

HEAT-SHIELD tools for short-term warnings and long-term planning: heat-stress strategies to reduce the geographical gap in different working environments and activities

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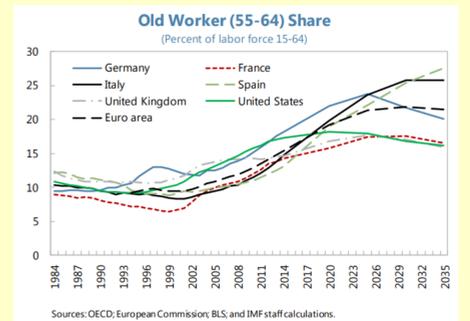
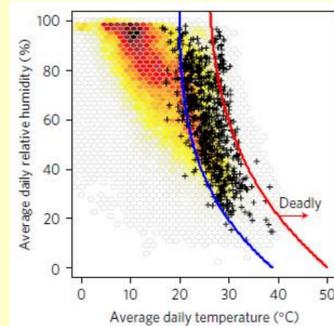
INTRODUCTION

Workers represent an important part of the population potentially at high-risk of heat exposure:

- They can be exposed to other sources of radiant heat (and heat interaction with hazardous chemical).
- They can wear heavy personal protective clothing limiting skin transpiration.
- They can be engaged in intense physical activity.
- They can be exposed to direct solar radiation.
- The average age of the working population is increasing.

These aspects have direct consequences on worker's productivity and health, in particular in outdoor environments.

At European level, the ongoing HEAT-SHIELD project (grant agreement No.668786) is focused on this topic with the aim to develop preventive solutions to protect the health and productivity in workplaces from excessive heat in the context of climate change.



Mora et al 2017-Nature Climate Change



METHODS

Short-term heat protection warnings

ECMWF Probabilistic weather forecast (Daily ensemble forecast of WBGT, °C)

Bias correction of ECMWF forecasts for ABOUT 1,800 European weather stations (20-year time series)

Personalized Heat-Risk-level-WBGT Thresholds

WBGT scale	UNACCLIMATIZED				ACCLIMATIZED			
	580W	465W	349W	233W	500W	400W	300W	200W
0min/hr	33	34.5	36.5	39	34	36	37.1	40
15min/hr	28.8	29.3	30.7	32.5	30.6	31.2	31.8	32.4
30min/hr	27.4	28	29.9	31.7	28.8	29.6	30.6	31.9
45min/hr	25.9	27	28.8	30.5	26.8	27.9	29.3	31
60min/hr	24.5	25.9	27.7	29.7	25.6	26.8	28.6	30.8

ISO 7243 & ACGIH, 1996

The daily probability of exceeding a determined WBGT heat-stress assessed by the ECMWF forecast model was implemented in the online web-platform to assess a personalized short-term heat warning for workers involved in outdoor sun/shadow activities.

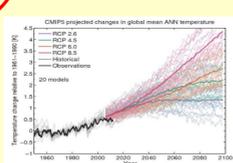


Calibration

HEAT-SHIELD adaptation tools

Long-term heat protection planning

Climatological modeling scenarios



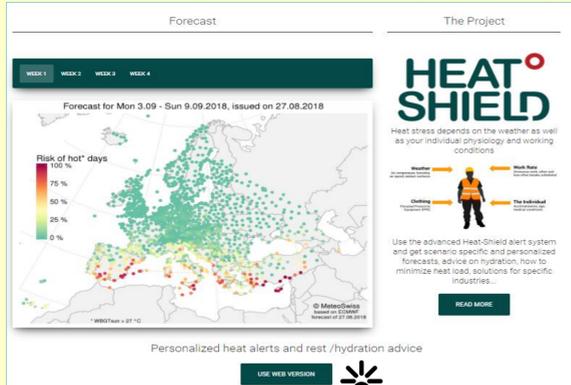
Detailed local micro-meteorological data and subjective informations were collected in the summer of 2017 and 2018 in some Tuscany farms (Italy)



RESULTS AND CONCLUSIONS

SHORT TERM HEAT PROTECTION WARNINGS

HEAT-SHIELD Occupational Heat Alert System Prototype



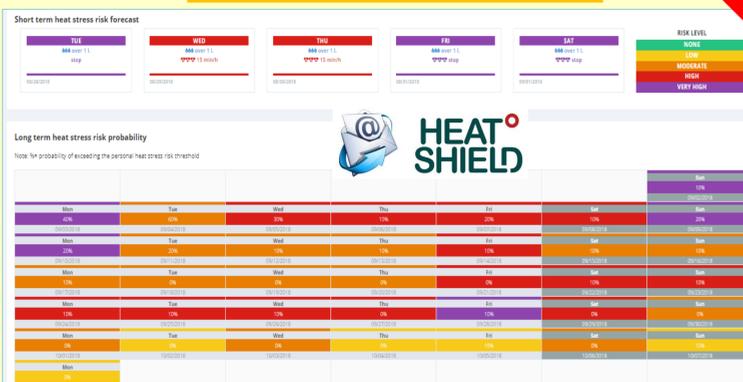
On the home page of the web site there is a map of the Europe with a weekly forecast (up to 4 weeks) for about 1,800 European locations of the probability of exceeding the outdoor WBGT (Wet-Bulb Globe Temperature) threshold of 27 °C

Clicking on "Personalized heat alerts and rest / hydration advice" (USE WEB VERSION) it is possible to access a user registration form that allow you to create your personalized profile and then get customized forecasts based on your anthropometric characteristics, the type of activity performed and the clothing worn



Type of user
 - Single workers
 - Stakeholder

Personalized forecast home page



Heat risk forecast up to 5 days

Chromatic risk levels for the first 5 days and the suggestions for the forecasted conditions (how much drink and rest during the worst hour of the day). In the case of high or very high risk levels (high WBGT values), the user will receive an email containing an alert message

Heat-risk forecast up to 46 days

A calendar shows, for each day, the heat-risk level (chromatic warning) and the probability of exceeding the personalized heat threshold, according to ECMWF ensemble forecast.

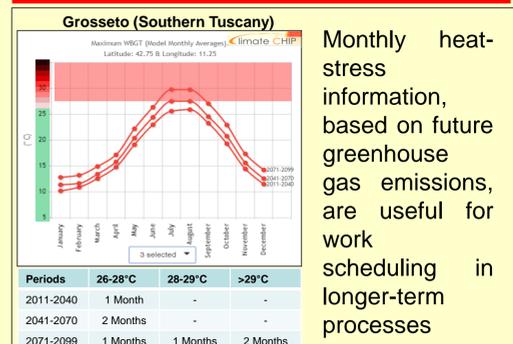


Thresholds recalibration

WBGT (°C) DURING THE AFTERNOON (MEAN 14-17PM)	SUBJECTIVE INFORMATION OBTAINED BY THE QUESTIONNAIRE SUBMISSIONS DURING FIELD TESTS		CRITICAL HEAT-STRESS CONDITIONS ESTIMATED WITH WBGT ISO-standard THRESHOLDS FOR THE DIFFERENT ACTIVITY LEVELS DECLARED BY WORKERS
	Activity level	Thermal sensation	
28.5	Moderate	Moderate	NO
29.1	Moderate	Low	NO
28.6	Moderate	Low	NO
32.6	High	High	YES
29.2	Moderate	Moderate	NO
30	Moderate	Moderate	YES
26.9	Moderate	Moderate	NO
28.5	Moderate	Moderate	NO

Results revealed agreements between the ISO-standard WBGT thresholds associated with specific work efforts and the worker's thermal stress perceptions for high WBGT values (> 30 °C), conversely no agreements were observed for lower WBGT values.

LONG TERM HEAT PROTECTION WARNINGS



Monthly heat-stress information, based on future greenhouse gas emissions, are useful for work scheduling in longer-term processes