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The Direct Impact of Climate Change on Regional Labour Productivity

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Abstract: Global climate change will increase outdoor and indoor heat loads, and may impair health and productivity for millions of working people. This study applies physiological evidence about effects of heat, climate guidelines for safe work environments, climate modelling and global distributions of working populations, to estimate the impact of two climate scenarios on future labour productivity. In most regions, climate change will decrease labour productivity, under the simple assumption of no specific adaptation. By the 2080s, the greatest absolute losses of population based labour work ability as compared with a situation of no heat impact (11-27%) are seen under the A2 scenario in South-East Asia, Andean and Central America, and the Caribbean. Climate change will significantly impact on labour productivity unless farmers, self-employed and employers invest in adaptive measures. Workers may need to work longer hours to achieve the same output and there will be economic costs of occupational health interventions against heat exposures.

Key words: Climate change, heat, work, labour productivity

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Introduction

"Too hot" working environments are not just a question of comfort, but a concern for health protection and the ability to perform work tasks. This occupational health problem has been known for considerable time and protective methods have been developed. Still, many workers are exposed to unacceptably high temperatures and humidity in work situations that cannot be modified and heat strain and heat stroke are important issues not only for health but also for labour productivity [1-4]. In outdoor, and many indoor, jobs, particularly in low and middle income countries, air conditioning of the workplace is not, and will possibly never be, an option. Global climate change will increase average temperatures, as well as shift the distribution of daily peak temperature and relative humidity – so that heat episodes will become more frequent and more extreme[5, 6]. In order to cope with heat, an instinctive adaptive action by a worker is to reduce work intensity or increase the frequency of short breaks. One direct effect of a higher number of very hot days is therefore likely to be the "slowing down" of work and other daily activities [7]. Whether it occurs through "self-pacing" (which reduces output) or occupational health management interventions (which increases costs), the end result is lower labour productivity (which is defined as the value of output over labour costs)[3].

When the body carries out physical work, heat is produced internally, which needs to be transferred to the external environment in order to avoid the body temperature increasing.[8] If body temperature exceeds 39°C heatstroke may develop and a temperature of 40.6°C is life-threatening. Before these serious health effects occur, at lower heat exposures, the effects are diminished "work ability"[8, 9], diminished mental task ability[2], and increased accident risk[10]. These effects all contribute to a reduced "work ability" and lower labour productivity.

Reduced work ability is a function of environmental humidity, radiant heat, air movement and ambient temperature[11]. In humid and calm conditions, it can occur above 26°C for heavy physical work[12, 13] but individual variations are large and a complex relationship between climate factors, sweat rate and body temperature has been used to establish a "predicted heat strain model"[14]. Heat strain can occur in arid climates [15], indoor office environments[16] and factories[17]. Unusual heat waves create particular problems, as during the 2003 heat wave in France[18]. The economic cost of the existing suboptimal climate in US workplaces has been estimated at many billions of dollars[19].

Quantitative standards to protect workers from heat injury have been developed by the International Standards Organization[13] and NIOSH[20]. More recent national guidelines also appear to be based on these. Most standards use "wet bulb globe temperature" (WBGT) to quantify different levels of heat stress and define the percentage of a typical working hour that a person can work assuming the remaining time is rest. The NIOSH standard also stipulates a WBGT level above which no worker should be expected to carry out ongoing tasks. The standards are stricter for persons un-acclimatized to heat than for those who are acclimatized. For un-acclimatised persons faced with a very energy demanding work task, the need to reduce heat stress starts at WBGT above 22.5°C; for acclimatized persons, this reduction starts at a WBGT of 26°C[13, 20].

An assessment of the potential impact of climate change on "work ability" and the associated economic costs has not yet been made. Occupational health risk have been given little to no attention in international or national climate change impact and vulnerability assessments [21, 22]. This paper estimates the extent to which climate change may affect labour productivity due to increased ambient temperatures and/or humidity, under future climate scenarios.

Methods

We used global climate model data for different world regions in combination with the relationships between WBGT and work ability to calculate the relative change in population work ability at different future time periods and for different climate scenarios. The analysis went through five steps:

1. Classify populations by world region and climate type and select representative points.
2. Obtain daily climate model data for each point, representing the sub-regional climate zone in which at least 5% of the regional population live.

3. Calculate current and future distributions of daily daytime WBGT ("work WBGT") for each sub-regional climate zone and then generate a single regional work WBGT series using a population-weighted average.
4. Estimate current and future relative work ability, in order to estimate labour productivity losses due to global climate change for each gross labour sector (agricultural, industrial, service).
5. Combine sector-specific estimates to a single regional estimate using the distribution of working population across sectors.

Note that throughout the paper, we assume that changes in labour productivity (an economic concept) are equal to changes in the work ability (a physiological concept) – that is, we abstract from changes in wages. We also ignore changes in behaviour (e.g., shifts in working hours, air conditioning). We estimated "labour productivity" for 21 world regions, where countries are grouped according to health indicators and geography (Figure 1). In order to take into account the diversity of climates within each region, we selected grid cells (from the climate model grid) representative of the main climate types in which people live within each region, based on the Köppen climate classification[23]. A Geographic Information System (GIS) was used to allocate the proportion of the regional population (year 2000) to each climate zone, using the Gridded Population of the World version 3 (GPW v3)[24]. We then selected the climate zones in which at least 5% of the regional population resided (Table 1). A population-weighted centre point was calculated for each of these climate zones and the climate grid cell in which this was located was then chosen. This gave a total of 93 grid cells (Figure 1).

Daily data (24-hour averages) were extracted for these climate grid cells for the years 1960 to 2100 for two climate scenarios: A2 and B2. These climate scenarios are derived from specified emissions scenarios that project future economic growth and technological development within a consistent storyline[25]. The A2 scenario assumes a high population growth and medium rapid economic development and therefore represents a moderately "high" emissions scenario. The B2 scenario assumes that greenhouse gas emissions are reduced through technological change and that there is more emphasis of governments addressing environmental problems through policy implementation. The increase in global mean temperature by the 2080s from pre-industrial levels is projected to be 3.4 °C (2.4 to 6.4) and 2.4 °C (range 1.4 to 3.8) for A2 and B2, respectively[26].

WBGT is calculated from measurements of the natural wet bulb temperature (Tnwb), the globe temperature (Tg) and the dry bulb air temperature (Ta). WBGT outdoors is 0.7 Tnwb + 0.2 Tg + 0.1 Ta, and WBGT indoors is 0.7 Tnwb + 0.3 Tg. Note that Tnwb and Tg outdoors are likely to be much higher than Tnwb and Tg indoors, because of the influence of solar radiation. The specialised measurements for WBGT are not available from routine weather stations, and various formulas have been developed to estimate WBGT from the routinely collected data (Ta, relative humidity, etc.). The Australian Bureau of Meteorology[27, 28] proposes a method for estimating "WBGT" from air temperature (Ta) and relative humidity (RH), assuming moderately high heat radiation level in light wind conditions (approximately outdoor work in hot calm environments with some, but not extreme, sun exposure or indoor work with some local heat source).

This method was adopted from one suggested by the American College of Sports Medicine in 1985[28], but the exact derivation of the formula was not explained. Other authors have proposed different formulas (e.g. Bernard and Pourmoghani[29]) and one of us (TK) has carried out preliminary field tests of measuring the difference between WBGT outdoors and indoors in the same location. TK also used hourly weather station data to assess the difference between 24-hour averages and mean daytime values for Ta and WBGT (6 am to 6 pm). Using 24-hour average temperature and relative humidity from the HadCM3 global climate model[30], we calculated WBGT using the Australian Bureau of Meteorology equations:

$$WBGT = 0.567 \times Ta + 3.94 + 0.393 \times E$$

$$E = RH/100 \times 6.105 \times \exp(17.27 \times Ta / (237.7 + Ta))$$

Where Ta = 24-hour average shaded dry bulb air temperature in °C; E = 24-hour average absolute humidity (water vapour pressure) in hPa, hector Pascal; RH = 24-hour average relative humidity in %. The factor 3.94 represents impact of WBGT from radiated heat, and we found that this formula produces too high WBGT values. In our (TK) analysis of hourly data we noted that the difference between 24-hour averages and daytime means in hot places were generally between 3 and 5°C. As a compromise we assumed that the WBGT values calculated from 24-hour values would represent the daytime mean WBGT outdoors.

Daily work WBGT estimates were made for the current climate (years 1961-1990) and three future 30-year time periods centred on the 2020s (2010-2039), 2050s (2040-2069) and 2080s (2070-2099). In order to take into account indoor heat exposures for industrial and service sector workers, we used the approximation that indoor WGBT = outdoor WBGT – 4, based on a deduction of the radiation exposure factor 3.94 from the formula above.

The distributions of the number of days at different work WBGT values within each future time slice period were calculated. Figure 2 shows the distribution of WBGT under the current climate and three future climates for one location in South-East Asia. To provide a single estimate of the daily WBGT distribution for each world region, we combined the distributions for regional cells using population weighting.

Using the ILO and NIOSH standards for acclimatized persons, Kjellstrom[7] produced a graph of "work ability" as the maximum percentage of an hour that a worker should be engaged working (Figure 3). The four curves represent four different work intensities. We assume that 200 W corresponds to office desk work and service industries; 300 W to average manufacturing industry work and 400 W to construction or agricultural work. 500 W corresponds to very heavy labouring work and is not considered in this analysis. Work ability rapidly diminishes within a 10-20 degree range.

We then classified the working population of each region into three sectors: service, industry and agriculture using World Bank data for 1990-2005[31]. In each region, any country without labour data was assumed to have the same distribution pattern as the country with the nearest GDP for which labour data were available. Country data were combined using population-weighted averages to give estimates of labour distributions for each region.

Assuming the different work intensities for each sector (see above), we estimated regional labour productivity as a weighted average based on the distribution of work activities across the three sectors within each region. We assumed that labour patterns change over time consistent with economic growth projected under the A2 and B2 emission scenarios[25, 32] (Figure 4). North America was kept constant and all other regions converged towards this pattern as per capita income increased. Globally, GDP growth is higher under B2, and therefore more rapid convergence to the high income distribution occurs under this scenario than under A2.

We then calculated the number of days with reduced work ability for each day during each 30 year period using the WBGT work ability relationships in Figure 3. The loss in work ability for each day was added up for each 30 year period. The reductions in work ability are presented for the baseline climate (we assume this to be 1961-1990 as it the standard now used for climate impact studies). For the two climate modelling scenarios and three future time periods, the additional reductions in relation to the reference period (no climate change) were calculated. As sensitivity analyses, we performed the same calculations assuming both constant climate and constant labour patterns over time.

Results

Climate change is associated with a shift in the distribution of daily temperatures to include more hot days, and more days with WBGT exceeding the threshold for heat tolerance in individuals. Assuming trends towards less labour intense work and no adaptation to climate change, our model shows significant reductions in labour productivity due to climate warming in a number of regions, particularly in Africa (Table 2). In terms of absolute change in labour productivity (hence reflecting both current and future climate patterns) by the 2080s, the greatest losses (11.4-26.9%) are seen under A2 in South-East Asia, Andean and Central America, and the Caribbean. Under the A2 scenario, Eastern and Western Europe, and Southern Latin America have the smallest losses (0.1-0.2%), with a gain seen in Tropical Latin America (3.0%). Under B2, the combined effects of less warming and greater wealth (meaning more people work in less labour intense jobs) result in considerably smaller impacts in all regions (the greatest loss being 16% in Central America), and overall productivity gains for many (up to 6%).

The difference between the climate scenarios is only apparent after the 2020s. This is due to the latency in the climate system, and any differences reflect natural climate variability and other uncertainties within the climate model. Ideally, an assessment should use a range of outputs from a range of climate models rather than a single model.

The estimates of labour productivity are sensitive to the assumptions about future workforce. As labour moves away from agriculture and toward industry and services as wealth increases the impact of climate warming is reduced (Table 3). The estimated differences in loss compared to baseline can be as high as 10% by the 2050s.

Discussion

The climate change "attributable" effect is the difference between labour productivity (in terms of lost labour days) under the baseline climate and under the climate scenarios. The relationship in our model are theoretical and potential and may not reflect actual labour productivity losses as there will most likely be some adaptation measures in place, such as the space cooling of offices and factories. It is not possible to validate the labour productivity loss for the current climate – but our measure of labour productivity is based on validated ergonomical guidelines[13.] However, adaptation measures will vary by country, with high income countries having higher rates of adaptation, using more expensive methods, than low income countries.

Countries and individual businesses will vary in their willingness or capacity to adapt to the projected climate change. There is a strong incentive to adapt though. On average, the elasticity of output to labour is 0.75[33.] This implies that, for every 1% reduction in labour productivity, income falls by 0.75%. Without adaptation, the economic losses of reduced labour productivity relative to baseline (Table 2) are up to 20% of GDP (Central America, A2, 2080).

There are several limitations to this study. We only look at one aspect of effects of climate change on labour productivity. The number of days worked depends on the weather in both cold and hot countries. Working hours and work practices may change, and air conditioning may be put in place. Wages would respond to changes in the ability to work and to the costs to enhance that ability; this would determine whether the employer or the employee bears the brunt of the decrease in work ability and it would shape the wider economic consequences. A more comprehensive analysis could address these outputs but is beyond the scope of this exercise. Second, the climate model grid cell output may not accurately represent the observed temperature and humidity exposures for a given location. We therefore only report the aggregated changes in the labour productivity by region under climate warming.

The global burden of ill health from occupational exposures is large and often underestimated and under reported. The current WHO assessment does not include the effects of heat or cold [34]. The direct effect of climate warming on direct [worker] productivity has not been investigated, as far as we are aware. Although some models have converted health impacts (mortality) into productivity losses, this is based on the assumption that mortality due to climate-sensitive diseases in adults will affect productivity at the regional level[35.]

Changes in productivity due to reductions on cold stress are not included because a different association applies between productivity and exposure to severe outdoor cold climate at work in polar or temperate regions.. Exposures to indoor cold are better regulated as they generally occur in high income countries. For outdoor workers, the projected increases in temperature in polar regions are likely to have productivity implications too, but the numbers affected (in polar and sub polar regions) are very small, compared to workers in temperate, tropical and subtropical regions. We are not addressing performance based on comfort and other issues in the environment, motivation, etc, which may also be important. Changes in temperature will affect days available for outdoor work (decreasing the number of too cold days) but this outcome is also not addressed. We also do not address days lost due to illness (either heat-related or cold-related or other climate-sensitive illnesses) which are an additional climate-change “cost”.

Assumptions about adaptation are key in all assessments of impacts on human systems due to climate change. As with many outcomes, there is a currently insufficient adaptation to climate factors in areas of limited economic development. There is an identifiable cost of climate change in terms of climate-proofing industrial and commercial buildings[36.] However, this is not always possible or may be prohibitively expensive, and it potentially increases greenhouse gas emissions. Further, there are limited adaptation options for outdoor work other than changes to hours and cooled suits. Nonetheless, future research should study adaptation to climate change in labour practices.

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Figures and Tables

Figure 1. Location of population-weighted centroids of climate zones which were matched to climate modelling points within the 21 GBD regions (regional boundaries shown as black borders on map).

Figure 2. Distribution of WBGT for South East Asia under A2

Figure 3. Schematic diagram – productivity and WBGT curves

Figure 4. Distribution of gross labour sectors, estimated for baseline and in the 2050s under the A2 and B2 scenarios, for selected regions.

Table 1. Regional characteristics

Table 2. Estimates % labour productivity loss due to climate change by region.

Table 3: Sensitivity of results to assumed labour trends and projected climate change, as change in percent days lost compared to baseline, for A2 in 2050s.

Figure 1. Location of population-weighted centroids of climate zones which were matched to climate modelling points within the 21 GBD regions (regional boundaries shown as black borders on map)

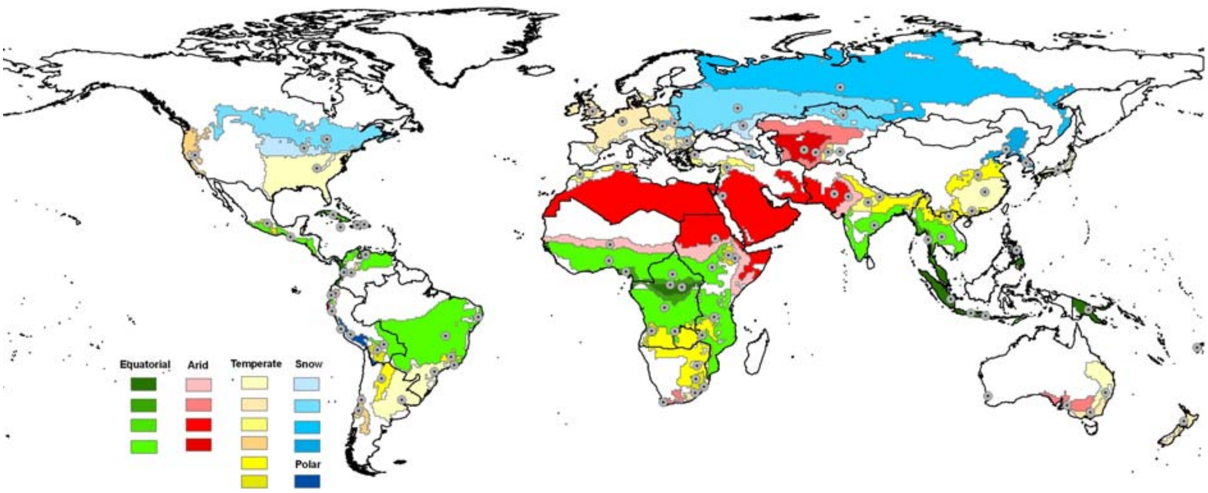


Figure 2. Frequency distributions of estimated WBGT in South-East Asia in current climate (1961-1990) and three future time periods under A2

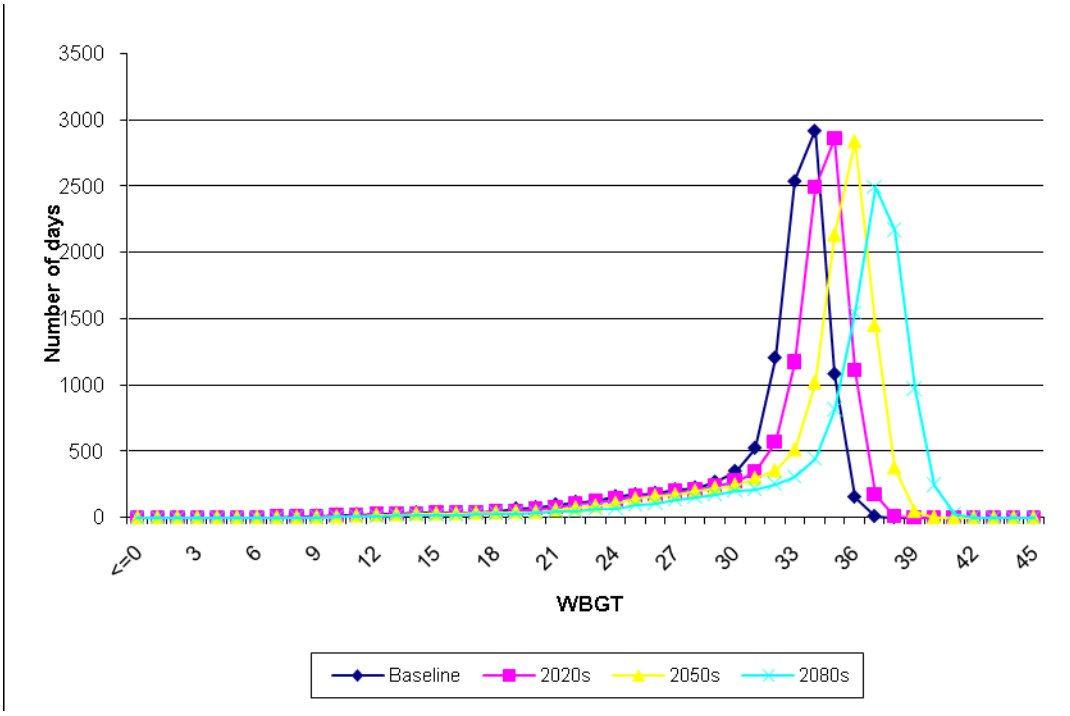


Figure 3. Association between work ability and WBGT for four work intensities. Based on recommendations by NIOSH, 1986 (ref 20)

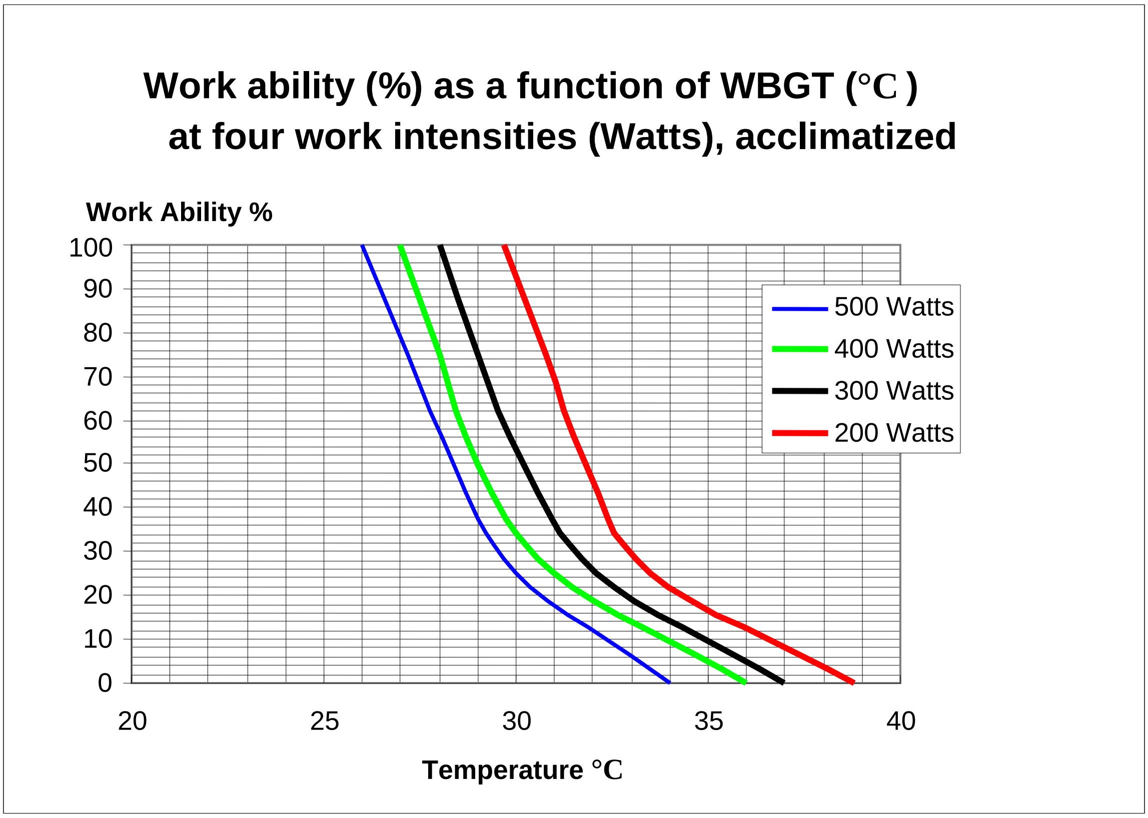
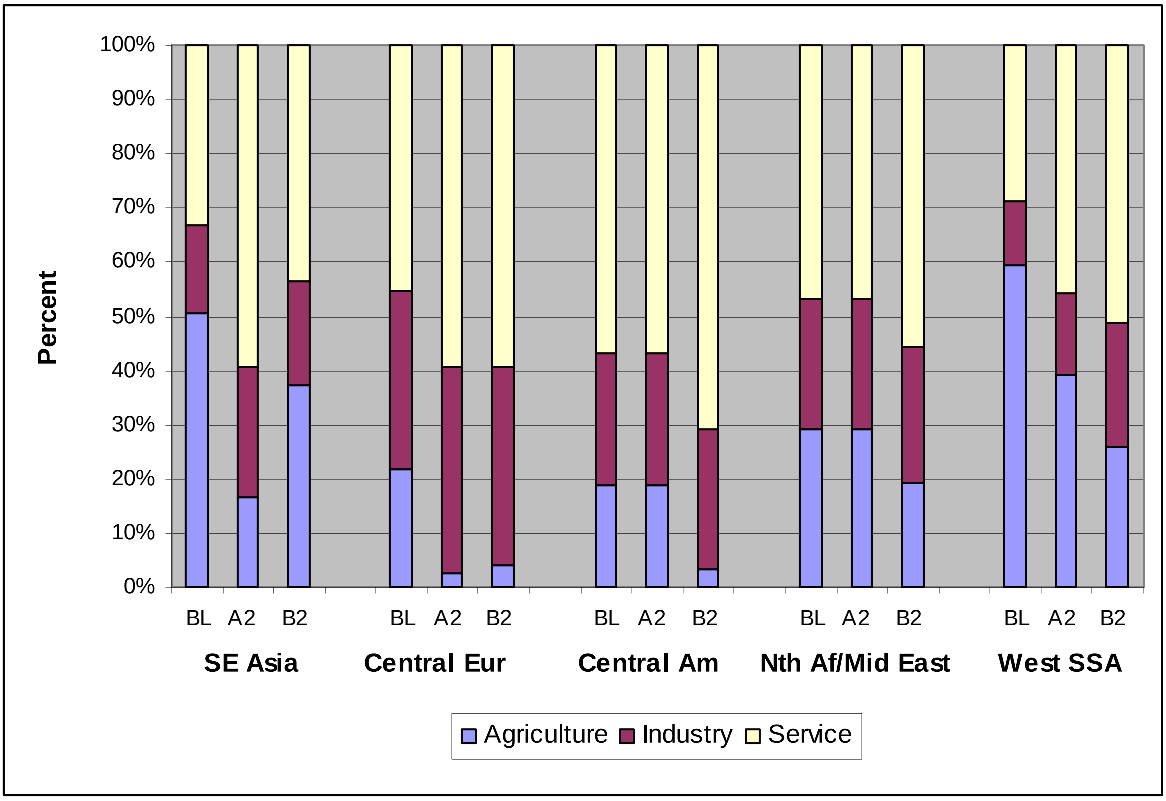


Figure 4. Distribution of gross labour sectors, estimated for baseline and in the 2050s under the A2 and B2 scenarios, for selected regions



* Regions are: SE Asia – South East Asia; Central Eur – Central Europe; Central Am – Central America; Nth Af/Mid East – North Africa and Middle East; West SSA – Western Sub-Saharan Africa. Bars are: BL – baseline; A2 – A2 in the 2050s; B2 – B2 in the 2050s.

Table 1. Region characteristics, based on climate zones with at least 5% of regional population.

World Region	Main climate types* (% population in the region)	Number of climate grid points	% of population represented
Asia Pacific, High Income	warm temperate, fully humid, hot summer (63%) snow, winter dry, hot summer (11%)	2	74%
Asia, Central	warm temperate, summer dry, hot summer (13.2%)	6	52%
Asia, Eastern	warm temperate, fully humid, hot summer (33%) warm temperate, winter dry, hot summer (27%) snow, winter dry, hot summer (11%)	4	79%
Asia, South	equatorial, winter dry (34%) warm temperate, winter dry, hot summer (27%) hot steppe (11%)	5	86%
Asia, South East	equatorial, fully humid (24%) equatorial, winter dry (20%)	7	76%
Australasia	warm temperate, fully humid, hot summer (35%) warm temperate, fully humid, warm summer (26%) warm temperate, fully humid, warm summer (16%)	5	91%
Caribbean	equatorial, winter dry (32%) equatorial, winter dry (28%) equatorial, fully humid (15%)	4	83%
Europe, Central	warm temperate, fully humid, warm summer (63%) snow, fully humid, warm summer (19%)	3	90%
Europe, Eastern	snow, fully humid, warm summer (71%)	3	83%
Europe, Western	warm temperate, fully humid, warm summer (49%) warm temperate, fully humid, warm summer (16%)	2	64%
Latin America, Andean	equatorial, winter dry (14%) warm temperate, fully humid, warm summer (10%)	7	58%
Latin America, Central	warm temperate, winter dry, warm summer (15%) equatorial, winter dry (15%) equatorial, winter dry (14%)	5	55%
Latin America, South	warm temperate, fully humid, hot summer (51%) cold steppe (10%)	4	76%
Latin America, Tropical	warm temperate, fully humid, hot summer (33%) equatorial, winter dry (29%)	5	80%
North America, High Income	warm temperate, fully humid, hot summer (43%) snow, fully humid, warm summer (18%) snow, fully humid, hot summer (10%)	4	80%

North Africa – Middle East	hot desert (37%)	5	63%
Oceania	equatorial, fully humid (62%)	2	71%
Sub-Saharan Africa, Central	equatorial, winter dry (55%) equatorial, winter dry (12%)	6	92%
Sub-Saharan Africa, East	equatorial, winter dry (25%) hot steppe (10%)	6	66%
Sub-Saharan Africa, South	warm temperate, winter dry, hot summer (42%) warm temperate, winter dry, warm summer (19%)	5	87%
Sub-Saharan Africa, West	equatorial, winter dry (61%) hot steppe (22%)	3	91%

*Only types with ≥10% of regional population are listed; type appears more than once within a region if non-contiguous zones of the same type are present.

Table 2: Impact of climate on labour productivity, as percent days lost and incremental loss relative to baseline, by region[1] for A2 and B2 scenarios, assuming changes in labour patterns.

Region	Impact	Baseline	2020s		2050s		2080s	
			A2	B2	A2	B2	A2	B2
AP_HI	%days lost	0.3%	0.2%	0.5%	0.5%	0.9%	2.0%	1.7%
	Increment		-0.1%	0.2%	0.2%	0.6%	1.7%	1.4%
As_C	%days lost	0.1%	0.4%	0.3%	0.5%	0.6%	1.1%	0.2%
	Increment		0.3%	0.1%	0.4%	0.4%	0.9%	0.1%
As_E	%days lost	10.1%	9.7%	11.3%	10.5%	7.7%	16.4%	10.4%
	Increment		-0.4%	1.2%	0.4%	-2.4%	6.3%	0.3%
As_S	%days lost	25.2%	30.1%	22.9%	29.6%	22.8%	32.7%	28.4%
	Increment		4.9%	-2.3%	4.4%	-2.4%	7.5%	3.2%
As_SE	%days lost	42.1%	38.2%	42.7%	44.1%	50.3%	59.1%	46.2%
	Increment		-3.9%	0.6%	2.0%	8.2%	17.0%	4.1%
Au	%days lost	0.0%	0.1%	0.1%	0.2%	0.2%	0.3%	0.3%
	Increment		0.0%	0.0%	0.2%	0.1%	0.3%	0.3%
Ca	%days lost	11.3%	12.3%	13.1%	19.1%	12.6%	25.3%	18.4%
	Increment		1.0%	1.8%	7.7%	1.2%	14.0%	7.1%
Eu_C	%days lost	0.1%	0.2%	0.4%	0.1%	0.1%	0.4%	0.3%
	Increment		0.0%	0.3%	0.0%	0.0%	0.3%	0.1%
Eu_E	%days lost	0.1%	0.2%	0.2%	0.5%	0.1%	0.2%	0.1%
	Increment		0.2%	0.2%	0.4%	0.0%	0.1%	0.1%
Eu_W	%days lost	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
	Increment		0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
LA_A	%days lost	1.8%	2.8%	2.7%	5.0%	2.9%	13.2%	6.7%
	Increment		1.0%	0.9%	3.2%	1.2%	11.4%	5.0%
LA_C	%days lost	15.5%	23.0%	22.9%	34.1%	19.9%	42.4%	31.5%
	Increment		7.5%	7.4%	18.6%	4.4%	26.9%	16.0%
LA_S	%days lost	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.2%
	Increment		0.1%	0.1%	0.1%	0.0%	0.2%	0.1%
LA_T	%days lost	11.9%	13.0%	13.3%	5.8%	3.6%	8.9%	6.0%
	Increment		1.2%	1.5%	-6.0%	-8.3%	-3.0%	-5.9%
NA_HI	%days lost	0.8%	2.1%	2.0%	4.2%	3.4%	9.0%	5.9%
	Increment		1.3%	1.2%	3.4%	2.6%	8.2%	5.1%
NA_ME	%days lost	0.0%	0.2%	0.1%	0.6%	0.3%	0.5%	0.1%
	Increment		0.2%	0.1%	0.6%	0.3%	0.5%	0.1%
Oc	%days lost	58.9%	50.8%	58.9%	62.0%	64.8%	61.8%	40.6%
	Increment		-8.0%	6.0%	3.1%	-18.2%	2.9%	-5.5%
SSA_C	%days lost	33.6%	41.1%	40.9%	34.5%	22.6%	38.2%	30.3%
	Increment		7.5%	7.3%	0.8%	-11.0%	4.6%	-3.3%
SSA_E	%days lost	6.3%	9.3%	10.4%	10.3%	9.8%	16.8%	11.0%
	Increment		3.0%	3.4%	4.0%	2.8%	10.5%	3.9%
SSA_S	%days lost	2.2%	3.4%	2.2%	1.8%	3.3%	3.1%	1.2%
	Increment		1.2%	1.1%	-0.4%	-1.1%	0.9%	-0.3%

SSA_W	%days lost	40.3%	47.0%	40.3%	43.8%	47.1%	49.6%	32.1%
	Increment		6.7%	6.8%	3.4%	-8.2%	9.3%	1.6%

[1]AP_HI: Asia Pacific, High Income; As_C: Central Asia; As_E: East Asia; As_S: South Asia; As_SE: South East Asia; Au: Australasia; Ca: Caribbean; Eu_C: Central Europe; Eu_E: Eastern Europe; Eu_W: Western Europe; LA_A: Andean Latin American; LA_C: Central Latin America; LA_S: Southern Latin America; LA_T: Tropical Latin America; NA_HI: North America, High Income; NA_ME: North Africa/Middle East; Oc: Oceania; SSA_C: Central Sub-Saharan Africa; SSA_E: Eastern Sub-Saharan Africa; SSA_S: Southern Sub-Saharan Africa; SSA_W: Western Sub-Saharan Africa.

Table 3: Sensitivity of results to assumed labour trends and projected climate change, as the incremental percent days lost compared to baseline, for A2 in 2050s.

	Change in percent days lost compared to baseline for A2 in 2050s		
Region[1]	**Constant labour, changing climate**	**Changing labour, constant climate**	**Changing labour and climate[2]**
AP_HI	0.8%	-0.2%	0.2%
As_C	0.7%	-0.1%	0.4%
As_E	7.0%	-5.1%	0.4%
As_S	11.5%	-6.7%	4.4%
As_SE	18.2%	-21.6%	2.0%
Au	0.2%	0.0%	0.2%
Ca	11.7%	-4.0%	7.7%
Eu_C	0.6%	-0.1%	0.0%
Eu_E	0.3%	0.0%	0.4%
Eu_W	0.1%	0.0%	0.0%
LA_A	4.1%	-0.6%	3.2%
LA_C	18.6%	0.0%	18.6%
LA_S	0.3%	-0.1%	0.1%
LA_T	3.6%	-8.3%	-6.0%
NA_HI	3.4%	0.0%	3.4%
NA_ME	0.6%	0.0%	0.6%
Oc	15.2%	-15.1%	3.1%
SSA_C	15.4%	-11.5%	0.8%
SSA_E	8.1%	-2.1%	4.0%
SSA_S	2.8%	-1.6%	-0.4%
SSA_W	15.8%	-13.0%	3.4%

[1]AP_HI: Asia Pacific, High Income; As_C: Central Asia; As_E: East Asia; As_S: South Asia; As_SE: South East Asia; Au: Australasia; Ca: Caribbean; Eu_C: Central Europe; Eu_E: Eastern Europe; Eu_W: Western Europe; LA_A: Andean Latin American; LA_C: Central Latin America; LA_S: Southern Latin America; LA_T: Tropical Latin America; NA_HI: North America, High Income; NA_ME: North Africa/Middle East; Oc: Oceania; SSA_C: Central Sub-Saharan Africa; SSA_E: Eastern Sub-Saharan Africa; SSA_S: Southern Sub-Saharan Africa; SSA_W: Western Sub-Saharan Africa.
[2]This equals the bottom line of the 6th column in Table 2.

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