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Abstract

This paper argues that economic activity and work cannot be understood independently from the natural environment in which they take place. Indeed, two major trends related to the natural environment – current and future environmental degradation on the one hand, and the push towards environmental sustainability on the other – will define the future of work and social justice. Environmental degradation negatively affects the world of work given the tight linkages it has with the natural environment, notably through the loss of ecosystem services, the occurrence of natural disasters and the inequalities related to the exposure to environmental degradation and its associated risks. Efforts to advance environmental sustainability will disrupt the world of work through a reallocation, since achieving sustainability is akin to a structural transformation. Importantly, however, efforts to advance sustainability are compatible with employment opportunities and with the promotion of decent work; sustainability is not a job killer. In all, this paper contends that a good future for work requires a stable and healthy environment. It contends that such future requires attention to environmental degradation and protection for workers and communities from it. The paper calls for a development and economic model that underscores environmental and social outcomes and ensures that the transition towards sustainability is just.

Preface

In August 2017, the Director-General of the International Labour Organization convened an independent Global Commission on the Future of Work. The Commission will produce an independent report on how to achieve a future of work that provides decent and sustainable work opportunities for all. This report will be submitted to the centenary session of the International Labour Conference in 2019.

The Future of Work Research Paper Series aims to support the work of the Commission by publishing in-depth, original studies on specific topics of interest to the Commission, ranging from explorations of artificial intelligence and the platform economy to lifelong learning and universal social protection. Each paper provides a critical analysis of current and future developments and raises important questions about how to ensure a future of inclusive development with decent work at its heart.

The Sustainable Development Goals, in putting a strong emphasis on the environment, recognize the close link between human well-being and a healthy, stable natural environment. This paper provides a compelling argument to include the natural environment in any discussion about the future of work. Environmental trends affect the world of work directly, just as the world of work affects the environment. The future of work cannot be conceived as independent of its effects on the environment nor independent from trends in the natural environment. As the ILO's *World Employment and Social Outlook 2018: Greening with jobs* explains, on the one hand, environmental degradation destroys work opportunities and worsens working conditions. On the other hand, any efforts to achieve sustainability will entail a structural transformation. Crucially, this transformation can result in more and better jobs.

Guillermo Montt, lead author of the paper, is a senior economist in the ILO's Research Department working on the relationship between the natural environment, sustainability and decent work. Federico Fraga, also from the ILO Research Department, is an economist with experience on macroeconomic analysis and academic background on environment and natural resources management. Marek Harsdorff is an economist of the ILO's Green Jobs Unit providing evidence-based policy advice for countries to achieve a just transition towards environmental sustainability.

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1. Introduction

Climate change and other forms of environmental degradation are among the defining challenges of our time. Humanity is using 1.7 times more resources and producing more waste than the planet can regenerate and absorb. We are using tomorrow's resources to satisfy today's needs (Global Footprint Network, 2017). Humanity's influence on the Earth system, which has been accelerating since the 1950s, has led to unprecedented rates of biodiversity loss, the emission of novel entities,[1] damage to the ozone layer, soil degradation and changes to global biogeochemical flows, and has altered the Earth system on a worldwide, and in certain cases irreversible, scale (Steffen, Broadgate et al., 2015; Steffen, Richardson et al., 2015). Environmental damage is a feature of our present. Its likely continuation will define our future and, in particular, the future of work.

In response, a general consensus on the need to achieve environmental sustainability has risen. It is expressed in multilateral environmental agreements and statements since the United Nations Conference on the Human Environment (1972) (Stockholm Conference), the United Nations Conference on Environment and Development (1992) (Rio Earth Summit) and the United Nations Conference on Sustainable Development (Rio+20). More tangibly, it is expressed in agreements like the Paris Agreement (2015) and the Kigali Agreement (2016) which provide a blueprint for countries to advance environmental sustainability in respect to specific environmental challenges. These trends are also visible in the emergence and empowerment of national environmental protection agencies and the establishment of national sustainable development plans.

Both these trends – environmental degradation and environmental sustainability – will profoundly shape the future of work, given the tight link between economic activity and the natural environment. This paper begins by understanding economic activity as a subsystem of the Earth's ecological system. Such a recognition is at the base of the United Nations' development of the internationally agreed System of Environmental Economic Accounting (UN, 2012). The economy uses natural resources, it draws on natural processes but it also affects and constrains the availability and distribution of natural resources and processes. By extension, the world of work, both paid and unpaid, is intrinsically linked to the natural environment. The second section thus shows how environmental degradation profoundly, and negatively, affects the world of work. The third section then explores how progress towards sustainability will also affect the world of work, noting that sustainability entails a structural economic transformation and one that can evolve towards more and better jobs. In all, given these linkages, this paper argues that the natural environment – through degradation or as a result of the policies to achieve sustainability – is a fundamental driver of the future of work. As such, a new development model is required, one that accounts for social and environmental objectives simultaneously, especially given that population projections point to the need to feed and sustain the livelihoods of 9.8 billion people living in 2050 (UNDESA, 2017). In this context, the final section outlines policy options to reorient the development model towards this objective.

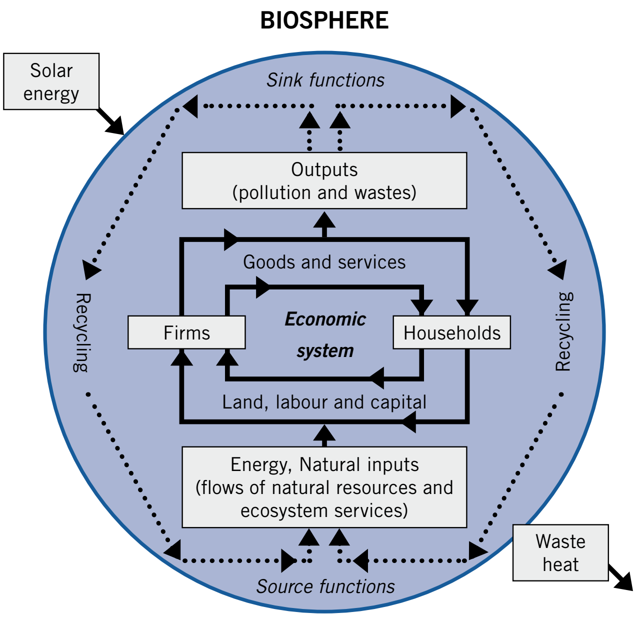
[1] *Novel entities include toxic compounds such as synthetic organic chemicals, as well as genetically modified organisms, nanomaterials and microplastics.*

2. The economy and the natural environment

Because human activities depend on and alter natural ecosystems, economic activity cannot be understood as independent from the natural environment in which they take place. In this context, the economy is part of a subsystem of broader ecological processes; ecological cycles and principles of physical and biological systems can be used to understand the human economy (Costanza, 1989; Harris and Roach, 2017; UN, 2012).

Figure 1 illustrates this idea. The economic system exchanges goods and services, land, labour and capital between firms and households. Importantly, it draws energy and natural inputs from the biosphere and releases pollution and waste into the ecosystem. The economic system is an open system; it exchanges energy and resources with the global ecosystem within which it is placed. The global ecosystem provides energy and resources to the economy (source functions), and absorbs, stores or recycles the energy and waste produced by the economy (sink functions). The global ecosystem has solar energy as an input and waste heat as an output; other than that, it is a closed system. In current models of economic growth, as the economic system grows within the global ecosystem it requires more resources and energy and generates more waste, making it more difficult for the global ecosystem to perform its source and sink functions. In parallel, some activities within the economic system affects the ecosystem's ability to perform its source and sink functions, both positively (e.g. technology) or negatively (e.g. pollution or destruction of ecosystems). The fixed size and closed nature of the planetary ecosystem imposes a limit to the resources and energy that can be sourced from the ecosystem and also imposes a limit to the amount of waste it can absorb, store or process. In sum, the economy cannot expand beyond the confines of ecological limits.

Figure 1. The economy as a subsystem of the global ecosystem

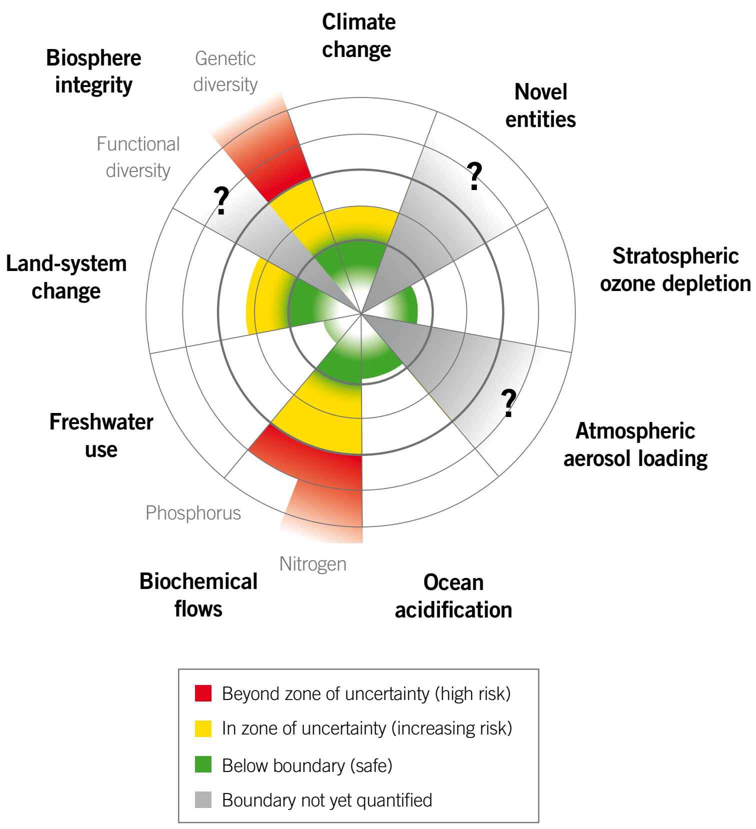


Source: Adapted from Harris and Roach, 2017.

This relationship between economic activity and ecological processes leads to the principle that economic activity must operate within certain boundaries and at an optimal macroeconomic scale, at which the Earth's ecosystems are preserved. This principle ensures that the benefits humans derive from ecosystems are not jeopardized over time (Goodland, Daly and Serafy, 1992; Harris and Roach, 2017).

The notion of boundaries leads to the observation that the material scale of human actions is severely outpacing the carrying capacity of the Earth. Since the 1970s, humanity has been using more resources per year than those the Earth can regenerate and has been producing more waste than the Earth can absorb (Global Footprint Network, 2017). There is consistent and robust evidence that humanity is already operating beyond several ecological limits, with consequences that are irreversible and that could be highly adverse or even catastrophic on a global scale (Rockström et al., 2009; Steffen, Richardson et al., 2015) (Figure 2).[2]

Figure 2. Current status of the control variables for seven planetary boundaries



Notes: The green zone is the safe operating space, the yellow represents the zone of uncertainty (increasing risk), and the red is a high-risk zone. The planetary boundary itself lies at the intersection of the green and yellow zones. Processes for which global-level boundaries cannot yet be quantified are represented by grey wedges; these are atmospheric aerosol loading, novel entities, and the functional role of biosphere integrity.

Source: Steffen, Richardson et al., 2015, p.15.

[2] *The nine planetary boundaries are, in no particular order: (1) biosphere integrity (biodiversity loss and extinctions); (2) climate change; (3) chemical pollution and the release of novel entities (e.g. the release of synthetic organic pollutants, heavy metal compounds and radioactive material); (4) stratospheric ozone depletion; (5) atmospheric aerosol loading (air pollution); (6) ocean acidification; (7) biogeochemical flows (nitrogen and phosphorous flows to the biosphere and oceans); (8) freshwater use; and (9) land-system change (Rockström et al., 2009; Steffen, Broadgate et al., 2015).*

Several examples show the deterioration of the Earth's ecosystem's sourcing functions or the generation of waste beyond the Earth's sink function. As described below, they negatively impact future economic activity and the future of work: when it comes to sourcing, at least 31 per cent of the world's marine fisheries are exploited beyond their capacity to replenish stock (FAO, 2016; Pauly and Zeller, 2016), about a third of the world's soils are degraded and, if current trends continue, all of the world's soils may be degraded in 60 years (FAO, 2015). Regarding the sink capacity of the Earth, climate change is the result of both the generation of waste in the form of greenhouse gas (GHG) emissions beyond the Earth's capacity to sequester and a reduction in the Earth's sink functions through, for example, land use change (IPCC, 2013).[3] The release of pollutants beyond the capacity of the ecosystem to absorb them affects the quality of soils, water and air, damaging the ability of the ecosystems to perform their source functions.

The notion of a fair and equitable intergenerational distribution of resources and opportunities underlies the concept of optimal macroeconomic scale and has given rise to the consensus to achieve sustainability (e.g. the Rio+20 Conference). This has brought a push towards redefining economies so that their environmental impact is minimal, to preserve source functions for future generations. These are low-carbon, resource-efficient economies, also dubbed environmentally sustainable economies or green economies (UNEP, 2011).

In an environmentally sustainable economy, the economically efficient allocation of resources considers the preservation of natural capital, and any changes in it. Yet current measures of economic accounting generally ignore this dimension. Thorough accounting of economic activity, potential and sustainability should include the state of natural capital and its progress or degradation (Costanza, Cumberland et al., 2014; Costanza, de Groot et al., 2014; Harris and Roach, 2017; Patil, 2012; World Bank, 2018). Put simply, in current economic accounting the conversion of forests to timber counts positively, given timber's commercial value. Yet in the context of the economy as a subsystem, considering only this value ignores the current and future costs associated to the loss of a forest, as forests provide key currently unvalued resources and services (e.g. climate regulation, water flow regulation, biodiversity preservation and water purification).[4]

Two important trends relevant for the future of work emerge from understanding the economy, and the world of work, as a subsystem of the global ecosystem: 1) environmental degradation, in some cases irreversible, is a fact and will likely continue; and 2) the economy will need to change to reduce its impact on the global environment and advance towards sustainability. The following two sections explore in more details how each of these two trends determine the future of work.

[3] *The emissions of several gases contribute to climate change. Carbon dioxide (CO_2) is the largest contributor to greenhouse gas (GHG) emissions. Other GHGs include methane, nitrous oxides and F-gases (HFCs, PFCs and SF6). For the purposes of simplicity, non-CO_2 GHGs are usually converted to a CO_2-equivalence based on their global warming potential (GWP). For example, nitrous oxide (N_2O), emitted during agricultural and industrial activities, decomposed only by bacteria, has a GWP of 298 times that of CO_2. F-gases, commonly used as refrigerants or fire suppressants, and in various industrial processes, have a GWP ranging from 124 for some specific hydrofluorocarbons, to 22,800 for sulphur hexafluoride. F-gases generally remain in the atmosphere for hundreds of years.*

[4] *Given the complexities of natural systems, capturing their stock and flow dynamics requires the combination of insights from both economic analysis and ecological principles. This does not mean that traditional economic techniques are unimportant; instead, that they must be complemented with ecological considerations to avoid inaccurate results. The System of Environmental-Economic Accounting 2012 (UN, 2012), which provides the conceptual framework for integrated statistics on the environment and its links with the economy, is a clear example towards that direction.*

3. The economy and the natural environment

Current and future environmental degradation is detrimental to the advancement of decent work and to the pursuit of social justice. This is because, as outlined by the ILO (2018), the world of work and the natural environment are intrinsically linked. Several channels, developed in more detail below, explain this link and outline the specific risks workers face from environmental degradation: 1) jobs in many sectors rely directly on natural resources; 2) jobs in many sectors rely directly on the services that ecosystems provide free of charge (ecosystem services); 3) jobs and the quality of work also rely on the absence of environmental hazards (such as storms, excessive heat and air pollution) and the maintenance of environmental stability; and 4) the risks and hazards associated with environmental degradation affect women and vulnerable workers the most, thereby generating, exacerbating and perpetuating inequality.

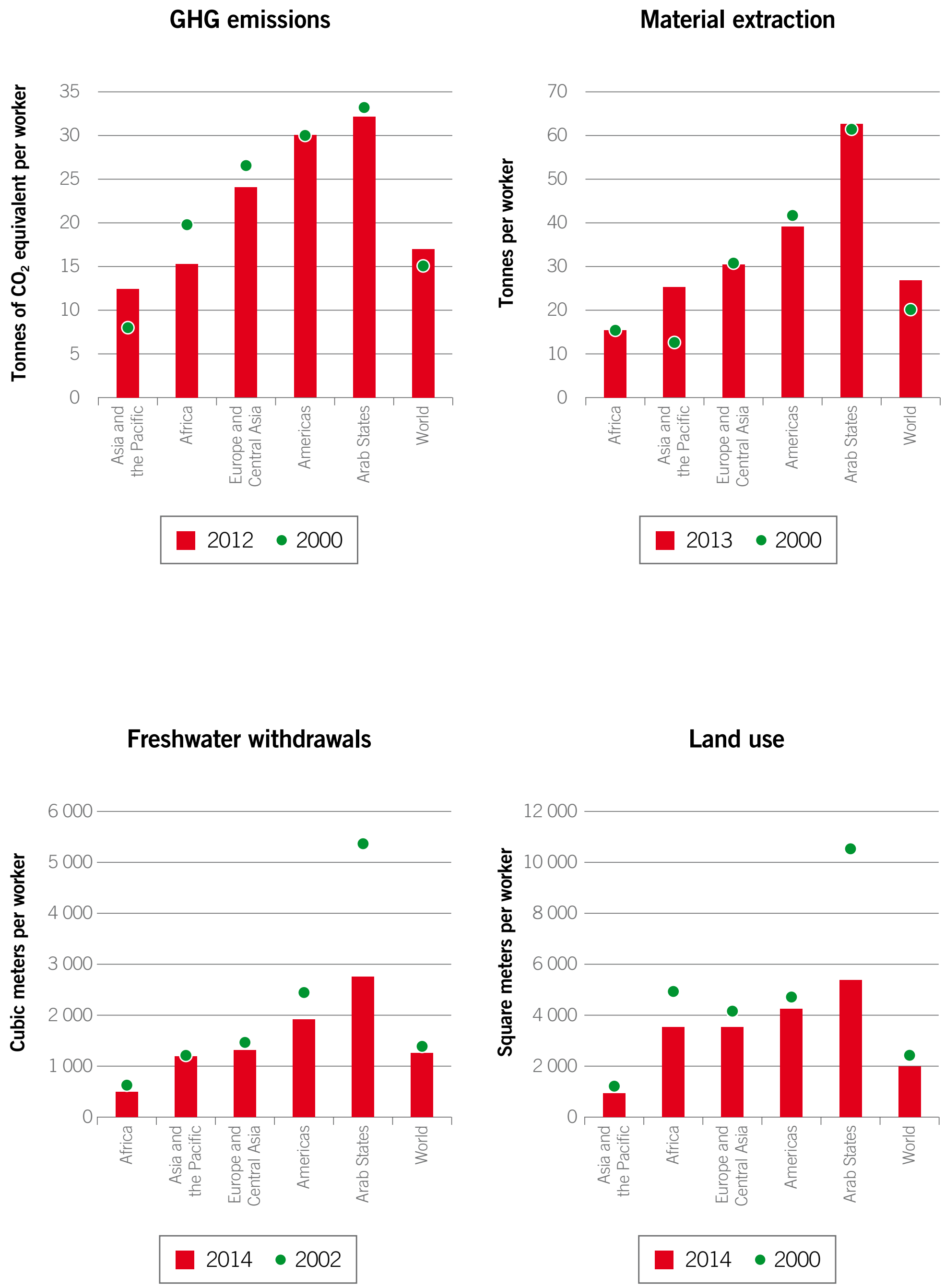
3.1. Economic activity, and many jobs, depend on the extraction of natural resources

The economic activity of many countries, and the jobs that depend on them, remain coupled to the extraction of natural resources. In 2015, for example, 1.7 per cent of global GDP came from natural resource rents, but this share reached 21 per cent in the Arab States and 7.1 per cent in Africa. Natural resource rents accounted for more than 10 per cent of national GDP in 40 countries, 25 of which are in Africa and six in the Arab States (World Bank, 2017).[5]

The carbon resource intensity of employment measures the amount of GHGs emitted and the material, land and water resources per person employed in an economy or sector. It serves as an indication of the extent to which employment in the economy depends on GHG emissions and resource extraction. Figure 3 shows that each job is more dependent on GHG emissions and resource use in the Americas than in Asia and the Pacific and Africa. This is a reflection of the fact that while resource extraction is important in both regions, there is a substantive subsistence sector in Asia and the Pacific and Africa. In the Arab States, jobs are more dependent on GHG emissions because of the importance of the oil industry. The unsustainable extraction of resources threatens the economic activity of these regions, and the jobs that depend on them.

[5] *These estimates do not account for the reliance on ecosystem services, which, as described below, make a substantial though unrecognized contribution to economic activity (Costanza, de Groot et al., 2014).*

Figure 3. Carbon and resource intensity of employment, 2000–14 or latest year available



Note: The GHG and resource intensity of employment divides the total GHG emissions or resources extracted by the employment in the region.

Source: ILO, 2018. Calculations therein based on ILOStat (employment), World Development Indicators (GHG emissions and freshwater withdrawals), FAOStat (land use) and Material Flows Data (material extraction). Data for 2000 and 2012 are used for GHG emissions, 2000 and 2013 for material extraction, 2002 and 2014 for freshwater withdrawals and 2000 and 2014 for land use.

3.2. 1.2 billion jobs depend directly on natural processes

Around 1.2 billion jobs in 2014, or 40 per cent of world employment, were in industries that depend heavily on natural processes; indeed, ecosystems provide services to economies, societies and individuals (i.e. ecosystem services) (see table 1). For example, dry-land farming relies on rain for irrigation and farmers rely on forests to prevent floods; farmers also rely on the capacity of the soil to maintain and renew its nutrients. Coastal fishing relies on the biodiversity of the ocean and its capacity to renew fish stocks, as well as on tidal marshes, mangroves and/or coral reefs for storm protection. These ecosystem services also include, among others, the purification of air and water, the generation and renewal of soil and soil fertility, the pollination of crops, the control of agricultural pests, the moderation of temperature extremes, protection against storms, floods and wind, and support for diverse human cultures and aesthetic beauty (Daily, 1997; Kumar, 2010; MEA, 2005).

The share of employment that relies on ecosystem services varies across regions, with Africa and Asia and the Pacific having the highest share, at 59 and 47 per cent, respectively. In Europe and the Americas, 17 per cent of total employment relies directly on ecosystem services, and the figure is 15 per cent in the Arab States. Globally, most of these jobs are in agriculture (80 per cent), forestry and fishing (5 per cent), food, drink and tobacco (6 per cent), and the wood and paper, renewable energy, water, textile, chemical and environment-related tourism sectors (9 per cent) (table 1).

These estimates consider only employment that is directly dependent on the provision of ecosystem services. Ecosystem services also support jobs indirectly through other industries that depend on or provide inputs for these activities (for example, these estimates account for farmers, but not salespeople selling seeds or truckers transporting produce).

Environmental degradation limits the ability of ecosystems to provide these services, damaging economic activity (Kumar, 2010) and putting the related jobs at risk (GHK, CE and IEEP, 2007; Rademaekers et al., 2012). For example, climate change affects temperature and rain patterns and the economic activity of farmers; deforestation increases the risk of floods; and intensive, repeated tillage and mono-cultivation of high-value crops reduce soil health and future yields, requiring more fertilizer use, which may lead to run-off and changing chemical balances in water bodies (eutrophication). Changing ocean currents and ocean acidification, also due to climate change, modify fishery cycles, making stocks less predictable. Overexploitation of these services, as is the case in fishery catches beyond their maximum sustainable yield, can lead to the collapse of entire industries, as is imminent in the sardine fishery in the Atlantic (ICES, 2017) or has been the case with the Anchoveta in Peru and the North Atlantic Cod in Canada and Norway (Pauly et al., 2002).

Table 1. Jobs relying on ecosystem services, 2014 (thousands)

Sectors	Example of ecosystem services	Africa	Americas	Asia and the Pacific	Europe	Middle East	World
Most activity in the sector is related to biodiversity and ecosystem services							
Agriculture	Genetic resources and stock availability, freshwater, pollination, seed dispersal	217 263	42 600	670 476	42 108	4 248	976 694
Forestry		1 634	1 103	11 866	2 061	36	16 700
Fishing		5 118	2 264	36 491	603	252	44 728
Food, drink and tobacco	Food, fibre and freshwater	3 267	10 470	46 141	11 083	510	71 471
Wood and paper	Fibre, water purification and waste control	487	3 605	7 789	3 694	126	15 701
Renewable energy	Fibre for biofuels	123	292	1 842	737	107	3 101
Water	Freshwater supply, recycling, regulation, purification and natural hazard regulation	23	136	414	320	57	950
Most activity in the sector relies on biodiversity and ecosystem services, but they do not determine the nature of the sector							
Textile	Fibre, water purification and waste control	595	5 409	39 423	4 263	165	49 855
Chemicals	Genetic resources, biochemical diversity, freshwater	247	2 254	10 938	1 388	<0.5	14 827
Environment-related tourism	Food, freshwater, air quality, education, aesthetic and cultural value	2 282	7 110	23 081	4 828	357	37 657
Total by region		**231 039**	**75 244**	**848 461**	**71 084**	**5 856**	**1 231 684**
Share of total regional employment (%)		**59**	**17**	**47**	**16**	**15**	**40**

Note: Only industries in which the activity has a "significant and substantial" link to the environment are shown. The identification of these linkages is taken from GHK, CE and IEEP, 2007. The environment-related tourism sector, following the same source, is estimated as a 0.3 share of the total hotel and restaurant sector.

Source: ILO, 2018.

3.3. Jobs are vulnerable to environmental risks and hazards

Besides their effect on jobs through the provision of ecosystem services, environmental risks, both local (e.g. air, water and soil pollution) and global (e.g. climate change) have the potential to destroy ecosystems and communities, as well as impoverishing working conditions of workers affected. This is a third way in which the environment – and environmental degradation in particular – is related to the world of work. Risks can stem from slow-onset events (as is the case of droughts, erosion, soil degradation or sea-level rise) or rapid-onset events (as is the case of extreme weather events), and can be local or global. Environmental risks can result from human activity (e.g. water pollution from non-compliant industrial activity) or natural hazards (e.g. water pollution following a volcanic eruption). Human activity can also increase the occurrence and intensity of natural hazards (e.g. increasing the intensity and frequency of extreme weather events as a result of human-induced climate change), and their consequences (for example, mangrove deforestation increases the consequences of storms on shores) (Whyte and Burton, 1980).

Soil, air and water pollution alone led to nine million deaths in 2015 (Landrigan et al., 2018). Taking into account only premature deaths, air pollution costs the world economy about US$225 billion in lost labour income and US$5 trillion in welfare losses (World Bank and Institute for Health Metrics and Evaluation, 2016). The detrimental effect of air pollution reduces productivity and working hours through the deterioration of the health of workers themselves, and of women when they take the burden of the caregiving role for sick children. Air pollution thus increases gender inequality in the labour market (Montt, 2018).

As a result of climate change and other forms of environmental degradation, projections point towards an increase in the frequency and intensity of extreme weather events and disasters (IPCC, 2014). With each disaster, jobs and productivity are lost. ILO (2018) shows that between 2000 and 2015, 23 million working-life years were lost annually as a result of different environmentally-related hazards caused or enhanced by human activity.[6] Beyond accounts of untold human suffering, this is equivalent to 0.8 per cent of a year's work, considering that 2.8 billion people aged 15 to 64 are in employment in any given year.

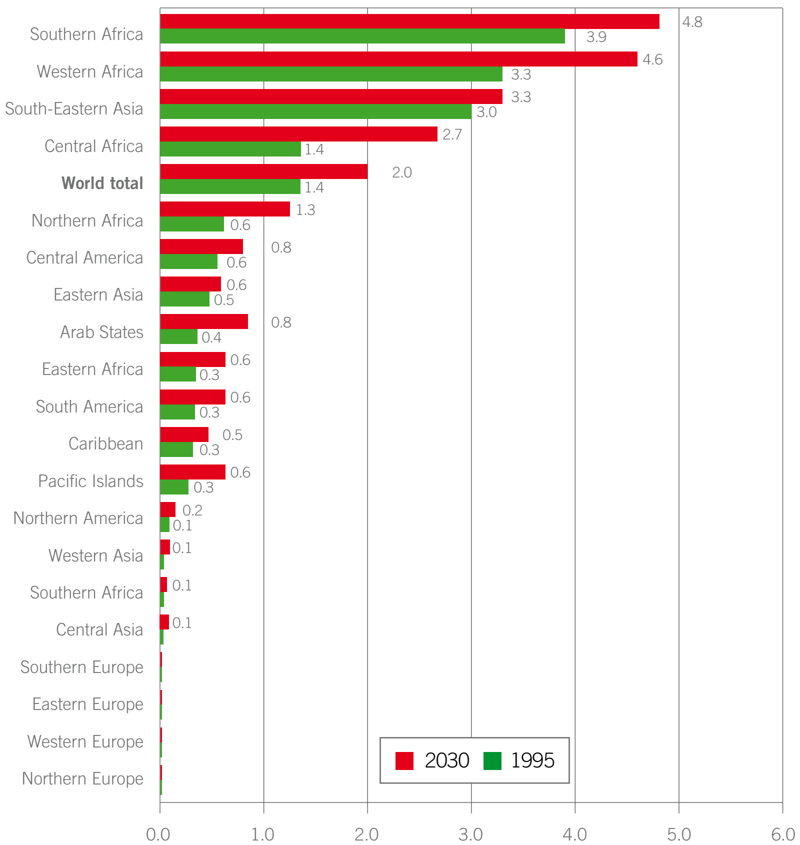
Also as a result of climate change, areas suitable for growing crops will move geographically (IPCC, 2014), but farmers may not be able to act on these changes by migrating or adopting alternative or drought-resistant crops, many of which require decades of investment before yields become profitable (Bhagat, Baruah and Safique, 2010; Bunn et al., 2015; Renteria, 2016; Schroth et al., 2009). These challenges specific to agriculture compound those related to overexploitation, chemical run-off and soil degradation following the injudicious use of the technologies that instigated the productivity gains in agriculture between the 1960s and 1980s (Pingali, 2012).

Rising temperatures increase the incidence of heat stress and health risks, and the proportion of working hours during which a worker needs to rest and cool down the body to maintain the core body temperature below 38°C and avoid heat stroke. During the course of the century, and as a result of human-induced climate change, many of the more than four billion people who live in hot areas will experience negative health and safety effects and reduced work capacity (Kjellström et al., 2016). ILO (2018) estimates, presented in figure 4, combine a global temperature rise of 1.5°C by the end of the twenty-first century and labour force trends. They suggest that, by 2030, the percentage of total hours of work lost will rise to 2.0 per cent, a productivity loss equivalent to 72 million full-time jobs. This is, most likely, an underestimate as it assumes a 1.5°C increase in global mean temperature (business-as-usual estimates put global warming at 6°C), assumes that agricultural work is carried out in the shade and does not consider indirect effects through, for example, the effect on livestock.

The negative impact of rising temperatures is unevenly distributed across subregions. Southern Asia and Western Africa will be most affected, with productivity losses equivalent to 4.8 per cent and 4.6 per cent, corresponding to around 40 and 9 million

[6] *The estimate of working-life years follows Noy's (2014) estimates for total life years lost due to disasters. Noy's methodology is adapted to take into account retirement and the population in employment in each country.*

Figure 4. Working hours lost due to heat stress under a 1.5°C scenario, 1995–2030, percentages



Note: The figure depicts the percentage of hours of a working year that are too hot to work, considering the observed (2015) and projected (2030) temperature and humidity levels, as well as the amount of work carried out in the shade and the sun, and the effort exerted by tasks in different industries. See ILO (2018), Appendix 1, for methodological details.

Source: ILO, 2018.

full-time jobs, respectively. Agricultural workers will be the worst affected, and will account for 66 per cent of global hours lost due to heat stress in 2030, in view of the physical nature of their work, it being undertaken outside, and the fact that a large number of workers are engaged in agriculture in the areas most affected by future high temperatures. Even greater temperature rises, as predicted under a business-as-usual scenario, will make some of these areas unproductive, displacing a large number of workers.[7]

[7] *These results are in line with those of the IMF (2017), which suggest that for a median low-income country, with an average temperature of 25°C, the effect of a 1°C increase in temperature will reduce annual GDP growth by 1.2 percentage points.*

3.4. Environmental degradation enhances inequality

People who are socially, economically, culturally, politically, institutionally or otherwise marginalized are especially vulnerable to the effects of climate change and other forms of environmental degradation. Environmental degradation thus increases inequality, signalling a fourth channel by which jobs and the environment are related. Groups at risk include populations not covered by national social protection systems, workers in the informal economy and many migrant workers (IPCC, 2014). People not covered by social protection systems which include, to a large extent, workers in the informal sector, do not have access to a safety net in the wake of a disaster or losses associated to other natural disasters. People in poverty are generally more exposed to hazards and disasters, as they have lower access to resources to adapt to climate change, including land, credit, agricultural inputs, participation in decision-making bodies, access to technology, social insurance and training. Also, indigenous and tribal peoples and the rural poor are especially vulnerable to environmental degradation that limits the provision of ecosystem services (Hallegatte et al., 2016; ILO, 2018). Exposure and vulnerability to environmental risks are not evenly distributed across countries; indeed, 80 per cent of the total life years lost to disasters are spread across low- and middle-income countries (UNISDR, 2015). Poor and low-income countries are at higher risk in view of their lower capacity to mitigate the damage and mobilize resources for reconstruction (Felbermayr and Gröschl, 2014; Noy, 2009; Schumacher and Strobl, 2011). For example, climate change is a direct threat to poverty eradication as a result of changes in ecosystems, which affect food prices and security, more extreme and more frequent natural hazards and the magnification of health threats, a key source of chronic poverty (Hallegatte et al., 2016). Gender differences in social and economic roles and responsibilities exacerbate the vulnerability of women, who have lower access than men to resources to adapt to climate change, including land, credit, agricultural inputs, decision-making bodies, technology, social insurance and training. For the majority of women working in the informal economy and in small enterprises, it is particularly difficult to recover from the effects of environmental disasters (ILO, 2009; IPCC, 2014).

Small Island Developing States (SIDS) are particularly vulnerable to environmental shocks. They have a narrow resource base, comparatively remote markets and a limited ability to benefit from economies of scale. Storm surges and sea-level rise degrade fresh groundwater resources and salinize agricultural land. The fragile land and marine ecosystems of SIDS, and the related economic activities, are sensitive to invasive alien species, globally emitted contaminants and overexploitation, among other human-induced risks (IPCC, 2014; UNEP, 2014). Many of the environmental risks that threaten SIDS originate outside their borders and directly affect key industries (such as agriculture, fisheries and tourism) and the substantial number of jobs and livelihoods that depend on them (ILO and ADB, 2017). Over 85 per cent of the land of the Cook Islands, Kiribati, Maldives and Marshall Islands, and 26 per cent of all the land of SIDS lies less than five metres above sea level, probably forcing displacement (ADB, 2012). In the Caribbean Community, around 30 per cent of major resort properties would be partially or fully inundated by a 1 metre rise in the sea level, affecting a key industry (UN-OHRLLS, 2015).

The annual impact of natural disasters in SIDS amounts to over 17 per cent of GDP, compared to 6 per cent in lower middle-income countries and 3 per cent in high-income countries (OECD and World Bank, 2016). By way of illustration, Cyclone Pam hit the islands of Vanuatu in 2015, levelling the housing and transport infrastructure and destroying crops, and the storm surge salinized farming land. The medium-term impacts on tourism and agriculture undermined economic activity, jobs and incomes in the islands for several years (ADB, 2015).[8]

3.5. Future environmental degradation will define the future of work and social justice

The above sections highlight the intrinsic link between jobs and the natural environment. They show, by extension, that environmental degradation negatively affects the world of work and the pursuit of social justice. They underscore that the world of work needs to consider and adapt to environmental damages that will continue in the future: climate change, soil degradation, overexploitation, biodiversity loss, soil, air and water pollution, eutrophication and others.

If current trends towards environmental degradation continue, the world of work will face increasing challenges through the effects on economic activity, working conditions and inequality, among others. It will need to adapt to limit the impact of environmental degradation on households, workers and enterprises. As described further in the final sections of this paper, certain environmentally-specific adaptation measures have already begun to emerge, as is the case of climate-indexed social insurance schemes (Béné et al., 2014; ILO, 2018; ILO and AFD, 2016).

[8] *The high vulnerability of SIDS to risks produced elsewhere means that adaptation is a core component of their long-term economic and social sustainability as, with their small relative size, they can do little to mitigate their occurrence. Several funding mechanisms exist to build resilience in SIDS. These include the International Development Association, the Adaptation Fund, the Green Climate Fund, the Global Environment Fund, the Least Developed Countries Fund and the Special Climate Change Fund. (OECD and World Bank, 2016).*

4. Potential for job creation and decent work in a green future of work

The previous sections concluded that environmental degradation negatively affects the world of work, highlighting how current and future environmental degradation will determine the future of work. In parallel, and in the context of the global consensus on the need to achieve environmental sustainability, this section examines how efforts to advance environmental sustainability affect the world of work. It shows that progressing towards low- carbon and resource-efficient economies does not limit progress towards achieving decent work. On the contrary, advancing towards sustainability can create employment, though it implies an important redistribution of labour, as environmentally damaging industries downsize or adapt and environmentally compatible industries emerge and grow (Bowen, Duffy and Fankhauser, 2016; Bowen and Kuralbayeva, 2015; ILO, 2012, 2018; UNEP et al., 2008; UNEP, 2011).

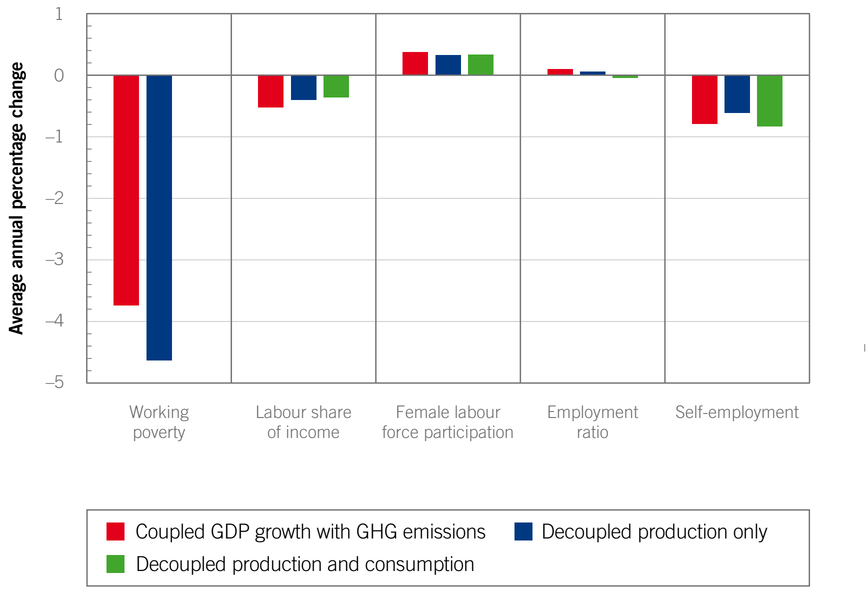
4.1. Advancing environmental sustainability does not limit progress towards decent work

Environmental sustainability can be compatible with decent work, especially when the institutional and policy tools adopted to promote decent work complement measures to advance a sustainable, low-carbon and resource-efficient growth. The ILO (2018) identifies 46 countries that have been able to grow economically in the 20 years between 1995 and 2014 while at the same time reducing their production-based GHG emissions. Of these, 23 decoupled growth from their carbon footprint, meaning that the emissions embedded in their consumption also declined; these 23 countries were able to achieve decoupled growth without exporting their emissions.

Denmark is a clear example of decoupling. It achieved average annual GDP growth of 0.94 per cent between 1995 and 2013, with an average annual GHG emissions and carbon footprint reduction of 3.0 and 2.8 per cent, respectively. This was largely due to the growth in renewable energy in its energy mix. By 2015, renewable energy sources accounted for 56 per cent of its domestic electricity supply (DEA, 2017). Germany also shows signs of decoupling, with average annual GDP growth of 1.3 per cent and a reduction of GHG emissions and the carbon footprint at an average annual rate of 0.9 and 0.7 per cent, respectively, over the same period. Decoupling in Germany has been driven by the substantial growth in environmental goods and services (i.e. green jobs) (OECD, 2012) and in the use of renewable energy, notably wind energy (WindEurope, 2017).

Data comparing the set of countries with GHG-coupled growth and those with GHG-decoupled growth, suggests that both sets improved certain labour market outcomes between 1995 and 2014 by similar proportions (figure 5). These results, which hold when controlling for other variables in the context of conditional time series, suggest that the promotion of positive labour market outcomes and some elements of decent work is compatible with environmental sustainability, particularly when economic growth and the specific sectors that promote decent work are decoupled from environmental degradation.

Figure 5. Changes in labour market outcomes for coupled and decoupled countries , 1995–2014



Notes: Calculations only include countries that experienced GDP growth between 1995 and 2014 (157 countries out of a total of 182 countries for which data are available) and countries for which data are available for the respective indicator (working poverty: 109; labour share of income: 117; female labour force participation: 157; employment ratio: 157; self-employment: 157). Results for the change in working poverty in countries that decoupled production and consumption-based emissions are not shown because working poverty data are available for only six countries in this group.

Source: ILO, 2018.

4.2. A low-carbon economy creates jobs

The Paris Agreement, signed in 2015 and ratified by 178 Parties, sets out a global objective to limit global warming to below 2°C above pre-industrial levels (UNFCCC, 2015), which would reduce the likelihood of catastrophic and irreversible climate change (IPCC, 2014). The International Energy Agency (IEA) has developed region-specific scenarios that decouple the energy sector from GHG emissions, which would limit global warming to 2°C (IEA, 2015a). It entails a shift in the energy matrix from fossil fuels to renewable energy sources; it also entails an increase in energy efficiency across all sectors (e.g. heating, transport, electricity use, etc.). Though the total employment in the energy sector may be relatively low, changes in the energy sector will necessarily affect all other sectors, such as electricity generation, transport, construction, agriculture, extraction of primary resources, etc. Changes in the demand for these sectors' products will, in turn, activate the demand in other sectors. In transport, for example, electric vehicles entail very different value chains compared to internal combustion engine vehicles. An accurate assessment of the employment impact of decarbonization in the energy sector requires paying attention to the economic linkages across all sectors in an economy.

The ILO (2018) estimates the impact of such a transition in the energy sector using multi-regional input-output tables to account for the economic linkages across industries and national borders.[9] It shows how advancing towards the decarbonization of the energy sector will result in the net creation of 18 million jobs around the world. This is the result of 24 million jobs created and six million jobs destroyed.

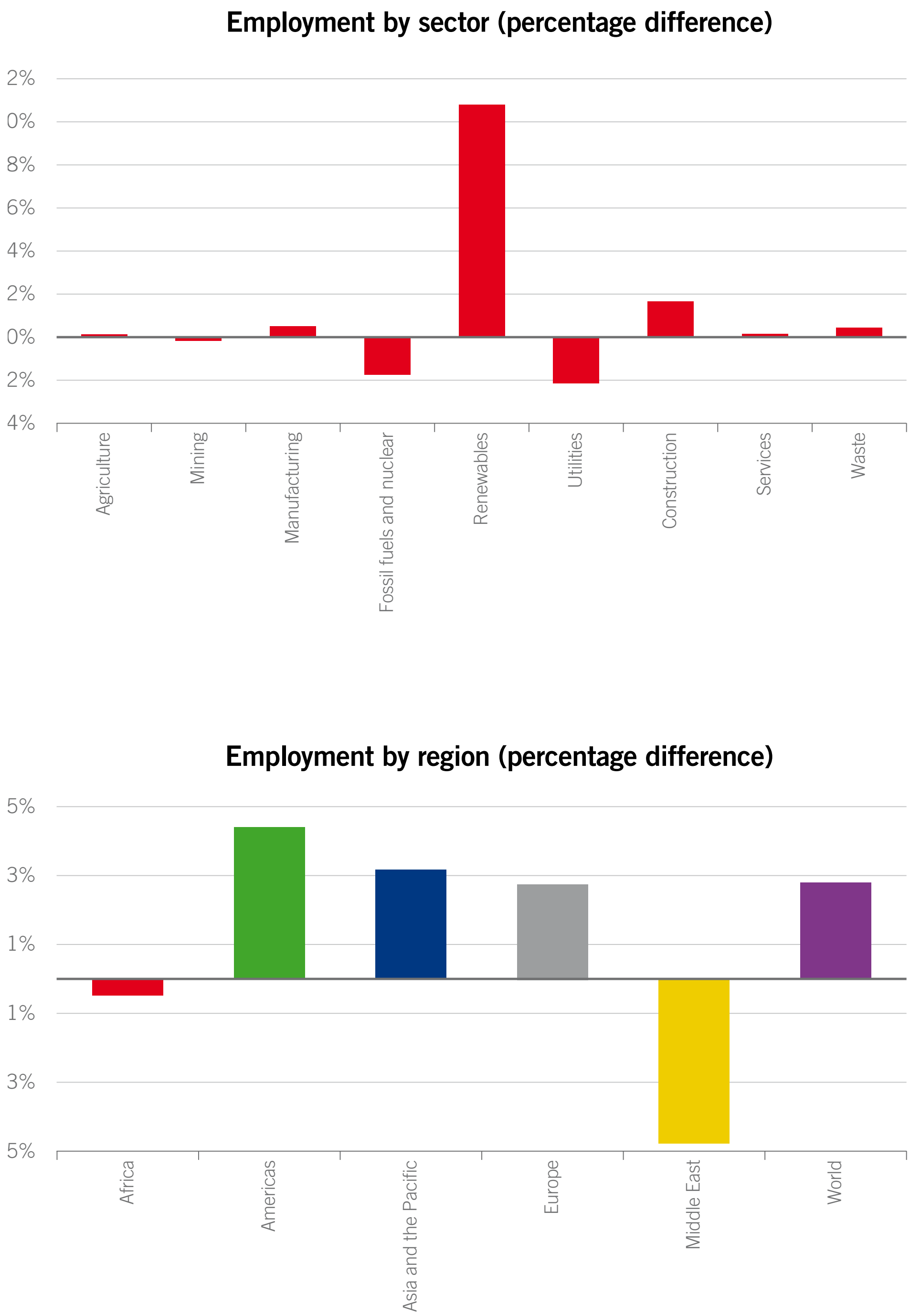
The job creation benefits are unequally distributed across regions (figure 6). There will be net job creation in the Americas, Asia and the Pacific and Europe (0.45, 0.32 and 0.27 per cent, respectively, representing around three, 14 and two million jobs). In contrast, there will be net job losses in the Middle East (–0.48 per cent, or over 300,000 jobs) and Africa (–0.04 per cent, or around 350,000 jobs) if the economic structure of these regions does not divert from the historical trend and projections to 2030.[10]

Job creation is led by the construction and the renewable energy sectors at around 6 million and 2.5 million jobs, respectively. This is expected, given the importance of energy efficiency and renewables in a scenario of energy sustainability. Industries that supply inputs to these industries, which are not necessarily sustainable in terms of resource or energy intensity, will also see job creation, as is the case with the manufacturing of electrical parts and machinery and the mining of copper ores and concentrates. These two sectors will see job creation, with around 2.5 and 1.2 million jobs, respectively. Job losses are concentrated in petroleum refining (around –1.6 million), crude petroleum extraction (around –1.4 million), production of electricity by coal (around –0.8) and the mining of coal (around –0.7) (table 2). Of the 163 industries analysed, only 14 see employment losses of more than 10,000 jobs. The focalization of employment losses in a few industries is due to the fact that reaching the 2°C goal requires the downsizing of a few carbon-intensive industries which are, in general, very capital-intensive and source input from other capital-intensive industries; a large percentage reduction in output in these industries leads to comparatively small reductions in employment.

[9] *Appendix 2 in ILO (2018) provides more details on the methodology used for this and other scenarios.*

[10] *Africa's net job loss is led by a total of around 650,000 jobs lost, mainly in fossil fuel-related sectors (e.g. petroleum refining, extraction of petroleum and mining of coal, electricity production by coal) and job gains of around 300,000, mainly in the construction, mining of copper ores and manufacture of electrical machinery sectors.*

Figure 6. Energy sustainability and employment in 2030



Notes: Percentage difference in employment between the sustainable energy scenario and the IEA 6°C (business-as-usual) scenario by 2030. Vertical scales differ by panel.

Source: ILO, 2018.

Table 2. Sectors most affected by the transition to sustainability in the energy sector

Industries set to experience the highest job demand growth (absolute)		Industries set to experience the strongest job demand decline (absolute)	
Sector	*Jobs (millions)*	*Sector*	*Jobs (millions)*
Construction	6.5	Petroleum refining	–1.6
Manufacture of electrical machinery and apparatus	2.5	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying	–1.4
Mining of copper ores and concentrates	1.2	Production of electricity by coal	–0.8
Production of electricity by hydro power	0.8	Mining of coal and lignite; peat extraction	–0.7
Cultivation of vegetables, fruit, nuts	0.8	Private households with employed persons	–0.5
Production of electricity by solar photovoltaics	0.8	Manufacture of gas; distribution of gaseous fuels through mains	–0.3
Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	0.7	Extraction of natural gas and services related to natural gas extraction, excluding surveying	–0.2
Industries set to experience the highest job demand growth (percentage)		**Industries set to experience the strongest job demand decline (percentage)**	
Sector	*Jobs (percentage)*	*Sector*	*Jobs (percentage)*
Production of electricity by solar thermal energy	3.0	Production of electricity by coal	–0.19
Production of electricity by geothermal energy	0.4	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying	–0.11
Production of electricity by wind	0.4	Extraction, liquefaction, and regasification of other petroleum and gaseous materials	–0.11
Production of electricity by nuclear energy	0.3	Petroleum refining	–0.08
Production of electricity by biomass and waste	0.3	Manufacture of gas; distribution of gaseous fuels through mains	–0.05
Production of electricity by solar photovoltaics	0.3	Mining of coal and lignite; peat extraction	–0.03
Production of electricity by hydro power	0.2	Extraction of natural gas and services related to natural gas extraction, excluding surveying	–0.03

Notes: Absolute and percentage difference in employment between the sustainable energy and the IEA 6°C (business-as-usual) scenario by 2030. ILO (2018) provides further details on the data and methods used. Vertical scales differ by panel.

Source: ILO, 2018.

4.3. A resource-efficient economy implies an important reallocation of labour

Resource-intensive sectors such as mining and manufacturing will also undergo substantial changes on the path towards sustainability (ILO, 2012; UNEP, 2011). The current economic model of production of goods could be typified as linear: extract, manufacture, use and discard. The circular economy, as an alternative, is based on the principle of produce-service-use-reuse. One of its tenets is to reduce the extraction of raw materials, and to rely instead on reuse, repair and recycling. In a circular economy, products are designed to have longer lives and to be repaired, reused or recycled to the extent possible as certain materials can be recycled more times (e.g. metals) than others (e.g. paper). Through changes to the incentive structure for enterprises to produce more durable goods, and goods that serve as inputs into other production streams when they are no longer usable, the circular economy keeps products, components and materials at a high level of utility. It maximizes product life and promotes the reuse, refurbishment, remanufacture and recycling of inputs and components (Ellen MacArthur Foundation, 2013). In view of the interlinkages in the manufacturing sector, and the fact that material inputs are recycled or reused, employment changes are warranted in manufacturing, extractive and waste management industries. A circular economy also results in changes in the services sector, as repair and rental services gain in importance over the replacement and ownership of goods (Wijkman and Skånberg, 2016).

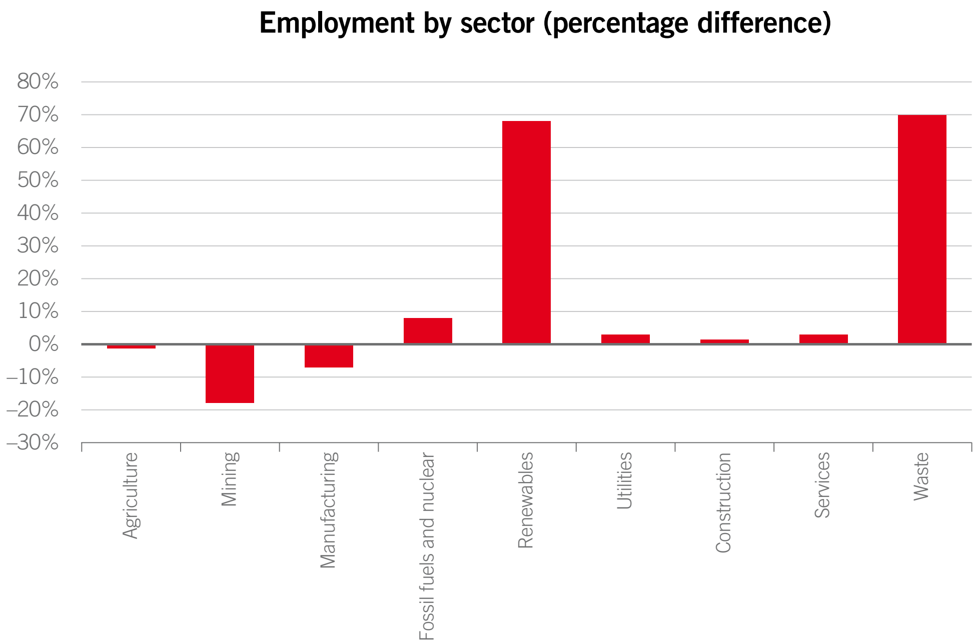
The ILO (2018) explores the employment impact of some tenets of the circular economy, notably the employment impact of a sustained 5 per cent annual increase in recycling rates for plastics, glass, wood pulp, metals and minerals, replacing the direct extraction of the primary resources for these products. This scenario also models growth in the service economy, which, through rental and repair services, reduces the private ownership and replacement of goods at an annual rate of 1 per cent.[11] Under this scenario, worldwide employment would grow to be, in 2030, 0.1 per cent higher than a business-as-usual scenario. This is equivalent to a net job creation of around six million more jobs. The biggest change, however, is a reallocation of production. Employment growth is led by growth in services and waste management, with some 50 and 45 million jobs, respectively. Overall employment gains offset employment losses in mining and manufacturing (where losses are expected to be around 50 and 60 million jobs, respectively). This important reallocation is largely due to the replacement of the extraction of primary resources and the production of metals, plastics, glass and pulp by the recycling and reprocessing of secondary metals, plastics, glass and pulp (table 3).

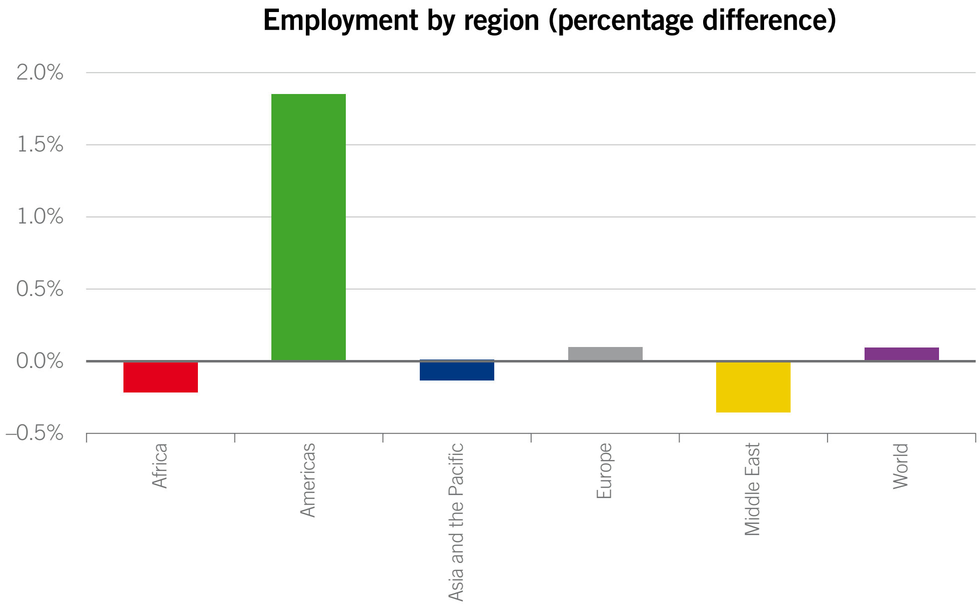
This global sectoral reallocation leads to different effects in the various regions. Like the energy scenario, net employment growth should be expected in the Americas (over 10 million jobs) and Europe (around 0.5 million jobs) and losses expected in Africa (around one million jobs) and the Middle East (around 200,000 jobs). In Asia and the Pacific, the circular economy is expected to bring employment losses as well (around five million jobs) (figure 7). Employment losses are expected only if no action is taken to promote economic diversification. By benefiting jobs in services, and if the gender distribution across sectors remains similar, the circular economy will raise both the female share of employment and the share of highly skilled jobs. However, it will also

[11] *In view of the limits to the recyclability of materials, recycling rates for all materials are capped at 65 per cent and remain stable thereafter. A 65 per cent recycling rate coincides with the European Union Circular Economy Package (EC, 2015). As indicated by the Ellen MacArthur Foundation (2013), this scenario only develops two dimensions of a circular economy and, for example, ignores the potential effects of changes to product design that enhances the durability, remanufacture, reusability and repair of goods.*

result in a small increase in the numbers of own-account and contributing family workers, highlighting the importance of decent work policies to complement policies to promote the circular economy. As employment will grow in the waste management sector, special attention is required to ensure that the new jobs in these sectors are decent (Weghmann, 2017).

Figure 7. The circular economy and employment in 2030





Notes: Percentage difference in employment between the circular economy scenario and the IEA 6°C (business-as-usual) scenario by 2030. ILO (2018) provides further methodological details on the data and methods used. Vertical scales differ by panel.

Source: ILO, 2018.

Table 3. Sectors most affected by the transition to a circular economy

Industries set to experience the highest job demand growth (absolute)		Industries set to experience the strongest job demand decline (absolute)	
Sector	*Jobs (millions)*	*Sector*	*Jobs (millions)*
Reprocessing of secondary steel into new steel	30.8	Manufacture of basic iron and steel and of ferro-alloys and first products thereof	–28.2
Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	21.5	Mining of copper ores and concentrates	–20.8
Production of electricity by solar photovoltaics	14.7	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	–10.2
Wholesale trade and commission trade, except of motor vehicles and motorcycles	12.2	Mining of iron ores	–8.0
Reprocessing of secondary wood material into new wood material	5.0	Manufacture of glass and glass products	–7.6
Industries set to experience the highest job demand growth (absolute)		**Industries set to experience the strongest job demand decline (absolute)**	
Sector	*Jobs (millions)*	*Sector*	*Jobs (millions)*
Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories	4.7	Mining of coal and lignite; peat extraction	–4.9
Research and development	3.5	Mining of nickel ores and concentrates	–4.3
Reprocessing of secondary lead into new lead, zinc and tin	15.0	Production of electricity by coal	–0.9
Reprocessing of secondary precious metals into new precious metals	11.2	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying	–0.9
Production of electricity by solar photovoltaics	4.9	Extraction, liquefaction, and regasification of other petroleum and gaseous materials	–0.9
Reprocessing of secondary copper into new copper	4.3	Petroleum refinery	–0.8

Industries set to experience the highest job demand growth (absolute)		Industries set to experience the strongest job demand decline (absolute)	
Sector	*Jobs (millions)*	*Sector*	*Jobs (millions)*
Reprocessing of secondary wood material into new wood material	4.2	Manufacture of gas; distribution of gaseous fuels through mains	–0.8
Reprocessing of secondary steel into new steel	3.1	Mining of coal and lignite; peat extraction	–0.8
Reprocessing of secondary aluminium into new aluminium	2.7	Extraction of natural gas and services related to natural gas extraction, excluding surveying	–0.8

Notes: Absolute and percentage difference in employment between the circular economy scenario and the IEA 6°C (business-as-usual) scenario by 2030. ILO (2018) provides further methodological details on the data and methods used.

Source: ILO, 2018.

4.4. Sustainability in agriculture will reshape the rural economy

Since the 1970s, agricultural output has increased threefold.[12] This remarkable achievement has outpaced population growth and resulted in only a 30 per cent increase in the use of cultivated land worldwide (Pingali, 2012). Yet challenges for the agricultural sector remain. It is necessary to continue improving productivity to secure future food demand, while becoming environmentally sustainable and overcoming the decent work deficits still faced by the sector (Alexandratos and Bruinsma, 2012; Godfray et al., 2010; ILO, 2016a; Swaminathan and Kesavan, 2017). Agriculture has become a major contributor to GHG emissions (through land use change, livestock and fertilizer use), soil degradation (the loss of organic matter as a result of overexploitation and mismanagement), desertification and freshwater scarcity (through inadequate land and crop management), biodiversity loss, pest resistance and water pollution (resulting from change in land use, eutrophication, run-off and improper nutrient management) (FAO, 2011). Mostly as a result of intensive farming, about a third of the world's soil has already been degraded and, if current rates continue, all of the world's topsoil could be degraded in 60 years (FAO, 2015). These environmental challenges contribute to environmental degradation at the global and local levels, enhancing the vulnerability of the sector, and jeopardizing the livelihoods of farmers and food security around the world.

A sustainable and productive future in agriculture is only possible with a transformation in agroecological and productive techniques. It also requires investment in infrastructure, such as irrigation, roads, storage, extension services, and research and development. This will increase present and long-term efficiency in the sector and increase adaptability and resiliency to climate- and other environment-related risks (ELD Initiative and UNEP, 2015; FAO, 2015; Headey and Jayne, 2014; Jayne, Chamberlin and Headey, 2014;

[12] *The productivity increase in agriculture following the Green Revolution is the result of investment in crop research, infrastructure, market development and policy support between 1965 and 1985. After this period, scientific advances in crop genetics were adapted to developing countries, propagating productivity growth in the developing world (Pingali, 2012). Some negative impacts have accompanied the Green Revolution, including environmental degradation, increased income inequality, inequitable asset distribution and higher levels of absolute poverty (Hazell, 2003).*

Jayne, Kwame Yeboa and Henry, 2018; OECD, 2017; Pagiola, 1999). Conservation agriculture (FAO, 2001, 2011; Friedrich, Derpsch and Kassam, 2017) and organic agriculture (Allen and Kovach, 2000; Etingoff, 2017; Godfray et al., 2010; Guthman, 2014; Merfield et al., 2017) have been proposed as sustainable alternatives to conventional agriculture. Both imply a change in how the land is managed and the inputs required. Both imply a change to the distribution and use of human capital, making sustainability in the agricultural sector a key driver of the future of work in the rural economy.

Conservation agriculture minimizes tillage, encourages crop rotation and the maintenance of a crop (or residue) cover over the soil. It helps maintain soil quality, reduces water consumption and increases the soil's carbon sequestration potential. According to its proponents, conservation agriculture requires fewer labour inputs as it requires no (or minimum) tillage and increases yields. In principle, conservation agriculture can be adopted massively; if so it can reshape the rural economy, opening up opportunities to free labour to sustain a structural transformation (ILO, 2018).[13]

Organic agriculture excludes the use of artificial products, such as genetically modified organisms, synthetic pesticides, veterinary drugs, additives and mineral fertilizers.[14] Organic agriculture is sustainable if coupled with sound management of chemical inputs, ecological synergies and land and water resources. Banning artificial products does not necessarily advance sustainability in the agricultural sector (Allen and Kovach, 2000). In general, the average yield of organic farms is lower than conventional farms for a wide range of crops throughout the world, though with good management practices, organic systems can nearly match conventional yields. Organic farms may contaminate less, but they need more land to produce the same quantity of output (Tuomisto et al., 2012). In general, organic agriculture seems to be more labour-intensive than conventional agriculture, as noted by studies in Europe (EC, 2013), India (Charyulu and Biswas, 2010) and Ghana (Kleemann, 2016), but the work may not necessarily be decent.

4.5. Sustainability will also touch other sectors, driving the future of work across the economy

The previous sections discussed how advancing sustainability in the energy, resource management and agriculture sectors will reshape employment, with impacts going far beyond those specific sectors. The same is true for other sectors which will be touched by an effort towards sustainability, impacting industries in their supply chains

13 *Conservation agriculture is promoted as a labour-saving technique and experimental studies support this claim. Studies that analyse the adoption of conservation agriculture techniques by smallholder do not support this claim. In Ethiopia, Kenya, Malawi, Mozambique and the United Republic of Tanzania, for example, conservation agriculture is associated with higher labour requirements. Though less labour is required in the land-preparation stage under conservation agriculture, the lack of machinery, chemical inputs and technification of production, and higher yields lead to higher labour requirements during the harvest and weed management production stages (Montt and Luu, forthcoming).*

14 *Organic agriculture encompasses several approaches, including Effective Microorganisms Agriculture, One-Straw Revolution (natural farming with no ploughing, chemical fertilizers, weeding or chemical pesticides and herbicides) and White Agriculture (substantial use of microorganisms, and particularly fungi). The Evergreen Revolution is an ecosystem integrated farm system that exploits synergies between crop and animal associations, both within the farm and with the surrounding ecosystem although, as with other sustainable farming systems, it requires a substantial knowledge base (Swaminathan and Kesavan, 2017). The mere adherence to organic standards, as defined narrowly by the absence of artificial products in agricultural production, is not necessarily sustainable and can be environmentally damaging if accompanied by an irresponsible use of organic chemical inputs and land and water resources (Allen and Kovach, 2000; Guthman, 2014).*

and industries across borders. This is the case for the fisheries, forestry and transport sectors, for example. For all sectors, the transition involves a reallocation of production, a restructuration akin to an industrial revolution (Bowen, Duffy and Fankhauser, 2016; Bowen and Kuralbayeva, 2015). As such, certain workers and enterprises will benefit while others will be harmed by the transition to environmental sustainability. Such a transition requires complementary measures to ensure that it is just, as outlined by the ILO's (2015) *Guidelines for a just transition towards environmentally sustainable economies and societies for all.*

5. Implications for a new, just and environmentally sustainable development model

From an ecological perspective, and from the perspective of the world of work, environmental sustainability is urgent. In addition, progress towards environmental sustainability does not limit job creation or the promotion of decent work. As the current model for economic development yields an unsustainable use of resources and impact on the environment, from the perspective of the future of work, a new development model is needed.

Such a development model should account for the intrinsic link between the world of work and the environment, and should adopt policies that simultaneously promote decent work and environmental sustainability. Put simply, a traditional development model governed by the "grow now, clean up later" does not necessarily consider ecological limits and runs counter to social justice and decent work objectives. This strategy needs to be replaced by one that advances decent work while paying attention to ecological limits. This section outlines some of the policies to achieve such a development model, several of which have already been outlined in the ILO's (2015) *Guidelines for a just transition towards environmentally sustainable economies and societies for all.*

5.1. Expand national accounts to include natural capital and make decisions based on long-term wealth rather than economic benefits

As outlined earlier, the economy can be understood as a subsystem of the global ecosystem. Its current and future activity relies on the ecosystem's sourcing and sink functions. It is necessary, then, for economic decisions to account for its effects on these functions, present and future (World Bank, 2018). The System of Environmental-Economic Accounting 2012 (UN, 2012), which provides the conceptual framework for integrated statistics on the environment and its links with the economy, and the World Bank's Wealth Accounting and the Valuation of Ecosystem Services (WAVES) are clear examples in this direction.

The same concept could be applied to corporations. Enterprises can monitor and disclose corporate externalities so that environmental and social performance can be considered in their investment decisions. With such accounting, the tax structure under which firms operate could be restructured to tax for resource extraction and negative externalities, incorporating the environmental and social cost of these activities. This, in turn, will lead to greater efficiency in the use of materials, energy and waste, as companies have direct incentives to do so (Mosher, Smith and Wicker, 2014). This can be achieved through product social life cycle assessments, for example (UNEP, 2009).

5.2. Promote an environmentally friendly structural transformation

Environmentally sustainable development requires economic activity that decreases – or at the very least does not increase – environmental pressures, all the while ensuring inclusiveness. Such is the definition of a green economy (UNEP, 2011).[15] This model of development requires a transition away from a model that is heavily dependent on natural resource extraction and waste generation. The transition to such a development model should also be inclusive, ensuring that the transition is just for all (ILO, 2015).

For developing economies, it means adopting a development strategy based on sustainable principles in energy, transport, construction, resource-intensive manufacturing, agriculture, forestry, fisheries and waste management. For developed economies, it means restructuring these industries so they become sustainable (ILO, 2012; UNEP, 2011). In advanced economies, it means, potentially, embracing zero growth (Victor, 2008). For both developed and developing economies, it means developing a service sector that is decoupled from material extraction or carbon emissions (Jackson and Victor, 2011) in addition to progress towards resource efficiency and low carbon intensity.

These development principles need to be adopted at the enterprise level as well to translate to real change. Some forms of social and environmental sustainability make business sense at the firm level (e.g. investments in energy efficiency, IEA, 2015b). Businesses are indeed more willing to adopt sustainable practices when they are compatible with profit maximization (Strand and Toman, 2010). This has been the case for companies that adopt circular economy principles (e.g. Renault, Veolia, Unilever, Kingfisher, Philips, Deutsche Post among others). Investors are also driving the adoption of sustainable practices by firms, as they are currently more willing to invest in firms that embrace sustainability because this signals the firm's willingness to consider a multitude of risks and opportunities (Unruh et al., 2016). Industrial relations have also advanced the adoption of sustainable practices by including them in collective agreements (ILO, 2018). Other steps to promote the adoption of sustainability at the enterprise level include funds divesting from fossil fuels and other environmentally damaging activity (see, for example, the UN Environment's Portfolio Decarbonization Coalition), public subsidies to firms in sectors that advance sustainability, green finance, or incorporating more realistic discount rates to projects that have an environmental impact (ILO, 2018; ITCILO, 2016; Robbins, Brunsting and Wood, 2018).

[15] *Though some overshoot with posterior reparation is conceivable, overshoot remains a form of "grow and clean up later". In the context of humanity operating close or beyond the boundaries of its safe operating space, overshoot is undesirable.*

5.3. Incorporate the negative externalities of resource extraction and pollution into prices

As noted earlier, a large part of the costs (immediate and long-term) associated with natural resource extraction and waste generation are not incorporated into the price of the related goods and services. Moreover, tax systems around the world tend to tax labour income and profit rather than natural resource extraction and pollution. Such tax systems can be inefficient, as they discourage work and profit-making while not discouraging resource use and pollution.

Two issues arise when taxing natural resource extraction and waste generation. First, the value such a tax will take should adequately capture the social and environmental value of the resource extracted and pollution generated. This requires, in turn, adequate accounting of the social and broad economic value/cost of environmental resources/waste.[16] Global, regional or border tax adjustments can be used to reduce leakage and losses to competitiveness (Ismer and Neuhoff, 2007).

A second issue is revenue recycling, or what associated revenues will be spent on. Related to the future of work, one proposal seeks to use this revenue to reduce labour taxes (Bovenberg and de Mooij, 1994; Combet, 2011). The OECD's Environmental Linkages model indicates that if revenues from an eco-tax are used to lower labour taxes, employment gains of nearly 2 per cent are possible by 2030, as compared to a business-as-usual scenario (Château, Saint-Martin and Manfredi, 2011). At a global level, if a tax on CO_2 emissions were imposed and the resulting revenues were used to cut labour taxes, then up to 14 million net new jobs could be created (ILO, 2010). In the United States, a US$40 tax per CO_2eq. tonne emitted, coupled with border tax adjustments, could help to meet the Paris Agreement target, reduce the burden of emissions regulation and improve the well-being of most citizens (Bailey and Bookbinder, 2017; Baker et al., 2017).

Along these same lines, the elimination of subsidies that cause pollution or resource extraction should be reconsidered. For example, global subsidies for fossil fuels, at US$325 billion in 2015, are still more than double the subsidies for renewable energy (IEA, 2016). They are being slowly phased out, with, in some cases, the resulting public revenue used to support households negatively affected by rising prices (IEA, 2017; ILO, 2018).

Indeed, the negative distributional effects of these polices need to be taken into consideration in discussing revenue recycling, as vulnerable population groups may be priced out when important resources are taxed.

[16] *See Appendix 2 in ILO (2018) for a discussion about the pricing of carbon emissions.*

5.4. Develop skills to sustain the transformation

Human capital accounts for 64 per cent of global wealth, making it the single most important production factor in the global economy. It accounts for 80 per cent in advanced economies, making it crucial for development (World Bank, 2018). Though investing in skills may be crucial for development, investing in the right skills is key to sustain an environmentally sustainable development. Of the 27 countries surveyed by the ILO (2018), skills mismatch in 21 countries is considered a major obstacle to advancing a transition towards sustainability.

The involvement of governments, workers and employers can strengthen skills anticipation systems and the reactivity of skills development programme to such transformational needs. The inclusion of skills development in the legal framework governing the transition is also important, as qualification and certification frameworks that recognize the relevant skills needed in new, emerging and growing sectors (ILO, 2018).

Of the 27 countries surveyed, 22 have established platforms to anticipate skills needs and adapt skills development programmes accordingly. Of these 22 countries, 19 consider skills relevant for a transition towards sustainability. Indeed, most countries surveyed adopt a sectoral approach to skills development, focusing on the anticipation and development of skills relative to a specific sector (e.g. renewable energy or energy efficiency). Political instability, the lack of definitions, the lack of labour market information and analysis and the evolving nature of skills for a transition make it difficult for policy-makers to devise a long-term and economy-wide portfolio of skills. Four countries, however, have created bodies specifically designed to address skills issues specific to this transition from a general perspective, and they have been successful in engaging the social partners in adopting a vision of sustainability, identifying the skills needed to achieve it and developing the corresponding programmes.

5.5. Social protection schemes are at the foundation of decent work in a changing environment

Social protection is a pillar of decent work. It ensures protection against risks throughout an individual's life cycle. Given the intrinsic linkages between the natural environment and the world of work, social protection is a first barrier of protection against environment-related risks. As in the general relationship between the world of work and the natural environment, there are three ways in which social protection becomes relevant. First, social protection can ensure income security to workers and households against the negative effects of environmental degradation. In the context of climate change, countries are already adapting social protection schemes to account for the income- and food-security risks that arise from floods or droughts through climate-indexed social protection (e.g. as seen in Ethiopia, Kenya). Social protection will be essential to support households and communities in coastal areas vulnerable to sea-level rise and people displaced by climate-related phenomena. Second, given the structural transformation associated with environmental sustainability, social protection schemes will protect workers in industries which may face lower demand or disappear altogether (e.g. as seen in the forestry industry in China or the coal mining industry in Poland) and protect workers who may be affected by increased prices (e.g. as seen in Egypt following the reduction of fossil fuel subsidies). To a large extent, the transition will not take place unless adequate protection for these workers and communities takes place, as is the case with the suspension of plans to phase down coal mines in the Philippines until adequate protection is implemented (Béné et al., 2014; ILO, 2018; ILO and AFD, 2016). Finally, social protection schemes can be adapted to meet environmental goals, as is the case of payment for ecosystem services with a social component or public work programmes with an environmental adaptation or mitigation component (e.g. as seen in India, South Africa) (Harsdorff, 2011; ILO, 2018; Lieuw-Kie-Song, 2010; Pagiola, Arcenas and Platais, 2005; Schwarzer, van Panhuys and Diekmann, 2016).

5.6. Social dialogue for consensus and effective implementation

Social dialogue, another pillar of decent work, can facilitate and accelerate the implementation of the above-mentioned policies by establishing a common vision and generating consensus on the policies and process to implement. Dialogue between the social partners has been instrumental in establishing sustainable development plans in Barbados, France, South Africa and Spain, among others. As mentioned earlier, and as detailed by the ILO (2018) through concrete examples, social dialogue is also instrumental in the adequate and timely development of skills development programmes. Through collective bargaining, social dialogue can promote the adoption of sustainable practices within a firm. Social dialogue can promote a large-scale consensus and facilitate the implementation of policies for a successful transition. Such is the case of the trade unions' and employers' *Pact for the environment and employment* in Germany. It has mobilized about €100 billion over the past decade, making it the largest such programme worldwide. It has created more than 300,000 jobs per year since its inception. Effective social dialogue is necessary to ensure that policies towards environmental sustainability are coherent and advance decent work, and that change is adopted and long-lasting (ILO, 2012).

5.7. Ensure rights to achieve a just transition

The tight linkage between the world of work and the natural environment requires the consideration of workers', communities' and vulnerable groups' rights. Environmental degradation affects them, particularly those exposed to hazardous materials, pollution and potential industrial accidents. Certain international labour standards ensure that workers have the skills to manage dangerous substances and processes (e.g. the Occupational and Safety and Health Convention, 1981 (No. 155)), guarantee compensation to victims of pollution or other specific forms of environmental damage stemming from industrial accidents (e.g. the Prevention of Major Industrial Accidents Recommendation, 1993 (No. 181)) and recognize the right to be protected from certain forms of pollution (e.g. the Asbestos Convention 1986 (No. 162)), and the right to information (e.g. the Safety and Health in Agriculture Convention, 2001 (No. 184)). Other international instruments protect workers, as is the case in the context of pollutant release and transfers, of the Kiev Protocol (2003).

The Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental issues is unique in that it encompasses a broad set of environmental issues and links them to human rights. It protects the right of living persons and future generations to an environment adequate to their health and well-being.

In parallel, the rights of workers and communities must be considered to ensure that any effort to advance sustainability does not undermine these rights. Instruments such as the Social Protection Floors Recommendation, 2012 (No. 202) is an important tool to ensure that livelihoods and communities are not put at risk as certain industries downsize.

Women, self-employed farmers in the developing world and indigenous and tribal peoples are among the most vulnerable to social, economic and environmental risks. Their rights are often unrecognized. These rights include access to property, the right to be consulted and the right to participate in decision-making. In addition, these workers tend to lack access to key resources for adaptation, including land, credit, agricultural inputs, decision-making bodies, technology, infrastructure, social protection and training. For the majority of women and vulnerable groups working in the informal economy and in small enterprises, it is particularly difficult to recover from the effects of environmental disasters, as they usually lack access to social protection (ILO, 2009; IPCC, 2014).

Securing rights for groups that depend heavily on the natural environment can help them better adapt to the effects of environmental degradation. Securing rights can also empower them to become actors to advance the transition, as they often care for vast amounts of natural resources (ILO, 2016b). For example, the deforestation rate in the Brazilian Amazon between 2000 and 2012 was 0.6 per cent on indigenous lands, compared to 7.0 per cent outside them (Stevens et al., 2014). Securing land rights can give people who care for natural resources access to payment for ecosystem service schemes, allowing them to contribute to conservation efforts and benefiting from cash transfers in exchange (ILO, 2018).

The UNFCCC has taken a step in the right direction by ensuring that climate action plans consider the interests, role and equity concerns of women and indigenous and local peoples (UNFCCC, 2017a, 2017b). The Indigenous and Tribal Peoples Convention, 1989 (No. 169) recognizes these peoples' rights to the natural resources pertaining to their land. It recognizes their right to participate in the use, management and conservation of these resources. It emphasizes the right of indigenous and tribal peoples to participate in the formulation, implementation and development plans which may affect them directly. These instruments remain, however, specific to certain population groups or to specific environmental issues.

6. Conclusion

If continued unabated, current trends towards environmental degradation will negatively affect the world of work. Air pollution and heat stress undermine working conditions. Overexploitation of soils and fisheries, as well as water pollution, will undermine the livelihoods of millions of workers around the world who depend on these resources. Land use change and GHG emissions will exacerbate climate change, which, through natural disasters, also negatively affects workers. These forms of environmental degradation are largely a result of economic development that tends to ignore its embeddedness in broader ecological processes. Its effects impact workers because the world of work is intrinsically linked to the natural environment.

In parallel, governments, firms and workers around the world are promoting the adoption of sustainability. This will also affect the world of work, because it entails a structural transformation not unlike an industrial revolution. In changing what resources are used and how they are used, sustainable economies will look different from those of today, reducing the need for work in industries related to fossil fuels and resource extraction, and adapting how work is carried out across the economy (e.g. through the adoption of sustainable agroecological practices in agriculture but also across all businesses and activities). Environmentally sustainable economies incorporate incentives to ensure that the resources and services ecosystems provided today are still available tomorrow (e.g. soil quality, biodiversity, air and water resources, etc.).

Environmental sustainability will imply a reallocation of production that will require complementary measures to ensure that the transition is just and promotes decent work. Such measures include skills development programmes, social dialogue, social protection, and macroeconomic policies like carbon pricing, among others.

Alongside any efforts to reduce environmental degradation for some environmental issues, it is likely that environmental degradation will continue on others. The future of work will thus be defined by and will need to account for both degradation and sustainability. Policies can help workers, households and enterprises adapt to the damages arising from environmental degradation through social protection and ensuring rights. These policies can also help workers and communities be better placed to take advantage of the new opportunities that arise with advancing sustainability, and engage them to be active players in this transition.

The world of work needs to monitor environmental degradation and progress towards sustainability to implement policies to protect and advance decent work. In all, trends in the natural environment and their effect on the world of work make a strong case for the adoption of a new development model that accounts for social, environmental and economic outcomes simultaneously.

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