and if so how to organize preventive actions (Robine et al. 2008) (Kosatsky 2005). Also in 2003, the Intergovernmental Panel on Climate Change (IPCC 2007) confirmed its projections that heat waves will increase in number, intensity and duration over most land areas in the 21st century (IPCC 2001, 2007). This trend will increase the risk of heat-related mortality and morbidity, and the changes are expected to be particularly relevant to cities, especially in temperate climate zones. These projections further boosted scientific and policy actions.

In the field of public health research, initiatives and epidemiologic studies were initiated at various levels, drawing on past available information and the lessons learnt during and after the 2003 heat waves. The observed lack of preparedness of key stakeholders in Europe pushed research towards the ascertainment of the factors (preventable or not) that most influence the public health impacts of heat waves (Kunzli 2006, Sunyer 2008). Many factors have been since found to influence the effect of heat waves on public health (WHO 2006) including:

- The timing, frequency, intensity and duration of the excessively hot period;
- The size and the demographic profile of the exposed population;
- Individual risk factors (e.g., chronic diseases, drug treatment);
- Concurrent risk factors, such as air pollution episodes;
- Preventive measures and preparedness arrangements in place; and
- Characteristics of the living and working environment of the population.

Populations have a temperature “comfort zone” above or below of which mortality and morbidity (diseases) increase. For the high temperatures, comprehensive meta-analyses for cities show increases



in mortality between 1% and 5% for every 1 °C increase in apparent temperature<sup>1</sup> above designated thresholds (Baccini et al. 2008). The older age groups, particularly over 75 years old are the hardest hit by heat-related mortality, showing a clear increase in effect with age. More specifically, heat waves increase or aggravate cardiovascular and respiratory diseases and mortality for these causes in vulnerable groups such as the elderly, the chronically ill, patients of nursing homes, infants and children less than five years of age and socially-isolated individuals (WHO 2006, 2009, 2011). The determination at the local level of these and other risk factors for morbidity and mortality during heat waves is of great importance for the early identification of vulnerable populations, to which most preventive measures are usually targeted.

Despite the consistency of effects in mortality, there is not as yet a generally accepted definition of a heat wave. This is so because of the difficulty in establishing one parameter as a comprehensive indicator of thermal comfort and also because of the wide variability of tolerances that different populations have to heat stress. Thus, what constitutes a heat wave in terms of public health is best defined at a local level, preferably based on epidemiologic studies linking temperatures with mortality and morbidity over time in a defined population or area.

It is also worth noting the effect of urbanization on environmental temperatures. Human-made materials such as concrete, glass or steel, conserve heat comparatively better than bare terrain or vegetation. That prevents temperatures in summer from cooling during the night, and it also increases thermal stress for city inhabitants during an entire hot spell. The overall increasing effect of urbanization on ground temperatures is known as “Urban Heat Island” effect (USEPA 2008).

## 1.2. Heat waves in Japan and Hyogo

### *Heat waves and health effects in Japan*

The coasts of the main islands of Japan, a highly urbanized territory with temperate climate, have historically recorded very hot periodical weather spells, although systematic measurements started only in the 1900s (JMA 2002). Their effect on public health was brought to public and scientific attention most strongly in the late 1990s, when the epidemiologic ascertainment of excess mortality became easier due to data availability and improved analytical capabilities.

In a study on heat-stroke mortality from 1968 to 1994 (Nakai et al. 1999) most of the heat-related deaths in Japan were observed to happen in the largest cities (Tokyo, Osaka and Nagoya), though almost every major city had heat-related deaths. High heat-related mortality was registered in 1978, 1983, 1990 and particularly 1994, which were years characterized by markedly hot summers with peak daily temperatures of at least 38.0°C. Furthermore, epidemiologic evidence supports the thesis of a worsening situation. Research based on ambulance records in Japan since 2000 shows a steady increase in the number of heatstroke patients in the 17 largest cities in the country (NIES 2009).

The greatest proportion of heat-related mortality in Japan happened among the elderly (over age seventy) and infants (under age five). These results are consistent with other international experiences, notably the European heat waves of 2003. In addition, there is a clear connection between physical activity in abnormally hot days and heat morbidity or mortality, as reflected by case reports of heat disorders while practicing sports (Nakai et al. 1992). Heat waves have continued occurring periodically during the last decade, with the 2004 summer temperatures marking a national all-time high on record of 39.5 Celsius for Tokyo. Summer 2004 was also record in total “Midsummer days” (>30C) in a season (a total 68) and consecutive “Midsummer days” (38) (JAMSTEC 2009).

<sup>1</sup> Apparent temperature is a measure of relative discomfort due to combined heat and high humidity developed by RG Steadman in 1979.

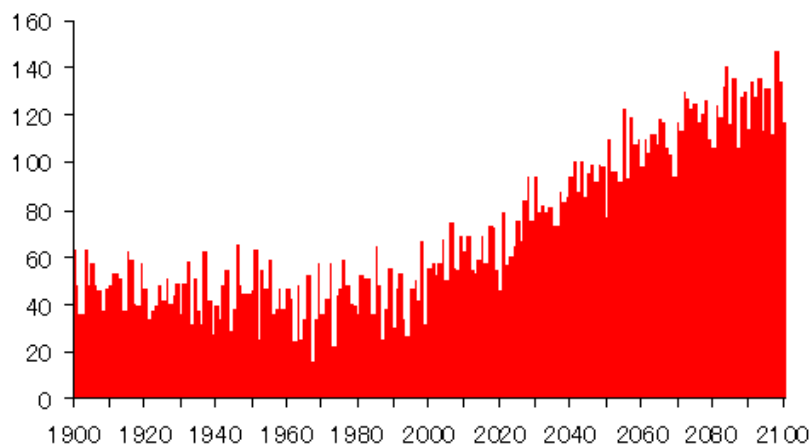
### Box 1. Urban heat island effect in Hyogo, Japan

Although the urban heat island effect is less intense in urban Hyogo than in other major cities in Honshu (e.g., Tokyo, Osaka) it is still a sizeable influence, as observed in the research carried out by the Hyogo Prefectural Institute of Public Health (Aikawa et al, 2005a). In addition, increasing trends of daily maximum, minimum and mean temperature have been observed in Hyogo from 1990 to 2004. Further, the daily minimum temperature has increased comparatively faster, thus decreasing the diurnal range (Aikawa et al. 2005b). This increase of temperature is likely to be related to land use changes (i.e., urbanization; Aikawa et al. 2008). The decrease in temperature range (i.e., not cooling off as much during the nights) can potentially have direct consequences on the health of cardiovascular patients. In the absence of substantive local epidemiologic evidence, but with similar climate patterns and population characteristics, urban settings in Hyogo can be assumed to also have similar heat-related health effects profile to other large urban areas in Japan. This extrapolation, however, is justified only while local evidence is unavailable because locally generated data ought to be the base for any local heat wave risk assessment.

#### *Projected effect of climate change on heat waves in Japan*

The Intergovernmental Panel on Climate Change (IPCC) projects that heat waves will increase in number, intensity and duration over most land areas in the 21<sup>st</sup> century (IPCC 2007). In Japan, a multi-partner study determined that the number of days over 30 °C in a year will grow almost three-fold on average for the whole country by the end of this century, even if strong action is taken to curb climate change (Sumi et al 2004, 2005). Consistently, if strong action against climate change is not taken soon, the increase in very hot days is likely to be much greater. Graph 1 below reflects the projected increase in annual number of very hot days under a worst-case climate change scenario.

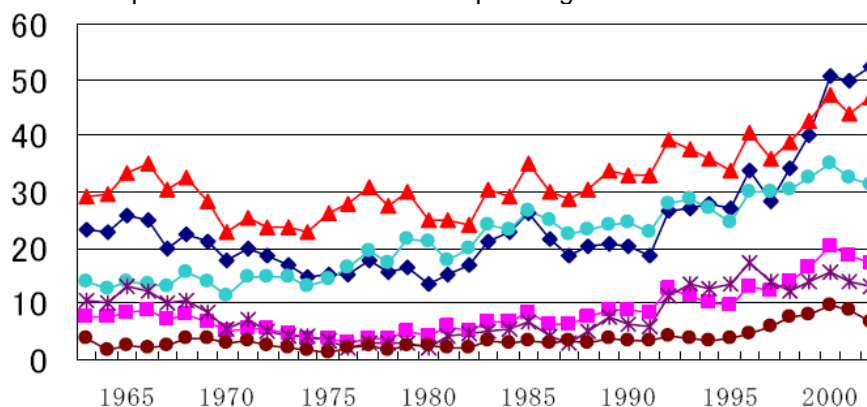
Graph 1. Projected change in summer days over 30C in Japan from the year 1900 to 2100



Source: Sumi et al. 2004

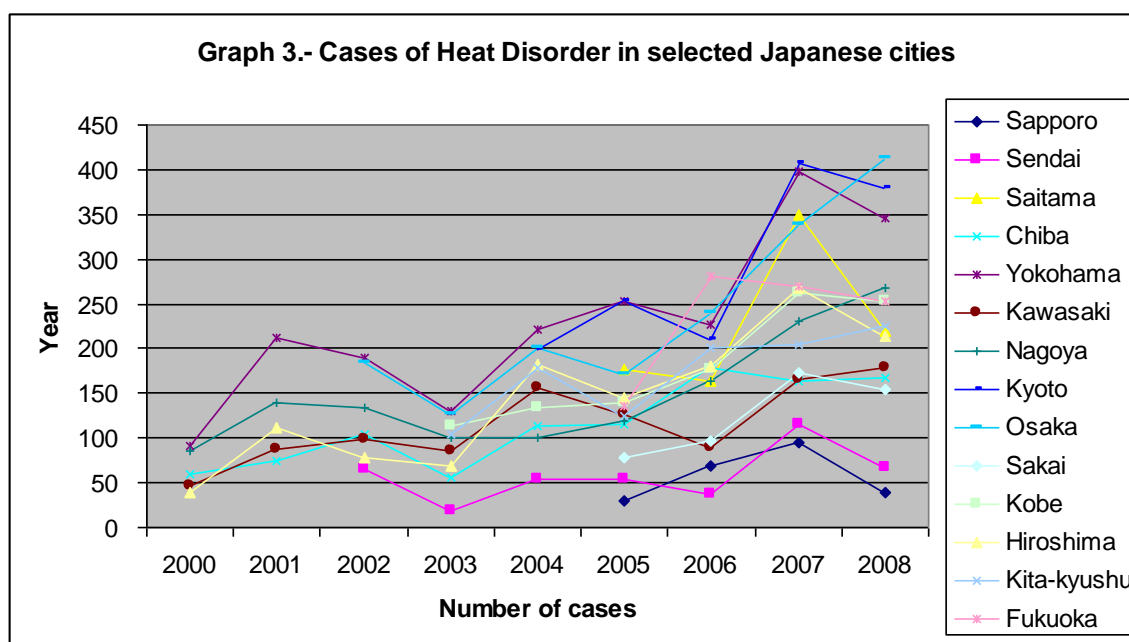
The trend will likely affect cities in the Hyogo prefecture. Further, highly urbanized settings in Hyogo and Kobe City in particular have been experiencing an overall increasing trend in tropical nights in the last decades, as observed in Graph 2 below. These observations are consistent with the increases in temperatures and decrease of diurnal-nocturnal along with the urbanization process in the Hanshin area observed by Aikawa et al (2005b) in the Hyogo Institute of Environmental Sciences.

Graph 2. Trends in number of tropical nights in selected cities



Source: Hyogo prefecture Air Pollution Control Division. Legend: Dark Blue: Kobe; Red: Osaka; Light blue: Tokyo; Pink: Himeji; Fuchsia: Sumoto; Brown: Toyooka

This steady upward trend in temperatures will continue to increase the risk of heat-related morbidity and mortality over time, especially for vulnerable groups such as the elderly, the chronically ill, patients of nursing homes, infants and children under five years of age, and socially-isolated individuals. Japan's and Hyogo's cities' public health vulnerability to this environmental exposure is further exacerbated by three factors: 1) The "heat island" effect derived from a high urbanization rate; 2) Traffic and industrial episodes of air pollution; and 3) an ageing population, adding to the pool of individuals at higher risk. Current epidemiologic analysis seems to support the assumption of an increasing health burden from heat waves, as observed in Graph 3 below. Kobe, in Hyogo, is no exception and constitutes a revealing example, with more than a two-fold increase in heatstroke patients in just six years.



Source: Data courtesy of Dr Masaji Ono (NIES) 2009.

Assuming the population at risk has not changed substantially, the increasing number of cases suggests that the incidence rate of heat stroke has also increased accordingly. It is important to remember, however, that the NIES data do not reflect a proven occurrence of disease (e.g., through hospital admission records) but a proxy indicator used for reasons of availability. Even a cautious interpretation of this data suggests a strong increase of heat stroke cases and a reason for growing concern for public health authorities.

## 2. INTRODUCTION: A heat-health action framework for Hyogo, Japan

## 2.1. The need for proactive action

Based on the information available, preventive and responsive action is justifiable in order to protect the public from the harmful effects of heat in the prefecture of Hyogo, Japan. Although the magnitude of heat disorders is relatively small as yet, the trend in number of cases clearly points at heat waves as a growing public health issue. An increasing number of studies have been published on heat waves mortality in Japan in the last decade, showing that very hot summers, such as the record-breaking one of 2004, have a significant effect on public health in major cities of Japan (NIES 2009). It is in this context that WHO Kobe Centre is supporting the Hyogo prefecture in its efforts to protect citizens in the recurrent event of heat waves. This guidance document towards a Heat-health action framework is one of the steps in the organization and systematization of that ongoing set of efforts.

The Hyogo prefectural government has taken on the challenge of climate change mitigation and adaptation to its wide range of impacts. In his opening remarks at the “Workshop on research priorities for climate change and health in urban settings” at WHO Kobe Centre in November 2008, Hyogo Governor stressed the actions that the prefectural government had taken action on protecting health and the environment from climate impacts, and made a call for further action to prevent health effects from heat waves and from climate change. The call by the Governor was taken as an opportunity to assess specific health system needs to cope with heat waves in the wake of Climate Change in the prefecture. WHO Kobe Centre has since liaised with the National Institute of Environmental Studies on building an evidence base to inform creation of a heat-health action guide.

## 2.2. Existing initiatives and bases in Hyogo

Since the Great Hanshin-Awaji Earthquake in 1995, the prefectural and local authorities in Hyogo have placed great emphasis on disaster preparedness, prevention and response. Hyogo’s extensive experience, world-class infrastructure and systems for disaster preparedness and response provide a conducive environment to achieve best practice standards the inclusion of heat-health provisions within the existing emergency management framework, complementing even further the existing all-hazards approach to public safety. A number of activities are currently in place in Hyogo to address the public’s exposure to excessive heat. For instance, a number of departments of the Hyogo prefectural government are involved in activities to avoid excessive heat exposure in cities (i.e., the urban heat island effect) - Outline of the Hyogo countermeasure plan against heat-island effect; Promotion of Global Warming Countermeasures - Hyogo CO<sub>2</sub> reduction promotion project - developed by the Environment Bureau, the Civil Engineering Department and other research and community actors. This plan is a solid basis for the urban management aspect of an eventual HHAP, and is explained in detail in the next section (Specific objective 4).

Most governmental actions on the matter are informed by locally relevant research by the Hyogo Institute of Environmental Sciences (HIES) and other research institutions and universities. Of special relevance are the research results on the heat island effect in elementary and junior high schools and the heat mitigation effect of different types of roof coating (Aikawa et al. 2005a, 2005b, 2008).

Researchers at HIES have also observed that the minimum daily temperature have been increasing in the Hanshin area relatively more than the maximum in several urban locations throughout the prefecture. That should be reflected in the long-term considerations of a HHAP. Because HIES does not have complete data from the metropolitan area of Kobe, data from the Japanese Meteorological Agency or the Kobe Maritime Observatory should be the basis for considerations in the Kobe area.

The health authorities of the prefecture also have a number of activities and strategies in place to deal with the health effects of heat waves. For instance, health education materials about heat waves are already being distributed to the public in the prefecture of Hyogo. The materials are those from the Japanese Ministry of the Environment’s guidance document on heat waves (JMOE 2007). They are distributed to health care providers by the Health Promotion bureau, which in turn has included some considerations on heat in its five-year “Prefectural plan for Health promotion” ([http://web.pref.hyogo.jp/hw13/hw13\\_00000032.html#h01](http://web.pref.hyogo.jp/hw13/hw13_00000032.html#h01)).

Also developed and implemented by prefectural authorities, the planned actions and priorities of the five-year “Prefectural plan for health care” ([http://web.pref.hyogo.jp/hw13/hw13\\_00000032.html#h01](http://web.pref.hyogo.jp/hw13/hw13_00000032.html#h01)) provide a solid basis for addressing inequalities such as the vulnerability to serious health effects from heat waves. The plan also provides the framework for the administrative divisions for the management of eventual hot weather emergencies.

### **Box 2. Hyogo’s prefectural “Urban heat island effect countermeasures plan”**

The Hyogo Prefecture, Japan has explicitly addressed the issue of exposure to heat in cities with its plan on countermeasures for the Urban “Heat Island” effect, issued in August 2005 with a timeframe of up to 2011. The plan has four main areas of action: 1) reduction of human-produced heat; 2) improvement of ground surfaces; 3) improvement of urban architecture; and 4) improvements in lifestyles. Many actions in the plan are interlinked with prefectural programs on Greenhouse Gas (GHG) mitigation including GHG emissions reductions through technology transfer and a system of carbon offsets for Hyogo (money raised goes to a Green Energy Fund that invests in solar, wind and forest preservation).

In addition to all the existing building blocks for health action on heat, there are several other areas of compatibility with existing infrastructure and organization. Such areas of compatibilities can be identified through focus groups or other coordination mechanisms, and are the basis for further progress towards a functional HHAP. However, there is no comprehensive or structured effort to prevent health effects from heat waves as yet. As with any activity related to emergency management, a HHAP should be built upon existing infrastructure and activities, and be aligned with initiatives developed by relevant stakeholders across sectors.

Under the auspices of Hyogo’s prefectural government, WHO Kobe Centre has liaised with key stakeholders to kick-start the process of designing and developing an incipient heat-health action plan. The first step of the process involved the gathering of inputs and existing information from potentially key players in a public health response to heat waves. These included, but were not limited to, institutions at the national, prefectural and local levels, health authorities, healthcare providers, social service providers, Non-Governmental Organizations (NGOs), Non-Profit Organizations (NPOs), research institutes, Academia, etc. Particular emphasis was put in obtaining information regarding mechanisms and initiatives in place, and different perspectives and views on how to proceed in the process towards a complete heat-health action plan. The present technical report is the result of that collection of critical inputs.

### **2.3. Drawing on the international experience on Heat-Health Action Plans**

The general principles of emergency planning, preparedness and response can be adapted and applied to the public health management of the effect of heat waves. Several local, regional and national governments worldwide have developed and implemented systems to address heat exposure, commonly referred to as heat-health action plans (HHAPs), to be integrated into their broader emergency management systems. Different countries (e.g., Australia, France, Italy, United Kingdom) and regions or cities (e.g., Paris, France; Toronto, Canada; Catalonia, Spain; Emilia Romagna, Italy; Victoria, Australia) have successfully implemented HHAPs which are credited with successfully reducing heat-related adverse health effects, particularly mortality. The World Health Organization has worked extensively in the field of heat waves and health. Since the 2003 European heat waves, that work has intensified, covering the epidemiology of heat, risk factors and responses, as well as issuing guidance documents to develop, implement and run heat-health action plans (WHO 2003, 2004, 2006, 2008a, 2008b, 2009).

A heat-health action plan is a guide for the integration of actions at different levels: from health system preparedness coordinated with meteorological early warning systems to timely public and medical advice and improvements to housing and urban planning. The design, development and implementation of HHAPs are based on a broad, multi-stakeholder process that relies on existing systems and effective communication. The resulting plan must be based on principles of sustainability (e.g., air conditioning, a greenhouse gas producing option, cannot be the main solution) and has to be subjected to continuous and periodical monitoring and evaluation. Although the process of development and implementation of a

HHAP comprises several aspects, there is a limited set of generally recognized core elements (WHO 2008a):

1. Agreement on a lead body (to coordinate a multipurpose collaborative mechanism between bodies and institutions and to direct the response if an emergency occurs);
2. Accurate and timely alert systems (heat-health warning systems trigger warnings, determine the threshold for action and communicate the risks);
3. A heat-related health information plan (about what is communicated, to whom and when);
4. A reduction in indoor heat exposure (medium- and short-term strategies) (advice on how to keep indoor temperatures low during heat episodes);
5. Particular care for vulnerable population groups;
6. Preparedness of the health and social care system (staff training and planning, appropriate health care and the physical environment);
7. Long-term urban planning (to address building design and energy and transport policies that will ultimately reduce heat exposure); and
8. Real-time surveillance and evaluation.

A heat-health action plan, however, does not have to include all of these elements, and may include others. In addition, these elements have different scopes and timeframes. Some of these elements are related to long term development and planning, while others are part of the yearly implementation of a HHAP.

In the following section (3. Objectives) a set of tools and actions are proposed for the long term development and planning aspects of a heat-health action plan. The section includes a number of basic systems and mechanisms that would ideally be in place to allow for effective public health action against heat waves. In section 5 (Action phases), a framework is suggested for organizing some of the general tasks and interventions that a HHAP would require upon implementation, on a yearly basis.

### 3. OBJECTIVES

#### 3.1. General objective

The ultimate goal of a Heat-Health Action Plan (HHAP) is to minimize or altogether avoid all public health effects of excessive environmental heat. However, limiting factors strongly determine how to direct and implement efforts towards that goal. The scarcity of public resources, data availability constraints, institutional cultures and structural considerations are only some of the barriers that need be overcome in public health organizational efforts against heat waves. Simultaneously, as with any other public policies, the principles of equity, transparency, information sharing and accountability must direct public health preventative efforts for heat.

#### 3.2. Specific objectives

The core elements of a HHAP can be roughly condensed into four main dimensions: Prediction, Health effects prevention, Coordination and Information, and Long-term planning. In line with these dimensions, the specific objectives of a Heat-Health Action Framework (HHAF) for Hyogo, Japan could be proposed as follows:

1. To predict and detect as far as possible, with the available technical means, any potentially hazardous situation and assess risks related to hot weather and heat waves;
2. To avoid or minimize the negative effects of heat on the population, particularly the most vulnerable population groups;

3. To coordinate actors, resources, measures and procedures to deal with potentially hazardous hot weather; and
4. To promote adequate urban planning and management measures to reduce hazardous exposures to heat.

Regardless of the final format of a HHAP, efforts towards each specific objective need to be undertaken in light of the existing relevant evidence. Below are some suggestions as to how to advance in that regard.

**Objective 1: To predict and detect potentially hazardous situations and assess risks related to hot weather and heat waves.**

The health risks from heat waves can be assessed prospectively through forecasts, and in (almost) real time or retrospectively through epidemiologic and syndromic surveillance. To allow for that risk assessment, the following issues should be considered in Hyogo:

Prediction: Heat risk situations can be predicted through adequate meteorological forecasts and data analysis based on daily figures for temperatures (maximum, minimum, daytime and nighttime average) as well as Relative Humidity. [Note: Local epidemiological data (Ono 2009) suggest that Wet Bulb Globe Temperature (WBGT) is a better indicator for heat exposure risk than other parameters, so it should also be part of the forecast for adequate risk assessment. Three-day or longer (accounting for fading accuracy) forecasts for selected urban locations throughout the prefecture of Hyogo should be considered for the evaluation of risk]. Duration of a hot spell is also a major determinant of heat-related mortality and morbidity (Nakai et al. 1999) so the forecasted number of successive days over the determined threshold temperatures should be a major component of the risk assessment.

Epidemiologic risk assessment: An assessment of each Heat Risk Situation (HRS) should be performed retrospectively based on comparisons with prior morbidity data (for Japan and for Hyogo in particular). Because contrasted morbidity and mortality data have an inherent delay, the risk posed by a heat wave can also be assessed through faster data streams, such as heat-related hospital admissions and heat-related emergency calls, daily mortality and funeral data. The use of these “faster” indicators (sometimes denominated generically by “syndromic surveillance”) (Josseran et al. 2007) has to be cautious. In general, any warning regimen has to deal with false alarms. Raising of false warnings is an important issue to consider as it burns the credibility of the whole HHAP system. Among others, the following activities and systems can be implemented:

- Epidemiologic analysis of heat-related morbidity data: ideally such studies would be conducted locally (i.e., cities in Hyogo). However, in the absence of locally generated studies, data from major cities in the Sanyo area of Honshu can be used to establish safe thresholds for Hyogo, with special attention to past data in Kobe and Osaka (Ono 2009). Furthermore, most existing locally-run HHAPs have established their thresholds according to national guidelines such as those proposed by the Japan Sports Association (JSA 1994) or the Ministry of the Environment (JMOE 2007).
- Daily monitoring of deaths from heatstroke, heat-related hospital admissions and emergency calls: daily collection of such data by a centralized unit of environmental health or epidemiologic vigilance, at least during the yearly period of the activation of the HHAP. Aside from the daily evaluation of data during the hot season, an inter-year comparison of weekly mortality and morbidity should provide the basis for risk assessment in the long term.
- Daily monitoring of all-cause mortality by age and sex, and cause-specific for cardiovascular and respiratory conditions. All-cause mortality can be used as a proxy for heat-related effects, particularly for chronic conditions affecting the cardiovascular and respiratory systems. Such mortality surveillance ought to be conducted on a daily basis by the competent office of vital statistics and/or epidemiologic surveillance.
- Daily monitoring of funeral data by age and sex in sentinel sites throughout the Hyogo prefecture can be used as a proxy for early warning of increase in mortality related to heat exposure.

### Box 3. Heat risk assessment based on forecasts: the example of Madrid, Spain

The region of Madrid (Spain), which includes the city of Madrid, has had a functional Heat Wave Response Plan (HWRP) since 2003. The basis for preliminary risk assessment was a large epidemiologic study on the relationship between temperature and mortality in Madrid, adjusted for the effect of atmospheric pollution. Heat-related mortality was observed to increase upwards of 28 degrees Celsius of maximum temperature, more steeply upwards of 36.6 C and strongly beyond 38.6 C (Madrid's summer is, however, of low relative humidity). The duration of the hot spell also had a strong effect on mortality with spells of 2 or more days increasing mortality steeply. Based on the temperature and mortality data, a Thermal Extremes Alert System was created whereby maximum temperature (the best predictor for mortality) for today and the next four days is received on a single forecast, which constitutes the basis for risk assessment. The risk assessment is translated into different bits of information which are passed on to different stakeholders in the form of alerts, useful information and/or specific instructions, according to the provisions of the HWRP (Comunidad de Madrid 2009).

### Objective 2: To avoid or minimize the negative effects of heat on the population of the prefecture of Hyogo, particularly the most vulnerable population groups.

Health protection is the ultimate goal of any HHAP. Risk factors for heat disorders tend to be fairly consistent, so, attention to vulnerable groups should be part of the public health preventive and responsive action to heat waves. The following issues should be considered regarding objective 2 during the development of a HHAF:

Identification of vulnerable groups: some population subgroups are more at risk of death and disease from heat waves. In general, the elderly (and the very elderly) constitute the largest defined group at risk of dying due to a heat-wave. Other groups at risk are those suffering from chronic disease, infants, and people under certain medications, in certain jobs or in social isolation (WHO 2008a). When developing a HHAP, the determination of vulnerable subgroups in the community is a crucial step towards the prevention of heat-related health effects.

Preparation of a census of individuals at risk at each primary health care centers (PHC), cross-referenced with the prefectural and/or local social services

Preparation of basic heat preparedness plans at each PHC, mental health care centre, long term care centre, hospital, social health care institutions, and nursing homes, based on templates provided by the prefectural government. Such plans will include at least:

- General preventive measures against heat;
- Specific measures for high risk groups;
- Provisions for communication and coordination with relevant agents; and
- Measures to be implemented urgently in the case of heat waves.

Development and arrangement of channels for dissemination of health education materials for different audiences on how to protect themselves and others from heat disorders.

Logistics assessments such as an assessment of available cooling areas (e.g., in shopping malls) needs to be conducted in each municipality<sup>2</sup>.

<sup>2</sup> Air conditioning, however, is to be promoted for prevention - only in risk situations. The use of carbon-intensive solutions ultimately worsens the problem by boosting GHG emissions and climate change.



Guidance and technical support to primary health care centers, hospitals and acute care centers, social care institutions, nursing homes and mental health institutions on how to develop, implement and update a heat-health action plan to prevent health effects in particularly vulnerable patients. The plan must include general preventive measures, specific measures for people at risk, the communication circuit with social services (including cross-referenced risk censuses) and the actions foreseen in case of a heat wave.

**Objective 3: To coordinate actors, resources, measures and procedures to deal with potentially hazardous hot weather in the prefecture of Hyogo.**

The design, development and implementation of HHAPs entail a broad, iterative and multi-stakeholder process that relies on existing systems and effective communication. As other public policies, it should be based on the principle of sustainability and subject to continuous and periodical monitoring and evaluation. To kick start the process from the institutional side, several actions can be taken:

- Agreement on a lead body within the prefectural government to coordinate a multipurpose collaborative mechanism between bodies and institutions and to direct the response if an emergency occurs;
- Issue and enforce clear mandates, roles and responsibilities for different agencies and personnel within each agency or institution;
- Actively identify and involve stakeholders within and outside the prefectural government in a broad approach; while many of the actions to prevent health effects from heat fall within the competencies of health bureaus, others do not, and require active participation of various other actors;
- Establishment of coordination mechanisms (e.g., committees, inter agency task forces) and communication channels (e.g., e-mail, phone, fax, radio, social networks) before and during the activation of the HHAP every year;
- Elaboration of a heat-related health information plan addressing specifically what is to be communicated, to whom and when before, during and after a heat wave;
- Allocation of resources for agencies and units that will bear substantial responsibility for the design and implementation of the HHAP;
- Facilitate resources for the preparedness of the health and social care systems in terms of staff training and planning;
- Establish a mechanism for continuous monitoring and evaluation: the prevention of health effects of heat needs to be addressed through a long-term approach, in which the appropriateness and effectiveness of the plan must be assessed on a regular basis; and
- Provide guidance to municipal authorities on how to improve their preparedness for and response to heat waves, including coordination with prefectural authorities, guidance on how to develop a municipal HHAP, etc.

**Box 4. Institutional framework of the Catalan regional heat-health action plan (HHAP)**

The region of Catalonia (Spain) has had a functioning HHAP since 2004. The plan, widely credited with reducing heat-related deaths, is led by the regional health service in coordination with the national ministry of health. Meteorological information is provided by the regional weather services, whereas the census of population at risk is cross-referenced jointly with the regional social services. Before and during summer, the regional health services provide and receive information from public and private primary health care centers and other health care facilities, as well as nursing and elderly homes. Heat wave alerts and appropriate instructions, if applicable, are distributed to all agencies and stakeholders concerned at the national, regional and local levels (Gencat 2009).

**Objective 4: To promote adequate urban planning and management measures to reduce hazardous exposures to heat in the prefecture of Hyogo.**

In the context of a long-term approach to prevent health effects from heat it is important that structural measures be taken to: 1) Improve the urban landscape so as to minimize the population's exposure to excessive heat; and 2) Avoid worsening the situation through an abuse of carbon-intensive solutions, such as air conditioning. Regardless of emergency preventive measures during heat waves, urban landscape needs to be continuously managed and improved to reduce its influence as a risk factor for heat-induced illness. Urban populations, subgroups and systems in general and in particular need to adapt (WHO Centre for Health Development 2010). In short, medium and long term measures can be taken in terms of urban planning and housing:

- The short term ones include behavioral changes and room for personal cooling alternatives;
- The medium term consist mainly of retrofitting and modification of the present built environment; and
- The long term concerns of improvements in building regulations and codes, better land use management, health-conscious urban planning and climate change mitigation.

The prefecture of Hyogo has been proactive in this front, from the application of the national "Cool biz" regulation to the modification of the built environment towards a lower heat island effect, and an appropriate land use and urban planning. The prefectural "Plan on countermeasures for urban Heat Island effect" (featured below) is a good example and encompasses many of the appropriate actions under this objective. While the actions undertaken under the prefectural plan are ahead of many other settings in terms of improvement of urban landscape, there is a wide range of possibilities to modify urban landscape in a way that matches public health protection with energy efficiency.

### **Box 5. Hyogo's prefectural Urban Heat Island Countermeasures Plan**

Several prefectures in Japan have programs for mitigation and adaptation to climate change, in which the fight against "Urban Heat Island" effect is a common component. In Hyogo, the prefectural Air Pollution Control Division serves as focal point for many of these activities, which involve several other agencies and external stakeholders. The Hyogo Prefecture Plan on countermeasures for "Heat Island" effect was issued in August 2005, with a timeframe of up to 2011 and it has four main areas of action:

#### 1. Reduction of human-produced heat

- Promotion of solar power panels for household energy use
- Regulations for industry regarding GHG emissions limits and targets
- Promotion of the use of energy-efficient cars
- Use of clean energy from solar, wind and marine heat pump power for public prefectural buildings

#### 2. Improvement of ground surfaces

- Introduction of natural grass in parking spaces: this is an ongoing research collaboration of the Hyogo department of civil engineering and local engineering university departments, regarding the use of different designs and materials intertwining grass and building materials to allow for cooler parking spaces

#### 3. Improvement of urban architecture

- Construction of "green" (vegetation) separators in roads
- Green belt areas around mountains
- Promote the presence and planting of flower gardens

#### 4. Improvement of lifestyles

- Promotion of energy-efficient driving (minimize idling, etc)
- Promote water sprinkling on the streets by civil society. 10 cities have sponsored events, promoting the use of water previously utilized for bathing or other purposes, just before sunset.
- Promotion of eco-friendly offices by keeping air conditioning low, turn off lights at night, etc. This campaign is managed by a Kansai-wide association and more than 500 offices are already registered. Hyogo prefecture has its offices included in this initiative.
- Scientific monitoring of heat island effect by a prefectural research center (the Hyogo Institute of Environmental Sciences).

Many of these areas of action are interlinked with programs on GHG mitigation, emissions reductions through technology transfer and financial support from bigger to smaller corporations, and a newly established system of carbon offsets for Hyogo (money raised goes to a Green Energy Fund that invests in solar, wind and forest preservation).

#### 4. TARGET (VULNERABLE) POPULATIONS

Although health effects and deaths from heat exposure can occur in all ages and population segments, some people are more at risk for these adverse effects (WHO 2008a; WHO 2011). The differences in risk can be attributed to the variation in levels of exposure, individual factors (such as underlying conditions) and the ability to adapt to hot weather conditions. Some of the reasons for the high vulnerability of these population subgroups are explained below:

- The elderly are at high risk because ageing decreases tolerance to heat; thermoregulation is impaired with age and the elderly often suffer from co-morbidity (other diseases) and physical and cognitive impairment. In addition, the elderly very often take multiple medications, whose effect in thermoregulation might be damaging.
- Chronic diseases also impair thermoregulation, thus making the patient more susceptible to heat disorders. Conditions that put the patient particularly at risk are psychiatric disorders, depression, diabetes, pulmonary, and cardiovascular and cerebrovascular conditions. Specific diseases increasing risk during a heat wave can be found in Table 2 below, by their chapter in the International Classification of Diseases (ICD).

Table 2. Conditions that increase the risk of death during a heat wave

| TYPE OF CONDITIONS  | ICD CHAPTERS |
|---|--------------|
| Endocrine disorders, including Diabetes   | E10-E14      |
| Mental and behavioural disorders, including dementias, Alzheimer's, substance use-related, Schizophrenia, etc | F00-F29      |
| Extrapyramidal and movement disorders, including Parkinson's disease  | G20-G26      |
| Diseases of the Cardiovascular system   | I00-I99      |
| Diseases of the Respiratory system  | J00-J99      |
| Diseases of the Renal system  | N00-N39      |

Source: adapted from Kovats and Hajat, in (WHO 2008a)

- Children and infants have a limited ability to thermoregulate, because of their high volume to surface ratio and because they depend on their caregivers for the thermal regulation of their environments. Also, children and teenagers tend to engage more freely in sports during hot weather, which accounts for a significant number of cases of heat disorders.
- Certain medications, in particular the ones which affect organs involved in thermoregulation (some brain areas, cardiovascular system, skin and lungs), can increase the risk of heat-related illness or death. The WHO Regional Office for Europe (2011) updated the public health advice for medical professionals as to adverse effects of medication during hot weather.
- Social isolation has been observed to indicate higher vulnerability to the health effects of heat and increased social contact (physical and virtual) has proven to have a protective effect.
- Certain occupations require individuals to work in hot environments, which, irrespective of occupational safety measures or other factors put them at higher risk for heat-related health effects. Emergency services workers and people who have to work outdoors in hot environments are among the highest heat-related risk occupations.

Targeted information need to be provided for population groups at high risk of health effects from heat waves: elderly and very elderly people, or people with chronic diseases and their caregivers. The WHO Regional Office for Europe (2011) developed a comprehensive table that contain the following columns: 1) risk factors; 2) mechanisms; and 3) selected evidence with a recommendation for public health advice on practical tips such as keeping cool and being well hydrated; information on first aid treatment; and important contact details for social and medical services, inclusive of ambulance services.

Risk factors are grouped into four categories: individual (demographic); health; socioeconomic; and environmental conditions. Risk factors are clustered in people at particular high risk such as: being elderly, having a chronic disease and being socially isolated and probably even living on the top floor. Such people should be targeted as a priority vulnerable group. Active and specifically tailored approaches to reach vulnerable population groups and individuals need to accompany the public health measures. These would include the use of a buddy system, visits and telephone calls. It was found out that distributing information through leaflets and brochures has proved ineffective in many situations: reaching older or homeless people, for example. Other population groups that may need to be considered for specific information may include athletes, tourists and parents of infants (WHO, 2011).

As a summary for Japan (and as guidance for Hyogo, until further local epidemiologic data are available): 1) the elderly (aged 65 and over) comprise the majority of the vulnerable population to severe health effects or mortality from heat waves in most communities; 2) adults of working age between 19 and 64 come second, being at risk due to occupational, exertional and outdoors exposures; 3) school students between 7 and 18 become at-risk population particularly while practicing sports; and 4) Infants and toddlers aged 0 to 6 are at-risk for heat disorders while outdoors (Ono 2009, Nakai et al. 1992, 1999).

However, the consideration of vulnerability to heat disorders should also include people with physical or mental disabilities, the chronically ill, frail people living alone, the socially isolated, patients on medication that affects the central nervous system, and all people who must spend time outdoors or participate in strenuous outdoor physical activity, either at work or for recreation during summer.

## 5. ACTION PHASES: RISK LEVELS, CRITERIA AND INTERVENTIONS

### 5.1. Introduction

The public health interventions contemplated in a Heat-Health Action Plan should be designed based on an assessment of the risk associated with hot weather situations in a particular area (e.g., Hyogo). Three major inherent components of a heat wave determine the hazard level: the intensity, the duration and the timing of the hot spell within the hot season. To establish the duration of the active phases of the plan, a detailed climatic analysis would be necessary. Safe temperature thresholds should ideally be set based on locally relevant epidemiologic research. Therefore, to appropriately determine such temperatures, it would be advisable to conduct epidemiologic studies monitoring heat-related mortality and morbidity in the prefecture of Hyogo in relation with maximum and minimum temperatures. This is not, however, the only option to set thresholds. Actually, several existing locally-run HHAPs in Japan have established their thresholds according to national guideline, such as those proposed by the Japanese Sports Association (JSA 1994) or the Japan Ministry of the Environment (JMOC 2007).

Most HHAPs have yearly active phases with duration roughly equivalent to the summer months, comprising June through September in the northern hemisphere. However, acclimation to hot temperatures plays a significant role in the population's sensitivity to heat (that is, heat waves early in the hot season tend to have a bigger mortality impact than those at the end of the season (Kysely 2004). Thus, an early activation of the plan is justifiable for technical as well as for organizational considerations. Preparations and updates necessary for a successful implementation of HHAPs can be resource-consuming and time-consuming tasks, best managed if started early on.

HHAPs are commonly divided into phases according to the risk for the population. The risk phases are defined according to a determined threshold maximum temperature and duration of a hot spell. If the temperature does not rise beyond the designated threshold, all the summer would be a no- or low-risk phase. Temperatures beyond that threshold would trigger a moderate or high-risk phase, depending on the severity and duration of high temperatures. Consistently, if temperatures beyond a threshold would last for various days, appropriate actions would be launched in each case.

The decision as to the temperature thresholds and triggers for switching between alert phases belongs to the HHAP implementing agencies, based on their resources and capabilities for risk assessment, as well as organizational, communication and data constraints. In general, the activation of the low- or no-risk phases (and the yearly duration of the active part of the plan) is based on past average temperatures

during the hot season. Thus, duration of the low-or no-risk phases is commonly fixed and actions are executed continuously. Moderate and high risk phases would be activated based on a continuous assessment of short-term forecasts or real time measurements and epidemiological surveillance indicating high heat risk situations.

For simplicity, phases can be categorized by simple codes such as numbers or colors; for instance, “Green level”/“Normal level” for low or no risk, “Amber level”/“Precaution level” for moderate risk and “Red level”/“Warning level” for high risk. Other collateral activities, preparations, communications and coordination meetings should start earlier to allow for sufficient time for necessary updates, and the plan would be followed by a period of monitoring and evaluation. Those activities (preparation and HHAP evaluation) should be undertaken during low or no-risk periods.

For illustration, below are proposed: 1) some key preliminary considerations for the operation of a HHAP for the Kobe city/Hanshin area in Hyogo, Japan; and 2) an example of a plausible organization of phases and interventions.

1) Some important considerations would be:

Duration and phases of the plan: according to the official climate statistics (JMA 2009) July, August and September are the three hottest months in Kobe, so the plan should be active (i.e. at least “Green”) at least during that period. High risk periods (i.e. “Amber” or “Red”) on the other hand, happen throughout the hot season in patterns that are not repeated year by year, so the high risk alert actions would be implemented only when the forecast or surveillance systems signaled enough of a meteorological risk to justify proactive public health prevention.

Risk indicators forecast and phase triggers: The choice of indicators for heat risk assessment greatly determines the shape and sequence of phases in a HHAP. Wet Globe Bulb Temperature (WBGT) seems to be a better predictor of heat-related risk than ground air temperature (Nakai et al. 1990) so it would be advisable to include that indicator in the risk assessment. The specific thresholds for WBGT should be determined through locally available data. In the meantime established guidelines, such as the ones proposed by the Japanese Sports Association (JSA 1994) or the Japanese Weather Association (JWA 2006) can be considered for guidance:

Table 3. Risk levels for heat disorders and preventive measures

| WBGT threshold (C) | JSA Risk Rank | JWA Risk Rank  | Measures to avoid heat disorders during physical exercise (JSA) | Measures to avoid heat disorders during daily activity (JWA)                  |
|--------------------|---------------|----------------|---|---|
| ≥31                | Danger        | Danger         | No exercise   | High risk for even healthy elderly. Stay in cooled indoors whenever possible. |
| ≥28                | Alert         | Strong warning | No strenuous exercise, hydrate frequently                       | Avoid excessive heat exposures. Keep indoors cool.                            |
| ≥25                | Advisory      | Warning        | Take frequent rests, hydrate frequently                         | Take frequent rests during even moderately vigorous activity.                 |
| ≥21                | Caution       | Attention      | Hydrate frequently  | Low risk; beware if engaging in strenuous activities.                         |
| Under 21           | Almost safe   | N/A            | No particular measures, but mild hydration                      | N/A   |

Source: adapted from JSA 1994, and JWA 2006

Some municipalities in Japan have adopted the highest thresholds (WBGT>28 and >31) for the general population, which has the advantage of reducing the burden of information flow in a HHAP. Others, however, have taken on the whole scale as a precautionary approach. Information on WBGT levels and associated risks are also published by the Japan Ministry of the Environment and the National Institute of Environmental Sciences in their ad hoc websites. In a simpler version of a HHAP, this source can be the source of heat warnings in the prefecture of Hyogo. It is important to note that WBGT forecast reliability declines sharply during Honshu’s rainy season – roughly covering the month of June in the Kansai area (Tonouchi 2009). Other important specific considerations, such as the identification of vulnerable groups in a geographic area or the roles and responsibilities of each stakeholder, are to be pondered by the agencies in charge of the development of the HHAP.

2) An example of a plausible breakdown of phases and activities for the prefecture of Hyogo would be the following:

### 5.2 Green Phase: actions under a low risk situation

Active from 1 June to 30 September, may include the following actions:

- Daily monitoring of 3 to 5 days temperature or WBGT forecast, as well as all-cause mortality and ambulance calls from sentinel sites;
- Update materials in local governmental and publicly-run websites as to the health effects of heat and the start of the hot season;
- Dissemination of health education materials (e.g., the guidelines from Japan Ministry of the Environment-MOE 2007) to the general public as to how to protect themselves and others from the adverse effects of heat;
- Reminders to schools for guidelines on sports and physical education, until the summer break (mid July) and upon return to classes until September 30;
- Dissemination of a daily bulletin of thermal risk for today and next days to a list of designated institutions and voluntary registrants for appropriate action at each level or individually;
- Web publishing of daily thermal risk bulletin for today and next days by HHAP lead agency;
- Dissemination of reminders to healthcare providers to start or update arrangements for the hot season, as well as updated guidelines on how to diagnose and treat heat disorders;
- Revision and inspection of “point heat plans” (to avoid health effects from heat) in health and social care centers (primary health care centers, hospitals, long term care facilities, mental health facilities, homeless people shelters, etc);
- Preparation at each Primary Health Care center of an updated census of outpatient individuals at greatest risk, which must be cross-checked with the regional social services.

### 5.3 Amber Phase: actions under a moderate risk situation

To be activated when a moderate hot weather risk situation is forecasted or heat-related health effects or mortality are detected, interventions may include:

- Dissemination of preventive recommendations and special attention to frail individuals at high social risk;
- Advice to the public regarding sports and outdoor exposures;
- Dissemination of recommendations for direct caregivers of vulnerable individuals;
- Dissemination of recommendations for social and healthcare workers;
- Active outreach to elderly homes and long-term care home managers regarding measures in place and projected, in case of extended or strong hot spell;
- Weekly dissemination of assessment of past temperature and deaths to public health professionals and healthcare providers;
- Activation of preventive measures for vulnerable people in institutions and in an outpatient basis, according to plans by designated points of health and social care;
- Activation of points of public information, including brochures, booths in points of social and health care, and governmental hotlines.

### 5.4 Red Phase: actions under a high risk situation

To be activated when a hot weather risk situation is forecasted or excess heat-related mortality is detected. Specific interventions may include:

- Periodical release of information to the media and healthcare providers about the alert situation;
- Real-time update of risk situation via HHAP lead agency website;
- Activation of the specific action plans in each healthcare centre, in institutions and residences for the elderly anticipated in case of a heat wave;
- Redistribution of vulnerable patients to areas with air conditioning;
- Active outreach to vulnerable and/or socially isolated individuals by social services and healthcare providers, by using the available census, as well as by information by relatives and/or neighbors;

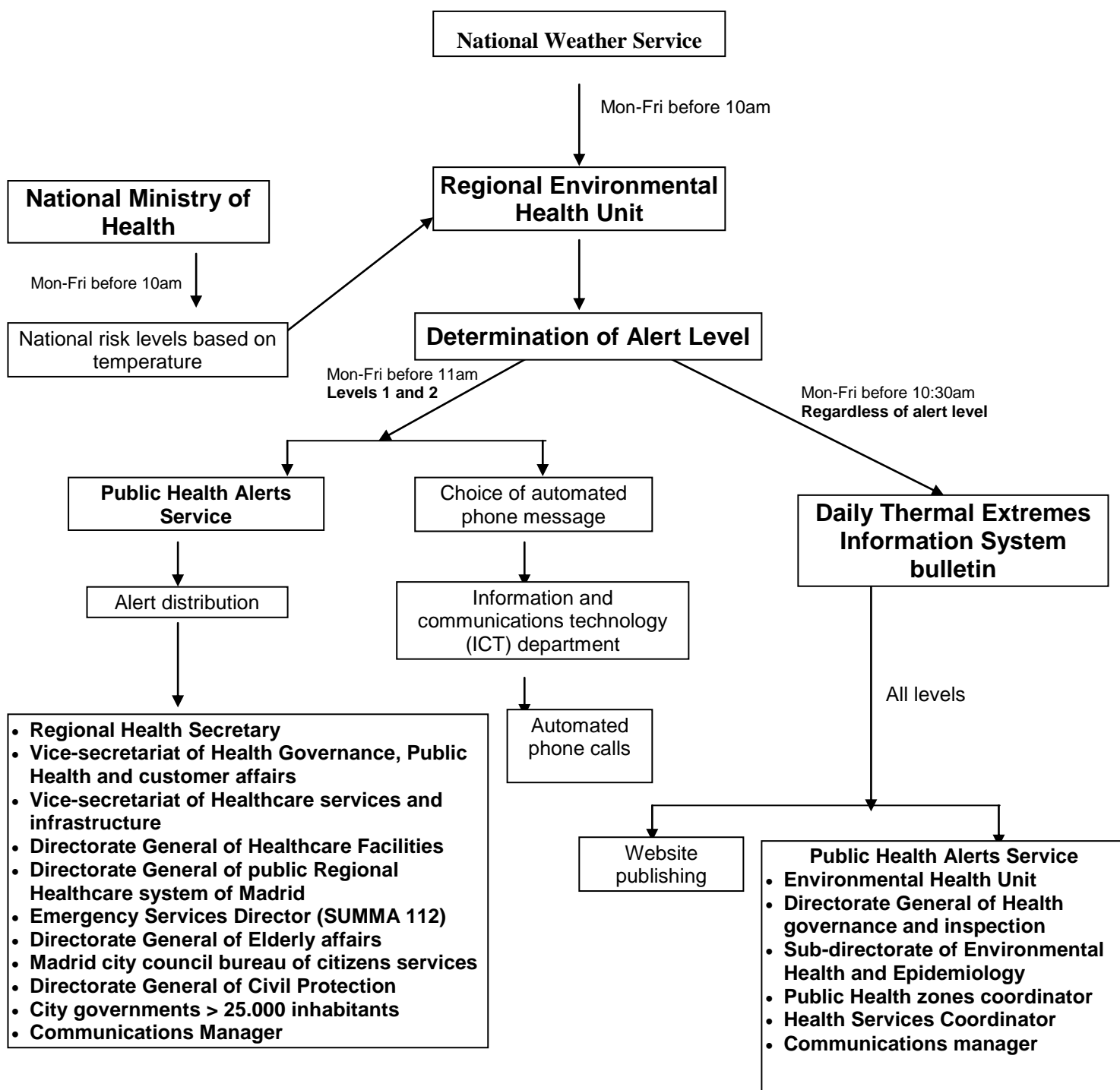
- Specific warning regarding the recreational practice of strenuous exercise and/or outdoor activities;
- Information hotline for healthcare providers;
- Activation of other emergency and response resources, as necessary.

The timely determination, emission and distribution of an alert require agile inter-institutional coordination and communication. Roles and responsibilities, contents of the alerts, channels of dissemination and prioritization of systems have to be clarified to ensure an appropriate process and avoid duplications or bottlenecks.

In general, consistency and economy are desirable attributes in the development of the flows in heat warning systems and heat-health action plans. The example of Madrid, Spain (featured in Diagram 1) can serve as an example to illustrate the flows in a heat warning system for the region of Madrid. The national weather service provides forecasts to the designated regional government lead unit, which determines whether to issue or not an alert based on various inputs (including a national HHAP). A thermal risk bulletin is issued regardless of the alert level; but if the situation is deemed of risk, an additional set of actions and interventions are set in motion to protect the public's health.



Diagram 1. Flows in a HHAP (Adapted from Madrid HHAP Jun-Sep 2009)



## 5.5 Actions to be carried out on a constant basis

In addition to the short-term, emergency activities of the plan, other activities should be carried out on a periodical or constant basis, for instance:

Measures against hazardous occupational exposures to heat: certain occupational groups are at increased risk of heat stroke or other health effects from heat, because they have to work in hot environments or wear heavy protective equipment. Such occupational groups need to be informed on a regular basis about the risks of heat overexposure, guidelines on how to prevent health effects and where to find more information.

Air pollution management measures: air pollution, particularly ozone and PM10, and high temperature have a synergistic effect in increasing mortality (Analitis et al. 2009). Further, the air pollution situation is often worse during a heat wave because smog (and ozone) is more easily formed and high pressure keeps pollutants from being dispersed by the wind. Therefore, it is important to have air pollution control mechanisms in place, so that levels of ozone and particulates can be kept as low as possible in general and during hot weather in particular. Because of the non-specific nature of both heat and air pollution mortality, it is also advisable to integrate the monitoring and warning systems for air pollution with those for heat.

Urban planning measures. The implementation of actions aimed at promoting adequate urban planning measures to reduce hazardous exposures to heat in cities in the prefecture of Hyogo deserve further attention. Structural measures (e.g., architectural improvement, planting of trees, etc) need to be carried out on a constant basis.

Monitoring and evaluation: as with most public policies or interventions, it is important that HHAPs are evaluated to make sure that they are as effective and efficient as possible. HHAPs are difficult to evaluate because of the nature of their purpose (Heat waves are rare, unpredictable occurrences), data reliability (many heat-related deaths are misclassified), because they differ widely from one another and because they change from year to year. However, any plan can be evaluated to some extent in terms of both processes and outcomes. Processes can be evaluated through surveys or other monitoring techniques applied to the stakeholders responsible for the implementation or operationalization of the plan (e.g., English HHAP, in WHO Euro HHAP guide). Outcomes are harder to monitor due to the complex nature of heat-related epidemiology, but mortality can be used in different ways to ascertain the relative effect of preventive actions. In general, it is advisable to have a holistic approach in the monitoring and evaluation of heat-health action plans. However, monitoring and evaluation must be an integral part of a HHAP. At any rate, the development of an evidence base to promote health and reduce health inequalities depends on high quality evaluations that can support decision-makers with information about the types of programmes that can be developed and implemented to ensure the most effective use of resources.

## 6. RECOMMENDATIONS

Should the prefecture of Hyogo, Japan pursue an integrated plan for public health prevention of heat waves, the mechanism should be similar to that of general disaster planning, with a long-term development and planning phase, an implementation phase including pre-summer preparations and the iteration of the plan, and periodical monitoring and evaluation.

Based on the information reflected in this technical report, these are some recommendations for the development and planning phase:

- a. Political commitment should be clearly transmitted to relevant stakeholders, and particularly to agencies and institutions involved in the design, development and later implementation of the HHAP;
- b. A lead agency should be designated and an appropriate institutional framework developed early on with clear mandates, roles and responsibilities and coordination mechanisms as well as appropriate allocations of authority, capacity, financial resources and personnel;
- c. A heat warning system (crucial for the effectiveness of prevention) should be established, preferably based on locally generated epidemiologic evidence and adequate forecasting indicators and technology;
- d. Regular epidemiological surveillance systems should be complemented with sentinel site with daily reporting of mortality and syndromic surveillance to quickly detect health effects from heat waves;
- e. Identification of vulnerable populations and at-risk groups in each community should be carried out at the primary health care (PHC) center level, aided by social services and effectively utilizing existing networks and resources in adequate compliance within the existing framework of privacy and confidentiality regulations;
- f. Basic heat preparedness plans should be developed at each PHC, mental healthcare centre, long term care centre, hospital, social healthcare institution, nursing home, etc. based on technical guidance and support provided by the local and prefectural authorities;
- g. Locally relevant health education materials should be developed to reach out to different audiences on how to protect themselves and others from heat disorders, with emphasis on active outreach to vulnerable populations;
- h. Structural measures should be taken within a long-term approach to prevent health effects from heat for: 1) improving the urban landscape so as to minimize the population's exposure to excessive heat; and 2) avoiding worsening of the situation through carbon-intensive solutions.

These recommendations are not exhaustive, nor intended as anything other than suggestions to be scrutinized according to their feasibility and applicability in the local context.

## 7. LIST OF ABBREVIATIONS

|      |   |
|------|---|
| GHG  | Greenhouse Gas                              |
| HHAF | Heat-Health Action Framework                |
| HHAP | Heat-Health Action Plan                     |
| HIES | Hyogo Institute of Environmental Sciences   |
| HRS  | Heat Risk Situation                         |
| HWRP | Heat Wave Response Plan                     |
| ICD  | International Classification of Diseases    |
| IPCC | Intergovernmental Panel on Climate Change   |
| JSA  | Japanese Sports Association                 |
| JWA  | Japanese Weather Association                |
| NGOs | Non-Government Organizations                |
| NPOs | Non-Profit Organizations                    |
| NIES | National Institute of Environmental Studies |
| PM   | Particulate Matter                          |
| PHC  | Primary Health Care                         |
| RH   | Relative Humidity                           |
| TEAS | Thermal Extremes Alert System               |
| WBGT | Wet Bulb Globe Temperature                  |
| WHO  | World Health Organization                   |
| WKC  | WHO Kobe Centre                             |

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