

SoK: Mitigation and Adaptation Strategies for Heat Waves

Bérengère Rondeau ^{1*}, Florian Klaus Kaiser ², and Frank Schultmann ²

¹ *French Red Cross, Montrouge, France*

² *Karlsruhe Institute of Technology, Institute for Industrial Production, Karlsruhe, Germany*

Abstract

Heat waves pose significant challenges to human health, infrastructure, and ecosystems, necessitating effective mitigation and adaptation strategies. This paper provides a systematization of knowledge focusing on advices presented by the international red cross and red crescent movement aimed at both lessening the impacts of heat waves and enhancing resilience in the face of rising temperatures with a special focus on human health and wellbeing. Mitigation strategies encompass technological innovations, urban planning, and behavioral change. Adaptation strategies include heat early warning systems, community engagement, infrastructure modifications, and policy frameworks designed to safeguard vulnerable populations. By examining these strategies, this paper aims to offer insights into holistic approaches for addressing the complex challenges posed by heat waves and engineering more resilient societies in a warming world.

Keywords: Climate change adaption; Literature review; Red cross; Humanitarian aid

1 Introduction

Climate change is considered to be the greatest public health challenge of the 21st century [1], and is easily and more frequently seen in increasing average temperatures on land and at sea, extreme temperatures, heat waves, severe floods, and droughts with unpredictable effects on humans. In this context, heat waves are amongst those effects most frequently named. Especially the 2003 heat wave in France and, more latterly, the 2023 heat waves affecting large areas of Europe have raised awareness of the risks involved [2]. Furthermore, these events showed the increasing dimensions of heat waves and their growing potential to lead to severe disaster situations even in temperate latitudes. Hence, heat waves need to be considered an extremely important phenomenon for risk management.

For this reason, disaster risk reduction as a disciplinary field and its set of measures is necessary to reduce vulnerabilities and disaster risks in the society, both in terms of preparedness (emergency plans, response and warning capabilities) and long-term risk prevention.

* Corresponding author: berengere.rondeau@croix-rouge.fr

It is in this context that civil protection organizations, and more particularly the Red Cross as an auxiliary to the public authorities, delivers valuable insights to disaster risk operations in face of heat waves and information on decision support for climate adoption and mitigation strategies once confronted with heat waves.

The information available supports the intuition that numerous measures can be taken to cope with heat waves, prepare for them and reduce their harmful impact. However, to be effective, most actions must be taken well before disasters occur, and must continue long after heat waves have passed by strengthening individual and collective resilience in the face of future hazards, by learning lessons from the previous heat wave. The aim of this article is to provide a systematization of knowledge (SoK) regarding mitigation and adoption strategies for heat waves. The work hereby analyses and systematizes white papers published by public institutions with a special focus on humanitarian action and medical aid i.e. the international Red Cross and Red Crescent Societies (IFRC).

2 Background and related literature

According to the definition given by the World Meteorological Organization, heat waves are characterized by a period of unusually hot weather in terms of average, maximum, minimum and daily temperatures, in a given region persisting for at least three consecutive days, during the hot period of the year, with thermal conditions exceeding certain threshold [3].

2.1 Effects of heat waves

During a heat wave, a person is exposed to a high outside temperature for a long period of time, without sufficient cool periods to allow the body to recover. The persistent exposition to heat during heat waves can lead to severe health issues. In this way, heat waves can have serious repercussions on human health, as the body's ability to regulate temperature is exceeded, thus leading to serious complications such as heatstroke, increased risk of accidents (drowning, work-related), and brain strokes. Also, new diseases linked to heat may emerge, or pre-existing pathologies may be exacerbated (allergies, respiratory diseases). These health aspects are closely linked to those of civil security, water and energy supplies.

Furthermore, collateral effects of heat waves are multiple, and if large-scale, require exceptional action. Inter alia systemic dimensions of these heat waves can be seen in their correlation with other cascading risks such as flooding, forest fires, drought, and landslides. In this sense, heat waves also affect infrastructures, causing difficulties in the supply of drinking water and electricity, as well as the saturation of hospitals.

2.2 Relevance of taking adaptive measures

The public exposed to the risks of heat waves depends on the one hand on the severity of the meteorological phenomenon, on the other hand, it also depends on the constitution of people. While people known to be vulnerable (elderly people, children, pregnant women, chronic illnesses, people with disabilities) are particularly at risk, people who are overexposed should not be forgotten (people living in precarious housing, homeless people, people living in dense urban

areas, exposed workers, prisoners). This is, due in part to climate change and rising temperatures, but also to population growth and demographic change, the population's exposure to heat has been steadily increasing in recent years [2].

Furthermore, heat waves are also highly interrelated with increasing urbanization, reinforcing and multiplying their effects, due to the enclosure between buildings, the absence of vegetation, additional diffuse heat sources or even pollution mists [4]. These factors can influence the heat pollution and hence the exposition to heat. This demands for strategic actions and reactions on this observed trend. Given the scale of the heat wave phenomenon itself and the associated risks to people, goods and the environment, disaster risk reduction is essential. Initiatives to reduce the effects of disastrous situations as a cause of heat have been initiated by diverse actors. This is, a number of institutional, health and risk-reduction measures have been taken. However, through practice and measurement, a number of positive signs suggest that heat has been managed more effectively over the past 20 years, but recent heat management does not always meet the increased demands posed by the heightened exposure of the population.

2.3 The international Red Cross and Red Crescent Societies in fighting the effects of heat waves

Associations such as the IFRC play an essential role in anticipating a heat wave, preventing it and limiting its effects, in particular by defining the actions to be taken at local and national level, and by adapting prevention and management measures.

For example, the French government has a heat wave plan that is systematically activated from 01 June to 15 September each year (with the possibility of extension or activation outside this period, depending on temperatures). It defines four alert levels with their associated actions, from seasonal watch to maximum mobilization in the event of an exceptional heat wave. The French Red Cross's heatwave plan is modelled on the government's heatwave plan and is addressed to establishments and regional delegations. It is organized around three alert levels and details the actions that can be taken in terms of prevention, preparation, and response. Hereby, the French Red Cross contacts elderly and disabled people living at home, organizes home visits, sets up water distribution points, etc. This is, during the seasonal watch period, Red Cross establishments play a key role in preparing for intense climatic episodes to limit the health effects of a heat wave as much as possible: raising awareness of the risks and how to recognize the signs of dehydration, the possibility of opening day or temporary shelters for vulnerable people who are not residents of the establishment.

The actions taken at the local level depend on the resources available to the French Red Cross at the time and can be linked to those already put in place as part of other ongoing crises. At national level, the inter-ministerial crisis cell can request the opening of the French Red Cross Operations Centre, chaired by its Director General. At local and national level, the French Red Cross is in contact with the other players involved in preparing for and responding to heat waves: prefectural crisis units, municipalities, public services (emergency medical services, fire and rescue services), private operators (motorways, railways), civil security associations, etc. Beyond the aspects relating to preparedness and crisis management, the Red Cross has a more general and essential role to play in raising awareness of climate change and the human impact on it. In fact, too many people, including the media and Red Cross volunteers, still treat these heat waves and the

phenomena associated with them as “separate” cases, unconnected with the notion of climate change. The Red Cross therefore has a duty of accountability to its volunteers, the people it assists and the general public to raise awareness and provide training on the impact of its actions on global warming, which is the cause of the intense phenomena mentioned above.

3 Methodology

3.1 Systematic information search

The information search was focused on information provided by the international IFRC and the national societies. We searched within the web pages of the national societies for information on heat related action taking. Furthermore, we included information found on international joint webpages such as web page of the IFRC and especially the IFRC Climate Centre. As inclusion criteria we defined the emergence of the term “heat” or “climate” within the title of the resource.

3.2 Information extraction

The information found within the material is analyzed qualitatively. We hereby applied the procedures of a systematic literature analysis. The material is analyzed with a deductive approach. Applying this approach, we separate information to one of the two categories “Proactive measures” or “Reactive measures”.

4 Results

Although sometimes inter-twinned, we separated reactive and proactive measures within this SoK. For efficiently responding to heat waves, frequently, preparedness is essential for effective responding to the extreme situation. In this sense, proactive actions need to be taken for being able to launch many reactive measures and be able to help citizens in the most effective way. We will first discuss these proactive measures and in a second step have a look at reactive measures.

4.1 Proactive measures

One of the most important proactive measures named is awareness training [5]. At a time when society is becoming increasingly digital and confidence in the authorities is fading, the digital sphere represents as many assets as challenges, particularly when it comes to managing and raising public awareness of recent and upcoming heat waves. The digital infrastructure can hereby be used to provide integrated warning and response systems. This is, information sharing can play a key role in preparing for and anticipating future heat waves. Training people to be prepared and informing the general public will help to develop a culture of risk and safety and increase public awareness of the potential dangers and associated vulnerabilities. Fostering the awareness of the importance of heat wave the Austrian Red Cross advises to keep informed on the weather situation and informs on the right health relevant behavior when facing a heat wave such as managing the exposure to heat by staying indoors, reducing activity, drinking enough, and eating food that is easy to digest [6]. The German Red Cross furthermore advises to use protective clothing [7].

Moreover, the Red Cross of Luxembourg adds to these advises to reduce alcohol and caffeine consumption and taking showers or partial baths to cool down the body [8]. Communication on the actions taken, both in terms of response and prevention, is essential, in order to share the right messages and ensure visibility. Social media and the digital sphere as a whole have a role to play here.

Furthermore, urban planning has a vital role in heat wave management. Spatial planning and development can help to accommodate increasing urbanization, especially as people living in dense urban areas are overexposed in the event of a heat wave. These measures *inter alia* include cool islands and water provisioning by public water wells.

For taking proactive measures and prepare for upcoming heat waves, moreover, climate forecasts are an important means. These forecasts can help medical facilities in preparing for the special needs of patients suffering from heat induced medical conditions [5]. Fine granulated information on the weather conditions can in this way help to improve preparedness and improve planning. The information can be a source to support decision making of the affected risk managers.

4.2 Reactive measures

First aid practices such as reducing heat exposure, providing electrolyte-containing drinks, and positioning are the most important measures to know when it comes to taking reactive measures when dealing with heat induced emergency situations [7].

Furthermore, in-situ and mobile cooling centers can be implemented and run in heat waves as a reaction on the extreme weather [5]. For example, ventilators, cooling fans and ice tanks can refresh exposed people and reduce health impacts.

Even housing conditions can be adapted with short term, reactive measures. Such means can be using sprinklers and shading of roof tops and windows [5].

5 Conclusion

Managing heat waves is a topic of increasing relevance given the heightened exposure of people around the globe. This development is fueled by increasing frequency of heat days and rising population densities. Furthermore, demographic changes contribute to this development. The problem of extreme heat waves and its management are thereby also relevant for decision makers in temperate regions such as France or Germany.

In an effort to improve visibility of this topic, a trans-boundary perspective was taken in this work leveraging on the experiences of the IFRC. With regard to this topic, the presented work aims at providing a brief overview on mitigation and adaption measures that should be discussed when dealing with heat waves. We present both reactive and proactive measures focusing on efficiently managing heat waves and their effects on society.

References

- [1] Red Cross France. “Conférence mondiale Croix-Rouge française : "Soigner une humanité à +2°C", Ed. by Croix-Rouge Française. 2019. url: <https://www.croixrouge.fr/actualite/conference-mondiale-croix-rouge-francaise-soigner-une-humanite-a-2c-2302> (visited on 06/12/2023).
- [2] A. Schäfer, B. Mühr, F. K. Kaiser, D., Böhnke, S. Mohr, and M. Kunz. “Untersuchung der globalen Hitzewelle im Jahr 2023”. In: CEDIM Forensic Disaster Analysis, 2023(1), pp. 1-20.
- [3] IFRC (International Federation of Red Cross and Red Crescent Societies). “Extreme heat/ heat wave”, In: Public awareness and public education for disaster risk reduction., pp. 4852.
- [4] S. De Schiller, and J. M. Evans. “Training architects and planners to design with urban microclimates”. In: *Atmospheric Environment*, 1996, 30(3), pp. 449-454.
- [5] Climate Centre. A guide to climate-smart programmes and humanitarian operations - Using climate information across timescales to enhance humanitarian efforts, 2023.
- [6] Red Cross Austria. “Hitzewelle”, Ed. by Rotes Kreuz Österreich 2023. url: <https://www.rotekreuz.at/hitzewelle> (visited on 06/12/2023).
- [7] German Red Cross “Heiße Sommertage – DRK: Hitzenotfällen vorbeugen und Erste Hilfe leisten”, Ed. Deutsches Rotes Kreuz 2022. url: <https://www.drk.de/presse/pressemitteilungen/meldung/heisse-sommertage-drkhitzenotfaellen-vorbeugen-und-erste-hilfe-leisten/> (visited on 06/12/2023).
- [8] Luxembourg Red Cross “Heat wave plan 2023: When heat becomes a health risk”, Ed. by Croix-Rouge Luxembourgeoise 2023. url: <https://www.croix-rouge.lu/en/blog/heat-actionplan-2023-when-heat-becomes-a-health-risk/> (visited on 06/12/2023).