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ON OCCUPATIONAL HEALTH AND SAFETY

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Climate change

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ILO

The scientific assessment of climate change as presented in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) has come up with far reaching conclusions and robust findings that are of great relevance worldwide. Firstly, it was concluded that “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level”. It was also found that most of the observed increase in global average temperatures since the mid 20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. When we use a term “very likely” in this context it represents a probability of 90% or more. The increase in temperature and impacts of climate change have been observed on the basis of past data and information across the globe.

Based on past observations and projections for the future, some important findings have been provided in the AR4, which need urgent attention and action to meet this growing challenge across the globe. For instance, in the case of Africa, between 75 to 250 million people are projected to be exposed to increased water stress due to climate change by 2020. Also, by the same year in some countries of Africa yields from rainfed agriculture could be reduced by 50%. Agricultural production, including access to food in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition. In Australia and New Zealand, for instance, by 2020 significant loss of biodiversity is projected to grow in some ecologically rich sites including the Great Barrier Reef and Queensland Wet Tropics and by 2030 production from agriculture and forestry is projected to decline over much of Southern and Eastern Australia.

Continued greenhouse gas (GHGs) emission at or above current rates would cause further warming and induce many changes in the global climate systems during the 21st century that would very likely be larger than those observed in the 20th century. For the next two decades a warming of about 0.2 °C per decade is projected for a range of emissions scenarios. As it happens, even if the concentration of all GHGs were to be kept constant at the year 2000 levels, a further warming of about 0.1 °C per decade would be expected. Beyond that, temperature projections depend increasingly on specific emissions scenarios.

Climate change can also result in abrupt or irreversible impacts. For instance, partial loss of ice sheets on polar land and or the thermal expansion of sea water over very long time scales could imply metres of sea level rise, major changes in the coastlines and inundation of low lying areas, with greatest effects in river deltas and low lying islands. It was also concluded that 20–30% of the species assessed so far are likely to be at increased risk of extinction if increase in global average warming exceeds 1.5–2.5 °C relative to temperatures that existed at the end of the last century. Altered frequencies and intensities of extreme weather, together with sea level rise, are expected to have mostly adverse effects on natural and human systems. Some systems, sectors and regions are likely to be especially affected by climate change. For instance, in the dry tropics and in the areas dependent on snow and ice melt, agriculture in low latitude regions and human health in areas with low adaptive capacity are particularly vulnerable. These regions include the Arctic, Africa, small islands and Asian and African mega-deltas. Within other regions including even those with high incomes, some people, areas and activities can be particularly at risk.

Overall, the impacts of climate change in the developing countries of the world need careful consideration, because resilience and capacity of societies in several developing countries to cope with projected impacts of climate change are limited. This is a subject which needs to be addressed both at the global, as well as the local level, and creating knowledge and awareness on this issue would be of great value not only for sensitizing policy makers but also the public at large, particularly the younger generations whose future would be impacted by various dimensions of climate change.

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Effect of climate change on food safety and the health of agricultural workers

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Introduction

The problems of food safety are complex and systemic, often extending from the production environment to the end consumer. Food safety issues would normally relate to aspects, such as residues and contaminants (pesticide residues, veterinary drug residues, heavy metals, toxins, cleaning chemicals, food additives, and adulterants), pathogens and spoilage microorganisms, zoonotic diseases, GMO issues, irradiation issues, physical contaminants (glass or metallic pieces, grit, vermin fecal matter or body parts), persistent organic pollutants, such as dioxins, food allergens, labelling and claims (incorrect or past "best before" date).

The concerns for food safety are felt and expressed, not only by the consumers worldwide who have become conscious of safe food and are discerning in their preference for high-quality products, but also by the governments, who have recognized their role in protecting the health and safety of their populations by imposing stringent requirements relating to pesticide residues, contaminants, microbiological parameters, pests, disease as well as various aspects of hygiene controls.

Shift from end-product inspection and testing to building safety as well as quality throughout the food chain, namely the food chain approach has been defined by FAO as "recognition that the responsibility for the supply of food that is safe, healthy and nutritious is shared along the entire food chain – by all involved with production, processing, trade and consumption". This approach covers various stakeholders involved from primary production to final consumption to include farmers, slaughterhouses, processors, transporters, distributors (wholesale and retail), consumers, and where the role of government is that of an enabler.

Multiple factors are considered to contribute to the occurrence of food safety hazards, one of which is climate change. In this paper, the potential impacts of climate change on food safety at various stages of the food chain are reviewed. It also discusses the implications of climate change on the health of agricultural workers, and some points to be considered for minimizing the impact of climate change.

Effects of climate change on food safety

There are many pathways through which climate related factors may impact food safety. Those include changes in temperature and precipitation patterns, increased frequency and intensity of extreme weather events, and changes in the transport pathways of complex contamination (Tarado et al., 2010).

Changes in temperature and precipitation patterns: Changes in temperature and precipitation patterns may provide ideal conditions for the proliferation of pests and diseases that affect plants and animals, or further create conditions for the emergence of new ones, which affect directly the quality, quantity and availability of food (FAO et al., 2009). There is evidence that climate change is altering the distribution, incidence and intensity of plant and animal pests and diseases as well as invasive and alien species (FAO, 2010). The proliferation of plant and animal pests and diseases due to climate change may lead to increased use of pesticides and veterinary drugs, which may result in higher levels of pesticide residues in crops as well as veterinary drug residues in animal-based food products.

Extreme weather event and changes in the transportation pathways of complex contamination: Increase in the frequency and intensity of extreme weather events such as floods, droughts and other similar natural disasters is considered one of the anticipated effects of climate change. Heavy rainfall and flooding can potentially increase the transmission of water-borne diseases such as typhoid, cholera, dysentery, hepatitis A, etc. as contaminants are spread by run-off and flood waters. While water-borne diseases are associated with the ingestion of contaminated water, food-borne transmission can also occur through the use of contaminated water for food preparation, or from consumption of molluscan shellfish (FAO, 2008a). Water and food-borne diseases, with diarrhea, may lead to nutritional deficiencies through decreased food intake and malabsorption.

Effects of climate change on the health of agricultural workers

Agricultural workers are susceptible to vector- and waterborne diseases as they have direct contact with plants, animals, soils and water, and there is a growing concern about the effects of climate change on the outbreaks of these diseases. Also, climate change is likely to increase the health risk of agricultural workers due to increased exposure to pesticides.

Water and food-borne diseases: Agricultural workers are vulnerable to water-borne disease as they have direct contact with water, and often use recycled wastewater for irrigation, which may facilitate the transmission of diseases. Water- and food-borne diseases, with diarrhea, may lead to nutritional deficiencies, and result in the reduction of productivity of agricultural workers.

> Also, climate change is likely to increase the health risk of agricultural workers due to increased exposure to pesticides.

Vector-borne and zoonotic diseases: Both temperature and surface water have influences on the insect vectors of vector-borne disease. Of particular importance are vector mosquito species, which spread malaria and other viral diseases such as dengue (WHO, 2011b). Warmer temperatures enhance vector breeding and standing water caused by heavy rainfall or overflow of rivers can act as breeding sites, and enhance the potential for human exposure to diseases (WHO, 2011a). Agricultural workers, especially those who practise irrigation, are exposed to health risks associated with vector-borne diseases. For example, in paddy fields, irrigation systems and peri-domestic environments facilitate breeding of vectors of malaria, lymphatic filariasis, Japanese encephalitis and dengue, and increase the risk of their transmission (WHO, 2011c).

Other hazards are also inherent in animal handling and contact with dangerous biological agents, and give rise to allergies, respiratory disorders, zoonotic infections and parasitic diseases (ILO/FAO, 2010). Climate change may drive the emergence and spread of diseases in livestock and the transfer of pathogens from animals to humans. Impacts of climate specific to zoonotic diseases, such as avian influenza include increase in the susceptibility of animals to disease, increase in the range or abundance of vectors or animal reservoirs, and prolonging the transmission cycles of vectors (FAO, 2008a).

Pesticides exposure: Agricultural workers are exposed to pesticides in many different situations, such as mixing, loading, spraying, transporting, storing, spillage and disposal (WHO, 2001). Health effects of using pesticides can be acute, delayed or chronic. But exposure to pesticides constitutes one of the major occupational risks causing poisoning and death and in certain cases allergies and work-related cancer among agricultural workers (ILO, 2011). Increasing use of pesticides would imply greater risks. In addition, their families may also be exposed to pesticides due to the misuse of containers for food or water storage, the diversion of chemically-treated seeds for human consumption, and the contamination of ground water with chemical wastes (FAO/ILO, 2010). It is recommended that workers protect themselves adequately against contamination when using pesticides. However, protective clothing may not necessarily be worn in hot and humid conditions (FAO, 1990). Climate change is likely to increase the use of pesticides or use of newer pesticides, which may negatively affect the health of agricultural workers.

Conclusion

Although there is still uncertainty about the implications of climate change, being prepared for climate change and implementing the adequate risk management strategies and measures at various stages of primary production, storage, transportation and processing would help mitigate the impact of climate changes on both food safety as well as health of agricultural workers.

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Photo by Tord Kjellstrom

The outside and inside heat during the hot season in areas like this in New Delhi can reach extreme levels.

Increased workplace heat exposure due to climate change: a potential threat to occupational health, worker productivity and local economic development in Asia and the Pacific region

Tord Kjellstrom, Australia
Bruno Lemke, Olivia Hyat, New Zealand

The climate change challenges to occupational health and safety

Global climate change is predicted to increase world average temperature by about 2–4 °C during this century depending on the extent to which greenhouse gas emissions are controlled (1). People working in hot environments are already at risk of health effects of heat and climate change will add to the risks. Populations in large cities experience additional heat exposures due to the "urban heat island effect" (2) making densely built up urban areas several degrees warmer than the surrounding countryside (3).

Daily heat exposure will become an increasing problem due to climate change, particularly for people working in jobs that cannot be, or are not, cooled by air conditioning or other technical methods (4). The current hazards of excessive heat exposure at work in Asia have been referred to, for instance, in recent reports in the Asian-Pacific Newsletter on Occupational Health and Safety (5, 6).

Protective measures include shading, fans and cooling systems, but these may not be sufficient or possible to apply in certain jobs. In those situations the most effective protective method is a reduction of internal heat production by, for example, taking more and longer rest periods during those work hours with excessive heat exposure. However, these rest periods reduce hourly productivity and possibly the daily economic output of the workers.

Ongoing global climate change and future projections are usually only described in terms of temperature changes (1). Heat exposure of relevance to human health and physiology is dependent on temperature, humidity, wind-speed and heat radiation. The Wet

Bulb Globe Temperature (WBGT) is an occupational heat exposure indicator that incorporates these four factors (7). The main international standard that advises on preventive approaches for high workplace heat exposures uses WBGT (8). It also takes into account clothing and work intensity (metabolic rate), the other two factors that affect heat stress impacts on working people (7). Other heat stress indicators have been developed in different countries (7) and these will be referred to in an accompanying article in this newsletter (9).

This report presents preliminary analysis of occupational heat hazards in Asia and the Pacific. We show that for workplaces in tropical low and middle-income countries in this region occupational heat stress problems are already apparent during long periods each year. While our underlying methods are still being developed by our research team, we can already give examples of how our new methods for occupational heat risk assessment quantify the effects of climate change at the local level. The details of the methods are in the process of being published, and the principles behind the methods were already published (10, 11). The results are of importance for the next IPCC assessment of the impacts of climate change on human health and well-being. The development of these methods is part of the international Hothaps programme (High Occupational Temperature Health and Productivity Suppression) briefly introduced in an item in this newsletter (12). Further details about the development and use of WBGT are presented in Lemke et al. (9).

Table 1. Health effects and related negative impacts of excessive heat exposure at work

Effect	Evidence	References (examples)
Death from heat stroke	South African mine workers; USA agricultural workers; etc.	Wyndham, 1965 (15), 1969 (16); MMWR, 2008 (17)
Specific serious heat stroke symptoms; heat exhaustion	Many hot workplaces around the world	Parsons, 2003 (7); Zhao et al., 2009 (18)
Clinical damage of organs	Heart overload and kidney damage; US military, El Salvador sugar workers	Parsons, 2003 (7); Schrier et al., 1967 (19); Garcia-Trabanino, et al., 2005 (20); Kjellstrom et al., 2010 (21)
Injuries due to accidents	Increased accidents in heat	Ramsey et al., 1983 (22)
Mood/behaviour/mental health	Heat exhaustion	Wyndham, 1969 (16); Kjellstrom, 2009b (23); Berry et al., 2010 (24)
Work capacity and economic loss	Low work capacity; global impact of lowered productivity, low and middle income countries	Nag and Nag, 1992 (25); Kjellstrom et al., 2009a (10); Kjellstrom et al., 2009c (26)

Physiological heat stress as an occupational hazard

The physical exchange of heat between the human body and the surrounding air is essential for health, because if the air is hotter than the body (usually at 37 °C), heat will be added to the body. Strong heat radiation that reaches the skin (e.g. via sun rays or from hot equipment) also adds heat to the body, depending on clothing or shading facilities. However, evaporation of sweat is a very effective way of transferring heat away from the body (7), and this is the mechanism for maintaining body heat balance in very hot, dry environments. Heat stress indicators incorporate humidity and wind speed as well as temperature. The rate of sweat evaporation is reduced with increasing humidity, and air movement over the skin greatly facilitates evaporation (providing the humidity is not greater than 80%). These modes of cooling need to be carefully considered when interpreting health risks and productivity because the internal heat created by muscular work (7) needs to be dissipated to maintain a safe core body temperature of 38 °C or less (10).

In order to quantify heat exposure and heat stress the key input variables need to be measured or estimated and recorded: air temperature, humidity, air movement over skin (wind speed) and heat radiation (13). The actual heat stress on a person's body is also determined by clothing and work intensity, which should also be estimated (13). With these input data any of the heat stress indices proposed over the years (7) can be calculated.

Occupational heat stress can cause several negative health and well-being outcomes as listed in Table 1. Quantitative exposure-response relationships are available for some of these heat effects, but the evidence is limited. The concern for health impacts of increasing occupational heat stress is starting to be documented (14) and two series of papers in 2009 and 2010 in the journal Global Health Action dealt with this issue. However, more research is required, particularly in hot tropical countries. (website: http://www.globalhealthaction.net/index.php/gha)

In order to quantify the heat stress and related health risks, the WBGT index was based on physiological models and developed after detailed studies by US military ergonomists in the 1950s (27, 28). The International Standards Organization (ISO) uses WBGT to recommend maximum hourly limits for work in hot environments (8) in order to ensure that average core body temperature of most workers is not higher than 38 °C.

Acclimatization to heat allows for 3–4 °C higher WBGT exposures according to the ISO (8) standard, but even acclimatized humans have an upper limit for the heat exposure that can be tolerated within different time durations. Even in acclimatised individuals, if the heat generated (by work) is greater than the heat lost via natural mechanisms (especially the evaporation of sweat) then core body temperature will rise. Acclimatization studies of South African gold miners (16) strongly emphasized the limits of acclimatization and recommended heat protection programmes for all working people exposed to heat and high humidity. Table 2 presents the recorded health risks at different heat exposure levels in South African mines.

Fundamental to the risks associated with heat exposure is the epidemiological (statistical) distributions of individual variability of sensitivity to heat stress on a particular day. This is determined by age, sex, nutritional status, and other factors (such as illness). Apart from the studies by Wyndham (16) in South Africa, there are few studies of this type available based on large groups of people in their usual work situation.

Balance between heat-induced health risks at work and worker productivity

It is important to note that the direct heat exposure situation for working people involves a "tension" between health risk protection (via neural feedback or advice by other people) and maintenance of worker productivity (Figure 1). Depending on the physical intensity of the work, a heat exposure threshold is set to prevent the core body temperature from rising too high.

If this threshold is exceeded then preventive measures (e.g. reduction in work intensity) need to be put in place to prevent core body temperature from continuously rising (Figure 1, top graph). The most likely preventive action, if cooling of the workplace cannot be applied, is a reduction of work intensity or increased rest periods, both of which reduce hourly productivity (Figure 1, bottom graph).

Interventions to reduce impacts of heat exposure

This brings us to the issue of protective policies and actions that can be taken to reduce heat exposure or heat effects. These actions are often labeled as "adaptation", and while very relevant even now, these protective actions will become even more relevant in the future with climate change.

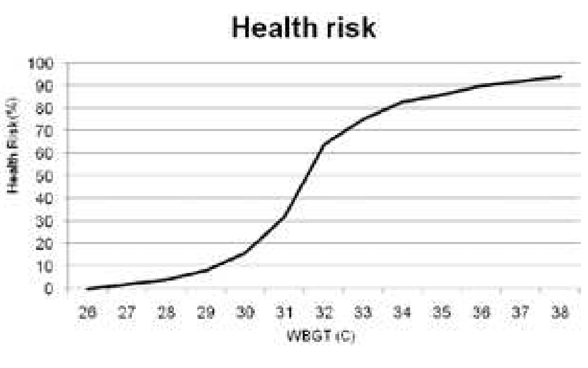
Heat exposure can be reduced by shading workers from direct sunlight or strong heat radiation from industrial equipment. It is also possible to use cooling fans or focused cool air flow, if air conditioning of a whole worksite is not possible. Actual hourly heat exposure can also be reduced by management procedures that limit work during the hottest part of the day, or the hottest part of the year. The Spanish tradition of "siesta" is a feature of such heat reduction. In Venice the glass workers have a tradition of taking August (the hottest month) as a holiday. In India, construction workers in some companies are given long breaks (like a siesta) during the hot afternoons of the hot season (referred to in 4). All of these seasonal adaptations for reducing work activities during the hottest periods will make less daylight hours available for work, and in a modern economic environment they reduce potential productivity.

Clothing, especially protective clothing can also impact on the ability of the body to cool down and while specifically designed clothing is being developed, this may not be affordable for the workers or the workplace.

If heat stress becomes so high as to affect human physiology and begin to produce clinical symptoms then action must be taken. The main action is a reduction in the heat generated by muscle action, which means lower work intensity and/or more rest periods. Moving the person to a cooler area (if available) and cooling of the person's body may be an essential preventive action. This could mean cooling part of the body (e.g. putting arms into cool water) or, in extreme cases, whole body immersion into cool water. The water should not be too cold, in order to avoid rapid vasoconstriction in the skin that would reduce the cooling effect on the core of the body.

Table 2. Relationship between Effective Temperature (ET, similar to WBGT in this situation) and heat stroke incidence among acclimatized workers in South African gold mines, 1956–1961 (Wyndham, 1965 (15); 1969 (16)).
(Wyndham reports heat exposure data as Tw, ET and WBGT in different publications, and it is not clear how these have been recalculated, if they have)

ET, °F	ET, °C	Number of workers	Annual risk of non-fatal heat stroke/million workers	Annual risk of fatal heat stroke/million workers
< 80	< 26.7	371,318	1.6	0
80–83.9	26.7–28.7	177,960	6.7	0
84–87.9	28.8–31.0	178,536	49	17
88–90.9	31.1–32.6	89,113	139	36
91–92.9	32.7–33.7	15,507	320	114
93 +	33.8 +	1,800	889	666



When WBGT goes up and a worker does not reduce physical labour output, the risk of serious health risk (e.g. heat stroke) goes up.

Although, long term, the productivity would also go down (e.g. worker gets too sick to work), the clinical health risk is the main issue.

If WBGT goes up and the worker reduces physical labour in accordance with occupational health standards to reduce heat strain, or as an outcome of "self-pacing" in order to reduce clinical health risk, productivity will go down substantially.

Any remaining health risk will stay relatively low, but will still increase in the most sensitive workers.

Figure 1. The competing situation between health protection and maintenance of worker productivity. Conceptual dose-response relationships between the impact of heat exposure on clinical occupational health risk and worker productivity.

Global and regional mapping of occupational heat exposure

Maps have been produced of calculated indoor WBGT levels in selected global regions: Australia, South Asia (India and neighbouring countries), Southern Africa, and the Mexican Gulf region (11). Data used for the calculations are from 0.5 x 0.5 degree (50 x 50 km squares at the equator) global gridded climate data for 1960 to 2002 from the Climate Research Unit (CRU) at the University of East Anglia, Norwich, UK. In order to calculate potential impacts of future climate change, we acquired similar scale global gridded data from five different climate change models recommended by WHO (the details of the methods will be presented in the near future in the resulting WHO report). We could then calculate the likely monthly WBGT levels in 21 global regions in 1975, 2030 and 2050, and used these estimates to calculate health and productivity impacts. Examples of heat exposure maps are given in the paper by Hyatt et al. (11) and the article by Lemke et al. (9) in this newsletter.

Impact of climate change on the occupational heat stress risks to health and productivity

Using the calculation formulas for indoor WBGT and the resulting gridded maps of heat exposure estimates as in Lemke et al. (9), we are calculating the heat impacts on working people in different regions of the world (the WHO-sponsored project to be completed in

Table 3. Results, percentage loss of daylight work hours per year in the age range 15–64 years; Heavy labor (metabolic rate = 500W), ISO (1989) risk functions, calculated indoor WBGT exposures in 1975, 2000 and 2050.

Region	Major countries included	1975, baseline, CRU real data (A) %	2000, CRU real data (B) %	25 years change, Ratio 2000/1975 (A/B)	2050, CRU adjusted model (C) %	50 years change, Ratio 2000/2050 (C/B)	50 years change, increase in 2050–2000 (C – B) %
Asia-Pacific, High Income (AP_HI)	Japan, Singapore	0.11	0.18	1.7	0.77	4.2	0.59
Central Asia (As_C)	Uzbekistan, Tadjikistan	0.08	0.12	1.5	0.30	2.5	0.18
East Asia (As_E)	China	2.03	2.19	1.1	3.42	1.6	1.2
South Asia (As_S)	India	14.5	16.4	1.1	18.0	1.1	1.6
South-East Asia (As_SE)	Thailand, Vietnam	10.2	13.7	1.3	19.1	1.4	5.4
Australasia (Au)	Australia	0.03	0.03	1.1	0.09	3.0	0.06
Oceania (Oc)	Fiji	3.74	6.28	1.7	9.13	1.5	2.9

the middle of 2011). Using exposure-response relationships for heat stroke (examples in Table 2), we can estimate the clinical heat effect risks as the number of affected workers per million population. These health impacts will very much depend on the extent to which workers can reduce their work intensity (as described in Figure 1).

Our focus has been on the likely reduction of "work capacity" due to hourly heat exposure during different months (9). As examples of the outputs from these calculations, Table 3 shows the percentage of daylight hours, (assuming twelve daylight hours, which can be expected in tropical areas) that would be "lost" due to heat exposure for people working in physically demanding jobs (metabolic rate = 500W). However, in places with longer daylight (the days get longer during the summer at higher latitude) the percentage of "lost hours" will be less and the possibilities to shift working hours to cooler parts of the day are greater.

Using this basic calculation approach, the "lost hours" in Asia-Pacific High Income Countries, Central Asia and Australasia in 1975 was less than 1% of all daylight hours and the actual lost hours in 2000, as well as the lost hours in 2050 based on CRU gridded climate change model estimates, were also less than 1% (Table 3). However, the ratios between lost hours in 2000 and in 1975 were greater than 1, indicating increasing workplace heat exposures due to ongoing climate change. The ratios between 2050 and 2000 are even greater (Table 3)

In the other four regions (East Asia, South Asia, South-East Asia and Oceania), the percentage loss of daylight work hours due to high workplace heat exposures among people working in physically demanding jobs (metabolic rate = 500W) was greater than 2% already in 1975 and increasing by 2000 (Table 3). South Asia (including India) had the largest losses in 1975 and 2000, South-East Asia (including Indochina) may experience the greatest absolute increase of lost work hours until 2050 (5.4%), while East Asia (including China) and Oceania (Pacific islands) may experience the greatest relative increase of lost work hours (Ratios = 1.6 and 1.5) (Table 3).

Photo by Tord Kjellstrom

Gluing job inside shoe factory, Vietnam. High heat increases breathing rates of workers and increases evaporation of the solvents in the glue so the hourly inhalation of toxic solvents may be increased due to heat.

These estimates will be influenced by the extent to which machinery is used to reduce physical workload or by management practices to avoid heavy labour during the hottest periods of each day during the year. The "confidence intervals" of the estimates in Table 3 also depend on several other factors that require further exploration, including the accuracy of estimates for heat exposure levels in the past and the validity of estimates based on models of future climate change. They also include any differences between the gridded climate data and the actual heat exposures in indoor workplaces in that grid cell. However, the estimates in Table 3 give an indication of the needs for heat exposure prevention policies and actions at present and in the future as climate change progresses.

Potential economic development impacts of increased workplace heat stress

The potential increasing impact of climate change on occupational heat exposure, and related health and productivity risks, is of importance to the economic development of local populations and their businesses. If daylight work hours cannot be used for active

Photo by Tord Kjellstrom

Construction site in South India. Many people have to work at high physical intensity in both outdoor and indoor work in construction with risks of heat stroke and impacts on hourly productivity.

work, hourly and daily productivity will be reduced. The regional daily work capacity reductions and the resulting annual "losses" of daylight work hours (Table 3) may cause significant impacts on the economic conditions for individuals, families, enterprises, communities and regions.

If usual daily farming activities are slowed down in communities heavily dependent on human labour for farm production, the total farming output may be significantly reduced. Other daily activities in low income communities, such as collection of household water or fire wood, may also be slowed down by increasing heat exposure, and reduce the time available for income generating activities. These types of relationships between local seasonal heat exposure and economic outputs have not been studied sufficiently using scientific methods.

If working people are paid for their hourly production output but their work intensity is reduced due to heat exposure, their hourly income will be reduced. In order to avoid such a reduction of income, some working people will keep up their work intensity and risk getting serious health effects of heat. One example of such behaviour is the heat stroke mortality among agricultural workers in the USA (17). Some workers kept working, even in extreme heat conditions, in order to maintain their income, and they ended up with fatal heat stroke. Many of the affected workers were recent immigrants from Central America whose primary focus was to earn as much money as possible to send back to their families. These clinical effects of heat, going as far as death, will also reduce the economic performance of affected sectors of the economy.

Examples of current impacts of hot work environments related to the outdoor climate include the need to employ two people to do one person's job in car assembly factories during the hottest season in South India (4), and the extra hours shoe manufacturing workers in Vietnam have to work in the hottest season in order to meet daily production targets (4).

A global analysis of the climate change impact on regional productivity was carried out using approximate regional climate estimates (26). This is now being followed up with more detailed analysis using 0.5 x 0.5 degree gridded data as shown by Lemke et al. (9). This first analysis showed that the changing climate until the 2050s would reduce the annual work capacity in all 21 regions and the equivalent number of working days lost due to heat exposure was estimated at between 0.1 and 19% for the different regions. South-East Asia and Central America were the worst affected by this aspect of climate change. The analysis also included assumed changes of the distribution of the regional workforce into manual labour outdoors, indoors and office type work, each of which may experience different degrees of heat exposure.

Past trends in the distribution of labour into agriculture, industry and services in relation to GDP development were used to estimate what the future distribution may be in the different regions. In most regions these future distributions implied that fewer working people would be exposed to the highest heat exposures. The impacts on population average annual work capacity would be lowered by those labour force distribution changes (26). Still, the estimated impact of climate change is a reduced annual work capacity in all regions. For example, in South Asia the resulting work capacity loss between 1975 and 2050 was estimated at 4%.

Clearly these economic impacts will very much depend on applications of technology to cool the environment or to reduce heavy work and so reducing the time working people need to spend in extremely hot work environments. However, this may not be the best long-term solution because air-conditioning and mechanization generally add to the atmospheric carbon dioxide load and so enhance global warming. It is very likely that in low-income countries and communities improvements of these heat related working conditions will be slower than in high-income communities. Many poor people in tropical and sub-tropical countries may therefore be affected by the Hothaps effects (High Occupational Temperature Health and Productivity Suppression) (29), while more affluent people will manage to avoid these effects.

Conclusions

Climate change is already happening and creating increased heat exposures in outdoor workplaces and non-cooled indoor workplaces in many tropical and sub-tropical areas. WBGT is a heat index that brings together the different climate factors that influence the human physiological impacts of heat. This index was used to estimate heat exposure in different parts of the world. With climate change model estimates one can also make estimates for the future. Using an international occupational health standard we calculated the likely impact on "work capacity" and the resulting "lost work hours" due to heat in the Asia-Pacific region. The calculated losses due to climate change in large parts of this region are substantial.

Thus, climate change will make the heat exposure levels higher in non-cooled work environments, and the reduction of productivity and the local economic performance may be substantial. This aspect of climate change impacts on human health and well-being has received very little attention until now, and we hope that our research will encourage WHO, ILO and other agencies to facilitate more analysis and research on this topic and develop policies and actions to protect current and future generations of working people from excessive occupational heat exposure.

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Sam Khok vegetable field


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Climate change and occupational health in Thailand

Uma Langkulsen
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Introduction

Thailand's weather is becoming increasingly unpredictable. Evidence of this can be seen in the recent unusually cool temperatures and heavy rains, with three different seasonal weather patterns occurring in a single day, namely summer weather, winter weather and rainy season weather. On 12 March 2011 westerly winds brought so much moisture to Thailand that it rained heavily in numerous areas of the country including Bangkok. Subsequently on 15 March 2011 Thailand was affected by a cold front that moved in from China. This caused the weather to change suddenly, resulting in rain and a rapid drop in temperatures for several days, with some areas experiencing temperatures as low as 10 °C, while the temperatures in Bangkok were between 18 and 20 °C, even though it was the beginning of summer. This extreme weather event is abnormal and may be a result of climate change.

Health impact

The increased average temperature of the globe, and increasingly frequent violent natural occurrences have a direct impact on the health and sanitation of the Thai public. Diseases that come from the consumption of food and water have a tendency to increase due to natural disasters. For example floods, such as those that occurred last March in the south, may cause waterborne diseases such as dysentery, diarrhoea and cholera. Communicable diseases that occur in tropical climates also increase and can take many lives, especially malaria, which is a disease transmitted by mosquitoes, since they breed in warm climates and uncertain seasons. Agricultural output also decreases due to natural disasters, which could lead to a shortage of food and thus cause starvation and nutrition deficiency, as well as lowered immune systems, especially among children and the elderly. Deaths from heat stroke were reported during the Thai marathon in 1987, and from 1990 onwards there have been reports of illness and deaths among conscripted soldiers that were undergoing severe military training in the Thai military. The latest reports showed that a total of 4, 5, 6, 5 and 8 soldiers died in 2005–2009, respectively. Dr. Pibool Issarapan at the Bureau of Occupational and Environmental Disease, Ministry of Public Health reported that from among the number of people who were ill or who had died as a result of the diseases listed under the International Classification of Diseases, Tenth Revision (ICD-10) between 2007 and 2009, seven people had died from the effects of heat and light (ICD-10 Category T67). Table 1 shows these data from the Program of National Health Security.

Occupational health research

The occupational health of workers in Thailand has been extensively researched in the past, but here we focus on research concerning heat-related illness that was published in 2010. First is a study conducted by Benjawan Tawatsupa et al. (1). Benjawan is a PhD candidate at the National Center for Epidemiology and Populations Health, the Australian National University, Canberra, Australia and is an academic at the Health Impact Assess-

Sam Khok pottery industry

ment Division, Department of Health, Ministry of Public Health. He conducted a study on the relationship between self-reported heat stress and psychological distress, and overall health status. A total of 40 913 Thai workers aged 15–66 participated in this study, which was the first large-scale study in Thailand on occupational heat stress and adverse health outcomes. Results showed that occupational heat stress needs more attention and development through occupational health interventions as climate change increases Thailand's temperatures.

The second study is conducted by a research team at the Faculty of Public Health, Thammasat University, Rangsit Campus (2), on the relationship between climate conditions and health status and productivity in two main occupational settings. One involves heat generated by industry, and the other heat in a natural setting among workers in the industrial, agricultural and construction sectors of the Pathumthani and Ayuthaya Provinces in five study sites, namely, the Sam Khok pottery industry, the Sam Khok vegetable field, Ratchasuda construction building, the Wang Noi power plant, and the Aranyik knife industry. In this setting, researchers measured the Wet Bulb Globe Temperature (WBGT) and used the Heat index (HI) to evaluate the effect of heat on health. In addition, a questionnaire was used to interview 21 workers, which showed that climate conditions in Thailand potentially affect both health and productivity in occupational settings. This was, however, merely a pilot study. Nevertheless, an effort was made to develop further more detailed research on this public health issue, by conducting research on the "Situation and Effects of Climate Change and Heat Exposure among Workers in Thailand" with support from the Office of the Higher Education Commission for a period of three years starting from October 2010.

Conclusion

In summary, climate change affects the health of human beings, especially workers who are exposed to heat, as it may cause injury and even loss of life if they are not equipped to face the said weather conditions. As regards workplace safety for those working in hot weather conditions, it is important for state agencies or private enterprises to set on a systematic basis a standard to protect workers against effects that may occur. Protection against danger from heat at the workplace generally has three main factors, namely, protection from and control of the source of the heat, protection from and control of the source of the heat in the environment, and protection of oneself. Therefore, occupational health and safety is an issue of foremost importance if the government is to develop the country's economy and industry.

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Table 1. Morbidity and mortality by ICD-10 category T67, Thailand, 2007–2009

ICD-10	Morbidity	Mortality	Total
T67.0 Heatstroke and sunstroke	94	6	100
T67.1 Heat syncope	39	1	40
T67.2 Heat cramp	15	0	15
T67.3 Heat exhaustion, anhydrotic	1	0	1
T67.5 Heat exhaustion, unspecified	30	0	30
T67.6 Heat fatigue, transient	33	0	33
T67.7 Heat edema	1	0	1
T67.8 Other effects of heat and light	4	0	4
T67.9 Effect of heat and light, unspecified	8	0	8
Total	225	7	232

Climate change and health: **Burden of Bangladesh**

Iqbal Kabir
Bangladesh

Climate change: risks to health

There is now widespread agreement that current trends in energy use and population growth will lead to continuing – and more severe – climate change. A changing climate will inevitably affect the basic requirements for maintaining health: clean air and water; sanitation and the environment; food supply; and adequate shelter. Many diseases and health problems may be exacerbated by climate change.

Each year, approximately 1.2 million people die from causes attributable to outdoor urban air pollution, 2.2 million from diarrhoea largely resulting from lack of access to clean water, sanitation and poor hygiene, and 3.5 million from malnutrition (1). In both industrialized and developing countries, approximately 60 000 people die in weather-related disasters, from heat waves to floods and drought (2). A warmer and more variable climate threatens to lead to higher levels of some air pollutants, to increase the transmission of diseases by unclean water, contaminated food, insect vectors and rodents, to compromise agricultural production in some of the least developed countries, and to increase the hazards of extreme weather (3, 4). Studies in Europe, Latin America and other regions have shown that expected future climate scenarios, with increasing maximum temperatures, humidity and extreme events, are likely to cause rising health impacts, especially for susceptible populations that have not previously experienced these hazards (5, 6). WHO estimates that the climate change that has occurred since the 1970s is already causing over 140,000 additional deaths each year (7), and that these risks are likely to continue to rise.

In the long run, however, the greatest health impacts may not be from acute shocks such as natural disasters or epidemics, but from the gradual build-up of pressure on the natural, economic and social systems that sustain health, and which are already under stress in many parts of the world. These gradual stresses include reductions and seasonal changes in the availability of fresh water, regional drops in food production, and rising sea levels. Each of these changes has the potential to force population displacement and increase the risks of civil conflict. Climate change has therefore been described as "the biggest global health threat of the 21st century" (8).

The challenge of linking climate change and health policy

The importance of health has long been recognized in climate policy. The United Nations Framework Convention on Climate Change treaty aims to avoid the "adverse effects" of climate change, which it defines as "changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare" (9). Surveys from around the world show that the general public places health threats at or near the top of the list of climate change concerns (10), and over 90% of the National Adaptation Programmes of Action for climate change developed by the least developed countries identify health as a sector that will suffer adverse impacts of climate change.

Despite this, the issue is currently neglected in the climate change mechanisms. A recent WHO review concluded that less than 3% of the international funding on adaptation to climate change has been directed to projects with the specific aim of protecting health. The joint benefits to health of climate change mitigation are omitted from almost all of the economic models that aim to guide decision-making on the reduction of greenhouse gas emission, leading to a bias against more sustainable and greener decisions.

Relationships between weather/ climate and health outcomes

A clear understanding of the relationships and sensitivity of health outcomes and determinants to weather and climate patterns is essential when determining the risks that climate change poses to population health. These analyses, often referred to as sensitivity analyses, should describe current vulnerability at the geographical scale and level of detail that is most suitable for decision-makers, taking into consideration the type and quality of evidence. In some cases, quantitative data are not available or even needed to describe these relationships.

The burden of the chosen health outcome can be estimated using expert judgment and described in relative terms (e.g. there is a high burden of endemic malaria in a particular district, or there is a medium-level risk of epidemic malaria in another).

At a minimum, analyses should be conducted of the relationship(s) between health data and core weather variables, such as temperature, precipitation, relative humidity, and extreme weather events and patterns. Health data are generally available from the Ministry of Health, and weather data from the national meteorological and hydrological services.

Table 1. Climate-sensitive health outcomes and particularly vulnerable groups

Climate-sensitive health outcome	Particularly vulnerable groups
Heat stress	The elderly, those with chronic medical conditions, infants and children, pregnant women, the urban and rural poor, outdoor workers
Air pollution	Children, those with pre-existing heart or lung disease, those with diabetes, athletes, outdoor workers
Extreme weather events	The poor, pregnant women, those with chronic medical conditions, those with impaired mobility or cognitive constraints
Water-borne and food-borne diseases	The immunocompromised, the elderly, infants; specific risks for specific consequences (e.g. *Campylobacter* and Guillain-Barre syndrome, *E. coli* O157:H7)
Vector-borne and zoonotic diseases	
Malaria	Children, the immunocompromised, pregnancy genetics (G6PD status), non-immune populations
Dengue	Infants, the elderly
Other	The poor, children, outdoor workers, others

Burden and distribution of disease: Bangladesh scenario

Bangladesh is already vulnerable to outbreaks of infectious, water-borne and other types of diseases (World Bank, 2000). Records show that the malaria incidences increased from 1,556 in 1971 to 15,375 in 1981, and from 30,282 in 1991 to 42,012 in 2004 (WHO, 2006). Other diseases, such as diarrhoea, dysentery, etc., are also on the rise, especially during the summer months. It has been predicted that the combination of higher temperatures and potential increase in summer precipitation may cause the spread of many infectious diseases (MoEF, 2005).

Climate change also brings about additional stresses, such as dehydration, malnutrition and heat-related morbidity, especially among children and the elderly. These problems are thought to be closely interlinked with water supply, sanitation and food production. Climate change has already been linked to land degradation, freshwater decline, loss of biodiversity and ecosystem decline, and stratospheric ozone depletion. Changes in the above factors may have a direct or indirect impact on human health. Bangladesh is already burdened by high population, natural disasters, diminishing and polluted natural resources. The added burden of increased health problems possibly due to climate change and climate variability will further retard the country's development achievements.

Public health depends on safe drinking water, sufficient food, secure shelter, and good social conditions. A changing climate is likely to affect all of these conditions. The health effects of a rapidly changing climate are likely to be overwhelmingly negative, particularly in the poorest communities.

Some health effects stemming from climate change

Increasing frequencies of heat waves: Recent analyses show that human-induced climate change significantly increased the likelihood of summer heat waves in Europe in 2003 and 2007. This phenomenon has implications for Bangladesh, since the elderly and children suffer most from increased temperatures. Even though there has been no formal study on the increase of heat waves in Bangladesh, we are already observing yearly trends of rising temperatures. Health impacts associated with heat wave are heat stroke, dehydration, and aggravation of cardiovascular diseases among elderly people. It should also be noted that Bangladesh does not have records on health, illness and death related to heat wave, but general observations revealed that the prevalence of diarrhoea increased during spells of extreme temperature and heat wave, affecting children in particular.

Variable precipitation patterns: Changes in precipitation pattern are likely to compromise the supply of freshwater, thus increasing water-borne disease risks . This is also associated with floods and water-logging that increase the incidences of diarrhoea and cholera, along with skin and eye diseases. Agricultural production and food security are also directly linked to precipitation pattern, thereby impacting on the nutritional status of the population.

Malnutrition: Rising temperatures and variable precipitation are likely to cause a decrease in agricultural production, thus increasing the risk of malnutrition. Malnutrition further increases the vulnerability to infectious, water-borne and vector-borne diseases.

Vector-borne diseases: Changes in climate are likely to lengthen the transmission seasons of important vector-borne diseases and to alter their geographical range, potentially bringing them to regions where the population lacks immunity or where the public health infrastructure is not strong. Dengue is already a regular disease in the major cities of Dhaka and Chittagong.

Rising sea levels: This increases the risk of coastal flooding and may necessitate population displacement. Rising sea levels may also cause many health-related problems, such as cholera, diarrhoea, malnutrition, skin diseases, etc. More than half of the world's population now lives within 60 km of the sea. Some of the most vulnerable regions are the Nile delta in Egypt, the Ganges-Brahmaputra delta in Bangladesh, and many small islands, such as the Maldives, the Marshall Islands and Tuvalu.

In Bangladesh, millions of people suffer from diarrhoea, skin diseases, malaria, mental disorders, dengue, etc. A recent study carried out jointly by the Bangladesh Centre for Advanced Studies (BCAS) and the National Institute of Preventive and Social Medicine (NIPSOM) in 2007 indicated that the annual incidence of diarrhoea was 2,841,273 during 1988–2005 and that of skin diseases was 2,623,092 during 1998–1996. Other health problems, such as malnutrition, hypertension and kala-azar, also affect people in different regions of the country.

Cost estimates for the possible additional health burdens of climate change in Bangladesh

Bangladesh faces a very high risk of impacts from climate change, including impacts on human health. It is estimated that the lives and livelihoods of 36 million people in the southern coastal regions will be affected by climate change, including the following: heat stress from extreme heat events; water-borne and food-borne diseases (e.g. cholera and other diarrheal diseases); vector-borne diseases (e.g. dengue and malaria); respiratory diseases due to increases in air pollution and aeroallergens; impacts on food supply and water security (e.g. malnutrition); and psychosocial concerns from the displacement of populations through a rise in sea level and after disasters. The Government of Bangladesh estimated the additional costs of controlling diseases attributable to climate change. The total costs were estimated to be USD 2.8 billion.

Disease	**Estimate in USD (million)**
Diarrhoea (3.5 episodes/person/year at BDT 50/episode)	102.94
Kala-azar	161.76
Filariasis	51.47
Dengue, malaria, chikungunya	308.82
Chronic obstructive pulmonary disease, NCDs	617.65
Injuries, drowning, emergency medicine	602.94
Malnutrition	735.29
Other diseases and events	220.59

To prepare for these impacts, the Government of Bangladesh is establishing a model health care delivery service based on the development of new community health clinics and revitalization of primary health care services, in order to reduce population vulnerabilities.

The way forward

Some possible measures for Bangladesh to reduce health impacts from climate change are given below:

- Water-borne diseases are a major public health problem in Bangladesh. Changes in climate factors will increase their incidences. To address these problems and reduce the possibility of incidences of climate sensitive diseases, some initiatives – including policy decisions, scientific efforts and broad research to confirm earlier findings, and institutional capacity building to handle the consequences – need to be considered.
- Government agencies can initiate climate-sensitive diseases surveillance separately or can include a separate component on this in existing national diseases surveillance programmes.
- The government can develop climate-sensitive disease datasets and vector data based on geographical distribution, for further research and prediction purposes.
- Health professionals may need to be trained on climate change and its impacts on human health, so they are equipped to deal with future adversities.
- The government, in association with NGOs and research organizations working on climate change and health issues, can initiate a training programme for health professionals.
- An awareness programme dealing with the impacts of climate change on human health would build the resilience of the community.
- Strategies for adapting to the impacts of climate change on health can be developed, taking account of all relevant climate factors and non-climate factors. Climate Change Cell (CCC) can initiate the development of such strategies, in association with relevant government partners and NGOs.
- Water supply and sanitation management can be improved.
- Water resources can be protected.
- Hygiene practices at both individual and community levels can be improved.

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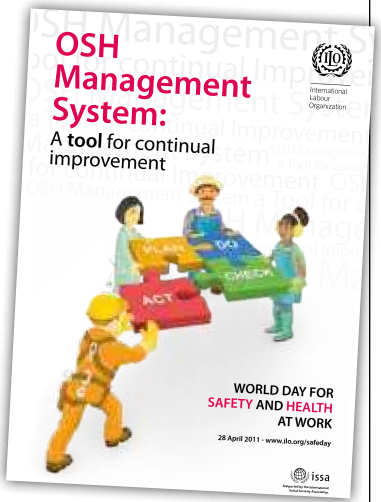
World Day for Safety and Health at Work



The International Labour Organization (ILO) celebrates the World Day for Safety and Health at Work on the 28 April to promote the prevention of occupational accidents and diseases globally. It is an awareness-raising campaign intended to focus international attention on emerging trends in the field of occupational safety and health and on the magnitude of work-related injuries, diseases and fatalities worldwide.

Occupational Safety and Health Management System

The 2011 World Day for Safety and Health at Work focused on the implementation of an Occupational Safety and Health Management System (OSHMS) as a tool for continual improvement in the prevention of workplace incidents and accidents.

An OSHMS is a preventive method to implement safety and health measures which consists of four steps and incorporates the principle of continual improvement. Its principles are based on the PDCA Cycle: PLAN, DO, CHECK, ACT. Its purpose is to establish a comprehensive and structured mechanism for joint action of management and workers in the implementation of safety and health measures. OSHMS can be an effective tool for the management of hazards specific to a given industry, process or organization.

The ILO has prepared a report, a poster and other promotional materials for the occasion.
Please see: **www.ilo.org/safeday**

More information can be found: www.ilo.org/safework as well as a video message from Mr Seiji Machida, Director of SafeWork, ILO

Contacts: safeday@ilo.org

ICB2011 19th International Congress of Biometeorology

Auckland, New Zealand
4–8 December 2011
Theme: Climate and Society

Close of call for abstracts: 29 May 2011
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The overall aim of ICB2011 is to explore the links between climate and society. This is because a central ethos of the interdisciplinary science of Biometeorology is the desire to understand interactions between atmospheric processes and living organisms – plants, animals and humans. Such interactions are fundamental to the well-being and sustainability of society at a range of geographical and time scales.

Clockwise from above left: Welding task in iron works, Ceramic & pottery works in an industrial unit, Powerloom, Breaking stone with a hammer in a stone quarry.

Perceived heat stress and strain of workers

PK Nag, A Nag, P Sekhar, P Shah
India

Introduction

Growing incidences of climatic events, such as heat waves, droughts, local storms, floods and cold spells emphatically demonstrate the vulnerability of humankind in different geographical regions (1). According to the World Meteorological Organization, as judged by combined global and ocean surface temperature, June 2010 was the warmest month on record, with prominent heat in many areas of eastern and western Asia. The cities of the Asia-Pacific have a varying magnitude of ambient temperature build-up, from 0.21 (Ahmedabad and New Delhi), through 0.45 (Bangkok) and 0.48 (Osaka) to 0.71 °C (Shanghai) per decade (2). The Centre for Research on the Epidemiology of Disasters (Brussels) recorded that ~90% of the nearly 208 million people affected by disasters worldwide in 2010 lived in Asia. As many as 48 million Asians were also affected by weather-related events In 2009.

There is a clear risk that Asia-Pacific regions might experience unprecedented environmental exodus due to extreme climatic events in the coming years (3). Despite projection that millions of people in the tropics are expected to experience frequent heat waves (4), public recognition of the enormity of this problem in the vast Indian subcontinent is very much subdued. Workers in informal occupations, farmers, construction workers, street venders, rickshaw pullers and others, as well as both the urban and rural poor dwelling in slums and on pavements, are faced with the daunting challenges that heat events pose. People with low adaptive capacity and lack of relief measures are at greater risk of morbidity and mortality in heat wave episodes (5, 6). Work both indoors and outdoors is the added stress dimension for people which exceeds climatic stress in naturally occurring hot climates. This paper covers case studies of the population exposed to high heat, with the aim of analysing their behavioural responses as regards the perception of heat-related stress and strain.

Indoor work environment

Occupational and environmental exposures are critical determinants of one's susceptibility and physiological and behavioural adaptations (7, 8). We examined the perception of heat-related stress and strain of 567 workers (Indoor environment: iron works and powerloom in informal sectors, and an industrial unit of ceramics and pottery), when heat waves occurred regularly. A heat wave is when the maximum ambient dry-bulb (DB) temperature is >40 °C, 3 to 4 °C above normal (Indian Meteorology Department). The DB temperatures exceeded 40 °C in all observations of the powerloom environment, 75% in the iron works, and over 33% in the ceramic and pottery works. The WBGT index was 35.2±1.1 °C in the powerloom environment, followed by the ceramic and pottery works at 33.8±1.9 °C, and the iron works at 31.6±1.5 °C.

Based on WHO ICD-10 code T69, a checklist enquiry covering heat-related symptoms was given to the workers, and their relative responses were rated. Only the behavioural responses that were found to be statistically significant in the analysis of variance ($p<0.001$ to 0.05) are shown in Figure 1. Some indicators such as feeling chills, redness of face, seizures, sensations of shivering, slurred speech, and feeling like collapsing/fainting did not markedly manifest in the responses of the workers. Among all indoor occupational groups, over 80% of the workers reported excessive sweating and thirst, tachycardia and dryness of mouth, ~70% reported feeling elevated body temperature, and half of the workers complained of generalized muscle pain/spasms. Nearly 33% of the workers reported reduced urination and itchy skin, however, a higher number of workers in the powerloom complained of itchy skin, and pink or red bumps.

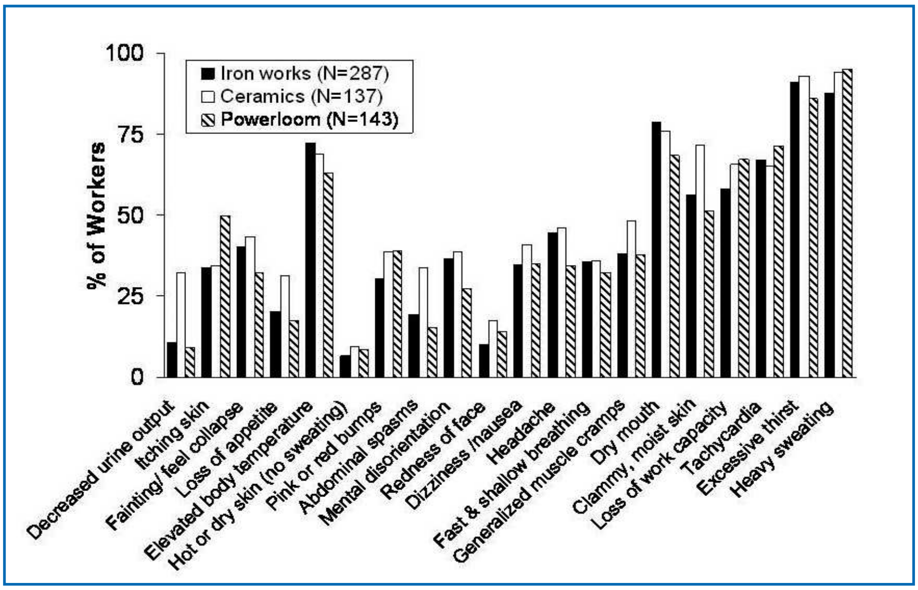

Figure 1. Perceived stress and strain of workers in indoor work environment during summer months.

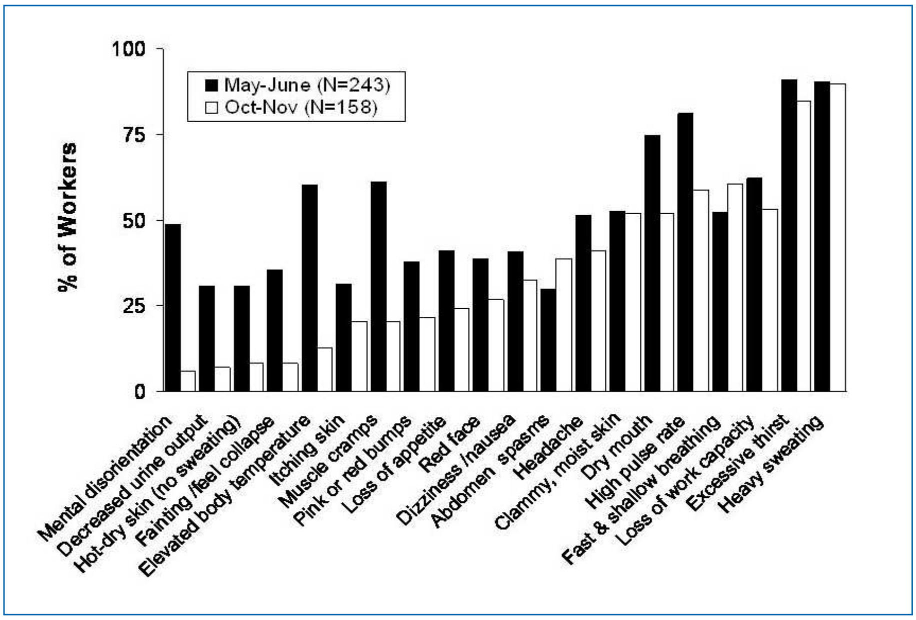

Figure 2. Perceived stress and strain of workers in outdoor stone quarry work in May–June, and October–November.

Outdoor work environment: stone quarry works

Working in stone quarry works is extremely arduous. These workers were monitored during the summer months (May–June, N=243) and October–November (N= 158). The DB temperatures during May–June and October–November were recorded as 40.3±2.2 °C and 35.4±2.3 °C, with corresponding WBGT values of 35±2.3 °C and 33.1±2.2 °C, respectively. Heat wave conditions prevailed in the region of the study; the 95th percentile value of DB the temperature was 42.8 °C. In comparison, the environmental load during October–November was substantially less.

Due to repeated exposure to high heat load and strenuous physical activity, even habitual workers were subjected to thermal instability. The workers' perceptions were an aggregate response over time, including peak loads (Figure 2). Behavioural responses were influenced by seasonal variation, and a higher number of workers complained of heat-related symptoms in the summer months, than in the October–November period. While excessive sweating and thirst were reported by a vast majority of workers during the summer and also in October–November, complaints of mental disorientation, reduced urination, dry skin (no sweating), elevated body temperature, muscle cramps and other skin responses were distinctively higher during the summer months. Redness of face, pink or red bumps as well as prickly sensations of the skin were high among the workers, due to possible sunburn. Analysis yielded that ~60% of the workers reported loss of working capacity, and about 20% were more vulnerable to heat illnesses during the summer months, than in October–November.

The behavioural responses of the men were examined with the premise that internal thermal stability and behavioural adaptations are critical to survive environmental heat (9, 10). With impending heat wave phenomena in the region, the surveillance data on the perceptions of workers might provide indications of vulnerability. However, perceiving heat-related symptoms of the workers had limitations, and their indoctrination was required to establish relationships between the symptoms and heat exposures.

The physical severity of the work of the indoor and outdoor occupational groups could not be equated, although it was noted that habitual workers were also at a potential risk of developing heat-related illness in peak summer exposures. At similar environmental warmth, the workers in outdoor environments (stone quarry) faced a much greater risk of heat illnesses, than those in indoor environments (iron, ceramic and powerloom). While only ~8% of indoor workers complained of dryness of skin or no sweat, nearly 33% of the stone quarry workers complained of the same. Among the indoor groups, powerloom workers suffered the highest heat stress. The present sample analysis has shown that large scale generation of similar data on perceptions of heat stress and strain in different occupational groups may ascertain the relative vulnerability of people to extreme heat. This, in turn, might provide information for decreasing and managing risks, including early warnings and response plans to combat heat-related emergencies.

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Estimating workplace heat exposure using weather station and climate modelling data: new tools to estimate climate change impacts on occupational health in Asia and the Pacific region

Bruno Lemke, Olivia Hyatt, New Zealand
Tord Kjellstrom, Australia

Quantifying workplace heat exposure

It is apparent when observing workers in hot conditions that their productivity goes down especially when they are required to do high intensity work (1). The problem is quantifying this observation so it can be linked to climate change where the temperature is expected to increase by 2–4 °C by the end of this century (2).

The most accurate estimation of heat stress is by physiological models that include as input not only environmental conditions, but also the individual variables such as body surface area, degree of acclimatization, degree of hydration and type of clothing worn. The Required Sweat Rate model (3), the PHS model (4), and the more recent Fiala model (5) are representations of such models. These individual calculations are important for athletes, people undertaking exceptionally hot work (e.g. fire-fighters or workers with impervious clothing) and people vulnerable to heat stress (with kidney or heart disease). However they are not practical for regional studies, epidemiological studies or future studies (in relation to climate change). These types of studies rely on a population distribution of individual differences and then need to focus on environmental changes that impact on heat stress as it affects a population.

Irrespective of the individual, the work they are doing and the clothing that is worn, the body temperature rises when work is done. For every kiloJoule of work done muscles generate about 4 kiloJoule of body heat. Unless this heat is dissipated it will lead to a rise in core body temperature which becomes life threatening once it is over 40 °C (1).

Under normal working conditions this heat is mainly dissipated by convection, radiation and evaporation of sweat. If the person is immersed in water then conduction also becomes important. The environmental variables that hinder or promote these heat loss mechanisms are ambient temperature, humidity along with wind to a localized build up of water vapour, and radiation from the sun and surroundings. Many heat stress indicators have been developed over the last 60 years, but to be a valid heat stress index it must include these four environmental variables.

Common (and recent) heat stress indices that incorporate all these variables include WBGT, UTCI (6) and CET (7) and for the tropics the Tropical Summer Index (8). Varying levels of the humidity and temperature components create different changes to the heat stress index values, these differences will be less than individual responses to heat stress, and most of the heat stress indices have been tested on a narrow group of individuals. The one occupational heat stress index that has been widely tested and adopted in many regions of the world is the Wet Bulb Globe Temperature (WBGT) index (1, 9) so we have chosen to use this index in our studies.

While the WBGT index is an environmental heat exposure index, it has to link in with the human response to heat stress in order to calculate the loss of productivity and the deterioration of health due to heat stress. The ISO (1989) standard (9) completes this link as it prescribes the recommended extent of hourly rest periods for specific WBGT values. The aim is to protect the majority of working people from clinical health effects of heat by keeping the core body temperature below 38 °C. Due to individual variation in the sensitivity to heat, some people can work continuously at higher temperature and humidity levels than others.

This approach of separating the environmental heat exposure and the predicted effect on a population, offers much flexibility, because once the WBGT value is known the

ISO standards can be adjusted to take into account clothing, intensity of work and natural variations between populations. For example, if a waterproof barrier (clo = 1.4) is worn instead of light summer clothes (clo = 0.6), the effect of the heat stress on an individual is 6 °C higher than the environmental WBGT (1, 9).

Calculating the WBGT heat stress index

WBGT is formally defined as a combination of the natural wet bulb temperature (Tnwb, measured with a wetted thermometer exposed to the wind and heat radiation at the site), the black globe temperature (Tg, measured inside a 150 mm diameter black globe), and the air temperature (Ta, measured with a "normal" thermometer shaded from direct heat radiation). The unit is degrees Celsius (°C).

Equation 1 (Parsons 2003): outdoors:
$WBGTod = 0.7\ Tnwb + 0.2\ Tg + 0.1Ta$
Equation 2 (Parsons 2003): indoors:
$WBGTid = 0.7\ Tnwb + 0.3\ Tg$

These simple equations were developed more than 50 years ago (10) and have withstood the test of time as they are still incorporated in the ISO standards (1, 9).

It is not practical to use special thermometers to measure Tnwb and Tg in epidemiological, regional and historical studies. A new formula is needed that uses readily available weather station data on temperature, dew point, wind speed and solar radiation to work out WBGT. Such formula have been available for some time for indoor WBGT (11), but it has not been till recently that formula have been developed to calculate outdoor WBGT from standard meteorological data so making available a wealth of historical and regional information on heat stress..

The outdoor formula presented in recent publications are by Liljegren et al. (12) and Gaspar and Quintela (13). (We will not reproduce their rather lengthy formulas here but they are included in the publications). We use the Liljegren et al. (12) formulas to calculate WBGT outdoors in the sun. For indoor WBGT calculations we use the Bernard formula with two assumptions. In the absence of strong radiation we assume Tg = Ta as the only radiant source is the surroundings at the ambient temperature. While indoors the wind speed is very low, people working at moderate to high activity generate their own wind which prevents high humidity accumulation around the body. We therefore assume for indoor WBGT calculations a wind speed of 1 m/s. For the same reason in outdoor calculations we assume a minimum wind speed of 1 m/s. (Tpwb = psychrometric wet bulb temperature)

Equation 3 This formula for indoors (11) works for low wind speeds (V) down to 0.3 m/s:
$WBGT\ indoors = 0.67Tpwb + 0.33Ta - 0.048\ log10V(Ta - Tpwb)$

Obtaining global climatic data

Our calculations use daily data from many thousand weather stations that can be downloaded for free from a US NOAA (National Oceanographic and Atmospheric Administration) website: (http://www7.ncdc.noaa.gov/CDO/dataproduct, scroll down, click on "Surface Data, Global Summary of the Day" [GCOS], and then select country, time point, etc.) (14). Hourly data from the same weather stations can be purchased on CDs (same website, but scroll to "Surface Data, Hourly Global summary"). We also used hourly solar radiation data (gridded dataset) from US NASA (website: http://eosweb.larc.nasa.gov/sse/, the "Surface meteorology and solar energy" site).

The US NOAA database includes data for almost every day for a large number of weather stations around the world. The weather stations with the most detailed data are often placed at airports and it must be recognized that this will not be the actual temperatures in the microclimates where people work. However, it will give averages and in particular it will represent changes over time. The NOAA "Global Summary of the Day" (GSOD) database has not been subject to as stringent quality control as other temperature only databases. We have compared different climate data sources and found good agreements in places where daily data records are over 90% complete. From this we conclude that in most places the NOAA data can be used to assess heat exposure and related risks in localities.

The Population Heat Exposure Profile

To make local heat hazard assessments we developed the "Population Heat Exposure Profile" (15) using hourly data (Figure 1 shows

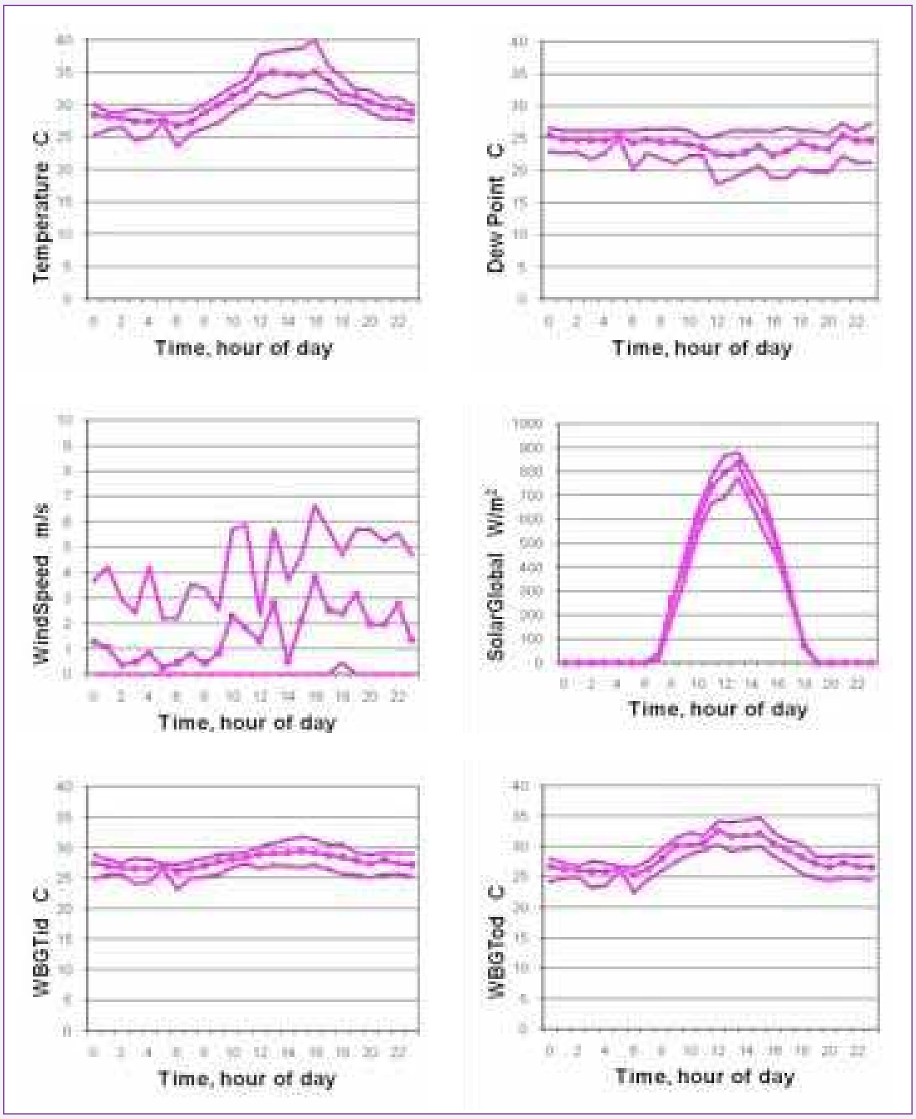

Figure 1. Population Heat Exposure Profile for Chennai, India, 1999, April (the hottest month). Hourly averages (middle curves) and 80% variation ranges (middle curve = mean value, upper and lower curves = 90 and 10 percentiles) of the actual data for air temperature, dew point (an indicator of absolute humidity), wind speed, solar radiation, indoor WBGT and outdoor (in the sun) WBGT.

an example). In Chennai, in April, the temperatures go up to 35 °C (on average for the whole month), WBGT indoors reaches 29 °C and WBGT outdoors in the sun reaches 32 °C. The dew point at 22–25 °C is relatively close to the air temperature, which indicates that the relative humidity is high (calculated at 50% midday and 85% at sunrise), which contributes to heat stress.

Impact of different levels of heat exposure on work capacity

Once the heat exposure has been estimated as WBGT, the international standard for occupational heat exposure (9) is used to estimate the extent to which rest periods are recommended for each hour. The standard identifies maximum WBGT levels for continuous work (hourly), 25% rest during a work hour, 50% rest and 75% rest, which can be used to analyse the reduction of hourly physical "work capacity" as WBGT increases. In order to calculate the effect on workers, different levels of work intensity are considered and we assume that clothing is light and not interfering with sweat evaporation.

Using the standard gives us an idea of the risks associated with local heat exposure and the potential impact on worker productivity via the percentage of rest time per hour (16). Figure 2 shows the results for Chennai, India in 1999.

In February 1999, the afternoon WBGT outdoors was approximately 29 °C on average (Figure 2). During the hottest period, if the international standard advice is followed by a person doing intense work (metabolic rate = 500W), only 60% of the work capacity is left, i.e. 40 % of each work hour needs to be used for rest in order to prevent core body temperature exceeding 38 °C .

Figure 2 also shows that in April 1999 when the afternoon WBGT outdoors goes to 32 °C, the remaining work capacity is only 10%; in June the results are between those of February and April. As mentioned earlier, individual workers with low sensitivity to heat can work with less rest, but even for them there is a point at which either rest periods must be taken or work intensity reduced to avoid clinical effects of heat.

The 3 °C difference of afternoon WBGT between February and April in Figure 2, is similar to the WBGT increase that may occur due to climate change during this century. If the work activities and conditions are the same, such a WBGT change could reduce the work capacity in February 2100 from 60% to 10% for people performing very physically active work tasks (Figure 3), and during the hotter months little work of this type can be carried out during daylight hours. These changes are the foundations for the Hothaps (High Occupational Temperature Health and Productivity Suppression) research and action programme (17).

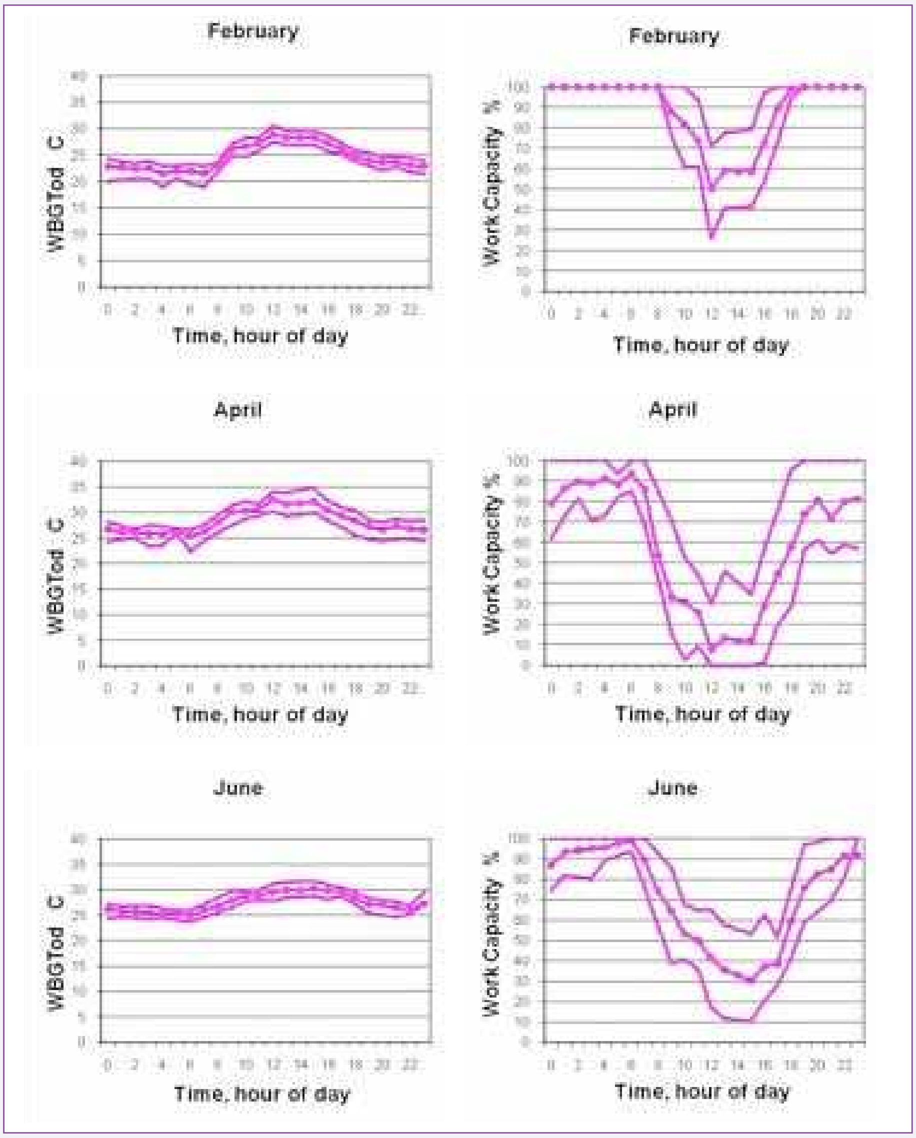

Figure 2. Chennai, India, 1999, comparison of WBGT and work capacity (%), for three months with different heat exposure. (middle curve = mean value, upper and lower curves = 90 and 10 percentiles; work intensity = 500W).

These changes in work capacity are particularly prominent in work situations where WBGT is in the range 26–35 °C, as below this range extra rest periods are not required, and above this range work capacity is very low. Already after a few minutes work at WBGT as high as 35 °C, a worker cannot cope without special protective clothing and air cooling. One example is a study of tobacco manufacturing workers in India exposed to a high heat level (18). They lost 9% of their hourly production rate for each degree increase of heat exposure.

Global and regional mapping of occupational heat exposure

Maps have been produced of calculated indoor WBGT levels in selected global regions: Australia, South Asia (India and neighbouring countries), Southern Africa, and the Mexican Gulf region (19). Data used for the calculations are from 0.5 x 0.5 degree (50 x 50 km squares at the equator) global gridded climate data for 1960 to 2002 from the Climate Research Unit (CRU) at the University of East Anglia, Norwich, UK. Regression lines were fitted to the data from each month for 1960 to 2002 to calculate a regression average for 2000 and 1975.

Figure 4 presents the monthly average afternoon indoor WBGT levels during three hot months in another part of the world: South-East Asia and East Asia. It is clear that heat exposure in parts of Indochina in particular, have increased dramatically between 1975 and 2000. If we add 3 °C to the indoor WBGT values for 2000 (Figure 3), we get heat exposure levels similar to what may occur later this century due to climate change. The area at risk of extreme heat in Indochina would extend in size, and large parts of China will be in the high risk category (Figure 4). Work outdoors without protection from direct heat radiation from the sun also adds approximately 3°C to the WBGT, so the maps at the bottom indicate how much heat exposure may already occur for outdoor workers on sunny afternoons in this part of the world.

Using the calculation formulas for indoor WBGT and the resulting gridded maps of heat exposure estimates as in Figure 3, we are proceeding with calculations of the heat impacts on occupational health and productivity in different regions of the world (a WHO-sponsored project to be completed in the middle of 2011). Further information about these impact assessments is provided in the article by Kjellstrom et al. (20) in this newsletter.

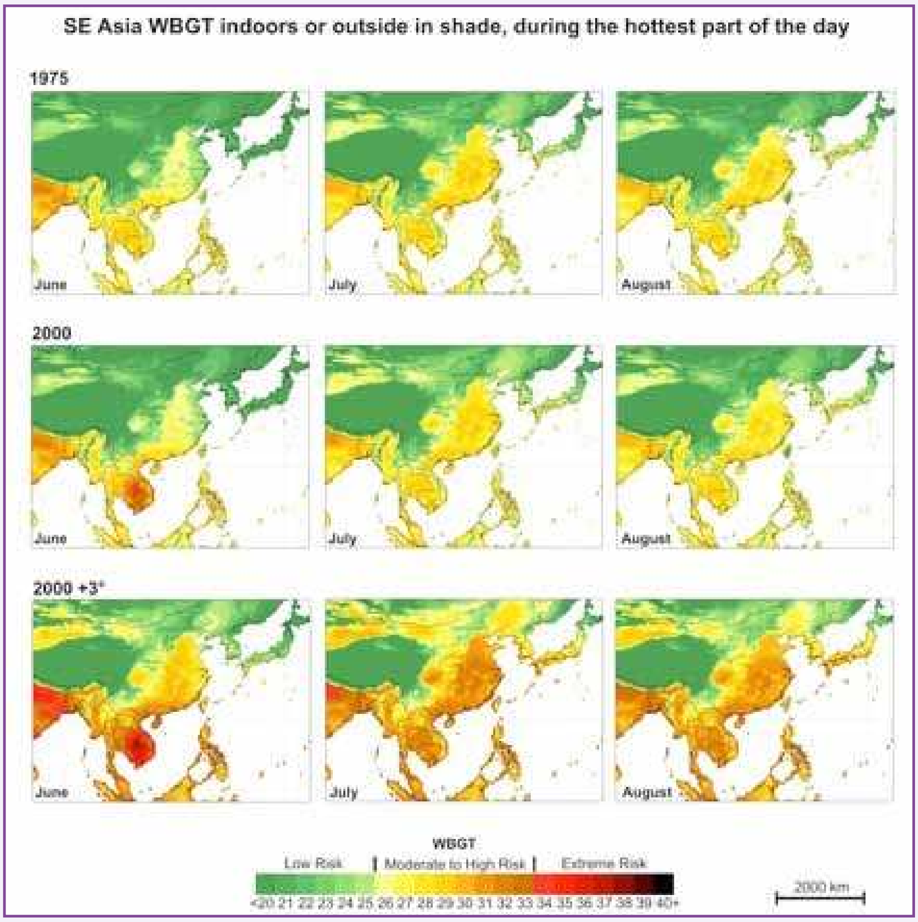

Figure 3. Monthly average afternoon indoor heat exposure (WBGT) in Asian workplaces without cooling systems.

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Progress in the Hothaps program assessing impacts and prevention of heat effects on working people in relation to local climate change

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Jon Oyvind Odland, Norway
Maria Nilsson, Sweden

Photo by Tord Kjellstrom

Sugar cane cutting by hand. This type of farm work has to be carried out during the hottest part of the year and work intensity is very high.

High Occupational Temperature, Health, and Productivity Suppression (Hothaps)

The Hothaps programme has been developing since 2008 (1) and it focuses on impacts of occupational heat exposure, how these can be reduced and how climate change may increase the exposures. Hothaps is an important health issue already now during the hot seasons in many places around the world (particularly in tropical areas) and it will become even more important as climate change makes many of these places hotter and hotter and hotter. These issues are described in detail in two articles in this newsletter (2, 3). The basic occupational health science issues concerning heat and health are presented in the excellent book by Parsons (4).

The programme is designed to carry out research and impact analysis on direct effects of heat exposure on working people (including gender aspects and effects on pregnant women and on working children). It aims to quantify the likely increase of exposures and effects due to climate change in different locations around the world (focus on Tropical low and middle-income countries), and to identify and promote feasible ways to reduce exposures and effects. Analysis is also carried out of the broader links between climate change and the health and productivity of working people in a variety of geographic settings, including Tropical and Circumpolar (mainly Arctic) areas.

A research and action programme

Hothaps includes studies that:

- Develop improved methods for human heat exposure assessment
- Measure and model such exposures in different parts of the world
- Test methods to measure effects on health and human performance (particularly physical activity and work capacity) due to heat, including studies of working children and pregnant women
- Apply such methods in local field studies of exposures and effects, focusing on workplaces in tropical areas
- Quantify the exposure-response relationships for direct heat effects and other workplace related effects of climate change
- Analyse the age-specific and gender specific impacts of heat exposures, including studies of pregnant women and working children
- Describe occupational health and safety issues influenced by climate change in different geographic regions (focusing on Tropical and Circumpolar areas)
- Use climate change modelling carried out by others to estimate future heat exposures and impacts on health and human performance of working people in a variety of locations (using globally gridded data)
- Estimate the "burden of disease" of climate change related to occupational heat exposure
- Estimate the economic consequences of these Hothaps impacts
- Describe the history and local cultural aspects of heat impacts on working people and how negative impacts can be prevented
- Link to other bio-meteorological research on the biological mechanisms and clinical consequences of effects of heat exposure.
- Link to studies of the built environment and workplace management to reduce excessive heat exposure in the future.

Only part of this research, analysis and action has been started and much work is needed before it can be integrated into future international assessments of the impacts of climate change. At the starting stage methods descriptions, guidance materials and proposed research protocols will be made available. Results of the research will be published as soon as it is finished, and these publications will be offered to be used in the next IPCC Assessment Report (to be published in 2013 or 2014). Progress reports are also planned for presentations at selected scientific conferences in 2011 and 2012.

The programme was initiated as a part of the Climate Change and Health research programme at the National Centre for Epidemiology and Population Health, Australian National University (under the leadership of Professor Tony McMichael). It is now implemented in collaboration particularly with the

University of Tromsø, Norway, and the Umeå University, Sweden. Several other partner research groups are located in low and middle-income countries, which include India, Thailand, Nepal, and Vietnam in the Asia-Pacific region.

New partners welcome

The Hothaps programme provides a proposed protocol for local field studies and encourages research and preventive actions at local level. The papers by Kjellstrom et al. (1, 5) give further details about the programme, and the websites for the participating universities also provide information. Interested occupational health scientists and professionals may also wish to email kjellstromt@yahoo.com.

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Trade union policies on climate change:

Relation to occupational health and safety

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A global challenge for trade unions

This article is based on information found in English on the internet. It gives an overview of the actions trade unions are undertaking on climate change with a particular focus on climate related occupational health and safety issues. A key question is whether any attention is being paid to the effects of rising temperatures on working people, particularly on those workers carrying out heavy labour in tropical countries where air temperature and humidity are already high and increasing (1). Worker heat exposure has been a neglected aspect of climate change and health in all international reviews to date (2).

Given the global nature of climate change it is not surprising that the most comprehensive trade union information is available from international confederations, particularly the ITUC (International Trade Union Confederation) and TUAC (Trade Union Advisory Committee to the OECD). Another important source of information is Sustainlabour (3), a trade union organization specifically established to involve trade unions in environmental debates. Additional information has come from the ILO (International Labour Organisation), and UNEP (United Nations Environment Programme).

The training manual "Climate Change, its Consequences on Employment and Trade Union Action" (2008) is a major source of information. This manual was developed under a project "Strengthening trade union participation in international environmental processes", jointly implemented by UNEP and Sustainlabour (3), in collaboration with the ITUC, the ILO, World Health Organization (WHO) and the Government of Spain. This is a very comprehensive document designed to enhance understanding of climate change and related mitigation and adaptation issues and their consequences on employment.

Union activities on climate change

Already in 1992 in the Rio Earth Summit's Agenda 21 (Chapter 29.1)(4), the importance of strengthening the role of workers and their trade unions in sustainable development is highlighted: "As their representatives, trade unions are vital actors in facilitating the achievement of sustainable development in view of their experience in addressing industrial change, the extremely high priority they give to protection of the working environment and the related natural environment, and their promotion of socially responsible and economic development". Other recommendations in Chapter 29 include: that the overall objective should be poverty alleviation and full and sustainable employment; the ratification of relevant ILO conventions, particularly on freedom of association; the establishment of bipartite and tripartite mechanisms on safety, health and sustainable development; the reduction of occupational accidents, injuries and diseases; increased workers' education, training and retraining, particularly in the area of occupational health and safety and environment (Agenda 21) (4).

UNFCC Conferences in Copenhagen 2009, and Cancun 2010

More than 400 trade unionists participated in activities related to the UNFCC Conference in Copenhagen, mostly from Europe, but also from both North and South America, Africa and Asia and Pacific regions. The World of Work (WOW) pavilion featured a wide range of events organized by trade unions from around the world. Themes included energy conservation in Japan; green jobs in India; low carbon industrial policies in Europe; women workers and green jobs; climate justice; sustainable transport policies in Spain; challenges for the power generation sector; the role of public services and many more. More than 1,000 people attended events in WOW. However, in contrast to the flexibility and inclusiveness of the UNFCCC process, trade unions were disappointed by the massive exclusion of most of civil society from the UN conference centre for the final four days of COP15. However, there was support from many governments for the inclusion of reference to Decent Work and a Just Transition to Decent Work and quality jobs for workers all over the world (ITUC article, Outreach, Special Post COP15 Issue, Stakeholder Forum)(5, 6).

There were 173 trade unionists participating in the UNFCC COP16 meeting in Cancun. The international trade union movement shared two major objectives for the Cancun meeting: to support balanced decisions including on emission reductions in developed countries, finance and adaptation and to ensure that key labour issues were included in these decisions. Governments' ambitions in terms of finance and emission reductions by developed countries remained low. However, more positive outcomes were a confirmation by governments to limit the global temperature increase to below 2 °C and a recognition in the final text of the linkage between climate change and social issues, notably employment, including Just Transition, equity, decent work, respect for human rights including indigenous peoples' rights (ITUC, Trade Unions at the UN Framework Convention on Climate Change, UNFCC – COP16, 2011) (5).

Priorities identified by unions in Copenhagen (2009) and Cancun (2010)

- Adaptation strategies that will reduce vulnerability to climate change. Adaption will require substantial investment in the most vulnerable sectors (water, health, agriculture, etc.) and is seen to principally provide local benefits. Workers and workplaces need proactive and preventive policies to be put in place regarding adaption and the potential impacts of mitigation policies.
- Sufficient public funding to be allocated by developed countries to adaptation in developing countries. Social protection schemes, the promotion of Decent Work and quality public services, including health services, are fundamental.
- A binding international Agreement stating the level of emission reductions to be accomplished by 2020 by developed countries in line with the need for keeping temperature increases below 2 °C, requiring a 25-40% reduction on the basis of 1990 emission levels, as well as ambitious and measurable actions in major emerging economies. Unions are still working towards a legally binding framework following the meetings in Copenhagen and Cancun, while it is acknowledged that there is still a long way to go for the UN to agree on such a framework. Unions are committed to continue work on a legally binding treaty by the UNFCC meeting in Durban in 2011.
- Clear acknowledgement of the need to ensure social justice in the transition towards a low-carbon and climate-resilient economy. The ILO's programme on Decent Work is a tool for trade unions to help eradicate poverty and accomplish the UN Millennium Development Goals. Trade unions are taking leading roles to better integrate sustainable development with occupational health and safety for workers under the Decent Work agenda.
- A transformation by the trade union movement itself to find ways and means to educate its members about climate change so that they have the knowledge and skills to actively participate in decision making and negotiation. This is particularly challenging for developing country unions.
- Extension of labour rights to the whole labour force. There are a number of ILO conventions that are relevant to the climate change agenda because they have a direct impact on the climate, e.g. the occupational safety and health conventions, primarily used to protect human health, but also the environment. Other ILO standards are indirectly related to climate change, but are highly relevant to sustainable development principles.

Occupational health policy and climate change

My particular interest was to see whether occupational health policies are developing to take account of workers' exposure to increasing heat due to climate change. Using agriculture as an example, I could not find any publications that examine the difficulties faced by workers as temperatures rise. Over 1 billion people are employed in the agricultural sector, the second greatest source of employment worldwide after services. The only papers available were written about the effects of heat waves on workers (7).

There is an international standard, ISO standard (ISO 7243, 1989) that puts strict limits on the levels of exposure to heat that workers should be exposed to. Government agencies such as ACGIH in the USA, have established a Threshold Limit Value (TLV) and a limit to prevent workers' body temperature from exceeding 38.5 °C for acclimitized workers. There are many government guidelines throughout the world on working in heat that include provisions for hydration, protection measures and rest breaks, but very few define a maximum unsafe heat exposure. Specific union policies on "Seasonal Heat" could not be found on the internet. The Transport Workers Union of Australia, Victorian/Tasmanian Branch has recommended guidelines for when the temperature goes above 30 °C (8).

There is no direct discussion of the effects of rising temperatures on productivity.

Conclusions

Trade unions are clearly committed to addressing the economic, social and environmental issues associated with climate change in both industrialized and developing nations. Their participation in the UNFCC process has been a positive force towards the recognition of the linkage between climate change and social issues, particularly employment. Trade unions are using the Decent Work agenda to better integrate sustainable development with occupational health. However, there seems to be little attention paid to the issue of rising occupational heat exposure affecting the health and productivity of working people.

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Participatory approaches to improving occupational safety and health and preventing influenza of migrant workers in Thailand

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Photos by ILO

Training was carried out in the workers' dormitory for their convenience.

A migrant worker learns how to fit a mask properly.

Migrant workers identify existing good OSH/influenza practices and areas that could be improved.

Migrant workers at work in a small-scale factory.

Migrant labour is an increasingly integral part of the Thai and regional economy. The demand for labour continues to be strong and will likely increase in both Thailand and the region. With 2.5–3 million migrant workers estimated to be living and working in Thailand already, the implications on social, economic and political life become apparent very quickly.

Within the framework of the ILO influenza project, we are presently conducting pilot Occupational Safety and Health (OSH) and Influenza training targeted at workplaces that utilize migrant labour (predominantly from Burma/Myanmar), particularly in the Small and Medium Enterprise (SME) sector. Our project team has approached workplaces using migrant labour and undertaken small-scale technical pilot training on OSH with a component on reducing the risk and spread of pandemic and seasonal influenza. The training used a participatory methodology similar to ILO's WISE (Work Improvement in Small Enterprises) programme encouraging workers and employers to apply action-checklists to jointly identify existing good practices and practices that could be improved upon.

From 29–30 November 2010, two technical training sessions were conducted in Samut Sakorn Province, which saw migrant workers and their employers partner up to find practical solutions to improve Occupational Safety and Health (OSH) and influenza prevention in the workplace.

The main aim of this training was to benefit both employers and workers by identifying cost-effective and practical methods to reduce the risk of OSH incidence at the workplace level and to also incorporate best practices and training to decrease the risk of influenza occurrence in the workplace and at home.

Workers engaged interactively by performing a checklist of common OSH and influenza issues and proposing if any action was required. Workers were able to identify existing good practices and areas that could be improved upon.

The results and demand for this type of training have been surprising and encouraging. In particular the workers engaged have demonstrated great enthusiasm for the training and requested that the ILO return to undertake further training. Similarly employers have found it useful for the ILO to provide technical advice in a way that is simple and easy-to-understand. This type of participatory approach can lead to greater confidence on behalf of workers in the workplace. This is essential for industries facing labour shortages – presently a common phenomenon in Thailand.

Experiences from this training have contributed to the (ongoing) development of a training tool designed specifically for migrant workers and their employers: the Work Improvement for Migrant Workers and their Employers (WIMWE) manual. It is designed to respond to an immediate need for the improvement of OSH conditions and influenza preparedness and awareness of migrant workers and the enterprises they work in. When complete the manual will provide them with practical, easy-to-implement ideas to improve their safety, health and working conditions. These improvements will also contribute to higher productivity and efficiency at the workplace and promote active cooperation between workers and employers.

Up-skilling workplaces through increasing knowledge and good practices in OSH/Influenza has proven to be a positive entry point to promote Decent Work.

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