

Submission to UNFCCC in response to the Nairobi work programme Call in the area of climate change impacts on human health, including on the effects of climate change on health and productivity in the workplace, with implications for occupational health, safety and social protection

**Submission title:** Integrated inter-sector framework to increase the thermal resilience of European workers in the context of climate change

**Primary current collaborators:**

1. University of Thessaly, Greece
2. University of Copenhagen, Denmark
3. University of Ljubljana, Slovenia
4. Center for Technology Research and Innovation, Cyprus

**Other main collaborators:**

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7. Swiss Federal Laboratories for Materials Science and Technology, Switzerland
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9. Lund University, Sweden
10. Federal Department of Home Affairs – Federal Office of Meteorology and Climatology MeteoSwiss, Switzerland
11. Loughborough University, UK
12. Institute Josef Stefan, Slovenia
13. Tuscany Centre of Injuries and Occupational Diseases, Italy
14. Age UK, UK
15. University of Porto, Portugal
16. Dutch National Health Service, Netherlands
17. University of Nicosia, Cyprus
18. Odelo Slovenia d.o.o., Slovenia
19. ACCIONA, Spain

**Countries of focus:**

All countries in the European continent

# 1. Relevant activities on the thematic area of health and productivity in the workplace, with implications for occupational health, safety and social protection

## 1.1. Aim

The HEAT-SHIELD project ([www.heat-shield.eu](http://www.heat-shield.eu)) has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement No 668786. The aim of the project is to promote health and prevent heat-induced illnesses of European workers and improve quality and productivity of strategic European industries (i.e. manufacturing, construction, transportation, tourism and agriculture) in the context of climate change and rising workplace temperatures.

## 1.2. Background and setting for the activities

It is beyond any doubt that climate change is the biggest global health threat of the 21<sup>st</sup> century<sup>1</sup> with enormous consequences for humanity. Rising temperatures have been observed in Europe considerably more than in other areas<sup>2</sup> and have become a growing challenge for our community. Problems are already experienced by millions of Europeans during the summer months particularly in occupational settings.<sup>3</sup> In addition to the well-known effects of heat exposure, a number of studies have confirmed a 2% productivity loss for each degree centigrade above 25°C.<sup>4,5</sup> The impeding effects of climate change require immediate adaptation actions. Even if the Paris Agreement is adhered to, rising temperatures and their associated threat to public health will continue for many decades.<sup>6</sup> Moreover, recent studies by members of the HEAT-SHIELD consortium<sup>7,8</sup> have shown that as the workforce ages, its resilience to heat stress becomes diminished with even further negative effects on productivity. Thus, it is crucial to develop strategies to mitigate the detrimental health, societal, and economic effects of rising workplace temperatures.

Manufacturing, construction, transportation, tourism and agriculture are the core of Europe's economy. Together, they represent 40% of EU's GDP and 50% of its workforce.<sup>9</sup> No other group of five industrial sectors amounts to this. More importantly, these strategic industrial sectors involve prolonged worker exposure to either outdoor environmental conditions (construction, transportation, tourism and agriculture) or increased indoor temperatures (manufacturing). Reducing the impacts of rising workplace temperatures in these five industrial sectors will ensure the wellbeing of the EU's workforce, and it will improve the EU's competitiveness and secure its future economy.

The HEAT-SHIELD Consortium represents the interests of a broad spectrum of European citizens and society. This is evidenced by the fact that the proposal is endorsed by Supporting Stakeholders, such as the UK Ministry of Health, the Cyprus Ministry of Environment, as well as relevant private sector and civil society entities from across the EU. These Supporting Stakeholders play vital advisory roles regarding the feasibility, transferability, and economical sustainability of the proposed technical and biophysical solutions in industrial settings, as well as in the dissemination of scenario-specific guidelines aimed at maintaining workers' health, well-being and productivity in spite of global warming.

## 1.3. Research, analyses, tools, and methods

The HEAT-SHIELD project uses a multi-stakeholder approach. This is because developing effective solutions to promote health, prevent disease, and maintain productivity of European workers in the context of rising environmental temperatures requires the creation and application of new knowledge in climatology, simulation techniques, as well as environmental and occupational physiology. Stakeholders such as policy makers, the private sector, and civil society organisations may lack the technical capabilities or the facilities to conduct R&D activities at the level of excellence required for such development. Conversely, European research institutes have the capacity to conduct the necessary R&D to develop these solutions, but lack the expertise and the capacity to transform these solutions into policies and assess their health, economic and social benefits as well as their impact on reducing

<sup>1</sup> Costello A, et al. (2009) Managing the health effects of climate change. *Lancet*, 373, 1693–1733.

<sup>2</sup> European Environment Agency (2010) The European environment - state and outlook 2010: synthesis. European Environment Agency, Copenhagen.

<sup>3</sup> Kjellstrom T et al. (2009) The direct impact of climate change on regional labour productivity. *Int Arch Env Occupat Health*, 64, 217-227.

<sup>4</sup> Kosonen R & Tan F (2004) Assessment of productivity loss in air-conditioned buildings using PMV index. *Energy Build* 36: 987-993.

<sup>5</sup> Franchetti M & Komaki G (2012) Quantification methods for employee health and productivity rates. *Int J Env Eng Res* 1: 104-114.

<sup>6</sup> European Commission (2009) White Paper "Adapting to climate change: Towards a European framework for action", COM(2009) 147 final.

<sup>7</sup> Stapleton JM et al. (2014) Do older adults experience greater thermal strain during heat waves? *Appl Physiol Nutr Metab* 39(3):292-8.

<sup>8</sup> Stapleton JM et al. (2015) At what level of heat load are age-related impairments in the ability to dissipate heat evident in females? *PLoS One* 10(3):e0119079.

<sup>9</sup> <https://stats.oecd.org/index.aspx?queryid=60702>

inequalities. HEAT-SHIELD brings together – in a harmonious and sustainable way – all these stakeholders in order to produce the most appropriate adaptation strategies.

To achieve the project's Overall Objective, a series of measurable and feasible innovation and policy objectives (termed "Specific Objectives" or "SO") has been planned (illustrated in Fig.1).

**SO1:** Forecast weather patterns in different European regions for various climate change scenarios to produce detailed information on workers' future conditions. This objective will be addressed primarily by the climatology partners of the consortium in collaboration with the research institutions.

**SO2:** Assess the effects of the above forecasts on the health and productivity of workers of strategic industries across Europe (e.g., manufacturing, construction, transportation, tourism, agriculture). The variations in age and gender distribution in different industries and the heat vulnerability of different population groups will be also assessed. This objective will be addressed primarily by the research institutions of the consortium in collaboration with the climatology partners.

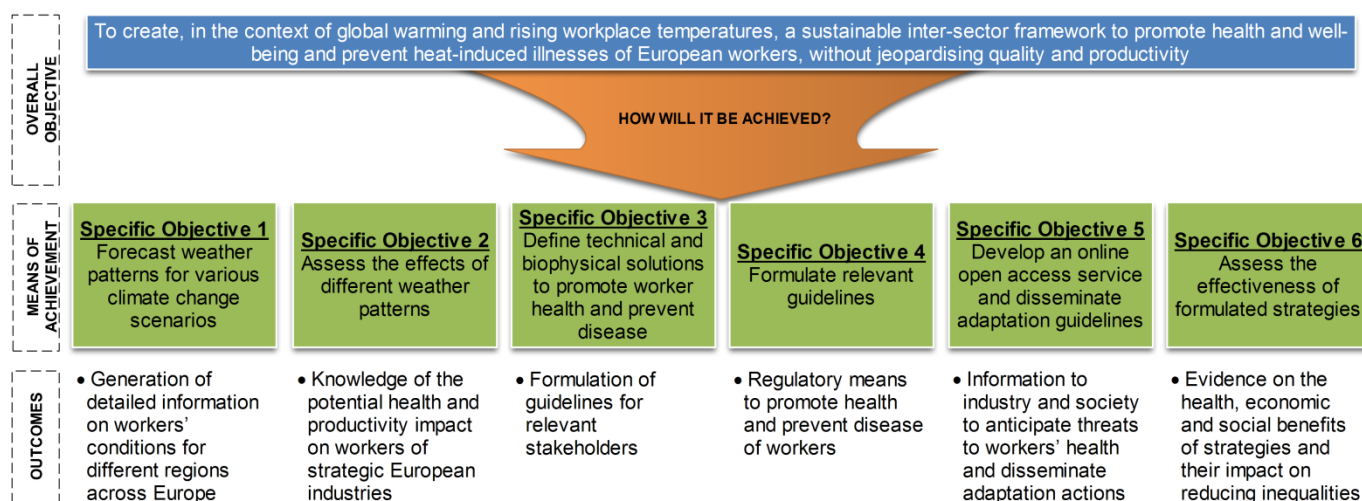
**SO3:** Screen and optimize technical and biophysical solutions to reduce workers' heat stress, thus promoting health and preventing disease. This objective will be addressed primarily by the research institutions of the consortium and implemented in collaboration with the industrial partners. This approach will ensure the feasibility and transferability of the solutions to industrial environments.

**SO4:** Formulate guidelines to promote health and prevent disease of workers, based on high-resolution heat strain data (per industry, per region and per climate scenario). This objective will be addressed by all stakeholders (climatology partners, research institutions, industry and policy makers).

**SO5:** Develop an online open access service to help industry and society anticipate threats to workers' health and to disseminate adaptation guidelines to relevant stakeholders (policy makers, private sector, civil society organizations). This objective will be addressed primarily by the research institutions of the consortium in collaboration with the climatology and the industrial partners.

**SO6:** Assess the efficacy of formulated strategies (guidelines and open access service) for their health, economic and social benefits, and their impact on reducing inequalities. The assessment will analyse links to EU commitments to Rio+20 and the UN Sustainable Development Goals. This objective will be addressed primarily by the policy making partners in collaboration with the all other partners.

**Figure 1.** Conceptual paradigm of the Overall Objective, the Specific Objectives, and the final outcomes.



The first step in the above process (SO1) will be to forecast weather patterns in different European regions for various climate change scenarios. Work on this front is already ongoing, and the results are expected in the spring of 2017. Achieving the SO1 will allow us to generate detailed information on the future workplace conditions across the five key industries addressed in the HEAT-SHIELD project (i.e., manufacturing, construction, transportation, tourism, agriculture). After generating these forecasts, the next step (SO2) will be to assess their effects on the health and productivity of the workers in these five industries across Europe. In this regard, the variations in age and gender distribution in different industries and the heat vulnerability of different population groups will be also assessed.

After producing forecasts about the future environmental conditions in the workplaces of the five key industries and assessing how these conditions will affect the workers' health and productivity, we will screen the available technical and biophysical solutions that can be used to reduce the heat stress experienced currently and in the future by the workers (SO3). Moreover, we will optimize these solutions to effectively address the needs of the workers in the five key European industries. As shown in Table 1, the solutions to be investigated will include advanced hydration/load planning techniques, smart clothing solutions, localized heating, ventilation and air conditioning (HVAC) systems, individualized workstations, as well as other customized solutions for the different industrial sectors, the associated specific needs, the workers' exposure characteristics, as well as the associated heat stress. By putting the worker health as the centre of the approach, different aspects of the problem will be investigated, in relation with the specificities of each occupational setting, stress put on the worker's body, and possibilities (i.e. solutions to be investigated and assessed) to help them cope with thermally demanding scenarios. This will link the environmental, the climate, and the health aspects of the problem, in a 'health in all' approach, thus creating conditions to foster the development of workers health, wellbeing and behavioural change. Concomitantly, this will produce critical information on how to improve the workers' resilience to heat, with direct application on existing industrial scenarios.

Once the appropriate technical and biophysical solutions to reduce workers' heat stress have been identified, the HEAT-SHIELD consortium will formulate guidelines (SO4) for each industrial sector aiming to promote health and prevent disease of workers, based on high-resolution heat strain data (per industry, per region and per climate scenario). Thereafter, these guidelines will be incorporated in an online open access service (SO5) that will be used to disseminate them to relevant stakeholders (policy makers, private sector, civil society organizations). Importantly, this open access service will also use current weather data as well as the long-range weather pattern forecasts (developed in SO1) to help industry and society anticipate threats to workers' health. Finally, in SO6 the HEAT-SHIELD consortium will perform a series of case studies across the five key industries as well as economic and health investigations to assess the efficacy of the formulated strategies (guidelines and open access service) for their health, economic and social benefits, and their impact on reducing inequalities. This assessment will also analyse links to EU commitments to Rio+20 and the UN Sustainable Development Goals.

**Table 1.3.5.** Matrix of technical and biophysical solutions to be addressed in each industrial sector.

		HEAT-SHIELD industry sectors				
		Manufacturing	Construction	Transportation	Tourism	Agriculture
Technical & biophysical solutions	Smart clothing solutions		X	X		X
	Efficient shading solutions	X	X	X	X	
	Individual workstations	X		X		
	Localized HVAC systems	X		X		
	Advanced hydration	X	X	X	X	X
	Advanced workload planning	X	X	X	X	X

## 1.4. Key results

In the coming months and years, the HEAT-SHIELD project will produce a series of key results including:

1. Detailed information on workers' conditions in different regions across Europe.
2. Knowledge on the potential health and productivity impact on workers of strategic European industries.
3. Technical solutions to reduce workers' heat stress (e.g., physiological techniques/models, heating, ventilation & air conditioning systems).
4. Regulatory means to promote health and prevent disease of workers, based on high-resolution heat strain data.
5. Open access service to anticipate threats to workers' health and disseminate adaptation guidelines to relevant stakeholders.
6. Assessment of health, economic and social benefits of strategies and their impact on reducing inequalities

To date, studies in the agriculture industry are already underway. A video showing parts of a study aiming to explore the effects of environmental conditions (particularly heat) on the health and productivity

of agriculture workers can be found here: [www.youtube.com/watch?v=LwKpStRVB7Y](https://www.youtube.com/watch?v=LwKpStRVB7Y). The study is being conducted in Cyprus. We are monitoring the physiology and behaviour of 9 workers during 9 full days of grape picking.

In addition, studies in the manufacturing industry are also underway. Specifically, the HEAT-SHIELD Consortium is conducting a study in odelo Slovenia d.o.o., a company developing and producing complex tail light systems and LEDs for the automotive industry. At present, we have already established a password-protected on-line system for continuous monitoring of the temperature and humidity conditions in the company's production halls and it is our ambition to use the knowledge we gain to assist the management of odelo Slovenia d.o.o. in implementing strategies to mitigate heat stress in the manufacturing halls, particularly during summer heat waves. Specifically, we will develop a model to predict the impact of external environment changes on the internal environment of the factory and we will develop and implement an early warning system regarding heat stress, allowing management to prevent detrimental effects of heat waves on the work force. This work will not only benefit Slovenian workers, but lead the way as an example for other European countries and companies.

### **1.5. Outputs of the activity**

HEAT-SHIELD will produce a series of state-of-the-art innovation outcomes including: (i) implementation of appropriate technical and biophysical solutions to counter the heat-induced risk to workers' health for key European industries; (ii) development of an online open access service anticipating and warning for events that may pose a threat to workers' health; (iii) dissemination of scenario-specific guidelines aimed at maintaining workers' health, well-being and productivity in spite of global warming among relevant stakeholders; (iv) assessment of formulated guidelines' effects for their health, economic and social benefits and their impact on reducing inequalities.

### **1.6. Potential challenges met when undertaking the activity, and how these will be overcome**

The following list outlines the barriers or framework conditions that may affect the extent that the expected impacts will be achieved as well as the actions that the consortium has taken / will take to mitigate them:

- The technical and biophysical solutions proposed via SO3 to reduce workers' heat stress are not adopted by industrial actors due to lack of practicality/feasibility and/or fear of impacting normal day-to-day routines. This barrier will be addressed by the consortium during the lifetime of the project by ensuring that all solutions proposed via SO3 are practical and feasible. This will be confirmed through workshops and consultations with the Supporting Stakeholders as well as through the evaluation case studies incorporated in SO6.
- Absence of regulatory framework regarding the adoption of the proposed guidelines and technical solutions. This barrier will be addressed by the consortium during the lifetime of the project through awareness initiatives highlighting the need for legislation initiatives to regulate the update of industry practices and adoption of new solutions.
- The guidelines proposed in SO4 to reduce workers' heat stress are not adopted by industrial actors due to associated cost. This barrier will be addressed by the consortium during the lifetime of the project by ensuring that all guidelines proposed in SO4 are economically viable. This will be confirmed through workshops and consultations with the Supporting Stakeholders as well as through the evaluation case studies incorporated in SO6.
- The guidelines proposed in SO4 to reduce workers' heat stress based on altering workload planning (i.e., changing work shifts to reduce workers' heat stress) do not coincide with existing legislation regarding work hours. This barrier will be addressed by the consortium during the lifetime of the project as well as following the project's completion through awareness initiatives highlighting the need for legislation initiatives to regulate the update of industry practices and adoption of the new solutions. In this regard, the Supporting Stakeholders of the HEAT-SHIELD project will be valuable. Moreover, we will also address this barrier by building on the networking capacity of the consortium partners, profiting from the fact that the Project Partners participate in Standardization Committees and have access to international organizations (UN, WHO, IPCC, NATO, ESA, ISO, etc.). By targeting directly individuals and institutions that wield the most influence in different society stakeholders, we will maximize the reach, the depth, and the

effectiveness of our communication strategy to ensure that all necessary legislative initiatives are in place during the project's lifetime or soon after its completion.

#### **1.7. Contact details for further information**

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