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# Chemicals and climate change in the world of work: Impacts for occupational safety and health

Research report







# **Chemicals and climate change in the world of work: Impacts for occupational safety and health**

Research report

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## ► Executive Summary

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Climate change has profound impacts on, and synergies with the world of work, especially regarding the sound management of chemicals. Many chemicals that are produced and utilized in the workplace can have impacts on the environment and climate, with climate change in turn impacting the ability to safely store, transport and use chemicals.

Appropriate climate change adaptation and mitigation measures are needed as a matter of urgency. The inclusion of a 'safe and healthy working environment' as an ILO fundamental principle and right at work (FPRW) provides a framework for action to tackle emerging risks to workers from climate change, through a systems approach to managing occupational safety and health (OSH). Addressing harmful chemical exposures in the working environment through effective OSH policies and practices are a top priority for advancing climate change agendas and ensuring decent working conditions.

### ► Several key lessons emerge from this report

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- The effects of climate change can threaten progress towards decent work by leading to a deterioration of working conditions. It has the potential to bring a host of new risks to the world of work, and can influence the use of hazardous chemicals.
- Several impacts of climate change on worker safety and health and the use of chemicals in the world of work were identified, including heat stress, air pollution, ozone depletion, increases in pests and vector-borne diseases, soil infertility, and a higher risk of major industrial accidents. Workers are likely to face increased risks related to toxic chemicals due to climate and environmental changes.
- Numerous health conditions in workers have been linked to climate change, including cancers, cardiovascular disease and respiratory illnesses.
- The risks and hazards associated with environmental degradation and climate change tend to affect workers in vulnerable situations most strongly. Those in low- and middle-income countries (LMIC) and outdoor workers, in sectors such as construction and agriculture, will be particularly impacted.
- Priority actions, at both national and workplace levels, should constantly evolve to consider new evidence for these emerging risks.
- Climate change concerns should not be considered as an afterthought, but instead should be integrated into OSH policy, programmes and profiles at all levels.
- International labour standards and social dialogue play an important role in addressing the challenges associated with climate change and chemicals exposure.
- Comprehensive workplace programmes and strategies are essential for protecting workers, with workplace measures implemented according to the Hierarchy of Controls.

# ► Introduction

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Chemicals are integral to almost all areas of society and are used across all economic sectors. Every year more than 1 billion workers are exposed to hazardous substances in the workplace, including pollutants, dusts, vapours and fumes (ILO 2021). In 2015 alone, hazardous substances claimed the lives of almost 1 million workers, with many more subjected to lifelong and debilitating chronic conditions (Hämäläinen et al. 2017).

Anthropogenic chemical pollution has devastated the environment, endangering global ecosystems upon which life depends. There is alarming evidence that important tipping points, leading to irreversible damage may already have been reached or passed (Persson et al. 2022). Undeniably, greenhouse gases, climate change and contaminants in the air, water and soil are, to a large degree, caused by chemicals. Industrial sources of hazardous chemicals, including heavy metals, plastics and pesticides, have contributed significantly to this burden, which now poses one of the largest environmental threats to humanity (Naidu et al. 2021).

The world of work faces new and emerging challenges from climate change, with workers in numerous industries impacted. Action is needed to protect the health of workers and the planet, whilst maintaining a resilient global economy, employment opportunities and decent work for all.

## ► Aim of this report

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The sound management of chemicals and waste is directly linked to the world of work and ultimately the natural environment. This report aims to explore the complex interlinkages between occupational chemical use, climate change and the health of workers in different sectors. Understanding these relationships will be key to developing effective and evidence-based policies and practice. It will identify the key climate change issues likely to influence the world of work and provide priority actions for protecting workers from these risks and the associated chemical hazards.





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## ► Pollution from chemicals in the world of work

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The chemical industry is the world's second largest production sector, with global sales valued at US\$5.68 trillion in 2017 (UNEP 2019). It has a long history of steady growth of about 4 to 4.5 per cent per year, with new chemicals constantly being produced (UNEP 2019).

The chemical sector is the largest industrial energy consumer and the third biggest industry subsector in terms of direct carbon dioxide emissions (IEA 2022). Greenhouse gases, such as carbon dioxide, are emitted at every stage of a chemical's lifecycle, including production, use and waste. For instance, perfluorinated chemicals (PFAS), a toxic 'forever chemical', emits HCFC-22, a greenhouse gas that is 5,000 times more potent than carbon dioxide (Chem Trust 2021). The industry's production capacity nearly doubled to around 2.3 billion tonnes between 2000 and 2017 (Cayuela and Hagan 2019), indicating potential future increases in the quantity of chemicals produced.

Trillions of tonnes of chemicals are discharged into the environment by different sectors, including mining, agriculture, construction and energy (Naidu et al. 2021). The petrochemical industry specifically is projected as one of the main drivers of increases in fossil fuel demand in the next decade (IEA 2018). The world's worst polluting industries are shown in Figure 1.

Evidence suggests that chemical pollutants can migrate globally in air and water, in human and animal vectors, in waste materials, and in nanoparticles, such as microplastics (Naidu et al. 2021). Whilst the environment has a certain capacity to biodegrade some toxic substances, others are resistant to decomposition processes and cause long-term environmental damage, as well as accumulating in food chains. Chemical emissions, therefore, have serious and lasting detrimental impacts on the climate, environment and ecosystems.

More than nine million people die prematurely each year – one in six deaths – due to contamination of the air, water, food, homes, workplaces and consumer goods (Landrigan et al. 2018). Excess deaths due to pollution caused economic losses totalling US\$4.6 trillion in 2019, which equated to 6.2 per cent of global economic output (Landrigan et al. 2018). 92 per cent of pollution-related deaths and the greatest burden of economic losses occur in low- and middle-income countries (LMIC) (Fuller et al. 2022).



► **Figure 1: The world's worst polluters**

A 2016 report by Pure Earth and Green Cross Switzerland identified that a staggering 200 million people in the developing world face health risks from industrial pollution. It highlighted the top ten worst polluting industries, which are responsible for 7 to 17 million disability adjusted life years (DALYs) in LMIC. Whilst figures represent the disease burden in the general population, they provide a useful indication of the industries which may put worker health most at risk. It is likely that workers are disproportionately impacted by hazardous substances, as they may be exposed to higher concentrations of chemicals over longer periods. Workers in LMIC are particularly impacted, as occupational safety and health (OSH) and social protections may be limited or non-existent.

Rank	Industries	How workers are exposed to hazardous chemicals	Examples of potential chemical pollutants
1	<b>Used lead acid batteries</b>	Chemicals are released in manual recycling processes, such as breaking batteries and smelting metallic components.	Lead
2	<b>Mining and ore processing</b>	Chemicals used in mining or processing activities and those produced as by-products.	Lead, arsenic, cadmium, mercury, hexavalent chromium
3	<b>Lead smelting</b>	Chemicals are emitted during smelting processes.	Lead, cadmium, mercury
4	<b>Tanneries</b>	Chemicals used in the tanning process are released in wastewater, leading to contaminated food and water.	Hexavalent chromium
5	<b>Artisanal and small-scale gold mining</b>	Chemicals are released during the heating of amalgam and other processes. Food sources may also be contaminated.	Mercury
6	<b>Industrial dumpsites</b>	Waste-pickers and scavengers are exposed to chemicals from products, in the form of leachate, dust and gases.	Lead, hexavalent chromium
7	<b>Industrial zones</b>	Exposures are industry dependent, however may be from chemical processes, waste products and dust.	Lead, hexavalent chromium
8	<b>Chemical manufacturing</b>	Workers may be exposed from emissions, accidental spills and waste products.	Pesticides, volatile organic compounds, heavy metals
9	<b>Product manufacturing</b>	Worker exposures depend on product type and chemicals used but may be from inhalation of contaminated dust and gases, the burning of solid waste and emissions from energy sources.	Lead, mercury, hexavalent chromium, dioxins, volatile organic compounds, sulphur dioxide
10	<b>Dye industries</b>	Workers may be exposed when handling dyes and from ingestion of contaminated water and food.	Lead, mercury, cadmium, chlorine compounds

## ► **Climate change threats in the world of work**

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Today, 1.2 billion jobs or 40 per cent of the global labour force are at risk because of environmental degradation (ILO 2018a). Between 2000 and 2015, 23 million working-life years were lost annually because of various environment-related hazards, caused or exacerbated by human activity (ILO 2018b). As global warming intensifies, it will damage infrastructure, disrupt business activity, and destroy jobs and livelihoods. It is a direct threat to the growth of real gross domestic product (GDP), as well as to labour productivity and working conditions (ILO 2019a). However, responding to these challenges has the potential to boost economies and improve the quality of working lives. ILO studies have shown that implementing the Paris Agreement on Climate Change could create a net gain of 18 million jobs by 2030 (ILO 2018a).

All regions of the world are impacted by climate change, with shifting weather patterns threatening food production and water availability, and rising sea levels increasing the risk of catastrophic flooding (IPCC 2021).

The relationship between climate change and the world of work is influenced by three crucial aspects (ILO 2018b):

- Jobs rely on the services ecosystems provide (e.g. freshwater provision and biodiversity). Climate change threatens the provision of vital services, thus endangering jobs which depend on them.
- Jobs and decent working conditions depend on the mitigation of environmental hazards (e.g. extreme weather events and air pollution) and the maintenance of environmental stability (e.g. normal temperatures and precipitation patterns).
- The risks and hazards associated with environmental degradation will impact workers in vulnerable situations the most (e.g. women, child labourers and people with disabilities).

Numerous sectors will be affected by the negative impacts of climate change, including those which are heavily dependent on natural resources, such as agriculture and forestry. Fisheries will be negatively influenced by ocean acidification and changing ocean temperatures. Natural disasters will destroy critical infrastructure and take lives, disrupting sectors such as energy and water providers, construction, transport and tourism. There will be increased pressure on emergency services, the health care sector and other public services. An upsurge in extreme weather events will be a concern for banking and insurance companies.

## **Climate change and occupational safety and health (OSH)**

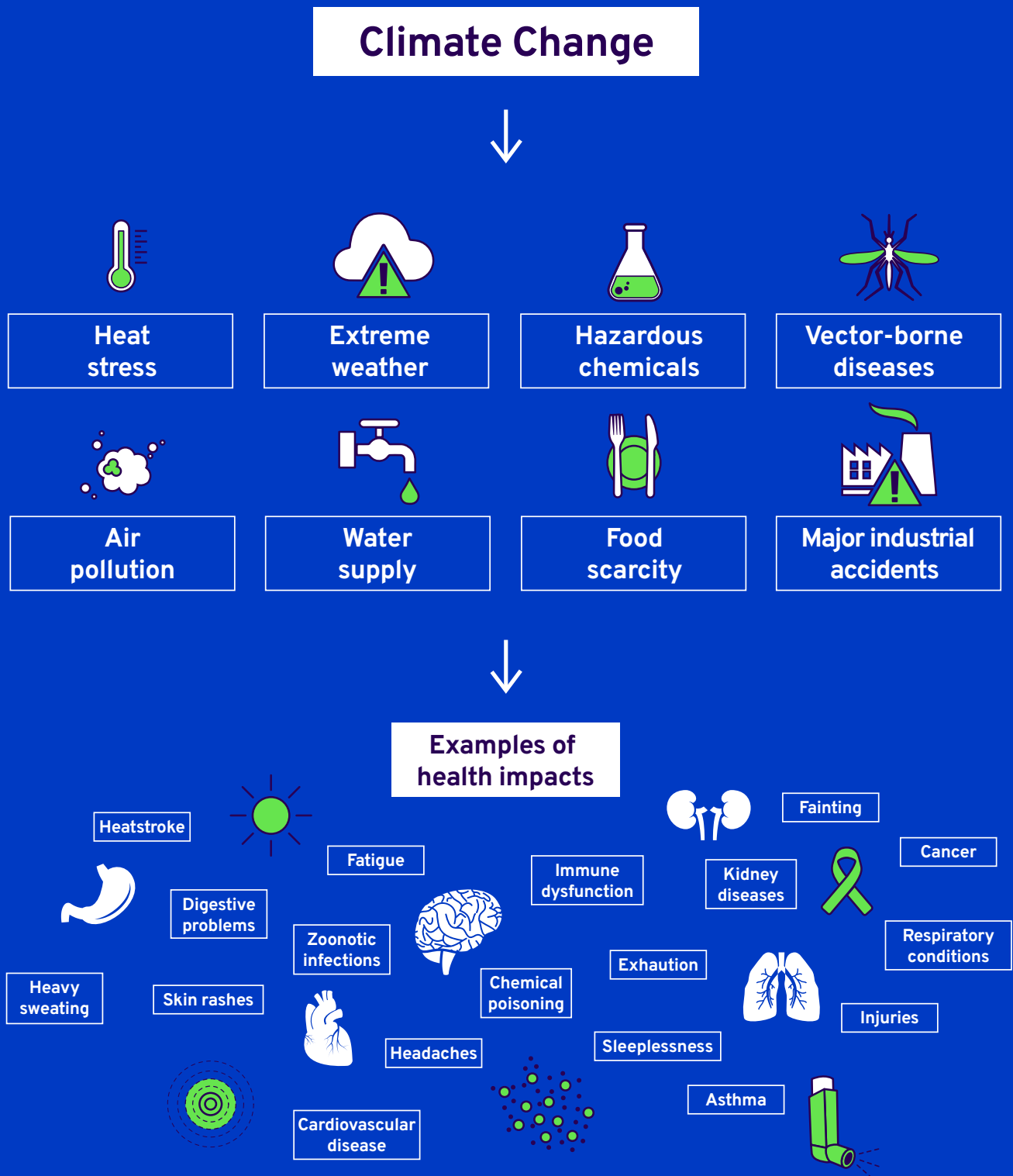
Climate change can influence human health directly and also indirectly through the ecosystem, with negative effects leading to a deterioration of working conditions and threatening progress towards decent work. Strong evidence demonstrates that climate change and environmental degradation present an increased risk of occupational injury, disease and death (Kiefer et al. 2016).

Workers are often the first to be exposed to the effects of climate change, for longer durations and at greater intensities. They are also frequently exposed to conditions that the public can choose to avoid (Kiefer et al. 2016). Numerous health conditions in workers have been linked to climate change, including cancer, cardiovascular disease and respiratory illnesses (Figure 2). Mental health will also be impacted (Charlson et al. 2021).

Aside from workers' well-being, consideration should also be given to impacts on work performance, such as decreased productivity, increased costs of production, accidents and injuries, and absenteeism (Habibi et al. 2021).

Workers in developing countries with a large informal sector workforce, inadequate OSH regulations and highly physical jobs are particularly vulnerable. OSH risks may be further exacerbated for migrant workers due to reasons such as cultural and language barriers. These workers are least able to afford the consequences of climate change.

► Figure 2: Main occupational health risks associated with some climate change hazards



## ► **Key impacts of climate change and chemicals on worker safety and health**

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Climate change has profound impacts on the world of work, especially regarding the sound management of chemicals. Many chemicals that are produced and utilized in the world of work can have impacts on the environment and climate, with climate change in turn affecting the ability to safely store, transport and use chemicals.

Seven key impacts of climate change on worker safety and health and the use of chemicals in the world of work have been identified and will be explained in the upcoming section.

1. Heat stress
2. Air pollution
3. Ozone depletion
4. Pests and pesticides
5. Infertile soil and fertilizers
6. Vector distribution and ecology
7. Major industrial accidents (MIA)

### ► **1. Heat stress**

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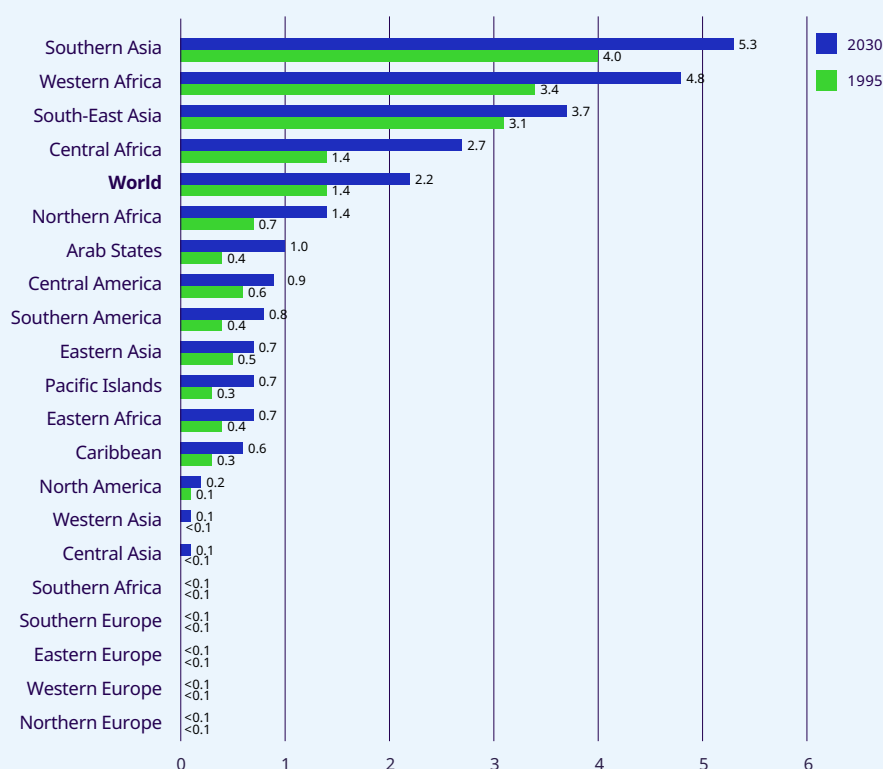
Heat stress refers to heat received in excess of that which the body can tolerate without suffering physiological impairment. The rise in global temperatures will make 'heat stress' more common.

Countries most affected by heat stress have higher rates of working poverty, informal employment and subsistence agriculture. The impact of heat stress is unevenly distributed geographically, with the expected reduction in working hours in 2030 amounting to around 5 per cent in both Southern Asia and Western Africa (ILO 2019a) (Figure 3).

Workers in all sectors will be impacted, but those most at risk include outdoor workers in physically demanding jobs and indoor workers inside factories and workshops, where temperature is not regulated (ILO 2019a). Agricultural and construction workers are expected to fare the worst, accounting for 60 per cent and 19 per cent, respectively, of working hours lost to heat stress in 2030 (ILO 2019a). Also workers in heavy clothes or protective equipment will suffer, for example, pesticide spreaders and firefighters.

Workers of all ages are susceptible to the ill effects of heat stress, even younger populations (Ansah et al. 2021). Older adults are especially affected however, due to reduced heat tolerance and poorer aerobic capacity (Lundgren et al. 2013). Workers in vulnerable situations, including child labourers and pregnant workers, are also at particular risk.

► **Figure 3: Working hours lost to heat stress by subregion, 1995 and projections for 2030 (percentages) (ILO 2019a)**



Sources: ILO estimates based on data from the ILOSTAT database and from the HadGEM2 and GFDL-ESM2M climate models (using as input the RCP2.6 climate change pathway, which envisages a global average temperature rise of 1.5°C by the end of the century).

## Impact on worker safety and health

Heat stress restricts a worker's physical functions and capabilities, work capacity and productivity. Excessive heat can increase OSH risks, impacting physical, as well as mental health. It can lead to heat stroke, heat exhaustion, rhabdomyolysis, heat syncope, heat cramps, heat rash and even death (NIOSH n.d.). It is also associated with changes in the way chemicals are processed by the body, which can worsen any toxic effects. For example, absorption of chemicals into the body may be increased due to the elevation in pulmonary ventilation and vasodilation, and a reduction in urinary excretion may lead to a retention of chemicals in soft tissues (Leon 2008).

Chemical agents can affect thermoregulatory mechanisms, which could reduce workers' capacity to adapt to thermal stress (Truchon et al. 2014). For example, vasoconstricting substances, such as lead and inorganic compounds, can hinder heat dissipation (Vyskocil et al. 2005). Organophosphorus compounds and carbamates can cause acetylcholinesterase inhibition, which can modify responses associated with maintaining body temperature, such as skin blood flow, heart rate, respiration and sweat secretion (Leon 2008). Pentachlorophenol (PCP) can cause increases in metabolism, body temperature and sweating (Gordon 2005).



### ► Case study: Heat stress and heavy personal protective equipment (PPE)

Heat stress is a concern for those wearing heavy PPE whilst dealing with hazardous chemicals. Havenith et al. (2011) looked at improvements to protective clothing to alleviate heat strain, whilst maintaining protection against chemicals. Selectively permeable membranes with low vapour resistance were compared to textile-based outer layers with similar ensemble vapour resistance, and also layers with increased air permeability. Heat strain was shown to be significantly higher with selectively permeable membranes, compared to air permeable ensembles. This was reflected in higher values of core and skin temperatures, as well as heart rate. Based on protection requirements, it is concluded that air permeability increases can reduce heat strain levels, allowing optimization of chemical protective clothing.

### Special focus: Chronic kidney disease of unknown aetiology (CKDu) in tropical countries

Epidemics of chronic kidney disease of unknown aetiology (CKDu) are affecting large numbers of workers conducting heavy manual labour in hot temperatures. CKDu has emerged in hot, rural regions of the Americas, Africa, the Middle East and India, where abnormally high numbers of agricultural workers have begun dying from irreversible kidney failure. It could be caused by a combination of factors, such as heat exposure and dehydration, chemicals, poverty and malnutrition. Over 30 factors have been proposed as causative, including agrochemicals and heavy metals (Wimalawansa et al. 2019). Conditions such as, having favourable climatic patterns, adequate hydration, and less poverty and malnutrition seem to prevent the disease (Wimalawansa et al. 2019). However research to pinpoint the risk factors associate with CKDu is not standardized and varies by geographical region (Redmon et al. 2021). A harmonized approach to research is needed to provide a better understanding of the condition.

## ► 2. Air pollution

Different air pollutants increase global warming, and global warming leads to formation of air pollutants (Schulte et al. 2016). For example, higher temperatures can lead to an increase in ground-level ozone or smog, and also particulate matter. The most common pollutants considered in air pollution estimates include fine (PM<sub>2.5</sub>) and course (PM<sub>10</sub>) particulate matter, ozone, nitrogen dioxide (NO<sub>2</sub>), and sulphur dioxide (SO<sub>2</sub>). Globally, over 1.2 billion workers spend most of their working hours outdoors, at risk of exposure to outdoor air pollution (WHO 2018a). Indoor workers are also impacted by poor quality air in their work environments.

## Impact on worker safety and health

860,000 deaths a year can be attributed to occupational exposure to air pollutants, although the real magnitude is likely to be much higher (WHO 2018a). The 2021 ILO Global Review linked ambient air pollution to numerous health impacts (ILO 2021). The IARC has classified air pollution, and particulate matter, as carcinogenic to humans (Group 1) and has found sufficient evidence that air pollution can cause lung cancer (IARC 2013a). For lung cancer alone, air pollution causes 223,000 deaths per year worldwide (IARC 2013b). Air pollution has also been linked to stroke, heart disease and both chronic and acute respiratory diseases, including asthma. Outdoor workers in hot environments have increased respiratory rates and thus may be more affected by air pollution than other members of the general population (Schulte et al. 2016).

### ► 3. Ozone depletion

The gradual thinning of Earth's ozone layer in the upper atmosphere is caused by the release of chemical compounds containing gaseous chlorine or bromine, from industry and other human activities. The Montreal Protocol, ratified in 1987, was the first of several comprehensive international agreements enacted to halt the production and use of ozone-depleting chemicals.

## Impact on worker safety and health

Ozone depletion is a major health concern, because it increases the amount of ultraviolet (UV) radiation that reaches Earth's surface. This is a particular problem for outdoor workers, who are at higher risk of adverse health impacts such as sunburn, keratinocyte cancers, melanoma, cataracts and pterygium (Wright and Norval 2021). Outdoor construction workers, for example, can accumulate sufficient solar UV exposure over 30-40 years of work, to more than double their risk of non-melanoma skin cancer (Cherrie et al. 2021). Other high-risk occupations include lifeguards, power utility workers, gardeners, postal workers and dock workers, among others (John et al. 2020).

### ► Case study: Airline pilots and UV exposure

Pilots may be exposed to solar radiation for periods of many hours during flight where UV radiation is known to be significantly greater. Several studies have demonstrated that airline pilots are at risk of adverse health effects in their eyes from exposure to UV radiation (Schulte et al. 2016). Hammer et al. (2009) observed evidence of increased melanoma and brain cancer occurrence in professional pilots, whilst Chorley et al. (2011) found that pilots flying during the daytime are exposed to 2 or 3 times more solar radiation at cruising altitudes, than at sea level.

Furthermore, UV radiation increases by 10–12 per cent for every 1,000 meters of altitude and thereby subsequently affects pilots (Chorley et al. 2014). Although pilots are protected by the aircraft windshield which blocks most UVB radiation, there is no standard for the optical transmission properties of the aircraft windshields (Schulte et al. 2016). Aircraft windshields should have a standard for optical transmission, particularly of short-wavelength radiation (Chorley et al. 2011).



## ► 4. Pests and pesticides

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Approximately 1.8 billion people are engaged in agricultural activities worldwide and most use pesticides to protect food and commercial products that they produce (Carvalho 2017). LMICs account for about 70 per cent of worldwide Highly Hazardous Pesticides (HHP) use, amounting to over 1.2 million tonnes in 2017 (Public Eye 2020). Global pesticide use has continued to grow steadily to 4.1 million tonnes per year in 2017, an increase of nearly 81 per cent from 1990 (FAOSTAT 2019).

Pesticides contribute, both directly and indirectly, to climate change. For example, fossil fuels are used in their production and transportation. Three main greenhouse gases are emitted during their production: carbon dioxide, methane and nitrous oxide (Heimpel et al. 2013). Pesticides also cause further emissions through their effects on soils, as they affect the soil's ability to sequester carbon (PAN 2021). Widely used soil fumigants such as chloropicrin can increase soil nitrous oxide emissions eight-fold (Spokas and Wang 2003).

Pesticide use is directly impacted by pesticide efficacy, crop characteristics and pest occurrence, all of which are influenced by climate change (Delcour et al. 2015):

- **Pesticide efficacy:** Climate change can reduce pesticide availability and efficacy due to a combination of increased volatilization and accelerated degradation, which are strongly influenced by a high moisture content, elevated temperatures and direct exposure to sunlight. In general, a warmer climate may necessitate an increased pesticide usage.
  - **Crop characteristics:** Food crops are sensitive to high temperatures and precipitation extremes, as well as indirect effects of the climate on soil processes, nutrients and pest organisms. This could lead to a potential increase in the volume and array of pesticides used. For example, increased temperatures will affect plant productivity and intense rainfall can damage plants and be detrimental to crop production. Climatic changes can also affect the location and availability of host plants for pest species and provide a green bridge for pests during winter.
-

- **Pest occurrence:** Temperature increases and precipitation changes are the main pest infection determinants. Climate change promotes the abundance and distribution of pests, through a rise in the number of pest outbreaks and shifts in their migration patterns and range. Plant diseases are mainly affected by temperature, rainfall, humidity, radiation and dew. For example, wet conditions encourage the germination of spores and the proliferation of fungi and bacteria. Higher temperatures can cause a geographic expansion of many species and increased atmospheric CO<sub>2</sub> concentration directly increases weeds' herbicide tolerance and severity. Stronger pesticides and more frequent sprayings may be necessary to deal with an increased prevalence of pests, diseases and weeds, causing workers to be at higher risk of hazardous exposures.

### ► Case study: Climate warming promotes pesticide resistance in the diamondback moth

Ma et al. (2021) looked at how increasing winter temperatures affect the range limits and pesticide resistance of a global pest, the diamondback moth (*Plutella xylostella*). This moth originated from South America and has spread to all other continents. It now ranges from tropic to temperate zones, causing economic loss as high as US\$ 4–5 billion per year, making it the most destructive pest of cruciferous crops around the world. The species is also famous for its strong resistance to over 97 different insecticide active ingredients.

Importantly, it can only overwinter in warm areas, from which it quickly migrates far north during the growing season, damaging local crops. By analysing experimentally parameterised and field-tested models, the study showed that climate change over the past 50 years has increased the overwintering range of this pest by approximately 2.4 million km<sup>2</sup> worldwide. Crucially, mean pesticide resistance was 158 times higher in overwintering sites compared to sites with only seasonal occurrence.

## Impact on worker safety and health

HHP use is associated with adverse health impacts in agricultural workers. WHO considers HHPs as a major public health concern (WHO 2019) and the introduction of regulations to substitute the use of HHPs with safer alternatives has saved countless lives (WHO/FAO 2019). Acute effects are related to pesticide poisonings, which occur commonly in developing economies where pesticides are often mislabelled. It is estimated that 385 million cases of unintentional, acute pesticide poisoning occur annually and 44 per cent of farmers are poisoned by pesticides every year (Boedeker 2020). A range of different pesticides have been classified by IARC as carcinogenic to humans (Group 1) and probably carcinogenic to humans (Group 2A). Other health impacts include neurotoxic effects, for example, Parkinson's disease and Alzheimer's disease, and endocrine disruption (ILO 2021).

## ► 5. Infertile soil and fertilizers

Fertilizer use can impact climate change, and climate change can also impact fertilizer use. Increased precipitation due to climate change can cause soil erosion and thus decrease essential soil nutrients such as nitrogen and phosphorus, which are essential for plant growth. Loss of fertile soil can pressure agricultural workers to increase use of chemical fertilizers and other agrochemicals, impacting safety and health. The use of nitrogen-based fertilizers in turn is driving up global emissions of nitrous oxide, a highly potent greenhouse gas which impacts global warming 300 times more than carbon dioxide (Tian et al. 2020).

### Impact on worker safety and health

Nitrogen-based fertilizers are made from ammonia, which can cause burns, laryngeal oedema, pneumonitis and pulmonary oedema, as well as permanent effects, including visual impairment and chronic pulmonary diseases (ILO 2022). White phosphorus, used in some artificial fertilizers, is extremely toxic to humans and can damage the kidneys, liver, cardiovascular system and central nervous system (EPA 2000). In addition, the unsafe storage of fertilizers is a risk for major industrial accidents, for example, as occurred in 2020, when around 2750 tonnes of ammonium nitrate stored in a warehouse at Beirut Port exploded, causing numerous deaths and injuries.

## ► 6. Vector distribution and ecology

Vector-borne diseases are responsible for more than 17 per cent of all infectious diseases, causing more than 700,000 deaths annually (WHO 2020). Changing climatic conditions, such as rainfall patterns, temperature and humidity, can impact vector-borne disease transmission, by affecting the number and survival rate of vectors. For example, higher ambient temperatures have been linked to expanded distribution of some vectors, such as mosquitoes, as well as increasing reproduction rate, biting behaviour and survival (WHO 2006). There are also indirect impacts of climate change on vector-borne diseases. These include wider effects on the natural environment and on human systems, for example, drought may change water-storage, land-use and irrigation practices (Campbell-Lendrum et al. 2015).

### ► Case study: Climate change and malaria

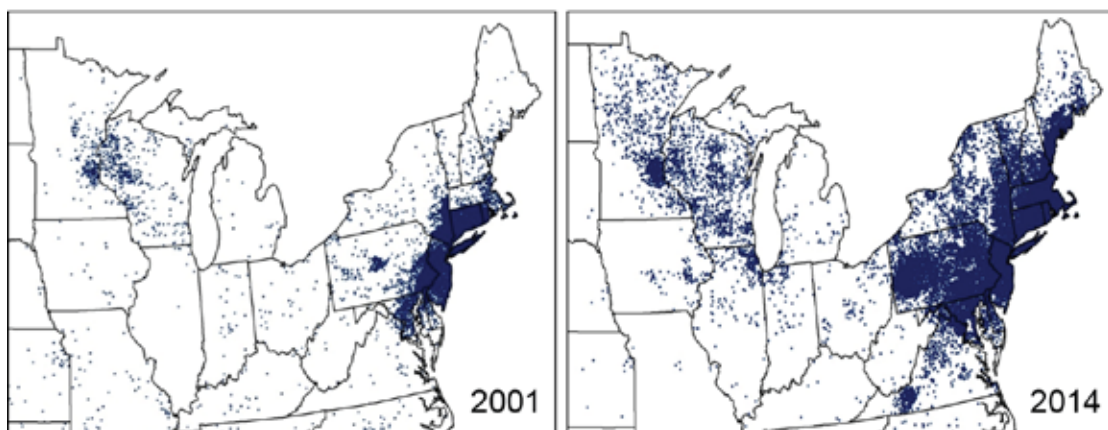
Climate change can increase opportunities for malaria transmission in traditionally malarious areas, in areas where the disease is controlled and in new areas (Fernando n.d.). An increase in temperature, rainfall and humidity may cause a spread of mosquitoes to higher altitudes, resulting in an increase in transmission in non-malarious areas (Jetten et al. 1996). At lower altitudes, where malaria is already a concern, warmer temperatures will enable the parasite in the mosquito to develop faster, thereby increasing transmission (Sutherst 1998). This means that a greater number of workers may potentially be exposed to malaria-carrying mosquitoes.



### ► Case study: Lyme disease in the United States

Lyme disease is a bacterial illness that can cause fever, fatigue, joint pain and skin rash, as well as more serious joint and nervous system complications. It is transmitted through the bite of infected ticks, that live on host animals, such as deer, rodents and birds. Outdoor workers in Lyme disease-endemic regions are at particular risk of contracting the disease, for example those employed in forestry or farming (Magnavita et al. 2022). The incidence of Lyme disease in the United States has nearly doubled since 1991, from 3.74 reported cases per 100,000 people to 7.21 reported cases per 100,000 people in 2018 (CDC 2019). Studies show that climate change has contributed to the expanded range of ticks, increasing the potential risk of Lyme disease, even in areas where the ticks were previously unable to survive (Beard et al. 2016). Warming temperatures associated with climate change are projected to increase the range of suitable tick habitats. Shorter winters could also extend the period when ticks are active each year, increasing the time that humans could be exposed to Lyme disease (EPA 2022).

#### ► Changes in Lyme disease case report distribution



Maps show the reported cases of Lyme disease in 2001 and 2014 for the areas of the country where Lyme disease is most common (the Northeast and Upper Midwest). Both the distribution and the numbers of cases have increased.

Source: CDC 2019

## Impact on worker safety and health

Outdoor workers are mainly susceptible to vector-borne diseases, as they have the highest exposure to vectors such as mosquitoes, ticks and fleas, that can transmit parasites, viruses, or bacteria (Schulte et al. 2016). High risk sectors include construction, landscaping, forestry, brush clearing, land surveying, farming, oil field and utility work, natural resources management and firefighting.

Some examples of how climate change has increased risk of vector-borne diseases for workers (Schulte et al. 2016):

- The numbers of high-risk counties for Lyme disease in the United States has increased over the last 20 years by more than 320 per cent in the north-eastern states.
- West Nile and Zika viruses, known vector-borne hazards to outdoor workers, may increase because of climate change.
- The incidence of coccidioidomycosis, a fungal disease endemic in the Southwest USA, has been associated with several outdoor occupations and has increased substantially from 1998 to 2011.

- Drought-ridden areas may lead to outdoor workers breathing more windborne dusts, which may be toxic or contain harmful organisms.
- Waterborne diarrhoeal disease is sensitive to climate variability, impacting workers in occupations such as fishing.

Increased exposure to biological hazards can lead to an intensified use of chemicals. For instance, vector control using insecticides plays a key role in the prevention and control of infectious diseases such as malaria, dengue and filariasis (WHO 2006). Workers may therefore be increasingly exposed to these hazardous chemicals. Additionally, workers may find themselves frequently working in the presence of disinfectants, which have been linked to COPD, infertility and asthma (ILO 2021).

## ► 7. Major industrial accidents (MIA)

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MIA can occur in major hazard installations, such as factories or extraction sites, which use one or more hazardous substances. They are events which occur outside the norms of the operation and include fires, explosions and uncontrolled chemical releases. Over the past decades, successive MIA caused by chemicals, have caused deaths, injuries, significant environmental pollution and massive economic losses. In Lebanon in 2020, for example, a large quantity of stored ammonium nitrate exploded, causing over 200 deaths, more than 7000 injuries and the displacement of hundreds of thousands of people. The impacts of climate change have the potential to increase the occurrence and severity of MIA.

Rising temperatures due to climate change can increase volatility of temperature-sensitive chemicals, which could lead to accidents (Truchon et al. 2014). Temperatures inside non-insulated, single skin chemical storage containers can reach as high as 50°C, when the ambient temperature is around 30°C. 'Thermal runaway', exponentially increased heat from a thermal reaction, can cause over-pressurisation due to violent boiling or rapid gas generation. This over-pressure may result in the plant failing catastrophically, resulting in blast or missile damage (HSE 2014). A release of flammable materials could result in a fire or an explosion.

More intense heat waves can also destabilize the components of munitions, particularly where explosives are not properly stored. Most munitions are designed to withstand severe heat, but only in the relatively

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short term. If exposed to extreme temperatures and humidity for long enough, a munition can become unstable. For every 5°C increase above its ideal storage temperature, the chemical stabilizer used to prevent self-ignition depletes by a factor of 1.7 (Scientific American 2019).

Climate projections point towards an increase in the frequency and intensity of extreme weather events, such as floods, drought, wildfires and hurricanes. Extreme weather events can cause Natural Hazards Triggering Technological Accidents or 'Natech', a technological accident triggered by a natural hazard, such as a flood, earthquake or cyclone. A technological accident can include damage to, and release of chemicals from, fixed chemical installations, oil and gas pipelines, storage sites, transportation links, waste sites and mines. They pose a serious risk for MIA and chemical exposures in the world of work. Many natural disasters have led to major damages to hazardous installations, triggering the release of hazardous substances, fires and explosions. It is likely that the risk and impact of Natech events is increasing, due to a combination of increasing industrialization and urbanization, combined with a predicted rise in hydro-meteorological hazards caused by climate change (WHO 2018b).

## Impact on worker safety and health

MIA and Natech events can affect workers in several ways, either due to the toxic effects of the chemicals, the effects of fire or the effects of explosion. Acute exposure to toxic chemicals can cause local injury, for example, skin burns due to a corrosive agent, or systemic damage to the whole physiological system, such as from mercury poisoning. If large quantities of hazardous chemicals are released, they have the potential to kill or injure people who are far away from the plant. Chlorine and ammonia are the toxic chemicals commonly used in major hazard quantities and both have a history of major accidents. Workers may also suffer skin burns and be exposed to toxic fumes from fires. Explosions may cause workers to be blown over, knocked down or buried under collapsed buildings or injured by flying glass.

First responders may be exposed to hazardous chemicals in the immediate aftermath of extreme weather events, for example, if chemical storage facilities are damaged. During clean-up operations, construction workers and other emergency workers may also be exposed to numerous hazardous substances, such as lead, asbestos and solvents. For example, the 2019 Tropical Cyclone Idai caused catastrophic damage, and a humanitarian crisis in Mozambique, Zimbabwe, and Malawi, leaving more than 1,300 people dead and many more missing. The cyclone left a high exposure of hazardous waste, primarily asbestos from lusalite sheets (ILO 2019b). Construction workers were particularly exposed when clearing up older damaged buildings.

### ► Case study: Natech events caused by Hurricane Harvey in Texas, USA (CSB 2018)

On 24 August 2017, a Category 4 hurricane called Hurricane Harvey hit southeast Texas. Over the next days, the storm produced unprecedented amounts of rainfall over southeast Texas and southwest Louisiana, causing significant flooding. A facility at Crosby, which handled organic peroxides, was located within the 100-year and 500-year flood plains. Rainfall exceeded the equipment design elevations and caused the plant to lose power, back-up power and critical organic peroxide refrigeration systems. On 31 August 2017, organic peroxide products stored inside the refrigerated trailer decomposed, causing the peroxides and the trailer to burn. Twenty-one people sought medical attention from exposure to fumes generated by the decomposing products when the vapour travelled across a public highway adjacent to the plant. Over the course of three fires, more than 350,000 pounds of organic peroxide combusted.



## ► Workers potentially at greater risk

Workers all over the world will be impacted by climate change, however the adverse effects will be greater for some. Workers in certain geographical regions are particularly at risk, as are workers in specific industries. The risks and hazards associated with environmental degradation tend to affect workers in vulnerable situations most strongly, who are therefore more likely to be impacted by climate change (ILO 2018b).

### **Women and pregnant workers**

Women differ from men in their physiologic compensation to elevated temperatures, which may increase their risk of heat stress (Sorensen et al. 2018). They are also at higher risk of fatal coronary heart disease (Chen et al. 2005) and impaired cognitive function (Kim et al. 2019) due to air pollution. Pregnant workers are more susceptible to heat exhaustion, heat stroke, or dehydration, with heat stress linked to birth defects and other reproductive problems (CDC 2022). Reproductive cycles and life stage impact vulnerability of female workers to chemical exposures e.g. pregnancy, lactation and menopause.

### **Child labourers and youth workers**

Developing children are especially vulnerable and may have different susceptibilities during different life stages, especially during “critical windows of development” (Landrigan et al. 2004). Exposures to even low doses of chemicals, for example, can cause devastating and lifelong functional impairments. Child labourers may be at higher risk of heat stress and vector-borne diseases, and exposure to increasing concentrations of air pollutants form an additional risk for children working outside. (Arnold et al. 2020). Youth workers are also more vulnerable to the impacts of climate change, as they may be still developing, both physically and mentally.

### **Older adult workers**

Older adults are particularly susceptible to heat stress, poor air quality, exposure to infectious diseases, weather extremes and other climate-related hazards. They are less able to tolerate stress and are more at risk of disease due to a lower physiological reserve capacity, slower metabolism and weaker immune system. They also have a higher disease burden and existing chronic health conditions may be exacerbated by climate-related risks at work (Carnes et al. 2014). Additionally, exposures to climate change induced vector-borne and waterborne pathogenic hazards may pose a greater health risk among sensitive older adults with compromised immune systems (Balbus and Malina 2009).

## **Migrant and informal workers**

Migration is a likely response to climate change (IOM 2017), with temperature levels having a causal effect on out-migration decisions. For example, if global temperature increases by 2°C by the end of the century, asylum applications to the EU are expected to double (Missirian and Schlenker 2017). International migration may be linked to the country of origin's dependence on agriculture (Cai et al. 2016). Weather shocks also affect internal population movements, including on migration to urban areas, as an analysis of sub-Saharan Africa has shown (Barrios et al. 2006). Climate change and rising temperatures are therefore likely to lead to larger populations of vulnerable migrant workers.

Migrants are more exposed to climate change-related events and are more sensitive to such changes because of their poverty and mobility. Heat stress is a concern, as migrant workers frequently work outside in physically demanding jobs. They often work in informal workplaces, where there is a lack of regulation and OSH, and limited access to healthcare and social protections. They may not speak the local language and therefore are unable to understand chemical labels, safe handling procedures and training materials.

## **Workers with a disability**

People with disabilities have been shown to have generally poorer health outcomes (WHO 2011). They are especially susceptible to heat-related illness and death, for reasons such as physical vulnerabilities, barriers to accessing healthcare services, poverty, lower education and communication difficulties (EPA 2016). For example, a disabled workers with a respiratory impairment may be more at risk of adverse health impacts due to air pollution. They may also be more susceptible to hazardous chemicals and face unique risks from chemical exposures depending on their disabilities.



## ► **Priority actions for protecting the safety and health of workers**

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Climate change is already having a profound impact on planetary health, human health and the work of work. Climate change mitigation measures, such as the decarbonization of the energy sector, electrification of transport and the promotion of sustainable agriculture, have the potential to limit the effects of climate change, whilst bringing net employment benefits. However, despite these measures, climate-change related events will continue to take place. The implementation of adaptation measures to protect the current and future labour force is therefore a matter of urgency.

The ILO highlights the importance of chemical exposures as a top priority for advancing OSH agendas worldwide and calls attention to significant interlinkages that exist between the world of work and other sectors, including the environment. Addressing the challenge of climate change and a path to decent work requires effective employment policies and appropriate climate change adaptation measures. Climate change issues should be incorporated into policy agendas and work practice at all stages.

Emerging trends in the world of work will impact OSH priorities and are producing new environmental challenges. Adaptations to issues such as climate change will themselves have environmental consequences which should be considered. Rapid shifts to sustainable technologies, for example, may create new OSH challenges, especially if the appropriate infrastructure and OSH protections have not yet been developed. National programmes on OSH programmes and policies will need to account for these changing world of work issues. Priority actions to protect workers from hazardous chemical exposures should be implemented at international and national policy levels, and at the workplace level, with a strong foundation of social dialogue throughout.

## ► **International labour standards**

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Climate change will require governments, businesses and workers to prepare for, adapt to, and manage the risks of new hazards. A national legal framework that integrates environmental with labour-related objectives can go a long way towards ensuring that climate change adaptation and mitigation measures are also employment friendly. In the past 100 years, the ILO has adopted more than 50 legal instruments on the protection of workers, as well as the public and the environment, from chemical hazards. Aside from conventions and recommendations, codes of practice set out practical guidelines for public authorities, employers, workers, enterprises and bodies. International labour standards, in particular those related to OSH, can strengthen adaptation frameworks by providing the legal foundation for addressing rising inequality and the increasing vulnerability of workers and enterprises in the face of climate change, as well as for enhancing the adaptive capacity of communities.

In June 2022, the International Labour Conference at its 110th Session adopted the resolution on the inclusion of a 'safe and healthy working environment' in the ILO's framework of fundamental principles and rights at work (FPRW). It is now an obligation of ILO Member States to promote, respect and realize safe and healthy working conditions in the same manner, and with the same level of commitment, as the other four principles covered by the ILO Declaration on Fundamental Principles and Rights at Work.

The following are key ILO international labour standards that can be applied for protecting workers from the effects of climate change through the sound management of chemicals in the workplace. Further information on international labour standards related to climate adaptation and mitigation policies can be found in the 2018 ILO document '[The employment impact of climate change adaptation](#).'

### ► Main chemical safety conventions and recommendations

- Chemicals Convention (No. 170) and Recommendation (No. 177), 1990.
- Prevention of Major Industrial Accidents Convention (No. 174) and Recommendation (No. 181), 1993.

### ► Instruments dealing with the fundamental OSH principles that provide a framework for risk management, including chemical risks

- Promotional Framework for Occupational Safety and Health Convention (No. 187) and Recommendation (No. 197), 2006.
- Occupational Health Services Convention (No. 161) and Recommendation (No. 171), 1985.
- Occupational Safety and Health Convention (No. 155) and Recommendation (No. 164), 1981, and its Protocol of 2002.
- List of Occupational Diseases Recommendation, 2002 (No. 194).

### ► Other relevant conventions and recommendations

- Asbestos Convention (No. 162) and Recommendation (No. 172), 1986.
- Working Environment (Air pollution, Noise and Vibration) Convention (No. 148) and Recommendation (No. 156), 1977.
- Occupational Cancer Convention (No. 139) and Recommendation (No. 147), 1974.
- Labour Inspection (Agriculture) Convention (No. 129) and Recommendation (No. 133), 1969.
- Safety and Health in Agriculture Convention (No. 184) and Recommendation (No. 192), 2001.
- Safety and Health in Construction Convention (No. 167) and Recommendation (No. 175), 1988.
- Safety and Health in Mines Convention (No. 176) and Recommendation (No. 183), 1995.

### ► Codes of practice related to chemicals and climate change

- Safety in the use of chemicals at work (1993).
- Ambient factors in the workplace (2001).
- Safety and health in textiles, clothing, leather and footwear (2022).
- Prevention of major industrial accidents (1991).

## ► Other policy level actions

- **Integrate climate change issues as a component of OSH policy and practice.** Adaptation measures should be integrated into policies, programmes and risk assessments at all levels, using an OSH management systems approach, based on the ILO Guidelines on occupational safety and health management systems (ILO-OSH 2001).
- **Develop occupational exposure limits (OELs) for proxy measures of climate change.** For example, some countries have already adopted specific regulations to protect workers from heat exposure and ensuing heat stress. These include maximum temperatures to which workers may be exposed. There are currently no harmonized international standards for work in hot environments or other adverse weather conditions.
- **Mainstream gender into OSH policy and practice.** This should be done specifically in relation to climate change concerns. For example, some workplace consequences of climate change may impact the health of pregnant women more seriously.
- **Carry out effective labour inspection services.** Inspectors should be provided with the means, qualifications and training to fulfil their duties, especially how they relate to emerging risks due to climate change.



## ► ILO's Guidelines for a just transition (2015)

The 2015 *Guidelines for a just transition* towards environmentally sustainable economies and societies for all developed by the ILO through tripartite discussion, can be used to ensure that no workers are left behind during the transition to a green economy, and that the transition also strengthens sustainable enterprises, jobs creation and decent work. A Just Transition involves maximizing the social and economic opportunities of climate action, while minimizing and carefully managing any challenges – including through effective social dialogue among all groups impacted, and respect for fundamental labour principles and rights. Ensuring a just transition is important for all countries at all levels of development. It is also important for all economic sectors – by no means limited to energy supply – and in urban and rural areas alike.



OSH is identified in the guidelines as one of the key policy areas to address the environmental, economic and social sustainability of the transition. Recommendations related to OSH for governments, in consultation with social partners, include:

- Conducting risk assessments of increased or new OSH risks resulting from climate change.
- Improving, adapting or developing awareness of OSH standards for technologies, work processes and new materials related to the transition.
- Adopting and implementing applicable OSH standards and monitoring compliance with labour inspectorates.
- Working towards greater OSH policy coherence and cooperation among occupational health and environmental agencies with regard to regulation and enforcement.
- Promoting the use of appropriate prevention, protection and safety processes.
- Incentivizing companies and supporting research to better understand OSH risks and new technologies.
- Establishing bilateral OSH committees at the workplace level.
- Regulating and incentivizing companies to reduce, minimize, and where possible, eliminate hazardous materials across the supply chain of products and production processes.
- Assessing and defining appropriate legislation to ensure that companies take appropriate steps to mitigate adverse impacts on health and safety throughout the life cycle of products and processes.

In addition, actions for governments and social partners include:

- Promoting adequate OSH training in green jobs for workers, employers, OSH committees and labour inspectors.
- Addressing the OSH impacts of informality, and facilitating the transition towards a formal economy, in activities related to the greening of the economy.



## ► **Multilateral environmental agreements**

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### **Climate change**

UN Framework Convention on Climate Change (UNFCCC) 1992, was ratified by 197 countries and was the first global treaty to explicitly address climate change. It established an annual forum, known as the Conference of the Parties, or COP, for international discussions aimed at stabilizing the concentration of greenhouse gases in the atmosphere. These meetings produced the Kyoto Protocol and the Paris Agreement.

The 2005 Kyoto Protocol was the first legally binding climate treaty. It required developed countries to reduce emissions by an average of 5 per cent below 1990 levels and established a system to monitor countries' progress. However, because many major emitters are not part of Kyoto, it only covers about 12 per cent of global emissions.

The Paris Agreement, the first-ever universal, legally binding global climate change agreement, was adopted at the Paris climate conference (COP21) in December 2015 (United Nations 2015). It has been ratified by 193 countries. The most significant global climate agreement to date, the Paris Agreement requires all countries to set emissions-reduction pledges. It also aims to reach global net-zero emissions, where the amount of greenhouse gases emitted equals the amount removed from the atmosphere, in the second half of the century. The Paris Agreement and the 2015 Sustainable Development Goals (SDGs) have brought nations together, with the objective of preventing dangerous climate change and promoting sustainable development.

### **Chemical safety**

There are various global agreements to regulate the release of toxic chemicals into the environment. These include:

- Vienna Convention for the Protection of the Ozone Layer (1985).
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989).
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998).
- Stockholm Convention on Persistent Organic Pollutants (POPs) (2001).
- Minamata Convention on Mercury (2013).

## ► **Workplace level priority actions**

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Climate change considerations can be integrated into workplace level actions, adapting existing measures to ensure they address emerging risks.

### **Implement a workplace programme for the sound management of chemicals**

The ILO recommends a number of components that make a general blueprint for the sound management of chemicals in the workplace (Table 1). Climate change should be considered for all components of a workplace programme. For example, health impacts that can be linked to climate change should be reviewed in medical and health surveillance, and operational control measures should include assessment for, and elimination of, climate change hazards.

► **Table 1: Components of a workplace programme – an overview**

General obligations, responsibilities and duties	Information and training
Classification and labelling following the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)	Maintenance of engineering controls
Chemical Safety Data Sheets	Exposure monitoring
Operational control measures	Medical and health surveillance
Design and installation	Emergency procedures and first aid
Work systems and practices	Investigation, recording and reporting of accidents, occupational diseases and other incidents
	Personal protective equipment

## Implement an adapted workplace level risk assessment

A workplace risk assessment is one of the key tools for protecting the safety and health of workers who may be exposed to climate change related hazards, including hazardous chemicals. A thorough risk assessment is necessary in order to identify hazards, evaluate risks and implement appropriate control measures. It should take into account worker exposure during all stages of a chemical's lifecycle, including production, use and disposal.

The risk assessment should follow these five steps<sup>1</sup>:

### ► Step 1: Identify the hazards

This involves surveying the workplace and identifying possible hazards and their specific risks to worker safety and health. Hazards may include those related to climate change directly, such as heat stress, or those associated with hazardous chemical exposures, for example, the increased use of pesticides due to changes in crop characteristics occurring as a result of climate change. Workers may face a range of exposure pathways, including inhalation, ingestion or dermal contact, depending on their job sector and specific tasks performed.

### ► Step 2: Identify who might be harmed and how

Once the sources of potential exposure have been identified, the risk assessment should recognize which workers are at particular risk of hazardous exposures, and also potential safety and health impacts. Workers in specific industries, such as those employed outside in farming and construction, may be at greater risk of the adverse health effects associated with climate change. Workers in vulnerable situations are also potentially at greater risk, for example pregnant and nursing women, older adults, migrant workers and workers with a disability. For instance, a worker with a respiratory impairment may be more impacted by air pollution. In each case, it is important to identify how the worker group may be harmed.

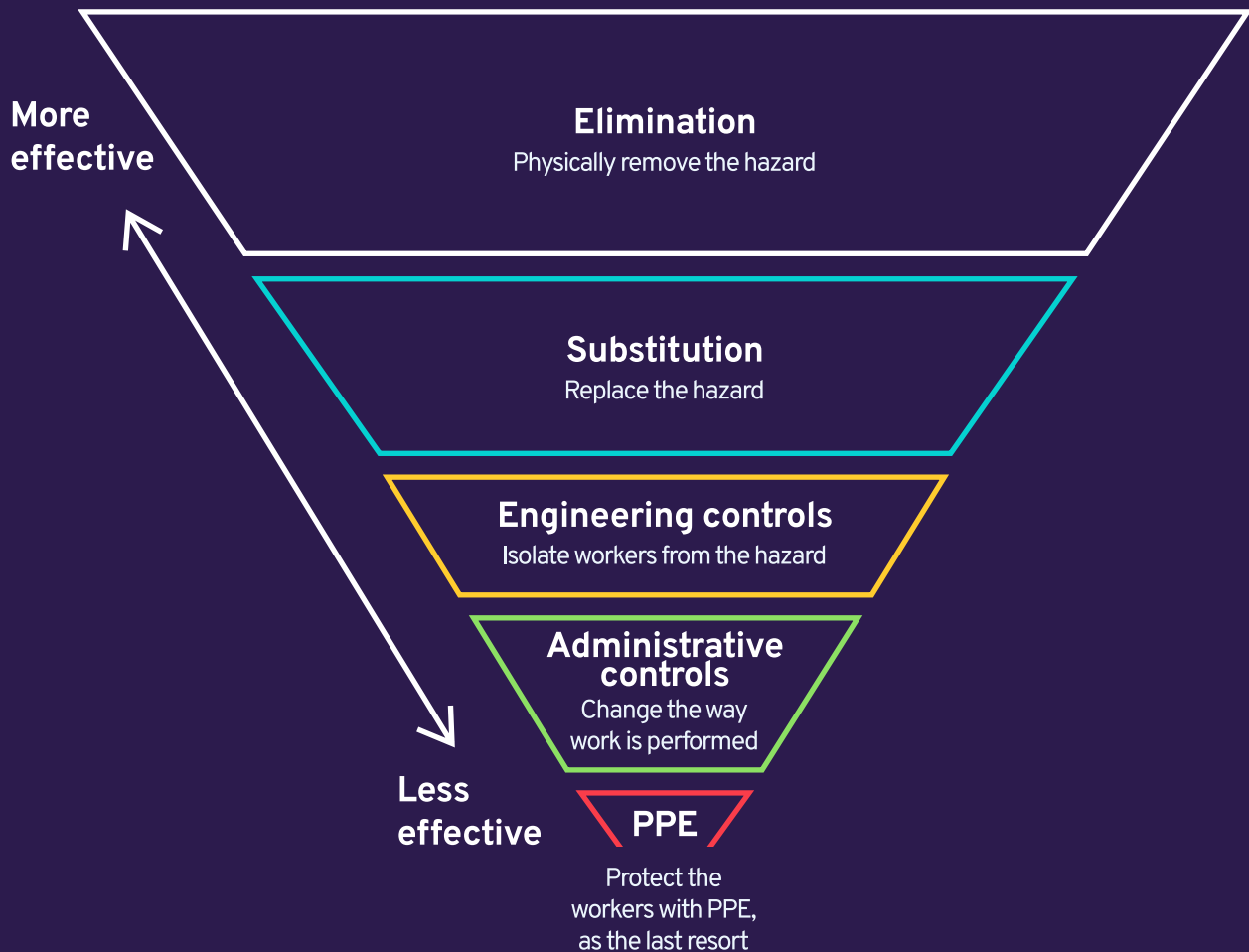
### ► Step 3: Evaluate the risk – Identify and decide on the safety and health risk control measures

Based on the identified hazards and potential routes of exposure for workers, the Hierarchy of Controls (Figure 4) should be applied to eliminate or minimize risks these hazards. There are five categories in the Hierarchy: Elimination, Substitution, Engineering controls, Administrative controls and Personal protective equipment (PPE), with control methods at the top of the hierarchy (Elimination) being more effective than those at the bottom (PPE). The Hierarchy of Controls can be used to minimize risks from hazardous chemicals, as well as the effects of climate change. For climate change concerns, it is not possible to eliminate or substitute the hazard, so control measures should focus on engineering controls, administrative controls and PPE (in order of effectiveness). Examples of control methods to combat heat stress are shown in Figure 5.

<sup>1</sup> See A 5 Step Guide for employers, workers and their representatives on conducting workplace risk assessments. ILO 2014.



► **Figure 4: The Hierarchy of Controls**



► **Step 4: Record who is responsible for implementing which control measure, and the timeframe**

Once control measures have been decided, the workplace should determine who will be responsible for implementing and overseeing these new measures, as well as an appropriate timeline for their implementation. If resources are limited, control measures should be prioritized based on degree of risk. A plan of action may also include worker training and regular checks to ensure the appropriate measures are still in place.

► **Step 5: Record the findings, monitor and review the risk assessment, and update when necessary**

Risk assessment findings should be recorded and made available to supervisors, workers and labour inspectors. Arrangements should be needed to monitor the effectiveness of the control measures, for example through workplace inspections. The risk assessment should be regularly reviewed and updated, as changes in the workplace as a result of climate change are likely to evolve, with new risks emerging over time. These may result in new potential exposure pathways that put workers' safety and health at increased risk.

## ► Figure 5: Examples of control methods to combat heat stress

### **Engineering controls (OSHA n.d.)**

- Air conditioning (such as air-conditioned crane or construction equipment cabs, air conditioning in break rooms).
- Increased general ventilation.
- Cooling fans.
- Local exhaust ventilation at points of high heat production or moisture (such as exhaust hoods in laundry rooms).
- Reflective shields to redirect radiant heat.
- Insulation of hot surfaces (such as furnace walls).
- Elimination of steam leaks.
- Cooled seats or benches for rest breaks.
- Use of mechanical equipment to reduce manual work (such as conveyors and forklifts).
- Misting fans that produce a spray of fine water droplets.

### **Administrative controls (NIOSH n.d.)**

- Limit time in the heat and/or increase recovery time spent in a cool environment.
- Reduce the metabolic demands of the job.
- Use special tools to minimize manual strain.
- Increase the number of workers per task.
- Train supervisors and workers about heat stress.
- Implement a buddy system where workers observe each other for signs of heat intolerance.
- Require workers to conduct self-monitoring and create a work group (i.e. workers, a qualified healthcare provider, and a safety manager) to make decisions on self-monitoring options and standard operating procedures.
- Provide adequate amounts of cool, potable water near the work area and encourage workers to drink frequently.
- Implement a heat alert program whenever the weather service forecasts that a heat wave is likely to occur.
- Institute a heat acclimatization plan and increase physical fitness.

### **PPE controls (OSHA n.d.)**

In most cases, heat stress should be reduced by engineering controls or work practice modifications. However, in some limited situations, special cooling devices can protect workers in hot environments:

- Insulated suits.
- Reflective clothing.
- Infrared reflecting face shields.
- Cooling neck wraps.

In extremely hot conditions, the following thermally conditioned clothing might be used:

- Vest that receives cooled air from a vortex tube connected to an external compressed air source.
- Jackets or vests with reusable ice packs or phase change cooling packs in the pockets.
- Workers should be aware that use of certain personal protective equipment (e.g. some respirators, impermeable clothing, and head coverings) can increase the risk of heat-related illness.



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### ► Case study: Green and conventional office environments

People spend approximately 90 per cent of time indoors, including in work buildings. The type of indoor environment can therefore significantly influence health. Rising carbon dioxide levels are one of the main problems inside buildings. A study by Allen et al. (2016) looked at associations between cognitive function and carbon dioxide, ventilation and volatile organic compound (VOC) exposures in office workers in either conventional or 'Green' buildings.

The study found that using low-emitting materials, which is common practice in 'Green buildings', reduces in-office VOC exposures. Also, increasing the supply of outdoor air lowers exposures to not only CO<sub>2</sub> and VOCs, but also to other indoor contaminants. Office workers had significantly improved cognitive function scores when working in 'Green' environments, whilst exposure to CO<sub>2</sub> and VOCs at levels found in conventional office buildings was associated with lower cognitive scores.

## ► Social dialogue

Social dialogue is needed to promote consensus building and democratic involvement at all levels and to create an enabling environment to ensure safe, healthy, decent and productive work.

It can play an important role in adaptation to climate change. Workers and employers need to be involved, together with governments, in the development of mitigation and adaptation policies, as these have a direct impact on working conditions and the world of work. Workers and employers are best placed to take appropriate action in the workplace, finding practical solutions to enable workers to do their jobs and continuously exploring new ways of coping with the effects of climate change (TUC 2009).

Collective agreements at the national level are beginning to include climate change-related provisions. Most national agreements that address environmental concerns focus explicitly on greening the workplace and actions that may have adaptation co-benefits (ILO 2018b). Social dialogue is also crucial to the development of national OSH policies, which should be drawn up in consultation with the most representative organizations of employers and workers (ILO 2019a). The implementing infrastructure for national OSH policies should be established, maintained, progressively developed and periodically reviewed in consultation with those organizations. In addition, social dialogue can help to make climate change governance more labour-friendly by promoting policies that take account of both environmental and labour concerns.

As recommended in the ILO Guidelines for a Just Transition, workplace cooperation and specifically, bilateral OSH committees should be established at the workplace level to enable workers and employers to engage in social dialogue. These allow for improved collaboration and coordination between social partners, in order to better address OSH issues in the workplace, including those related to environmental concerns, such as climate change. They are composed of an equal number of workers' and employers' representatives, with legislation in some countries also requiring an OSH practitioner as a member.

### ► Possible research priorities for climate change concerns in the world of work

- Strengthen Global Burden of Disease (GBD) estimates for all exposures and outcomes associated with climate change.
- Investigate emerging diseases which may be related to climate change and the world of work e.g. chronic kidney disease of unknown aetiology (CKDu).
- Identify the work sectors and geographical locations most impacted by the various climate change concerns.
- Research which adaptation strategies are most effective for protecting workers from the main increases in hazardous chemical exposures caused by climate change.

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