Initiating a Multi-Party Collaboration for Adaption and Resilience to Urban Heatwaves

A Report Prepared for the Netherlands Organisation for Scientific Research : NWO Grant Number KI.18.043

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Project Partners:

TU Delft

The Netherlands Red Cross

NWO

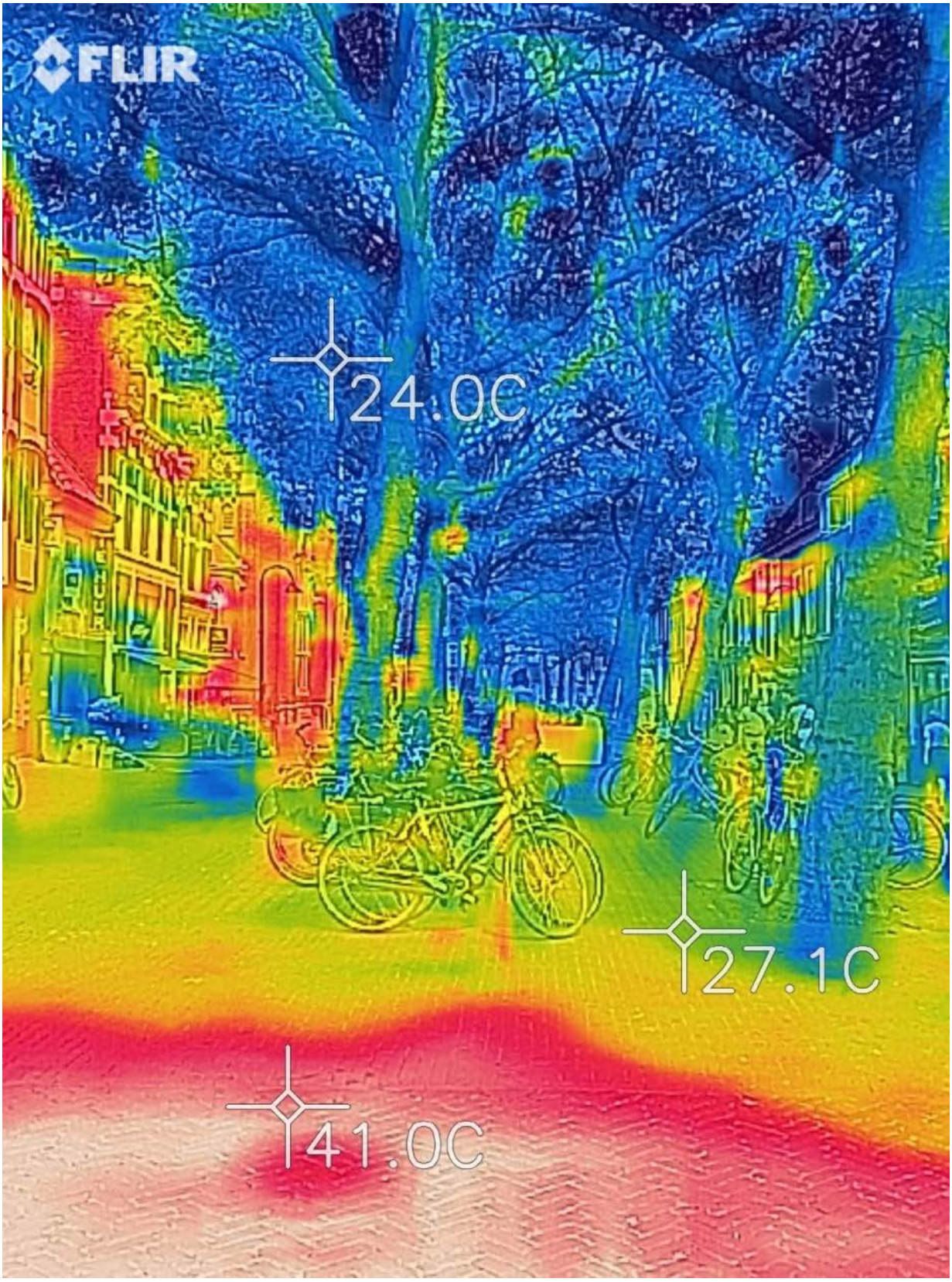

Figure 1 Thermal Image of Heat Variance in Delft on 21-05-2020 (Actual Air Temperature 24.0 Celsius)

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1. Initiating a Multi-Party Collaboration for Adaption and Resilience to Urban Heatwaves (KI.18.043)

1.1 Introduction to the Project

This project concerns a consortium for knowledge sharing/research between TU Delft (IDE Faculty) and the Netherlands Red Cross for the purpose of developing a co-creation approach to resolving complex humanitarian problems. We focus on design for adaption and community resilience to the phenomena of urban heatwaves—prolonged periods of excessive heat in city environments.

A heatwave can be defined as a three-day mean temperature that is significantly above average temperatures of a region for the time of year[1]. There is a clear correlation between urban heatwaves, periods of excessive heat and high humidity, and national mortality rates (See Figure 2). Yet because urban heatwaves do not leave a trail of visible destruction like earthquakes, tsunamis and pandemics, these crises are often termed 'silent-killers'.

Urbanisation, climate change, wealth disparity and an aging population mean that the veracity to which heatwaves effect society will increase leading to increased humanitarian risks and needs. There is now acknowledgment amongst the medical, climatic and humanitarian community that novel approaches to the development of strategies to mitigate the devastating effects of urban heatwaves are required[2]. The Netherlands Red Cross in collaboration the International Red Cross are increasingly focused on urban heatwaves as an identified humanitarian problem[3].

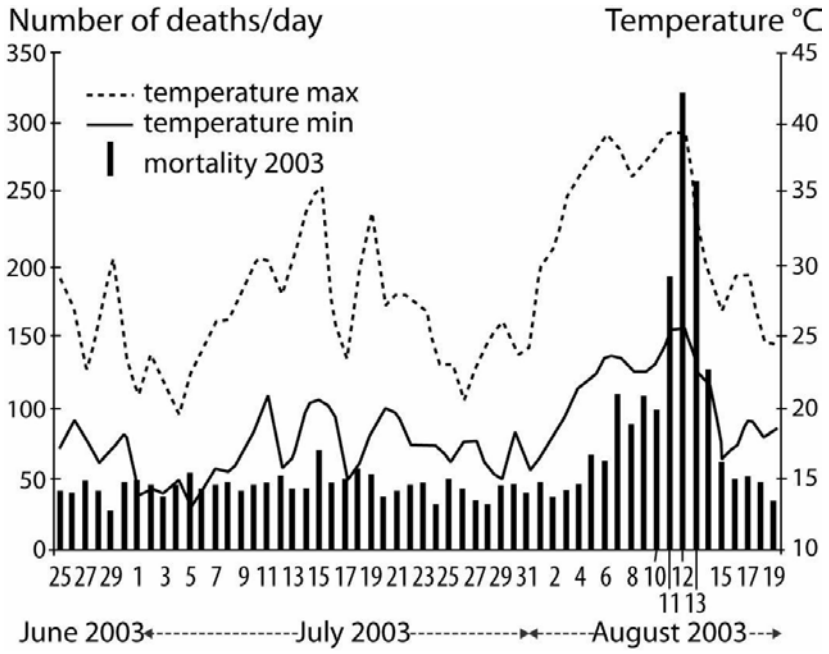

Figure 2 Mortality Rates during French Heatwave 2003 (University of Hawaii at Manoa/ Benedicte Dousset)

Because heatwaves effect cities as a whole, an ecosystem approach is required. However it is often unclear how stakeholders act or are governed within ecosystems. During this KIEM project nested in

[1] Otto, F -- Oxford University & Oldenborgh, G.J -- Royal Netherlands Meteorological Institute. *Report.*
[2] Watts, et al (2017) The Lancet Countdown: tracking progress on health and climate change. *The Lancet, 389* (10074) 1151-1164.
[3] Red Cross Climate Centre (2018). *Extreme heat damaging health and livelihoods and threatening to overwhelm hospitals worldwide*. www.climatecentre.org

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the Big Picture Lab at TU Delft Faculty of Industrial Design Engineering, we have involved parties that form the urban ecosystem effected by urban heatwaves. Our KIEM project has developed two mutual yet exclusive design concepts that can address the increasing concern of urban heatwaves. These concepts are:

1. "See the heat, Solve the problem": making use of thermal imaging to give the Red Cross volunteers 'super-powers' to map out how heat affects urban settings. From these intelligence, the Red Cross can make community building interventions to reduce heat-build up in urban spaces while driving reform of urban planning with city/municipalities.

2. "Stories from the field": one of the key issues identified in our research and design is that public awareness of the effects of urban heatwaves is limited. People are simply not aware how dangerous urban heatwaves can be. This lack of awareness is also present at a policy level, where policies that clearly define and acknowledge heatwaves are limited. Stories from the field aims to collect stories of how urban heatwaves effect citizens through the eyes of Red Cross volunteers and make this accessible to policy makers, private organisation and other interested parties through a democratic web platform.

1.2 Project Aims

This project aims to yield the following results:

- Initial knowledge sharing workshops, resulting in the identification of complementarities between the parties leading to;
- Co-creation sessions including mapping the city ecosystem (during urban heatwaves) leading to design interventions for adaptions that initiate broader socio-technical transitions toward liveable cities;
- A strong foundation for a following project proposal that include wider selection of multiple parties.

1.3 Alignment to ClickNL Objectives

In line with the overall ambitions of CLICK NL, this project builds a sustainable partnership between the Netherlands Red Cross and TU Delft around the issue of urban heatwaves. We have specifically addressed the following research themes that form the CLICKNL 2018-2021 Knowledge and Innovation agenda:

- *Design for Change.* The CLICKNL agenda posits that collaborations between highly diverse people are needed to realise systemic change that merges collective and individual interests. This project addresses this aim by building new collaborations between multiple parties that represent different levels of the system.
- *The Human Touch*. Urban heatwaves are considered a 'silent killer'. These natural disasters effect the most vulnerable: the elderly, women, children, the poor and those with underlying health conditions and disabilities. Making people aware of this silent killer is core to our approach. We have investigated how communities of concern could facilitate this awareness, how to deliver the right information (e.g. through smart systems) and how these systems can be interacted with in desirable ways (e.g., of there is help/support needed and how people can help themselves and their communities (relatives, friends and neighbours). As stated in the CLICKNL agenda, the Creative Industries can play an important role here: designers are known for their ability to function as integrators and to advocate for different stakeholders in transitions.
- *Value creation.* Humanitarian innovation involves paradox. On the one hand, capital derived

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from a charitable sources requires transparent use to give confidence to build base of loyal donors. As such, non-profit organisations are held to strict processes to reduce risk. Yet innovation is inherently risky and involves stepping into the unknown. Here lies an organisational paradox that creates barriers to innovation for non-profit organisations. This project approaches this barrier by exploring, framing, prototyping concepts to address urban heatwaves. These activities inherent to design lower the risk of innovation by gathering insights iteratively that enhance final concepts ready for production and launch.

1.4 TU Delft Scholars Involved

Scholars involved and contributing to the realisation of this project from TU Delft are:

- Dr. Rebecca Price – Assistant Professor of Transition Design in Faculty of Industrial Design Engineering - (NWO Project Lead)
- Professor Jeroen van Erp – Professor of Concept Design in Faculty of Industrial Design Engineering
- Noemi Fuentes Flores – Master Graduate of Strategic Product Design in Faculty of Industrial Design Engineering
- Joseph Kesisoglou – Master Graduate of Strategic Product Design in Faculty of Industrial Design Engineering

1.5 Netherlands Red Cross Practitioners Involved

Netherlands Red Cross practitioners involved and contributing to this project are:

- Michel Becks – Team Lead of Humanitarian Innovation
- Raimond Duijsens – Snr Officer Policy and Strategy at Netherlands Red Cross
- Joost Möhlmann - Head of Business Development, Advisory and Innovation Unit at Netherlands Red Cross

2. Actual and Expected Results

This KIEM project has delivered upon expected results, yet in unexpected ways due to the exogenous event of SARS-CoV-2 (better known as Covid-19).

2.1 The Heatwave Phenomena

Heatwaves are three-day periods where mean temperatures significantly surpass the average mean of that time-period. Depending on location on the planet, a heatwave will occur as a result of a series of antecedent climate events. For this reason, urban heatwaves can be predicted days in advance. We can localise to Europe to explore one set of antecedent climate events that lead to urban heatwaves.

Figure 3 is an isobaric weather chart superimposed with temperature zones using a colour scheme (hot = red, cool = blue). In this case, the source of a prolonged heatwave is the transfer of super-heated desert air from North Africa north across the Mediterranean into Europe. This isobaric phenomena is stimulated by two low pressure zones to the south east of Europe, (East of Spain and Portugal in the Atlantic Ocean) and across Russia and Siberian region. These low pressure systems bring dense humid weather but also create an isobaric corridor through which hot-dry air from North Africa travels into Europe – in this case known as the 'Spanish Plume'. During this particular heatwave

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event, Toulouse in France recorded a heat temperature record during this particular heatwave with 41.1 degrees Celsius recorded[4].

Coincidentally, a convention of statistical climate scientists took place in Toulouse during this very heatwave event. Climate scientists at this conference statistically demonstrated that these types of extreme weather events are five times more likely to occur than 50 years ago[5]. This concerning trend is cause for action. We have explored urban heatwaves using Europe as a basis. However, countries within the Africa, South East Asia, Oceania and Central America also experience severe and life threatening heatwaves.

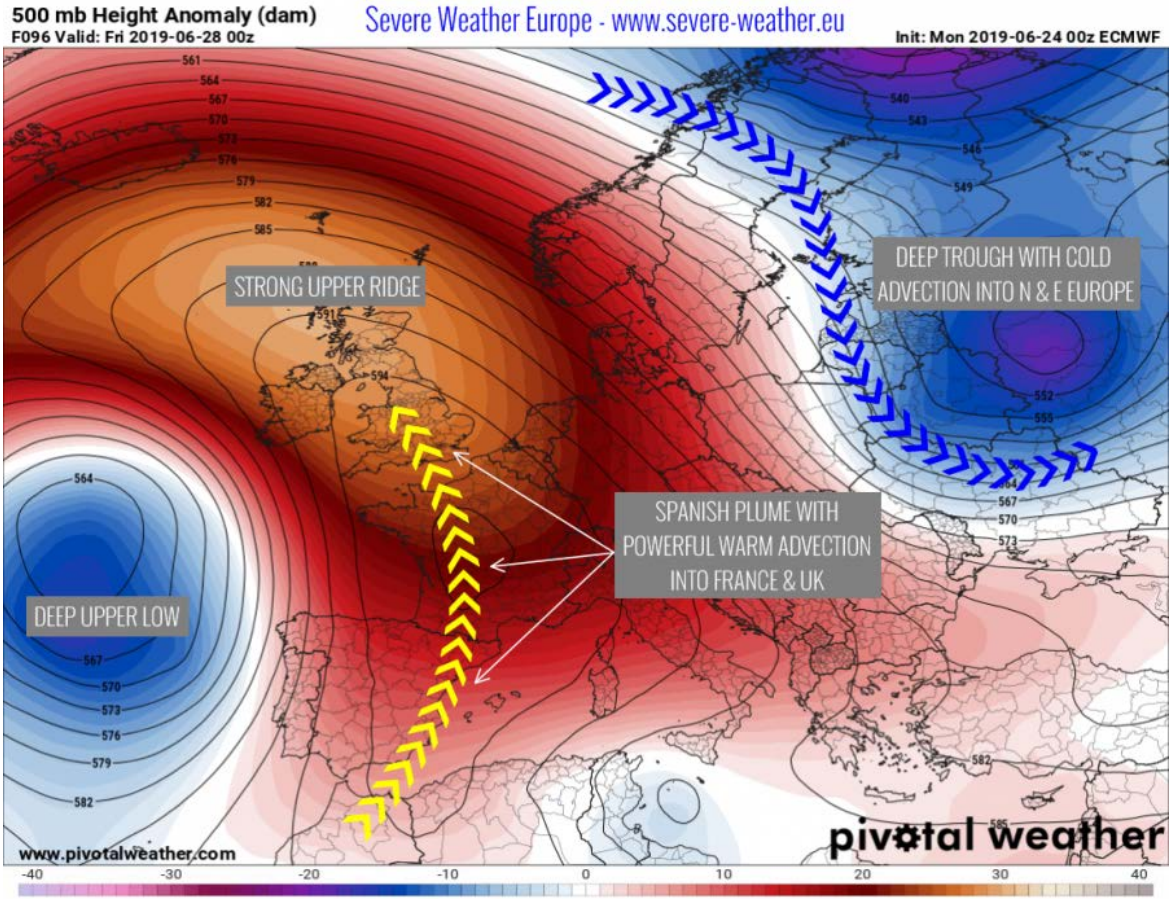

Figure 3 Heatwave Isobaric Chart for Europe 24-06-2019: (Pivotel Weather)

2.2 "See the Heat, Solve the Problem: Designing cities that live": A strategy to reduce heat in cities

Words by Noemi Fuentes Flores

The focus of the research is in the thermal dynamics in the built environment to anticipate heat behaviour during urban heatwaves, with the goal of understanding the behaviour in order to design solutions for it. This design research consists of a literature review, expert interviews and a thermal image study.

[4] Otto, F -- Oxford University & Oldenborgh, G.J -- Royal Netherlands Meteorological Institute. Report.
[5] Ibid.

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The duration and intensity of heatwaves is one of the impacts that climate change has brought with it[6]. Heatwaves impact livelihoods, health, infrastructure, nature and economy. The Global Heat Health Information Network (GHHIN) lists the most vulnerable people that can suffer from health hazards due to extreme heat[7]. These are the most vulnerable people:

- People with disabilities;
- The poor, displaces and homeless;
- Children;
- Elderly;
- Outdoor workers, and;
- Athletes and attendees of outdoor events.

The special report Global Warming of 1.5°C by the Intergovernmental Panel on Climate Change (IPCC) shows that 420 million additional people will be exposed to extreme heat (IPCC Report, 2018)[8]. In addition, we know that cities face higher temperatures due to the Urban Heat Island effect (Bornstein, 1968)[9]. The world's population is expected to have two thirds of it living in cities by 2050[10]. Rapid urbanisation and the increase of urban heatwaves call for a solution exploration in a city level. How might we reduce the effects of urban heatwaves?

The following Expert interviews were conducted:

1. Eva Stache - PHD researcher Materials & sustainability - Green as building material in TU DELFT
2. Jan Henk - Director The Rooftop Revolution - Amsterdam
3. Julie Arrighi - Urban Manager & ICRC Partnership Lead at Red Cross Climate Centre - New York
4. Guy Lafranchi - Architect GLAD Architects - Zurich
5. Raimond Duijsens - Community Resilience Advisor at Netherlands Red Cross - The Hague
6. Lotte Heuberger - Planning Monitoring and Evaluation Officer at Red Cross - The Hague
7. Matthew Webb - Architect at Herzog & De Meuron - Basel
8. José María Pastrana - Strategic Designer at Designit - Oslo

The following webinars were attended:

1. May 26 - "Prevention of heat-health effects in the context of COVID-19" - World Health Organisation + Global Heat Health Information Network (GHHIN)
2. June 26 - "Innovating in urban planning and governance for heat health" - GHHIN

6 Coumou, D., & Robinson, A. (2013). Historic and future increase in the global land area affected by monthly heat extremes. Environmental Research Letters, 8(3), 034018.
7 Ghhin.org. 2020. Heat Health. [online] Available at: <http://www.ghhin.org/heat-health-explained>

8 IPCC Report: Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C https://www.ipcc.ch/site/assets/ uploads/2018/02/WG1AR5_SPM_FINAL.pdf
9 Bornstein, R. D. (1968). Observations of the urban heat island effect in New York City. Journal of Applied Meteorology, 7(4), 575-582.
10 NASA Climate Kids. 2020. What Is An Urban Heat Island?. [online] Available at: <https://climatekids.nasa.gov/heat-islands/> ; IRFC Heatwave Guide For Cities (2019) [Report] Available at: <https://www.climatecentre.org/downloads/files/IFRCGeneva/RCCC%20Heatwave%20Guide%202019%20A4%20RR%20ONLINE%20copy.pdf>

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This study consists on images taken with a Flir Pro thermal camera attached to an android cellphone. Three cities in the Netherlands were thermally photographed: Delft, Amsterdam and Utrecht in different days across May and June between 13:00 and 17:00 when the weather forecast was around 20ºC to 23ºC for all of them.

First, Figure 4-8 have been analysed based on the literature review, expert interviews and the following research questions:

1. *How hot do surfaces get in public spaces (plazas, streets, side walks, etc.) around the city compared to the temperature from the weather forecast?*
2. *What is the thermal impact of greenery elements in buildings and streets?*

Finally three comparisons are made (Figure 4-8), first one between two main squares in Delft, second one between two neighbourhoods in Delft and lastly between images from the three cities photographed.

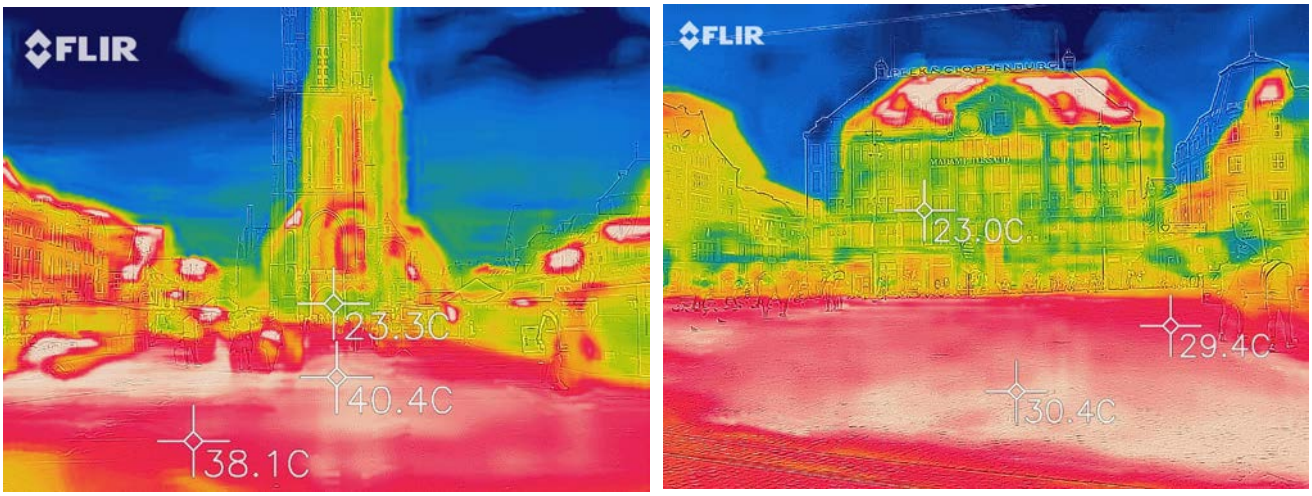

Figure 4 L: Delft Market square. Taken on 20-05-2020. Temp 20º R: Amsterdam Dam Square. Taken on 14-06-2020. Temp 22º

The first insight was the difference of temperature in surfaces. In most cases around city squares and plazas the ground temperature was double as the forecasted data. Meaning some surfaces reached over 40ºC on a 20º forecast. See figure 4.

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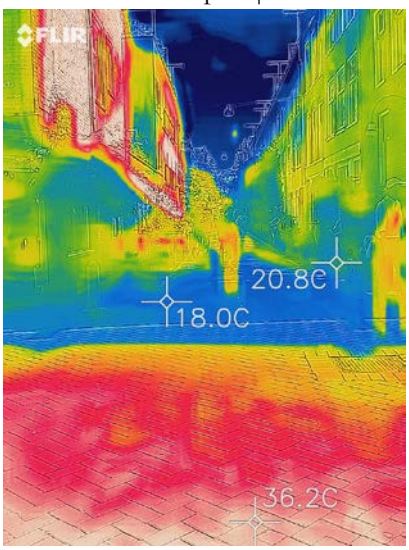
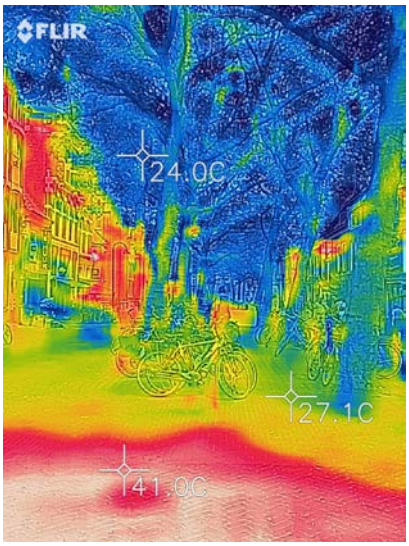




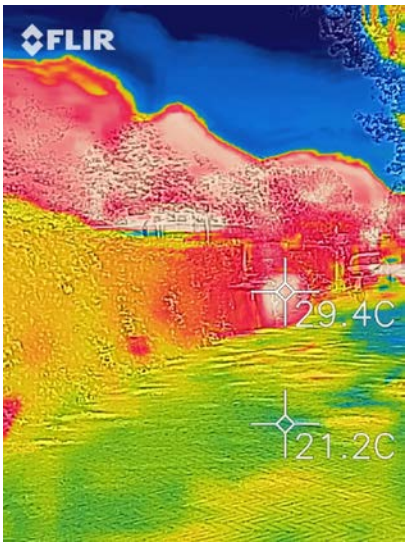
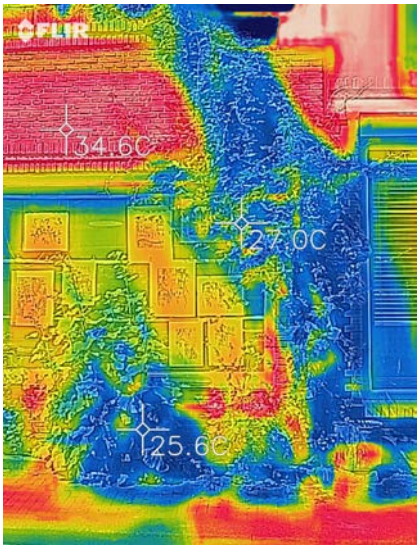


Figure 5 L: Amsterdam. Temp 22º *M: Delft Temp 20º.* *R: Utrecht. Temp 21º*

From the literature review held, it was expected that shadow from green elements would show a lower temperature than more strong surfaces like stone, concrete or asphalt[11]. This was confirmed during the study, what was not expected was the degrees of difference could be so high.

Another surprising finding was the amount of green needed to cool down a surface, this showed that it is a very small amount of vegetation that can make a difference on the temperatures and heat absorption. In figure 7-8 we can see a temperature difference of 7.6ºC from the climber plant (27ºC) to the tiled roof (34.6ºC) and in figure 6 we see a difference of 6.6ºC between the climber plant in the fence of the house facade (22.8ºC) and the brick flooring (29.4ºC).



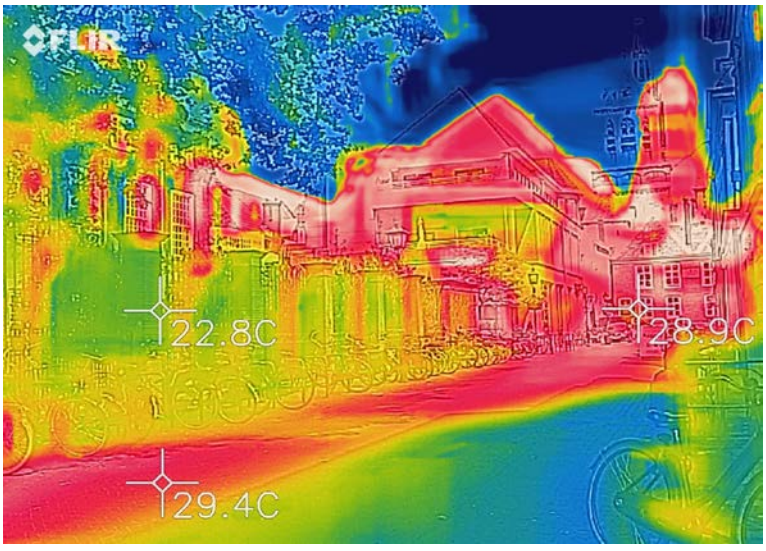


Figure 6 L: Amsterdam. Temp 22ºC *R: Delft. Temp 20ºC*

[11] Ossola, A., Staas, L., & Leishman, M. (2020). *Urban trees and people's yards mitigate extreme heat in western Adelaide: final summary report*. North Ryde, Sydney: Macquarie University. https://doi.org/10.25949/5df2ef1637124; Stache, E., Jonkers, H., & Ottelé, M. (2019). Integration of Ecosystem Services in the Structure of the City is Essential for Urban Sustainability. In *Ecological Wisdom Inspired Restoration Engineering* (pp. 131-150). Springer, Singapore.

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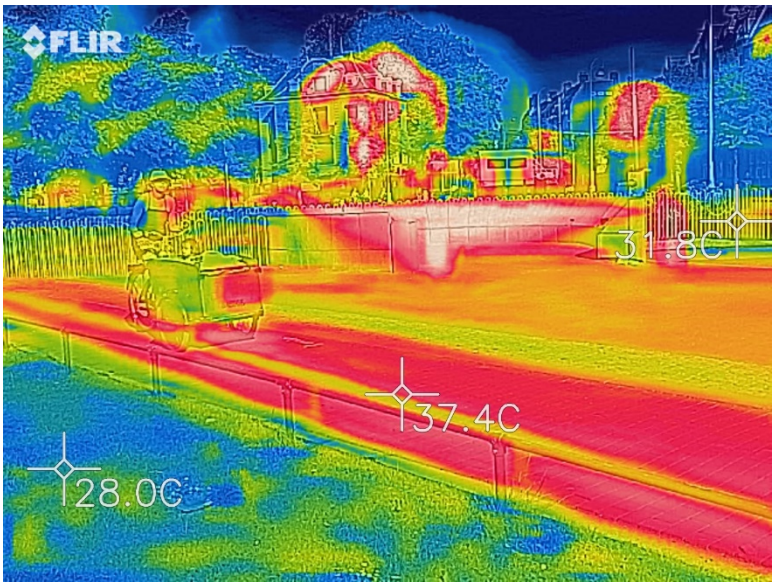

Figure 7 Amsterdam Museumplein. Temp 22°

There are other elements that influence the temperature of surfaces, one that was evident through the photographic study was the orientation of buildings. This could determine the shade they would get and also the wind directions. However this changes with sun direction throughout the day.

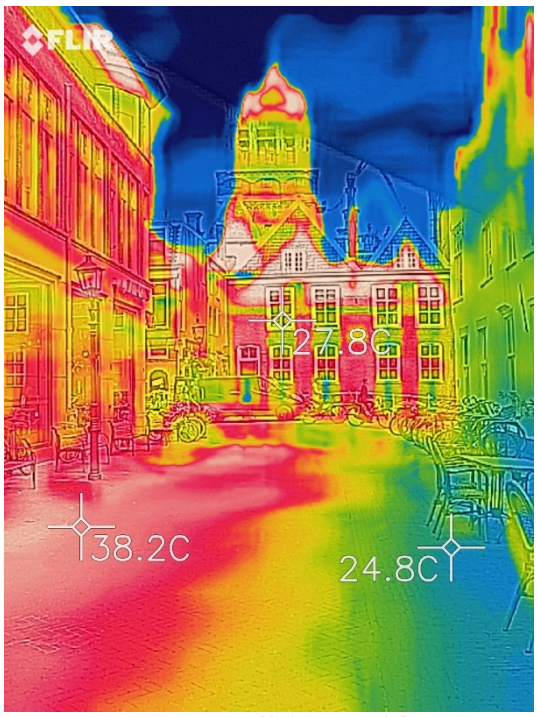

Figure 8 Delft. Temp 20°C

Two areas of Delft were selected for a comparison. The city center area which is the most dense and with less green areas and the south-west area of Voorhof which shows less ground space built and more vegetation (Figure 9 and 10). The thermal photographs showed that in the case of Voorhof in spite of having more vegetation, the surface areas without tree shade were as hot as the areas in the city center. This shows that vegetation cooling of surfaces is immediate to the area of greenery or

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shadow projection. In Figure 9 we can see temperature reaching 45.7ºC when the temperature was forecasted on 22ºC.

However, since the vegetation elements were more-dense in this neighbourhood, most of the streets surface temperatures were below the 20ºC.

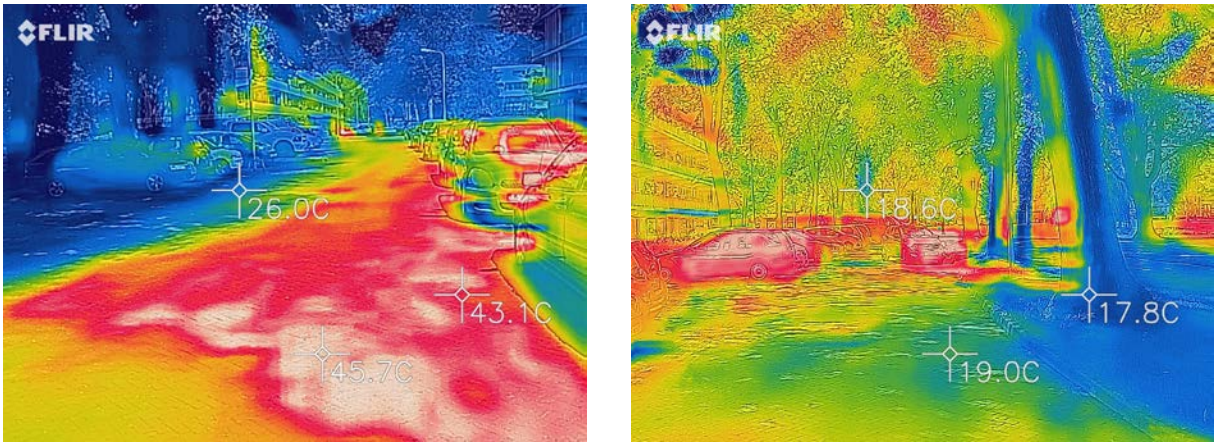

Figure 9 L: Voorhof neighbourhood Delft. Temp 22ºC *R: Voorhof neighbourhood Delft. Temp 22ºC*

Further research needs to be explored in temperature on neighbourhoods with different characteristics, this study only covers surface temperatures but did not measure the overall temperature perceived by pedestrians. This study only shows the impact that a hot day can have in our built environment's temperature. Extreme heat is deadly and with this technology it is possible to see the real increase in temperature and identify hotspots around our streets in order to propose solutions to this increasing problem.

Figure 10 L: Delft City center Via Google Earth Pro *R: Delft Voorhof Via Google Earth Pro*

The fastest, easiest and most effective way to bring temperature down in the urban environment is through vegetation. The Red Cross can act as a catalyst for small actions at big scales using its unique strategic position which gives them trust from the people and respect from governments and municipalities. This approach from the middle can enable people to join a grassroots movement to green their neighbourhoods to adapt the city to extreme heat.

A three step strategy can help achieve this vision:

1. *See the heat*
2. *Share the data*
3. *Solve the problem*

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1.See:

See the risks, continue research on extreme heat effects through the Climate Centre. See the heat. Identify hotspots in neighbourhoods with thermal imaging technology. This stage involves acquiring Thermal Cameras to lend out to Red Cross volunteers. This technology has become accessible through the years and now is possible to have it for less than 300 euros. Volunteers would then explore the city and identify spots that can be improved with greenery.

2.Share:

Share the data, show how hot it can get and get people's attention on the issue. During the summer, the set up of "cooling stations" in public squares can be a conversation starter. This pavilions will provide cooling assistance, but they will also act as an information source to educate its visitors about heat and the risks with it. This can act as a hub for neighbours to connect in initiatives to donate or join a greening local activity.

By sharing the information about the heat while it is being felt by the people will increase awareness, and at the same time by feeling fresh inside of the cooling station surrounded by greenery, users will be able to experience directly the benefits of green infrastructure.

3.Solve:

Solve the problem. Enable a network of neighbours that want to help by offering different alternatives to bring vegetation to their environment. Support them with Red Cross volunteers and provide the necessary tools. The vision of greening the cities might feel too overwhelming for single individuals, but there are many ways that small interactions can lead to big change, the Red Cross will provide the neighbours with a variety of activities that can adapt to the amount of people, the built environment, the cost and the time of completion. This way everyone can join an initiative accordingly.

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DESIGNING FOR CITIES THAT LIVE

A DESIGN STRATEGY FOR URBAN HEATWAVES AND RESILIENT CITIES

The fastest, easiest and most effective way to bring temperature down in the urban environment is through **vegetation.**

The Red Cross can act as a catalyst for small actions at big scales using it's unique strategic position which gives them trust from the people and respect from governments and municipalities. This approach from the middle can enable people to join a grassroots movement to **green their neighbourhoods** to adapt the city to extreme heat.

A three step strategy can help achieve this vision:
1. **See** the heat
2. **Share** the data
3. **Solve** the problem

BEFORE the heatwave

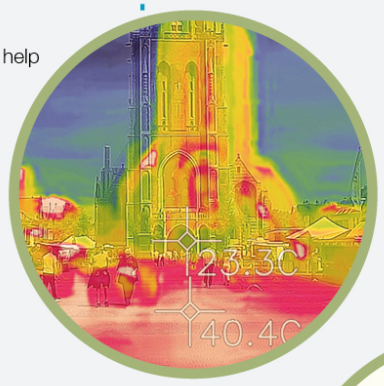
Before the heatwave, **identifying hot areas** that lack vegetation in the urban fabric by taking thermal images of these spaces. Young volunteers can do this if they borrow equipment from the Red Cross.

DURING the heatwave

During the hot period of the summer, **set up "cooling stations"** in cities main squares. A structure for people to :
a) **Cool down**
b) **Get information** on heatwaves, its risks and solutions.
c) **Engage** with the neighbours and join an innitiative.

AFTER the heatwave

After the summer period, is time to engage the **neighbourhood action**. Set up a platform for them to connect and get help from volunteers for **greening actions.** Collaborate with start-ups and ventures who's **purpose is shared** with the greening of the cities.

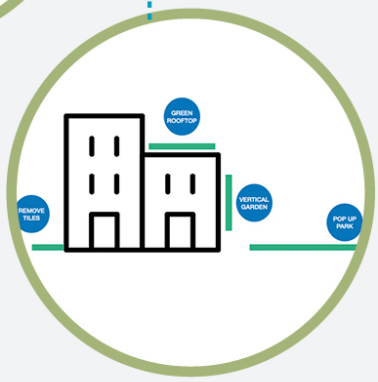


SEE

See the heat. Identify hotspots in neighbourhoods with thermal imaging technology.
See the risks, continue research on extreme heat effects through the Climate Centre.

SHARE

Share the data. Show how hot it can get. Get people's attention on the issue. Set up a conversation starter in the cities, when it is hot. Follow up with a digital campaign to raise awareness and reach more people.



SOLVE

Solve the problem. Enable a network of neighbours that want to help by offering different alternatives to bring vegetation to their environment. Support them with Red Cross volunteers and provide the necessary tools.

Figure 11 See the heat solve the problem, concept overview.

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2.3 "Stories from the Field to Inform Policy Design": A digital platform for the Red Cross

Words by Joseph Kesisoglou

As the fatal 2003 European heatwave seems distant[12], and the 70,000 lives lost being dwarfed by the coronavirus epidemic casualties (WHO, 2020) it is significant to remember the impact this extreme event had for our daily lives.

Before we even reach the peak of summer 2020, we are warned with predictions that this year will be the warmest year since records began.[13] In late January, researchers recorded what might be called the first heatwave in Antarctica.[14] At the time of writing, the Arctic Circle has experienced all-time records (June 20th, 38C in Verkhoyansk, Siberia), part of a series of abnormal temperatures across the region.[15] A year ago, during the June and July European heatwaves we were already counting the victims of extremely high temperatures. Last summer, was a new record.[16] Will this summer be another?

We are no longer talking about isolated events, but new weather patterns [IPCC?]. New patterns represent new realities for our communities and lifestyles. In fact, we should refrain from the comforted tone of the "new normal", since it inherently conceals the climatic transitions underway. On the basis of living in times of transition[17], we should aim for designs which endorse and build proactiveness, and resilience through social cohesion.

My research has concluded that top-down approaches in policy-making are slow at delivering impact to the people mostly affected by climate change effects.[18] Aligned with the ambitions of the Red Cross to be a proactive organisation and positively contribute to the effort of addressing the impacts of heatwaves within cities[19], this project aims at reducing the gap between policy-making and policy enactment by positioning Red Cross as a broker between citizens and policy-makers.

Every Red Cross national society is comprised of a pool of trained volunteers. It is this project's ambition to empower them to be the voice of the people in their communities. This can be achieved

12 Robine, J.-M., Cheung, S. L. K., Le Roy, S., Van Oyen, H., Griffiths, C., Michel, J.-P., & Herrmann, F. R. (2008). Death toll exceeded 70,000 in Europe during the summer of 2003. Comptes Rendus Biologies, 331(2), 171-178.

13 Watts, J. (2020, April 27). Meteorologists say 2020 on course to be hottest year since records began. The Guardian. Retrieved from https://www.theguardian.com/environment/2020/apr/27/meteorologists-say-2020-on-course-to-be-hottest-year-since-records-began

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by reconfiguring relations within the Red Cross, by primarily empowering existing volunteers to share their experiences from the field, and then enable a younger generation of volunteers to contribute without having to undergo the laborious training of the typical volunteer.

Figure 12 Delft Live Well App Concept

The design of a community digital commons, a shared co-created resource, which can act as vehicle for manifesting the lived experiences of citizens, their immediate needs and desires as well as their visions for the future of their habitat. This project aims at assisting the re-thinking and re-designing of how people live together.

Suggested and provisional names for this resource are Delft Encyclopedia of Wellbeing, Delft Live Well, and Live Well in Delft (see figure 12) For this community platform to flourish and serve its purpose the following stakeholders are expected to actively participate; Red Cross Netherlands and their volunteer base, the Delft Gemeente (municipality), local business, the citizens of Delft and education institutions. Find below the respective value creation for each stakeholder.

Red Cross Netherlands lowers the threshold for new volunteers to join, and begins to transition towards a volunteer base which is younger, more diverse, proactive and takes initiative.

Red Cross volunteers are empowered to act in the interest of their community using their existing skills and knowledge.

Delft Gemeente listens closely to the needs of citizens, which helps them make and enact more localised policy.

Local businesses are incentivised to be socially responsible and active, by assisting in the development of ideas coming from the citizens, and in return receive revenue and brand awareness.

Education institutions such as TU Delft, IHE Delft Institute for Water Education, Haagse Hogeschool can collaborate in developing concepts and prototypes with and for the citizen's ideas and while gaining practical experience.

2.4 Results Summary

A summary of the results in relation to the project proposal are listed further in Table 1.

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Table 1 Project Results Summary

Intended outcomes	Person(s) responsible	Realisation	Actual Results
Knowledge sharing; three knowledge sharing workshops in the TU Delft Big Picture to explore and select promising design experiments	Both parties contribute equally in different roles; (TU Delft: Facilitation and participation; The Netherlands Red Cross participation; inviting stakeholders from their network)	09-2019	We have participated in and shared our knowledge via two web-seminars instead of physical workshops and a significant number of expert interviews. More information regarding this change can be found in Chapter 3.
An emerging multi-party collaboration for developing smart solutions to mitigate urban heatwaves; Five follow-up workshops in which Dr. Price will follow a co-create approach and leading to a refinement of the project scope and understanding of the ecosystem. ; Potential agreements for commencing formal collaboration around one or more of the developed proposals for mitigating heatwaves	Both parties contribute equally in different roles; (TU Delft: Facilitation and participation; The Netherlands Red Cross participation; inviting stakeholders from their network); Additional parties (to be decided who; They will participate in the network)	02-2020	Our projects, "see the heat" and "stories from the field" have brought together a network of stakeholders involved in the addressing urban heatwaves through design. These projects have investigated the topic of urban heatwaves with both experts in climate science, policy and design, and citizens of nations that experience heatwaves.
Developing grant proposal (EU/NWO/CLICKNL) ;A submitted grant proposal to sustain the knowledge sharing and collaboration between the involved parties over time	Both parties contribute equally in the grant writing; Additional parties (to be decided who; They will participate in the writing)	04-2020	In progress (50% developed). See Chapter 5. Developing tri-lateral relationship between TU Delft, Humankind City and Netherlands Red Cross.
The dissemination of the project outcomes through an open seminar where communities of concern that are identified through the project are invited to take audience.	Both parties contribute equally in different roles; (TU Delft: Facilitation and participation; The Netherlands Red Cross participation; inviting stakeholders from their network); Additional parties (to be decided who; They will participate in the network)	08-2020	Completed: we have disseminated through participation in online webinars hosted by the WHO and GHHIN.
Dissemination of the project at Design Research Society Conference 'Synergy' in Brisbane, Australia June 2020.	Both parties contribute equally in different roles (TUD lead writing while Netherlands Red Cross will provide support); Additional parties (to be decided who; They will participate in the writing)	06-2020	This conference has gone 'online' due to Covid-19, so we will focus on a building a conference paper and journal paper for 2021 publication.

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3. Changes and Developments with Respect to the Original Plan

This project has been undertaken during the SARS-CoV-2 global pandemic. Because of this exogenous event, we were forced to adjust our approach to make optimal use of web platforms as work moved 100% 'online'. In our initial project plan, we had placed emphasis on workshops to bring the network together and collect insights. Three workshops were planned where we could invite physical members of the network. Five workshops were also planned to build insights. We have found that workshops online are not effective for network building.

Instead, we have changed tact and placed emphasis on working with experts from the field and research through web seminars. We conducted 8 interviews and participated in 2 webinars to disseminate the project, build a network and knowledge.

Hence our interaction with experts has been less generative (design workshop) and more descriptive (interview or focus group techniques). This change in approach has not affected the prescribed outcomes of this KIEM project. We have still delivered two concepts and developed a robust network of stakeholders interested in remedying the issue of urban heatwaves. Further our aim to continue this project via new funding opportunities with the Red Cross is evidence that the project, even with altered approach due to Covid-19, has been successfully completed.

4. Evaluation of the Project

4.1 TU Delft Perspective

We evaluate the project on the same criteria that guided our funding proposal. As this is a replacement grant, the main function is to build a network of interested organisations who wish to continue work in the domain of urban heatwaves. The project has achieved this aim, with drafting of further funding underway. In addition to this key outcome, we evaluation the project positively (Table 2).

Table 2 Project Evaluation

Funding Criteria	Description	Evaluation
Design for change	*Design for Change.* The CLICKNL agenda posits that collaborations between highly diverse people are needed to realise systemic change that merges collective and individual interests. This project addresses this aim by building new collaborations between multiple parties that represent different levels of the system.	The project has built relationships between the TU Delft and Red Cross team to policy organisations like the WHO, GHHIN, and creative top sector industry organisations like Humankind City. These organisations represent the various parties that comprise of the urban planning and urban health system. *Evaluation: Positive*
The Human Touch	As stated in the CLICKNL agenda, the Creative Industries can play an important role in bringing the human touch to technological development: designers are known for their ability to function as integrators and to advocate for different stakeholders in transitions.	Throughout the project, we have relied on simple technologies like thermal heat mapping to 'see the heat'. However, without the human touch, the narratives and stories from the field, these images do little than to create temporary interest. This stories allow thermal-heat mapping and the consequences of urban heatwaves to be heard by those in public policy decision making positions. *Evaluation: Positive*
Value creation	This project approaches the innovation barrier for non-profit organisations by exploring, framing, prototyping concepts to address urban heatwaves. These activities inherent to design lower the risk of innovation by gathering insights iteratively that enhance final concepts ready for production and launch.	Value creation for non-profits in the humanitarian sector come when crises are responded to. Humanitarian aid is reactive and highly rational. Innovation however, requires taking proactive approaches to foretelling the future (with associated risks) and taking leadership to act. This project has demonstrated to the Red Cross how foresight (used in strategic management and design) can be highly beneficial to a humanitarian organisation.

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		Evaluation: Positive

4.2 Netherlands Red Cross Perspective

Prepared by Michel Becks

Extreme heat in cities is one of the deadliest natural hazards facing humanity, and the threat posed by this 'silent killer' will become more serious and more widespread as the climate crisis continues. The good news is that urban heat stress is also predictable and preventable. By taking the right local action, Red Cross Volunteers and urban dwellers can reduce suffering and even save lives.

Within this context, the Netherlands Red Cross (NLRC) has launched a flagship challenge to reduce the impact of heat stress on vulnerable urban dwellers. Through this project, co-creation on this challenge together with TUD allowed us to book significant progress on the project outcomes stated in the project outline:

- Knowledge sharing: Through numerous co-design sessions with both MSc and BSc students, we managed to expand the existing evidence base on impacts of heat stress on vulnerable urban dwellers. Further, through our joint work we were able to continue to raise awareness on the topic of urban heat stress and present designs and potential solutions to partners in the Netherlands
- Dissemination to communities of concern: Our collaboration with TUD allowed us to test and refine a viable co-creation approach on the challenge of urban heat stress. Through a collaboration process that included co-creation sessions and knowledge workshops, we were quickly able to develop a repository of actionable design options to reduce heat urban stress
- Multi-party collaboration: The design process piloted in this project demonstrated that we were quickly able to connect to a range of strategic partners of importance to create and embrace designs. We are now in contact with Municipalities (e.g. Rotterdam, Delft and The Hague) and knowledge institutes (e.g. Hogeschool van Amsterdam. But also many 'unusual suspects' including local start-ups, pharmacies, market operators, etc.)

In summary, the project proved that ***co-designing for change*** through an inspiring challenge can deliver very tangible results within a short timespan. We now piloted a co-design process that has potential to be expanded to other challenges as well. By applying interactive design approaches, we experienced that it is feasible to accomplish a ***human touch*** throughout this project. Many of the designs included a strong consultation process, very specifically targeting a certain (group of) users. This made designs very credible and easy to translate to specific contexts related to urban heat stress. A large number of the designs are of such quality that they can serve as a foundation for value creation with other partners. Already, we are now looking for collaboration with for example HvA (on another urban stress-related challenge) and private sector partners such as Evides (on feasibility of applying a certain design).

5. Future Prospects of the Project

This KIEM project has intended to 'initiate' the development of a network of organisations concerned with urban heatwaves as an increasing and dangerous phenomenon. As an indication of the success of that project ambition, we are now in the process of drafting a proposal to obtain further funding from ClickNL. In the next subsections, we share an early outline of our ClickNL proposal. As funding has been frozen for 2020 due to Covid-19 uncertainty, we expect to submit this in early 2021.

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5.1 ClickNL Funding Grant – Design for Climate Transitions: Developing Heatwave Resilience

ClickNL Proposal

Prepared by: Dr. Rebecca Price, Professor Jeroen van Erp and Michel Becks
Big Picture Lab, Delft Design Labs

Funding Requested from ClickNL to **TU Delft:** 50,000€
Funding to be matched by the **Netherlands Red Cross**: 50,000€
Potential tri-lateral contributor: **Humankind City (Rotterdam)**[20]

5.2 Introduction to ClickNL application

Climate scientists have identified that the Earth's climate is at a tipping point.[21] This consequences of climate change affect every aspect of human life as is it today.

The built environments around us, most notably urban dwellings, have been constructed with the rational of keeping inhabitants safe and comfortable according to a predictable range of temperatures that typify the surrounding climate. These climates can be arranged into general geographical zones (See Figure 1). Moving out from the equator toward the two poles are four general climate zones: (1) tropics, (2) sub tropics, (3) temperate, and (4) frigid. These zones are atmospherically connected and together regulate the global climate, for example the passing of the four seasons in temperate zones and the dry and monsoon periods of the tropics. In the subtropics, an intersection takes place with cool dry winters and warm and humid summers.

Global warming is pushing warmer temperatures experienced in tropic and subtropics zones into temperate zones with higher veracity and frequency.[22] Further, urban centres can be as much as 4-6 degrees warmer during urban heatwaves than regional areas. The outcome of this phenomena is that urban dwellings designed and constructed to meet the demands of a certain range of temperate climates (cool summer, cold winter) are now being challenged by abnormally hot conditions. These hot conditions challenge the very logic driving building techniques and cultures underpinning behaviour patterns that have been formed over many centuries.

Urban heatwaves are weather events where abnormal temperatures hit urban centres for a 3-day period.[23] The *July European Heatwave* (21st of July to the 28th of July, 2019) led to record high temperatures across much of Western Europe. In the United Kingdom, a record temperature of 38.7 degrees was set on the 25th of July. 200 additional deaths were recorded on this day alone by the United Kingdom Office for National Statistics. All time temperature records were also set in Belgium, Germany, Luxemburg and the Netherlands. In France, the same heatwave event led to record temperatures of 42.6 degrees in Paris. 868 mortalities were recorded between the 21st and 27th of July, 2019 in France.

In the heatwave that hit the Netherlands of July 2019, the top temperature recorded was 39.3 degrees in Eindhoven. Yet buildings within the Netherlands are designed and constructed to keep inhabitants warm during winter months by retaining heat. *The very design principles that keep*

[20] Rotterdam based Urban Planning studio: https://www.humankind.city/
[21] William J. Ripple et al., "World Scientists' Warning to Humanity: A Second Notice," BioScience 67, no. 12 (2017): 1026–28, DOI: https://doi.org/10.1093/biosci/ bix125
[22] Jones, N. (2018). Redrawing the Map: How the World's Climate Zones are Shifting. *Yale Environment 360.* Yale School of Forestry & Environmental Studies. Accessed: https://e360.yale.edu/features/redrawing-the-map-how-the-worlds-climate-zones-are-shifting
[23] Pyrgou, A., & Santamouris, M. (2018). Increasing Probability of Heat-Related Mortality in a Mediterranean City Due to Urban Warming. *International journal of environmental research and public health, 15(8), 1571. doi:10.3390/ijerph15081571*

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inhabitants protected in winter, place inhabitants at risk in summer. The heatwave of July 2019 led to a spike in mortality rates with 400 deaths more than the weekly average.[24]

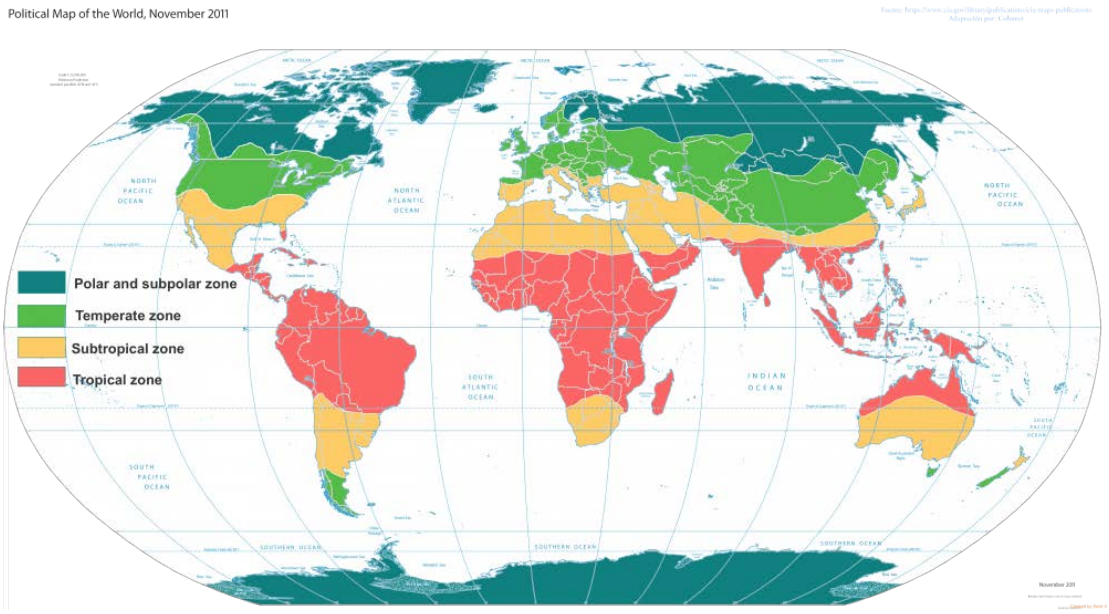

Figure 11 World Atlas with Four Climate Zones. Source: Meteoblue

Retrofitting the urban environment with new materials and technologies will be an incredibly expensive and a lengthy process. Further, the installation of air-conditioning units (considered the easiest solution) that draw upon finite energy sources will only exacerbates the problem of climate change. In cooling down houses and workplaces, we may be generating more unnecessary greenhouse gases that contribute further to global warming and climate variance. Thus, the solution does not lie in planning, or architectural domains alone, but must encompass many disciplines; a process of collaboration and co-creation that can be undertaken through design.

5.3 Identified 'Big Picture' Problems

There are two noticeable problems that are raised by urban heatwaves. Both problems are suitably complex and present immense challenges in isolation:

1. Design to prevent heatwaves (climate change) through new behaviours, products, services and systems that follow the guidelines of the Paris Agreement, and;
2. Design to mitigate harm to human populations' already experiencing heatwaves in urban settings.

The two problems are entwined- mutual, yet exclusive. Each problem must be approached in a strategic way to ensure the scope of work is achievable yet the outcomes of our project yield high impact.

5.4 Proposed Click NL Design Project

With the funding gained from ClickNL and the Red Cross, we would achieve the following outcomes:

- Design of emergency humanitarian services to keep citizens safe during heatwaves;

[24] CBS Report: https://www.cbs.nl/en-gb/news/2019/32/more-deaths-during-recent-heat-wave

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- Design and dissemination of a public campaign with the Red Cross to raise the awareness of and profile for heatwaves;
- Leverage the campaign to drive donor support (funding) for the Netherlands Red Cross, and;
- Development of a network of interested public and private organisations that will build momentum for climate change.

5.5 Project Leads

The project will be led by Dr Rebecca Anne Price and Professor Jeroen van Erp and be based in the *Big Picture Lab* (Delft Design Labs). A short bio is below:

Dr. Rebecca Price: Dr. Rebecca Anne Price is an Assistant Professor of Transition Design at the Faculty of Industrial Design Engineering at Delft University of Technology. Rebecca is based in the Product Innovation Management department where she investigates how design can advance sectors and industries through multi-leveled and networked innovation. Her work increasingly explores the intersection between the design of socio-technical systems and transitions theory to consider new methodological opportunities.

Professor Jeroen van Erp: Professor Jeroen van Erp graduated from the faculty Industrial Design Engineering at Delft University of Technology in 1988. In 1992, he was one of the founders of Fabrique in Delft, which positioned itself as a multidisciplinary design bureau. He established the interactive media department in 1994, focusing upon developing websites for the world-wide-web. Under Jeroen's joint leadership, Fabrique has grown through the years into a multifaceted design consultancy. At Delft University of Technology, Professor van Erp brings his extensive experience to the tuition of students through course work. His involvement in design and emotion studies and defining of strategic design through the CRISP project are evidence of his research strengths.

6. How did you find your partner(s)? To which extent did either the Chamber of Commerce or the CLICK NL networks help in finding the partner(s)?

Our partner the Netherlands Red Cross was acquired through a professional network. The ClickNL funding did not so much assist in finding the partner, but attaining the commitment from that partner to pursue this urban heatwaves project. In particular, as our partner is a non-profit humanitarian organisation, the presence of third party funding has been crucial to beginning investigation into urban heatwaves. Without this funding, the Netherlands Red Cross would need to mobilise donor funding and other financial approaches that carry restrictions to spending. For this reason, the ClickNL funding has been crucial to building a partnership by allowing a non-profit organisation to commit to a research agenda.

7 In what respect did you benefit from the TKI CLICK NL for the Creative Industries when setting up your project or during the realisation of your project?

We have benefited greatly from the TKI Click NL funding for KIEM. This replacement funding allowed researchers to step away from educational activities and apply energy to a research project. This experience of managing a project with an industry partner has led to the development of practical and project management skills.

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In addition to the design outcomes of the project, this project funding to initiate a multi-party collaboration has created enough momentum from interested parties to pursue further and more significant funding. This is a strong indication of the success of the project for the parties involved. IN particular, the development of a new funding proposal connecting TU Delft, Netherlands Red Cross and Humankind City (Rotterdam) has major outcome of this project.

8. Other comments

N/A

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