

SDG 3 ENSURE HEALTHY LIVES AND PROMOTE WELL- BEING FOR ALL AT ALL AGES

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INTRODUCTION

SDG3 seeks to ensure health and well-being for all, at every stage of life. In its 1948 constitution, the World Health Organization defined health as “*a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity*” and this is the definition adopted here. SDG3 is underpinned by nine targets that broadly fall into separate, but overlapping groups: reducing morbidity and mortality for vulnerable groups (mothers, newborns, the elderly and children), reducing communicable and non-communicable diseases, reducing risk factors (tobacco, substance abuse, road traffic injuries and hazardous chemicals and pollution), providing universal health coverage, and strengthening the health sector. While SDG3 targets do not specifically address the social determinants of health and well-being (CSDH, 2008; Solar and Irwin, 2010; Berkman et al., 2014), the importance of social factors, such as working conditions, income, education, and housing, is recognised within other SDGs. Waage and colleagues noted that achieving health and well-being for all relies not only on meeting the SDG3 targets, but also on ending poverty (SDG1), providing access to education (SDG4), achieving gender equity (SDG5), reducing inequality between and within countries (SDG10), and promoting peace (SDG16). Health and well-being also relies on adequate services and resources, including infrastructure (SDG9), food security and agricultural production (SDG2), decent work (SDG8), sustainable consumption (SDG12), provision of water and sanitation (SDG6), access to energy (SDG7), and resilient and inclusive cities that provide universal access to housing and transport

(SDG11). Health and well-being are also critically dependent on a safe and enabling environment, supported by mitigation of climate change (SDG13) and sustainable protection and use of the oceans (SDG14) and land (SDG15) (Waage et al., 2015). The broad interdependence between environmental and human health is recognised in systems thinking and the new focus on planetary health (Whitmee et al., 2015; Gatzweiler et al., 2017).

The text that follows provides an overview of interactions at the goal level between SDG3 – the ‘entry level goal’ for this assessment – and the other 16 SDGs. Taking into account all the underlying targets of this entry goal, a set of key interactions is identified between the SDG3 targets and those of other SDGs, principally interactions within the range of the highest magnitude or strongest impacts based on available scientific literature and expert knowledge. The typology and seven-point scale for characterising the range of positive and negative interactions described in the opening chapter to this report is used to assess the selected target-level interactions and the context in which they *typically* occur. Illustrative examples from different world regions show how these linkages manifest in practice. Policy options are identified for how to maximise positive interactions and minimise negative interactions between now and 2030, and beyond. The chapter concludes with a list of key knowledge gaps related to the interactions studied.

KEY INTERACTIONS AT GOAL LEVEL

3 + 1

Poverty reduction leads to improved health and well-being, while good health is a strong enabling factor for effective poverty reduction. In fact, a healthy population is a prerequisite for development, constituting an engine for economic growth. Conversely, it is very difficult to ensure health without addressing poverty. At low income levels, rising incomes lead to health gains as basic needs are fulfilled (such as nutrition, health care, health awareness, and shelter). Increased income is likely to enable positive interaction effects, yet beyond a certain threshold, further increases may not lead to further positive health effects. Similarly, poverty reduction will have a greater effect on health in the presence of diseases associated with poverty, including AIDS, tuberculosis and malaria, as well as neglected tropical diseases, diarrheal and respiratory diseases, and the consequences of malnutrition. Where poverty reduction is most needed, governance structures are often ineffective, and great health challenges usually exist. Reducing poverty will generally result in immediate and long-term improvements in health. This relationship is highly bidirectional – ill health can constitute an inescapable poverty trap, where governmental redistribution is absent. Before conventional poverty reduction policies can be effective, the poorest of the poor often need special assistance to enable them to engage effectively with poverty reduction measures. Good governance, plus investment in health, skills, infrastructure and education, is crucial to reducing poverty.

3 + 2

Health and nutrition are inextricably linked. The relationship between food consumption and health is highly context-dependent. Under-nutrition is generally associated with poverty, whereas overconsumption can accompany either poverty or wealth and may be associated with poor nutritional intake. The relationship between food and nutrition is bidirectional: in some cases, ill health can diminish the ability of households or individuals to farm and produce food, or to work and acquire food. Fundamentally, meeting caloric and micro/macro nutrient needs is a primary requirement for health. Interruptions in food intake and quality, whether short- or long-term, can have lasting impacts on mental and physical development, impacts that begin during pre-natal growth and continue through childhood. Good health also depends on consumption of sufficient micronutrients over the life course. Reducing hunger will result in immediate improvements in health, and carries long-term implications for physical, psychological and neurological development. Increasing agricultural production may improve food security and reduce hunger; however, it also impacts on the environment, with potential implications for infectious disease transmission, and can negatively affect health through contamination of local environments with arsenic, cadmium and other pesticide residues. Technological elements of food and agricultural systems, including genetically modified organisms (GMOs), monocultural crop production, food processing, forest clearing, and irrigation, have the potential to increase production,

but also to harm the environment and adversely affect future food security. There is much uncertainty about how to manage zoonotic diseases related to agricultural production. Food security will also be increasingly affected by climate-induced extreme weather events, as well as geopolitical and economic considerations.

3 + 4

Access to high-quality education is associated with better health, at both individual and community levels. Maternal and paternal education can each influence the health status of children – indeed, the favourable impact of maternal education is well known in developing countries and has also been demonstrated in the developed world. Informal education and other sources of information can also play a strong role in good or ill health: for example, misinformation can lead to poor health decisions in both developing- and developed-world contexts (as in the case of anti-vaccine sentiment). Education can affect health immediately through changed behaviour or the adoption of new technologies. It can also affect long-term health through increased income, opportunity, self-reliance and empowerment. Health benefits from education are not limited to early schooling – lifelong learning offers important opportunities in contexts of rapid change. While these relationships are universal, greater gains are possible in developing-world contexts. New technologies (such as health promotion using information and communication technologies) may increase the efficiency of health interventions and spread knowledge to more people. The relationship between health and education can be bidirectional, as poor health limits school attendance and educational achievement.

3 + 5

Improving gender equality generally enables the achievement of better health. Women's health issues are in some contexts under-prioritised and under-funded, and promoting gender equality in these cases can lead to easy health gains. Moreover, mothers make most health decisions for their children, so their empowerment leads to improved child health outcomes. Increasing participation of women in the paid work force can lead to overall economic gains and hence improved health. Health gains may be immediate (when they directly improve resources or access for women) or long-term (mediated through childcare). The strength of the enabling interaction among these goals will be greatest where women face the greatest inequalities. In general, gender equality has a greater effect on health than health on gender equality, although improved health of women or children can offer women more time and resources to participate in decision-making and economic activities.

3 + 6

In all contexts, improving water quality and access leads to improved health – without clean water and adequate sanitation it is difficult to achieve health gains. The latter are immediate in terms of decreased water-borne infections (e.g. acute diarrheal infections, viral hepatitis) and improved nutrition; improving water quality and sanitation also leads to long-term developmental gains. The interaction between these goals is strongest in parts of the developing world where water-borne infectious disease is still prevalent, but water quality and environmental pollution issues are also widespread in many high-income contexts. This relationship is essentially unidirectional, although where health is poor, it may be that water-borne pathogens themselves are adding to the poor management of water treatment systems.

3 + 7

There are synergies and trade-offs in the relationship between energy and health. Affordable energy contributes to both economic development and the availability of other basic services like health care, transport, and heating/cooling, all of which have consequences for health. Lack of affordable energy can create or amplify health risks, such as excess-winter hospitalisation and mortality in temperate countries. However, energy development involving non-clean energy sources creates substantial short-term health issues (e.g. from direct exposure to short-lived climate pollutants or indoor air pollution from unclean cook stoves) and very large threats in the medium- to long-term (e.g. direct and indirect impacts from climate change caused by greenhouse gas emissions). Nuclear energy poses unique risks in terms of waste storage and accidental or deliberate release. Geography can modify the interactions of energy production with health – for example, urban air pollution risk is modified by local topography, modes of transport, and regional industries and agricultural activities such as burn-offs. Long-term climate-related risks are locally uncertain but modified by proximity to low-lying coastal zones and local temperature and weather patterns. The interactions between health and energy use are strongly technology-dependent. In some cases, poor health and concomitant poverty can reduce household ability to access cleaner (more expensive) energy sources where available.

3 + 8

The relationship between SDG3 and SDG8 is highly context-dependent. For example, where it reduces poverty (SDG1), economic growth leads to health gains as workers' income increases. Yet, rapid economic growth may lead to new health issues. Where it damages the environment, a variety of adverse health impacts are likely (e.g. mortality from air pollution) although often avoidable.

Inequities in the distribution of wealth gains can not only exclude some from health benefits, but can also create new issues – for example, inequality may lead to a higher incidence of mental health problems and of illnesses and deaths related to violence. In industries such as manufacturing, agriculture or construction, if appropriate protections are not in place, workers' health may suffer from exposure to contaminants, heat stress, and injury. Economic growth affects health over various timescales: provision of decent work and basic income enable immediate health gains, while increases in national wealth generally lead to long-term improvements in health. However, long-term health gains are complex: for example, transitional economies often experience significant mortality related to pollution and road traffic accidents, while wealthier countries tend to experience an increase in non-communicable diseases with changed lifestyles. As well, national economic growth may mask inequalities at local level. In general, low-income countries will see greater health gains from economic growth and better working environments. The relationship between economic growth and health is strongly modified by the presence and quality of social safety nets, which mitigate the consequences of periods of unemployment or lack of wealth. In addition, the adverse impacts of growth need to be mitigated by careful social and environmental regulation. The relationship between economic growth and health is bidirectional. Ill health can constitute a major drain in low-, medium as well as high-income settings.

3 + 9

Synergies or trade-offs between health and SDG9 are strongly dependent on choices about which industries, innovations and infrastructures are favoured. Historically, development stages have been associated with typical patterns of health challenges – most prominent is the

characteristic epidemiological transition from infectious to non-communicable disease, which can be exacerbated or mitigated by industrial and infrastructural decisions. Over the long-term, advances in industry, innovation and infrastructure tend to favour better health. However, there may also be negative impacts, particularly associated with land use and urbanisation, transport/mobility systems, and residential development. For example, motor vehicle-based infrastructural investment has well-established adverse unintended health consequences, including air pollution from vehicle emissions, traffic congestion, road traffic accidents and reduced physical activity from urban sprawl. However, appropriate planning, especially in cities, can minimise adverse impacts and improve health, such as through promotion of active transport. Health effects can be immediate to long-term. Due to the long timescale of infrastructure development, health consequences may be locked-in decades in advance of the completion of construction. The relationship between infrastructure and health is basically unidirectional, although poor health can influence labour participation, and therefore the ability of nations to innovate or implement various technological / infrastructural advances.

3 + 10

Reducing inequalities in income, wealth, education, health care services and access to power can contribute to the achievement of health and well-being goals. In particular, there is evidence that income and social inequalities have substantial adverse health outcomes in low-, medium- and high-income contexts. Inequalities may create health impacts through multiple pathways, including heightened psycho-social stress, higher rates of adverse health behaviours such as smoking, and poor physical environments (e.g. higher levels of air pollution). This relationship is bidirectional and can lead to feedback loops with negative

consequences: for example, ill health can limit household income by directly limiting work capacity and through borrowing-related ‘poverty-traps’, where high interest rates force householders to sell their land to pay for medication or care, thus reducing their livelihood opportunities and further reducing their capacity to assure health. At the community level, a high burden of ill health can limit available resources and revenues and thus entrench inequalities, as in some slums/informal settlements and isolated rural areas.

3 + 11

The impact of ‘place’ on health is well recognised. Well-designed cities promote health and support the achievement of SDG3 while poorly designed cities create unhealthy environments, discouraging physical activity, exposing people to hazards such as air pollution and dangerous traffic, and contributing to mental illness and non-communicable diseases. In the short term, housing which is free of pollutants and hazards and which provides adequate temperatures and space supports health. In addition, transport infrastructure promotes health immediately and directly by improving access to health care and access to work and education, which supports health. Sustainable urban form and design offer some of the most cost-effective options for avoiding carbon lock-in and hence limiting or reducing carbon emissions, which supports health in the long-term. The relationship between sustainable cities and health is basically unidirectional, although ill health or disability can limit resources, labour participation and the attractiveness of active travel options and thus policy options for urban development.

3 + 12

Sustainable consumption and production is strongly connected with health over the long term; the dependence of health

goals on sustainable action is strongly recognised in the new paradigm of planetary health. Short-term connections between these goals are less pronounced or may involve trade-offs. Indeed, sustainable consumption and production may require foregoing immediate economic gains. This tension has been recognised in debates over the right to development, and research is needed into mechanisms by which global financing might offset losses to enable sustainable consumption and production. The health consequences of failing to achieve this can be local (e.g. ecosystem depletion/collapse, as for some fish stocks) or global, but often are most severe in low-income contexts where regulation is weakest.

3 + 13

Many health impacts from climate change are direct, such as the effect of increasing heat stress on ability to work outside, impacts of severe weather events, especially floods and droughts, and increased frequency of intense storms. Other effects are indirect, including climatic change that promotes the spread of disease vectors (e.g. for dengue and malaria) and contributes to food insecurity and undernutrition. Such impacts may increase rapidly with the scale of climate disruption, which have the potential to precipitate local or regional conflicts, breakdown of governance or social norms, and massive flows of people. In the face of these effects, it will be very difficult to achieve health goals. Conversely, the scale of potential savings with respect to morbidity and mortality from minimising climate change is large and growing. Climate action will result in modest immediate improvements in health and well-being but major and long-lasting (multi-century) health and developmental gains. New financing mechanisms are needed to encourage poorer countries to adopt climate-friendly development trajectories and use zero-carbon energy sources.

3 + 14

The health of marine systems is directly connected to human health in coastal areas and where populations depend on marine food sources. Marine pollution and collapse of fish stocks from overfishing can have direct impacts on nutrition, and thus on health in these contexts. Reduction of marine pollution will likewise reduce morbidity and mortality. Seawater intrusion into groundwater in coastal aquifers, potentially exacerbated by extreme weather events, can contaminate freshwater resources and pose concomitant health risks. Loss of marine biodiversity can affect human health over short or long timescales, particularly as it affects the viability of marine ecosystems and thus availability of fish stocks or the potential for discovery of new pharmaceutical compounds from marine bioprospecting. Tackling marine challenges, including pollution and overfishing, requires cross-sectoral action and multi-scale integrated governance, and will take time, but should have both short- and long-term impacts on health.

3 + 15

Changes to the environment caused by human actions, including deforestation, desertification, pollution and contamination, and associated losses of biodiversity, can affect health along a number of pathways. For example, reductions in populations of bees or other pollinators resulting from environmental disruptions can affect agricultural yields and thus human health. Changes in land use, often associated with agricultural production, can expand pathogen habitats and degrade waterways, increasing the risk of infectious disease transmission. As such, achievement of health goals depends on careful management of such ecosystems. The Millennium Ecosystem Assessment categorises the role of natural ecosystems in four service areas: supporting, provisioning, regulating, and cultural services. Each has a direct or indirect connection

to human health and well-being from basic functions such as nutrient cycling, provision of food and shelter, and regulation of water quality, to the spiritual and recreational components. Taken together these not only map directly to aspects of both physical and mental health but also support broader aspects necessary for human well-being such as income provision and cultural identity (Millennium Ecosystem Assessment, 2005).

3 + 16

Peace, justice and strong institutions are strong enablers of improvements in health. Conversely, their absence can impede initiatives to improve health and exacerbate inequalities. High burdens of ill health or of violence itself can limit the capacity of governments to deliver justice and implement strong institutions. In extreme cases, emerging health threats can pose challenges to peace. The impact of inter-state wars and conflicts on health are often not well recognised in the development discourse. The current crises in Libya, Syria and Iraq have promoted devastating civil strife, mass migration, and destruction of infrastructure, which have disrupted health services and may have contributed to antimicrobial resistance. Inclusion in economic life and governance processes can play an important role in maintaining trust in institutions and the preconditions for high-quality governance. This can support better health and well-being outcomes; reciprocally, good community health is likely to support stronger and more inclusive institutions.

3 + 17

Effective partnerships are critical for achieving health. It is increasingly recognised that with complex systemic problems, interventions in one subsystem are likely to lead to unintended consequences in other areas. Approaches to management and governance are often siloed, and fail to appreciate such

cross-sectoral feedbacks. In contrast, adoption of systems approaches allows for the anticipation of unintended negative or positive consequences and formulation of potentially wiser interventions. Cross-sectoral, cross-spatial and multi-regional partnerships and exchange of information grounded in systems thinking are needed. This relationship is bidirectional, as ill health itself limits the capacity to participate in effective partnerships, both directly and through its impacts on education and capital. The SDGs have been criticised for not adequately emphasising the role of international trade on health. Institutionally, the majority of multilateral and some bilateral trade agreements are 'outside' the UN development agenda at present, except discussions mainly in relation to private-public partnerships. Substantively, trade contributes to health primarily through economic growth (SDG8). However, there is increasing concern about diminishing returns from trade liberalisation, and the potential adverse impacts of trade agreements, especially in low-income countries. These could be through a brain drain of qualified health workers, patents and increasing costs of medicines, and in relation to removal of trade barriers that could have adverse health impacts (e.g. easy importation of calorie dense foods to poorer countries).

KEY INTERACTIONS AT TARGET-LEVEL

A comprehensive assessment of all SDG interactions at target-level was beyond the scope of this chapter, but several proposed frameworks exist for integrating health and well-being across the SDGs, encompassing both health and non-health sectors and locating health and well-being as both pre-conditions and outcomes of sustainable development (Dora et al., 2015; Nunes et al., 2016). This section analyses some of these interactions in detail at the target-level. SDGs were selected based on the strength of the interlinkages and the magnitude and scale of impact in relation to the overall objective of the 2030 Agenda, while ensuring a balanced consideration of the economic, social and environmental dimensions. Target-level interactions are judged to fall within one of seven categories and are scored accordingly: indivisible (+3), reinforcing (+2), enabling (+1), consistent (0), constraining (-1), counteracting (-2), and cancelling (-3). Following a generic analysis of the selected interactions, specific examples are provided to illustrate how interactions unfold in different geographical and policy contexts.

Six targets/goals were selected for detailed analysis, with three accompanied by an illustrative example:

SDG2

Specifically target 2.3

SDG3

Illustrated using the example of improving health outcomes by improving air quality

SDG8

Illustrated using the example of the interaction between work, labour productivity and health in the context of high temperatures

SDG11

Specifically targets 11.1 and 11.2; the latter illustrated using the example of the Cheonggyecheon Stream Restoration Project, Seoul

SDG13

Specifically target 13.2

Given the comparatively large number of target-level interactions for SDG3, the focus is largely on interactions with only one target from other SDGs.

SDG 3 + SDG 2



TARGETS	KEY INTERACTIONS	SCORE	POLICY OPTIONS
3.1, 3.2 ← 2.3	Increasing the agricultural productivity and incomes of small-scale producers will improve access to food and economic resources, which supports the health of mothers, newborns and children	+2	Implement financial and educational policies that support smallholders to increase agricultural productivity
3.3 ← 2.3	Increased agricultural production, even at the small scale, can create new pathogen habitats, increase the risk of animal-human disease transmission, damage ecosystems, promote antimicrobial resistance in pathogens and insecticide resistance in vectors, and pollute drinking water, all of which can expose people to the risk of communicable disease	-1	Develop resource management regulation to prevent ecosystem degradation
3.9 ← 2.3	Agriculture labour may expose people to hazardous chemicals	-1	Regulate to minimise exposure to hazardous chemicals. Provide education to agricultural workers on the safe use of chemicals
3.3 → 2.3	Ending communicable diseases will have a significant positive effect on the availability and health of the labour force to achieve the targets related to agricultural productivity and income growth	+2	Invest in healthcare services

KEY POINTS

Increasing agricultural productivity can improve nutrition, which supports health. Increased production can also lead to indirect health gains through increased economic welfare among individuals and households

Environmental and habitat changes induced by human agricultural activity can lead to ecosystem shifts which may intensify communicable disease transmission

Use of insecticides for crops and antibiotics for animals can promote antimicrobial resistance in pathogens and insecticide resistance in vectors. Intensive agricultural production can pollute drinking water through soil pollution, ground and surface water contamination, or cause direct harm to agricultural workers.

KEY INTERACTIONS

This section considers how efforts to increase agricultural productivity can interact with health. Target 2.3 calls for a doubling, by 2030, of the agricultural productivity and incomes of small-scale food producers, especially women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment. Other SDG2 targets provide important context for this: increasing agricultural productivity (2.3) should occur in tandem with provision of

organic, safe and nutritious food for all (2.1), a guarantee that food production is sustainable, resilient, adaptable and supports ecosystems (2.4), the maintenance of genetic diversity and traditional knowledge (2.5), and support for agricultural infrastructure (2.a), free trade (2.b), and the proper functioning of food commodity markets (2.c).

Increasing agricultural productivity (2.3) through cost-effective technologies at the local scale can improve nutrition, which directly supports health. Without increases in production, rapidly growing human populations will face food scarcity at both global and local scales in the coming century. There is a need for increased agricultural productivity to feed unprecedented numbers of people; moreover, promotion of small-scale production, especially among the most vulnerable, can counter the distributional inefficiencies that lead to regional scarcity and provide much-needed income and livelihoods for the poor.

At the most basic level, increased agricultural productivity (2.3) often increases the likelihood of uninterrupted consumption of sufficient calories; even short-term interruptions of food intake (e.g. resulting from drought, conflict, extreme climatic events or household economic shocks) can have lasting effects on health and physical and neurological development. Sufficient nutrition supports reductions in infant mortality (3.2), newborn/child mortality (3.1), and mortality associated with infectious disease (3.3) and cardiovascular disease (3.4). Variety in local agricultural production can promote consumption of the range of micronutrients essential for health. Increased production can also lead to indirect health gains through the improved economic welfare of individuals and households; in particular, high proportions of the rural and peri-urban poor are involved in agricultural work, so are well positioned to benefit from such efforts.

However, increased agricultural productivity (2.3) may challenge efforts to control communicable disease (3.3), if contextual environmental and social factors are not accounted for, or if sustainability is not explicitly considered. At a basic level, increasing agricultural production often requires expansion of agricultural lands. Such expansion generally leads to expanded human and livestock interfaces with natural systems, and a greater opportunity for cross-over of zoonotic pathogens (Institute of Medicine (US) Forum on Microbial Threats, 2008); for example, HIV, SARS, and a range of other important diseases of humans appear to have originated in humans as a result of spillover from sylvatic systems (Jones et al., 2013). In some cases, the conversion of land to agricultural uses can shift vectors or pathogen species assemblages in ways that promote disease. In Tanzania, for example, agricultural sites were found to harbour double the abundance of plague-seropositive rodents as non-agricultural sites, mediated by substantial increases in species of rodents and fleas that efficiently transmit the disease (McCauley et al., 2015). In other situations, irrigation (or other agricultural practices) can create new habitats for vectors of malaria and other diseases – this is particularly true in low-income settings (World Bank, 2008). Such risks can be countered by careful management with full awareness of ecological and social context, for example through alternation of rice with dryland crops or integrated vector management.

Increasing agricultural productivity (2.3) may be accompanied by increases in livestock or poultry populations and/or closer physical associations between humans and animals, which can dramatically intensify transmission of zoonotic disease. A signal case is that of H5N1 avian influenza, which has been associated with abundance of free-grazing domestic ducks, human population and rice-

cropping intensity in Southeast Asia (Gilbert et al., 2008). Productivity increases in agriculture are sometimes achieved through a focus on monocultures in crop, plant and animal production. Often involving GMOS, and frequently accompanied by extensive application of fertilisers, pesticides, antibiotics or other inputs, this may increase efficiency and yield and allow increases in the scale of production, but may also lead to loss of biodiversity and increased vulnerability to plant or animal pathogens or climate change. Such systems threaten food security, with results that potentially cascade across systems to negatively affect health.

Large-scale livestock production, when accompanied by poor land management, can lead to increased effluent flows and contamination of natural environments with pathogens that cause of schistosomiasis (*bilharzia*) and taeniasis (tapeworm infection) (WHO, 2013). Where antibiotics are routinely used to promote growth and feed efficiency or prevent disease in animal stocks, livestock management can also contribute to infectious disease severity (Spellberg et al., 2011). Antibiotic use in agriculture has been linked to the emergence of antimicrobial resistance in human pathogens (WHO, 2013). Similarly, the use of insecticides in agriculture can lead to resistance in vectors; for example, a recent review found that in 23 of 25 studies across Africa, higher resistance in malaria vector mosquito populations was associated with agricultural insecticide use (Reid and McKenzie, 2016). This is such a significant issue that WHO has argued that insecticide resistance has generally been conceptually omitted as an important class of emerging infectious disease (WHO, 2013).

Increasing agricultural productivity (2.3) may also challenge efforts to reduce mortality and morbidity associated with air, soil and water contamination (3.9). Insecticides, pesticides and fertilisers can be harmful to human health, whether

through contamination of food or water or through occupational exposure. Unintentional exposure kills over a third of a million people per year (World Bank, 2008) and is associated with serious economic burdens, including direct costs and lost labour. Pesticide exposure has been associated with both acute toxicity and long-term increased risk of some cancers, neurological and respiratory disease, birth defects, and significant ecological disruptions.

The interactions between **target 2.3** and the health targets operate on both short- and long-term scales. Increases in epidemic risk through expansion of agricultural lands or ecosystem shifts can be extremely fast, especially where urban areas are in relatively close proximity to newly-cleared agricultural lands and where workers frequently travel back and forth between them. The recent West African Ebola epidemic is likely to have had its origins in agricultural borderlands, but was intensified by urban mobility patterns. The evolution of antibiotic and insecticide resistance generally operates over a timescale of several years. Contamination resulting from agriculture can follow floods or other extreme events, or can build up over longer periods, and its effects can be acute, as in unintentional poisoning, or long-term, as in the development of cancers or other health issues.

Many of the trade-offs observed between target 2.3 and health targets are more relevant in low-income settings, where larger proportions of people work in agriculture, and are therefore directly exposed to its effects. Thus, unintentional poisoning and emergence of zoonotic diseases are more likely in these contexts. Agricultural production systems in the developed world tend to be more monocultural and may involve heavier inputs of chemicals or antibiotics, promoting the evolution of resistance. Monocultures may also increase the likelihood of catastrophic disease spread, thus affecting food systems.

Careful consideration must be given to regulation and technology in increasing local and small-scale agricultural productivity. In many cases, this can be achieved while avoiding negative trade-offs with health, but this requires a clear understanding of local ecology and of the likely ecological and environmental effects of agricultural technologies (e.g. irrigation systems, feed supplements, cropping practices) and crop/plant/livestock choices.

The relationship between these targets is bidirectional. Health issues can impact on agriculture through reductions in the healthy labour force or in institutional capacities and knowledge. For example, high levels of endemic malaria have been shown in some contexts to limit agricultural earnings, although labour substitution within households may mitigate these effects (Institute of Medicine (US) Committee on the Economics of Antimalarial Drugs, 2004; Audibert et al., 2012). High rates of HIV mortality have in some cases led to significant losses of skills and capacity in the agricultural sector (World Bank, 2008).

The strength of the listed trade-offs between agriculture and health vary, but are in part a function of scale. To achieve increases in throughput and efficiency, growing agricultural systems are more likely to adopt technologies that lead to negative health consequences.

KEY UNCERTAINTIES

The largest uncertainties concern how to scale up healthy small-scale production without creating ecological or direct human harm. Increased health risks should be mitigated through appropriate regulation, which will vary with context.

KEY DIMENSIONS

Time: Increased agricultural production can produce quick gains in nutrition for small-scale producers, and have long-term positive effects on food security, incomes and food supply, all supportive of

long-term health. Expansion of agricultural lands or changes in agricultural techniques can produce rapid or long-term shifts in ecosystem structure and function. Resulting risks to health can thus be acute (e.g. outbreaks of new zoonotic diseases) or long-term (e.g. shifts in vector habitats). Contamination from agriculture can also have both acute (e.g. poisoning) and long-term (e.g. cancers) effects.

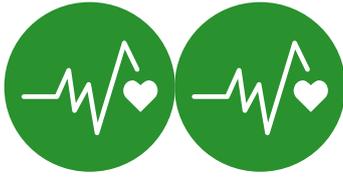
Geography: In general, producers in low-income countries face higher risks and opportunities from changes in agricultural production, although specific elements of developed-world agriculture (e.g. monocultures, large-scale production) may increase some risks. The borderless nature of communicable diseases means that changes in agricultural production locally may have global impacts on diseases.

Governance: Good governance and careful planning are key to ensure that the benefits of increased agricultural production accrue to small-scale farmers and their local communities. Moreover, effective governance is key to anticipating and mitigating impacts on ecosystems from agriculture at all scales.

Technology: Technology can assist both in improving productivity (e.g. irrigation systems, feed supplements, cropping practices) and crop/plant/livestock choices and in monitoring the ecological impacts of increased productivity in order to inform appropriate regulation.

Directionality: Bidirectional. Health issues can have an impact on agriculture through reductions in the healthy labour force, and increasing agricultural productivity can expose workers to hazardous chemicals or result in ecosystems degradation that increases the risk of non-communicable disease.

SDG 3 + SDG 3



TARGETS	KEY INTERACTIONS	SCORE	POLICY OPTIONS
3.1 ← 3.3	Efforts to eradicate communicable disease will substantially contribute to targets to reduce newborn/infant mortality	+3	Give particular focus to the control of infectious disease in educational and medical environments
3.2 ← 3.3, 3.4	Achieving targets for non-communicable and communicable disease will assist in reducing maternal mortality	+2	Reduce prevalence of non-communicable diseases, such as diabetes and risk factors such as obesity. Eliminate smoking during pregnancy. Give particular focus to the control of infectious disease during ante-natal care and in medical environments
3.3 ← 3.5, 3.a, 3.b	Controlling tobacco, reducing substance abuse, and reducing exposure to hazardous chemicals, will assist in reducing premature mortality associated with non-communicable disease	+2	Ensure regulation prevents exposure to hazardous chemicals, and controls tobacco use
3.7 → 3.2, 3.3	Targets around reproductive and sexual healthcare provision will assist in reducing maternal mortality and help control communicable disease	+2	Support funding towards reproductive and sexual healthcare services and education
3.8 → 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.a, 3.10	Provision of universal healthcare will assist to achieve most other targets	+2	Prioritise the provision of universal healthcare
3.b, 3.c → 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.a	A strong health workforce and supportive research infrastructure support the achievement of all the other health targets	+2	Invest in the health workforce and in research infrastructure

KEY POINTS

Efforts to eradicate communicable disease will assist in targets to reduce newborn/infant mortality and maternal mortality

Controlling tobacco, reducing substance abuse, and reducing exposure to hazardous chemicals, will assist in reducing premature mortality associated with non-communicable disease

Targets around reproductive and sexual healthcare provision will assist in reducing maternal and infant mortality and help control communicable disease

Provision of universal healthcare will assist in achieving all other targets

KEY INTERACTIONS

There are several potential negative interactions among health targets. For example, there is much debate over whether and under what circumstances vertical disease-orientated health programmes can negatively affect the integrated operation of health systems, particularly in low-income settings – and thus their ability to deliver other health outcomes (Atun et al., 2008; De Maeseneer et al., 2008). Moreover, where funding is limited, efforts to achieve particular health targets could limit resources potentially applicable to achieving other targets. However, in general the health targets are mutually supportive. For example, achieving reductions in the maternal mortality rate (3.1) will be made easier by achieving

the targets concerning sexual/reproductive health, universal health coverage, infectious disease, and non-communicable disease. This is illustrated in the following examples:

- Increasing access to reproductive healthcare services (3.7): In Texas, United States, the rate of women who died from complications related to pregnancy doubled between 2010 and 2014 (MacDorman et al., 2016), soon after a drastic reduction in the number of women's health clinics in 2011 in response to major cuts in the state legislature's budget for family planning (Redden, 2016).
- Achieving universal health coverage (3.8): Millions of births (more than 40% in Africa and South-East Asia) are currently not assisted by a midwife, doctor or trained nurse. Improved access to skilled attendance will significantly reduce complications and deaths (WHO, 2016).
- Ending communicable disease epidemics (3.3): Around 25% of maternal deaths during or following pregnancy or childbirth are caused by or associated with diseases such as malaria, and AIDS during pregnancy (Say et al., 2014).
- Reducing the incidence of non-communicable diseases (3.3): Early detection and management of diabetes in pregnancy as part of a comprehensive antenatal package was shown to reduce stillbirths by up to 45% and also to prevent maternal and newborn deaths (Pattinson et al., 2011).

Similarly, achieving reductions in newborn/infant mortality (3.2) will be supported by efforts to reduce infectious disease incidence (3.3) and to reduce exposure to toxic substances and tobacco (3.9).

The leading causes of death in the world in 2013 among children younger than five years of age were lower respiratory tract infections, preterm birth complications, neonatal encephalopathy following birth trauma and asphyxia, malaria, and diarrheal deaths. These accounted for 3.4 million deaths or 54% of all deaths among children younger than five years (Global Burden of Disease Pediatrics Collaboration, 2016). Providing for universal health coverage (3.8) and combating AIDS, malaria, and waterborne and other communicable diseases (3.3) will clearly play an important role in ending preventable deaths in children and infants (3.2).

Protecting against toxic hazards (3.11) and controlling tobacco (3.10) each support reductions in newborn/infant mortality (3.2). Smoking, exposure to second-hand smoke and indoor air pollution during pregnancy increases risk of pregnancy complications, including foetal deaths, low birth-weight and premature delivery (Lumley et al., 2004; Pope et al., 2010).

Along similar lines, achieving the target of reducing premature mortality associated with non-communicable disease (3.4) will be made easier by action towards targets on substance abuse (3.5), tobacco control (3.a), and hazardous chemical exposure (3.9). Cardiovascular diseases (e.g. heart attacks and stroke), cancers, chronic respiratory diseases (e.g. chronic obstructive pulmonary disease and asthma) and diabetes account for 82% of deaths from non-communicable diseases. Tobacco use, physical inactivity, unhealthy diet and the harmful use of alcohol increase the risk of these non-communicable diseases. As such, strengthening the prevention and treatment of substance abuse, including harmful use of alcohol (3.5) will support the achievement of this target, as will strengthening the implementation of the World Health Organization Framework Convention on Tobacco Control (3.a).

Some cancers are linked to exposure to hazardous chemicals such as particulate

matter wood-smoke, lead and asbestos. As such, reducing the number of deaths and illnesses from hazardous chemicals in the air, water, and soil (3.9) will contribute to reductions in non-communicable disease mortality.

Achieving universal health coverage, including access at affordable prices to essential medicines and vaccines (3.8) will facilitate achievement of virtually all other SDG3 targets. Universal coverage allows for access to health professionals, who not only provide essential treatment, but can provide education on healthy lifestyles and disease prevention. The health of women during childbirth (3.1), of newborns/infants (3.2), of people suffering from communicable (3.3) or non-communicable disease (3.4) or from exposure to chemicals (3.9), or of those impacted by road traffic accidents (3.6) all rely on affordable, effective and safe treatment by health-care professionals. A strong public health service is critical to the provision of messaging, education and resources for healthy sexual behaviour (3.7) and reductions in consumption of alcohol (3.5) and tobacco (3.10). Achieving universal health coverage can be supported by the recruitment, training, development and retention of a strong workforce (3.12) and by research and development of essential vaccines and medicines (3.11).

Many interactions between SDG3 targets are clearly bidirectional. For example, eradicating infectious disease (3.4) will help reach targets for maternal mortality (3.1) and infant mortality (3.2); conversely, efforts to achieve the latter will reduce infectious disease incidence. Thus each of the health targets enables or reinforces other health targets (Nilsson et al., 2016). Many of the actions required to meet targets – investment in vaccines, medicines, health care provision, health promotion, tobacco control, hazards reduction, workforce development and research – can be achieved locally, in some cases with support from donors, and are likely to improve population health. Other actions

– such as control of infectious disease and clean air policies – require regional cooperation and long-term planning.

KEY UNCERTAINTIES

The evidence base is strong for the positive interactions between the health targets discussed. There is considerable debate over the potential conflict between vertical disease programmes and health system strengthening.

KEY DIMENSIONS

Time: Action on several targets – such as investing in maternal and newborn health – would have immediate effects. Other actions are more long-term. For example, while policies to reduce hazardous chemicals can be introduced quickly, it may take some time for air, water and soil to become safe.

Geography: While some of the targets can be managed locally, infectious diseases and environmental health issues such as clean air and water require regional co-operation. Disease burdens vary significantly depending on geographic and socio-economic context, such that efforts to achieve particular targets can imply much greater effort in certain areas.

Governance: Good governance and careful planning are key to ensure that health programmes are equitable, effective, efficient and inclusive.

Technology: Technologies – for example, to prevent infectious disease and monitor its spread – are crucial to achieving targets.

Directionality: Bidirectional. Each of the health targets support achievement of other health targets.

ILLUSTRATIVE EXAMPLE IMPROVING HEALTH OUTCOMES BY IMPROVING AIR QUALITY: THE US CLEAN AIR ACT 1970

Policies aimed at reducing exposure to hazardous chemical substances in the water, air and soil (3.9) also assist countries towards meeting targets around non-communicable diseases (3.4) and infant health (3.2), as shown by the experience of the United States' Clean Air Act of 1970.

Air pollution, including particulate matter, ozone, heavy metals and acidic gases, affects health throughout the life-course. Several studies have demonstrated a relationship between exposure to air pollution *in utero* and lower birth weight, placing babies at greater risk for the development of respiratory diseases and diminished lung function. Air pollution is associated with increased post-neonatal infant mortality, including sudden infant death syndrome. Exposure to air pollution negatively affects lung growth and places children at greater risk of development of respiratory symptoms including asthma. In adults, exposure to air pollution promotes the development of high blood pressure, heart disease and stroke; elderly people are at particular risk (Ross et al., 2012; Shah et al., 2013). Policies to reduce air pollution thus are highly supportive of health. The US Clean Air Act became law in 1970 and was strengthened in 1990, giving the Federal Government the authority to enforce regulations to limit air pollution. The reduction in particulate matter had an immediate impact on health. For example, it is estimated that 1300 fewer infants died in 1972 than would have done in the absence of the Clean Air Act (Chay and Greenstone, 2003). In 2010 alone, reductions in fine particle matter and ozone pollution resulting from the 1990 Clean Air Act amendments prevented more than 160,000 cases of premature mortality, 130,000 heart attacks, 13 million lost work days, and 1.7 million asthma attacks (US EPA, 2011).

SDG 3 + SDG 8



TARGETS	KEY INTERACTIONS	SCORE	POLICY OPTIONS
3.3, 3.9 ← 8.1	Economic growth can be associated with adverse effects on the environment, including water, air and soil pollution and ecosystem change, which can increase the risk of communicable disease, illness and death	-1	Put in place mechanisms in relevant industries to ensure that economic growth does not degrade the environment
3.8 ← 8.1	Increasing economic growth can enable governments to increase spending on healthcare, including towards providing universal health coverage	+1	Invest in education and training to lift productivity, create employment and strengthen the tax base, while moving to equal pay and an inclusive workforce
3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9 → 8.1, 8.5, 8.6	Increased health/well-being supports people to enter the workforce and contributes to economic growth and employment	+2	Invest in healthcare and social services
3.1, 3.2, 3.3 ← 8.5	Increasing the number of people employed supports people gaining access to the conditions for health, such as food, shelter, education and medical care	+2	Invest in the creation of decent jobs in social services that assist people into employment
3.8 ← 8.8	Safer working environments reduce exposure to hazardous chemicals	+3	Strengthen unions and regulate to protect labour rights and health and safety in the workplace

KEY POINTS

There are many positive interactions between growth/employment/work and health/well-being. For example, higher growth can enable greater government investment in health and other social services

The interaction between growth and well-being is context dependent: the quality, nature and sustainability of growth and its relationship with the sustainability of production and consumption critically influence well-being outcomes

Growth is particularly attractive to low- or middle-income countries, but may also be associated with environmental damage and consequent loss of health/well-being; context-dependent policies must ensure appropriate conditions for growth and an appropriate allocation of its benefits

At the individual level, higher incomes are associated with greater access to the resources that help enable a healthy life: food, shelter, medical care, and education. However, stressful working conditions, poor labour rights and unsafe workplaces can put people at risk of illness and injury

KEY INTERACTIONS

Economic growth (8.1) and higher productivity (8.2) encourage job creation (8.3) and support full and productive employment (8.5, 8.6), which supports health and enables greater public investment in healthcare, education and environmental protection, which further supports well-being. Interactions are bidirectional, with increased health and well-being raising productivity and incomes (Bloom and Canning, 2001; Wagstaff, 2002). Thus, economic growth and stronger employment can be enabling or reinforcing of health/well-being goals, and vice versa (Nilsson et al., 2016). These positive links are widely understood.

It is widely accepted that greater resource efficiency – the efficiency with which resources (physical and natural) are used and allocated – increases economic growth potential and minimises ecosystem-damaging waste. Examples include ensuring that fish harvesting methods are not wasteful and avoiding the discarding of non-target species. The longer-term benefits for human populations include lower costs of marine food supplies, and availability of certain species, maintaining dietary diversity. In such a context, reducing waste can work in the direction of economic gain and better human health.

However, the gains in terms of health/well-being from economic growth are in practice not universal, nor can growth be endlessly sustainable in a finite and ‘full’ world (Daly and Farley, 2004). In particular, inequality in income growth across countries and across groups within countries can create difficulties such as perceived relative deprivation, which weakens the relationship between growth and health/well-being (Layard and Layard, 2005). The association is more likely to be strongly positive in low- to middle-income countries than in higher-income countries (Jackson, 2009). In the latter, growth can be ‘uneconomic’, namely lowering quality of life at least for some, either in

rich countries themselves or owing to spillover impacts on other countries (e.g. climate change impacts). In such circumstances, gross domestic product (GDP) and gross national income (GNI) may be increasing, but indicators which more effectively measure society's well-being, such as the Genuine Progress Indicator (GPI) may be static or even declining. The GPI adapts the GDP measure so that negative outcomes such as crime and pollution count against 'progress'; and considers income distribution. The GPI is adversely affected where growth is based on undermining social and environmental capital (Kubiszewski et al., 2013; Costanza et al., 2014).

Diminishing returns to well-being arise because economic growth in high-income countries generally yields increasingly smaller gains at the margin in terms of health/welfare as indicated for example by life expectancy (Bloomberg and Aggarwala, 2008). There is also growing concern in developed countries about long work hours, work-life balance and rapid automation associated with growth. Yet growth is driven by production systems, which often have environmental impacts (e.g. carbon-emitting energy production, loss of soils/farmland to urban expansion, water use that damages aquifers) which cause damage to ecosystem or human health and constrain efforts to achieve health targets. For example, efforts to end water-borne diseases (3.3) and address maternal and child mortality (3.1, 3.2) require the availability of clean drinking water. In such cases, increasing adverse side-effects of growth can exceed growth's diminishing benefits at the margin. In short, high-income country growth may in some cases constrain or even counteract gains in health/well-being. The implication is that policies to make production and consumption significantly greener are urgently required (8.4).

Even within low- or middle-income countries, where economic growth is more likely to increase well-being, growth

may nevertheless be associated with environmental damage and consequent loss of health/well-being, especially in specific domains or regions where earth system processes are especially vulnerable. For example, air pollution in China is estimated to cause damage equivalent to a loss of up to 13% of GDP (Global Commission on the Economy and Climate, 2014; Stern, 2015). This potentially negative linkage ('constraining' or 'counteracting') between growth and health/well-being depends on the nature of the impacts, such as physical effects on the natural resource base, and the way these are mitigated by governments.

The path from environmentally unsustainable production to adverse health outcomes may be indirect or incremental. For example, minor inputs of polluting chemicals from agriculture may lead to cumulative effects as soil gradually becomes contaminated and contamination levels gradually rise in water supplies or food grown in a particular region (Millennium Ecosystem Assessment, 2005), leading to longer-term food shortages and health impacts, even though agricultural production may increase in the short term. The need to abandon particular regions following salination, such as in Sumeria, is a lesson from the deep history of civilisation (Diamond, 2005), but the unintended consequences of new irrigation systems that are poorly regulated are still being encountered today.

Target 3.8, which involves reducing the number of deaths and illnesses from hazardous chemicals, is closely aligned with protecting labour rights and promoting safe and secure working environments for all workers (8.8). Exposure to asbestos is associated with a number of cancers (Nielsen et al., 2014); yet about 125 million people worldwide are exposed to asbestos in the workplace (Concha-Barrientos et al., 2004). In the short term, some employers may pursue economies in health and safety conditions in order to enhance profits; but in the

longer term, pursuit of such savings can jeopardise not only the health and sometimes lives of employees but also – in some cases – the sustainability of the commercial enterprise itself. Economic growth and jobs that are dependent upon poor labour conditions, or the continuing abrogation of labour rights are analogous to growth secured through environmental degradation: in both cases, one goal (that of growth and jobs) is advanced at the expense of others. Governments, given sufficient resources, are typically in a better position than individual employers are to assess the preferred balance between health and safety conditions in the workplace (where better conditions enhance the quality and productivity of work) and the social costs arising if and when more costly production conditions lead to the pricing of production off the international market (diminishing the quantity of jobs in the economy). However, in some countries the level of regulation by government of labour conditions may reflect other factors such as inadequate information about risks (EU-OSHA, 2013), or even poor regard for the health and safety of migrant workers and others in precarious employment. Studies on the health and safety effects of precarious employment found a negative association with occupational health and safety and that the higher the instability of employment, the more it is associated with morbidity/mortality (EU-OSHA, 2013). In such cases, joint monitoring of working conditions by labour unions and employers can lead to greater awareness of the need for improved health and safety.

As working conditions change over time, with changing technologies and the impacts of climate change, continuing globalisation and other impacts, certain sectors may be particularly affected. For example, with the increased temperatures driven by climate change in most countries – affecting especially agriculture, horticulture and forestry work, governments have a role in ensuring that

regulation of health and safety conditions stays up to date (Kjellstrom and Crowe, 2011; Maloney and Forbes, 2011; UNDP, 2016). In short, context and conditions are critical if growth is to be beneficial for well-being (van den Bergh, 2011). Where growth damages the natural resource base (biodiversity, forests, water bodies, oceans, atmosphere, bio-geochemical cycles) or crosses boundaries of the ‘safe operating space’ for humanity, it undermines the conditions for long-term well-being (Rockström et al., 2009; Griggs et al., 2013). Thus, a reorientation of business activity towards a green economy is essential for sustained health and well-being (Biermann et al., 2012). An understanding of this dynamic is implicit in SDG8, which includes endeavouring to decouple economic growth from environmental degradation, in accordance with the 10-year framework on sustainable consumption and production (8.4). Better understanding of the specific contexts and policies where SDG3 and SDG8 conflict is important for minimising trade-offs between growth and long-term health/well-being.

KEY UNCERTAINTIES

There are uncertainties about some interactions, such as conditions under which increased income and associated spending might lead to negative health outcomes. But most interactions are positive and clear.

KEY DIMENSIONS

Time: Taking action on several targets – for example by improving occupational conditions – would have immediate effects. Many impacts are long-term: where growth contributes to growing environmental pressures it reduces health/well-being over time.

Geography: Loss of health/well-being can be especially severe in some regions where interacting factors including topography, weather and technology mean some populations are especially vulnerable (e.g. air pollution in parts of China).

Governance: Good governance and careful planning are key to ensuring the ‘right’ conditions for growth and rewarding employment. Negative impacts of growth can be mitigated by governments.

Technology: Net benefits for health and well-being cannot be assumed when some technologies or their application can have adverse social and environmental impacts.

Directionality: Bidirectional. However, while growth and employment do not always contribute to health/well-being, increased health/well-being almost always contributes to economic growth and employment. More fundamentally, health and well-being is a higher-level human aspiration than growth and employment (Meadows, 1998).

ILLUSTRATIVE EXAMPLE THE INTERACTION BETWEEN WORK, LABOUR PRODUCTIVITY AND HEALTH IN THE CONTEXT OF HIGH TEMPERATURES

Health and work are closely related. Access to work increase incomes, which supports health. However, working in an unsafe environment (8.8), harms health. For example, excessive heat in the work place represents an occupational hazard. High temperatures and dehydration place people at risk of acute heat stroke, heat exhaustion, and death. In addition, chronic heat exposure can lead to cardiovascular diseases, mental health issues and chronic kidney disease (3.4) (Xiang et al., 2014). Working in high temperatures increases the risk of having accidents, and impairs capacity to undertake physical and mental work (UNDP, 2016). This means that heat can limit labour productivity and economic growth. Modelling suggests that currently, worldwide, up to 10–15% of annual daylight hours are so hot that productivity is lost

(UNDP, 2016). Therefore, to support both health and economic growth, labour policies should ensure that employers reduce workers’ exposure to heat, through providing shade or ventilation and avoiding work in the hottest periods of the day.

The crucial connection between heat, health, productivity and economic growth is likely to be of increasing concern due to global warming. Further reductions in labour productivity associated with a warmer climate could result in reduced output in affected sectors of over 20% during the latter half of the century. The global economic cost of reduced productivity may be over US\$ 2 trillion by 2030 (Dunne et al., 2013). The impacts of climate change on labour productivity as mediated by heat stress would be especially severe in tropical and sub-tropical environments with large primary sectors where workers carry out heavy labour for long periods at the hottest times of year (UNDP, 2016).

Climate change is associated with increasing frequency and severity of heat waves, which directly impact on health and labour productivity (Kjellstrom and Crowe, 2011). The city of Ahmedabad, India, provides an example of the devastating consequences of heat waves, and proactive policy action to reduce the impact of future heat waves. The 2010 heatwave in Ahmedabad resulted in an estimated excess 1344 deaths, with a direct impact on productivity (NRDC, 2013; Azhar et al., 2014). As a result, city officials and partners focussed on reducing the risk of heat stress by developing the Ahmedabad Heat Action Plan. This sets out an early warning system and planned response strategies to protect residents, workers, employers, and officials with strategies to reduce exposure to heat (AMC, 2013).

SDG3 + SDG11



TARGETS	KEY INTERACTIONS	SCORE	POLICY OPTIONS
3.2 ← 11.1	Improving access to adequate housing supports the reduction of preventable deaths of newborns and children. For example, cold housing is associated with respiratory illness in children	+2	Ensure people have access to adequate housing through a range of measures appropriate to the local context, including: slum upgrading; the provision of permanent housing to homeless people; planning, building and tax policies that ensure high-quality housing and adequate housing supply; regulation and subsidies to support the improvement of existing dwellings (including through installing insulation, clean cook-stoves, ventilation, heating or cooling systems, safety measures)
3.3 ← 11.1	Improving access to adequate housing reduces crowding and hence exposure to communicable disease	+2	
3.4 ← 11.1	Improving access to adequate housing is likely to reduce premature mortality from non-communicable diseases. For example, cold housing is associated with cardiovascular symptoms	+2	
3.9 ← 11.1	Ensuring access to adequate housing will reduce exposure to hazardous substances currently present in some housing, such as polluted air and lead	+2	

KEY POINTS

Thirty per cent of the urban population, not counting those in unaffordable housing, live in slums or are in severe housing deprivation

Deaths of newborn babies, children under five years of age and older people from respiratory and communicable diseases can be prevented by retrofitting insulation and installing effective heating and cooling. These measures are also effective in reducing cardio-vascular deaths in older people

Providing good quality housing improves mental and physical health

Providing safe and affordable housing reduces household crowding and exposure to close-contact infectious diseases

Adequate provision of social housing enables household health and well-being, social cohesion and community stability

KEY INTERACTIONS

As more people migrate to cities in search of a better life and urban populations grow, housing issues intensify. Housing in slums and informal housing poses particular risks to health. About 880 million people live in slums and informal settlements (UN, 2015b), lacking durable housing, sufficient living space, security of tenure, sanitation and infrastructure, and clean water (WHO, 2011b). In addition, many people, whether in slums or not, live

in unaffordable housing (defined as costing more than 30% of total monthly household income) or in severe housing deprivation (defined as people living in crowded, poor quality, unaffordable housing, without privacy or any security of tenure) (Amore et al., 2011). Inadequate housing poses risks to health in low-, medium- and high-income countries (Haines et al., 2013). Ensuring access for all to adequate, safe and affordable housing (11.1) helps to end or combat communicable disease epidemics (3.3). Household crowding is associated with several infectious diseases, including flu, pneumonia, typhoid, tuberculosis, and diarrhoeal and gastrointestinal diseases, as well as risk factors for water, sanitation and hygiene (Baker et al., 2013). Reducing household crowding, by building new housing, extending existing housing, or through making parts of a dwelling habitable, is likely to reduce the risk of close-contact communicable diseases (Baker et al., 2013).

Improving access to adequate housing also contributes towards target 3.4. Evidence connects high indoor temperatures with high blood pressure and other poor health outcomes (Kim et al., 2012a,b; Uejio et al., 2016; van Loenhout et al., 2016), and low indoor temperatures with cardiovascular and respiratory disease (Thomson et al., 2013; Maidment et al., 2014). Excess winter deaths due to cold housing were estimated at 38,200 per year (12.8/100,000) in 11 European countries (WHO, 2011a). Extreme indoor heat also increases excess summer deaths, particularly for older people (Dhainaut et al., 2003; Stedman, 2004). Improving housing temperatures, including through making housing weather-tight and installing insulation, heating and ventilation, helps protect against disease (Howden-Chapman et al., 2007, 2012; Telfar Barnard et al., 2011).

Removing dangerous building materials reduces the risk of cancer (associated with asbestos; Goswami et al., 2013) and impaired brain development and cardiovascular disease (associated with lead; Lanphear

et al., 2005; Navas-Acien et al., 2007; Levin et al., 2008). Modifying homes to reduce hazards reduces the risk of falls and injury (Keall et al., 2015b). Removing polluting cooking-stoves, installing ventilation, taking measures to reduce dampness and mould, and protecting against outdoor pollutants improves indoor air quality and reduces the risk of chronic respiratory disease, including asthma (WHO, 2009, 2010, 2014a). In 2012, 4.3 million people died prematurely from illnesses caused by household air pollution, closely associated with using solid fuels for cooking and heating, mainly in low-income countries (WHO, 2014b). Improving housing, through providing warm dry homes has been associated with reducing stress and contributing to improved mental health (Howden-Chapman et al., 2007). Thus efforts to improve housing (11.1) are likely to contribute towards reducing premature mortality from non-communicable diseases and promote mental health and well-being (3.4).

Improving housing (11.1) will play a major role in reducing the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination (3.9). Housing can be a site of exposure to hazardous substances such as lead and asbestos. These substances can also pollute water and soil. For example, lead paint degrades and mixes with dust and soil where it may be ingested by children. In the US, about 70% of childhood lead poisoning cases are associated with housing (Levin et al., 2008).

KEY UNCERTAINTIES

Associations between inadequate, unsafe and unaffordable housing and poor health outcomes are clear, although further research is needed to understand exposure-response relationships between indoor and outdoor heat and cold and cardiovascular and respiratory symptoms.

KEY DIMENSIONS

Time: Poor housing can affect health immediately (e.g. injuries sustained due to bad wiring or broken steps) or cumulatively over time (e.g. exposure to lead in paint or exposure to damp and cold housing). Some interventions to improve housing can reduce the risk of adverse health outcomes immediately (e.g. installing smoke alarms or mosquito nets or replacing lead pipes). Timing of the effects of other interventions, such as those aimed at enabling housing to be heated or cooled to a healthy temperature will depend on the season.

Geography: The risks housing poses to health depend on geography. For example, in hot countries, high indoor temperatures pose a risk to cardiovascular health, while in cold and temperate countries, cold and damp housing poses a risk to respiratory health. In low-income settings, use of solid fuel is common, which means the risks of respiratory illness associated with indoor air pollution are greater. In some places, natural disasters can damage housing and pose additional risks to health. The effectiveness of interventions to improve housing also depend on geographical context.

Governance: Several interventions to improve housing (retrofitting insulation, installing insulation, improving structural integrity) require a trained workforce, good health and safety procedures and quality control. Providing social housing requires a redistributive tax system or a strong cooperative tradition.

Technology: Technology can assist in making housing safer. For example, installing chimneys and ventilation when people use solid fuel and open cooking-stoves and lamps can reduce indoor pollution.

Directionality: Unidirectional. Better quality, affordable housing improves the health of occupants.

SDG 3 + SDG 11



TARGETS	KEY INTERACTIONS	SCORE	POLICY OPTIONS
3.4 ← 11.2	Improving transport and particularly supporting active travel modes, promotes physical activity and helps to mitigate or prevent non-communicable diseases	+2	Ensure that transport systems connect active and public transport modes, and encourage cycling and walking through measures appropriate to the local context, such as street lighting, traffic slowing measures, footpaths, cycle lanes, shading, and pedestrian crossings
3.6 ← 11.2	Improving road safety, with particular regard to vulnerable road users such as cyclists and pedestrians, will reduce harm from traffic accidents	+3	Design infrastructure that prioritises safety and protects vulnerable road users. Ensure comprehensive road safety legislation
3.8 ← 11.2	Transport systems support access to healthcare, employment, family and friends, and education	+2	Ensure that public and active transport systems are integrated and well-connected to homes, jobs, and services
3.9 ← 11.2	Compact cities with well-designed public transport, cycling and walking networks enable reduced car use and contribute to reductions in carbon emissions and reduce exposure to air pollution	+3	Promote policies for compact, accessible mixed-land use urban development in order to reduce car dependence and carbon intensity of urban transport and encourage physical activity

KEY POINTS

A reduction in transport emissions improves air quality and reduces the incidence of air pollution-related disease

Enhanced active travel networks support reduction in mortality from, and prevention of, non-communicable diseases

Improved road safety for vulnerable users will reduce harm from traffic accidents

Better and more affordable transport networks support access to key amenities, such as healthcare and education

Infill or brownfield development can better support improved transport networks than greenfield developments, which are more likely to rely on private motor vehicle use

KEY INTERACTIONS

Improving transport systems (11.2) is likely to contribute towards the health targets of reducing the incidence of non-communicable diseases (3.4) and the incidence of mortality and morbidity related to pollution and to road traffic (3.6, 3.9), via a number of pathways: reducing exposure to harmful substances and poor air quality; encouraging physical activity; improving access to healthcare, education, and employment; and improving the safety of vulnerable road users.

Achieving target 11.2 is likely to support the positive health outcomes associated with improving housing and

settlements. Affordable transport systems connect housing to employment and education opportunities, medical services, and to friends and family, all of which are associated with improved health outcomes (Hine and Mitchell, 2003; Syed et al., 2013; Sagrestano et al., 2015). Compact cities, green spaces, making roads safer for cyclists, and investing in footpaths and cycle ways that are safe and attractive, all work to encourage walking and cycling which can contribute towards reducing the risk of cardiovascular disease, cancer, obesity and obesity-related illnesses, diabetes, and mental health problems (3.4) (Andersen et al., 2000; Matthews et al., 2007; Boone-Heinonen et al., 2009; Lim et al., 2012; Keall et al., 2015a). Compact cities can also reduce the need for transport, avoiding the costs and adverse effects of travel, and increasing mobility options for non-drivers (Litman, 2016). There are also social benefits to compact walkable cities, with increased interactions between residents (Litman, 2006). It is estimated that for every 10% increase in urban sprawl there is a 5.7% increase in per-capita carbon dioxide emissions and a 9.6% increase in per capita hazardous pollution.

Improving transport systems (11.2), particularly for vulnerable road users such as pedestrians and cyclists can also help reduce deaths and injuries from road traffic accidents (3.6). Road infrastructure is mainly constructed with the needs of motorists in mind. Yet in the African region, for example, 43% of all road traffic deaths occur among pedestrians and cyclists (WHO, 2015). Most traffic crashes are predictable and preventable: the roll out of key interventions to make roads safer can prevent fatalities while encouraging more people to travel by active means (WHO, 2015).

The promotion of walking and cycling, as well as public transport, over private motorised transport can also contribute towards a reduction in transport emissions. Improving transport systems will play a

major role in reducing the number of deaths and illnesses from hazardous chemicals and air, water and soils (3.9).

Greenfield development in comparison to infill or brownfield developments can encourage car-orientated transport reliance. Increased reliance on private motor-vehicle transport carries environmental burdens, such as leaching of zinc and copper into soil and water-bodies (Moores et al., 2010), which carry risk for human health as well as increased cost of development (Adams and Chapman, 2016). With the right infrastructure commitments, infill and brownfield developments can facilitate a shift towards greater reliance on public transport networks, and active travel such as walking and cycling (Howden-Chapman et al., 2011; Sallis et al., 2016). Urban developments in the present will 'lock in' infrastructure possibilities for the future, contributing to a time-lag between decisions now and effects later for transport infrastructure, including the relative physical activity of affected populations and vehicle emissions. Integrating improved transport decisions into urban planning is likely to help reduce premature mortality from non-communicable disease by 2030 (3.4) and to help reduce the number of deaths and illnesses from hazardous air quality (3.9).

KEY UNCERTAINTIES

There are few uncertainties, because the links between improved transport networks and health are well-established.

KEY DIMENSIONS

Time: Improving transport networks has immediate and long-term benefits. In the short-term, greater access is achieved for those who use transport networks. In the medium- to long-term, physical activity is improved, air quality improves, and carbon emissions are reduced. However, developing or redeveloping cities to fit this vision can take decades.

Geography: Different contexts will require different methods of improving transport networks, for example depending on the age and built environment of a city, what access exists to renewable energy networks to power (for example) electric buses, and regional, national, and international interlinks. Cultural attitudes to public transport and active transport may also require special attention.

Governance: Local governments have a strong role to play, in association with central governments. City municipalities may provide the mandate for improving the city's transport networks.

Technology: A conversion to electric-powered public transport infrastructure will be beneficial in places that have access to renewable, fossil-fuel free electricity. Technological improvements to vehicle emissions and safety will contribute to reducing mortality and morbidity related to pollution and road traffic.

Directionality: Unidirectional. Better transport systems support health goals by reducing air pollution, improving road safety, and encouraging physical activity.

ILLUSTRATIVE EXAMPLE RESTORATION OF CHEONGGYECHEON STREAM RESTORATION PROJECT, SEOUL, REPUBLIC OF KOREA

Decision-makers often face the dilemma of having to choose between a more expensive but sustainable development path and a cheaper quick-fix solution with foreseeable future adverse repercussions. The Cheonggyecheon Stream Restoration Project provides an internationally significant example of how a metropolitan government took steps towards sustainability with a new focus on the well-being of its citizens.

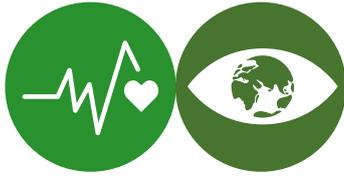
Multiple factors contributed to the stream restoration. The Cheonggyecheon motorway, that covered the stream allowed easier access to the downtown area of Seoul during the mid- to late 1900s leading to rapid industrial development. However, by the early 2000s it was so dilapidated that a decision was needed on whether to demolish it completely and build a new motorway or to deculvert and restore the Cheonggyecheon stream. The worn out infrastructure in Gangbuk (north of Han river) where the Cheonggyecheon stream runs, compared to the newer infrastructure of Gangnam (south of Han river) were causing an urban imbalance that was contributing to a loss of economic competitiveness in the area as a whole. The dramatic change in Seoul's priorities in favour of sustainable well-being, including cultural and historical renewal of the stream, followed the collapse of two major pieces of infrastructure in Seoul due to poor construction. These factors contributed to the Cheonggyecheon restoration becoming a major political issue during the 2002 Seoul mayoral election and led to the victory of Mayor Lee Myung Bak, who successfully advocated for the immediate restoration of the stream. Cheonggyecheon became reborn into a multipurpose public space with

continuous walkways and cycleways along the length of the stream.

The motorway had previously had a daily traffic flow of around 170,000 vehicles, but after its demolition the Seoul Metropolitan Government limited car traffic to two-lane one-way streets on either side of the stream and in conjunction, invested heavily in public transport (Chung et al., 2012). Investment focused on making public transport the cheaper, easier and faster option. Bus services were improved (e.g. colour coding and reformed bus numbers) and made as fast, or faster than car trips (Seoul Development Institute, 2005). Integrated ticketing was introduced, with a standard fixed fee for trips under 10 km. Active travel networks were built with the opening of two new subway stations close to the stream, continuous pedestrian roads along the length of the stream and 22 bridges connecting the north and south side of the stream.

These efforts increased bus and subway usage and reduced daily traffic in the Cheonggyecheon area by a third, while maintaining the average speed of vehicles. The restoration also reduced fine particulate matter (PM₁₀) and nitrogen dioxide (NO₂) in air by 15% and 10% respectively between 2002 and 2005 (Jang et al., 2010). The reduction in cars and the opening of a new winding path along the continuous depressed length of the stream, reduced the heat island effect and average temperature in the Cheonggyecheon area fell by 6–9°C.

SDG 3 + SDG 13



TARGETS	KEY INTERACTIONS	SCORE	POLICY OPTIONS
3.9 ← 13.2	Integrating climate change measures into national policies will support improvements in air quality	+3	Recognise the co-benefits from simultaneously mitigating climate change and reducing air pollution. Utilise systems thinking and frameworks to help structure and prioritise urban transport carbon mitigation policies
3.4 ← 13.2	Integrating climate change measures into national policies has some costs. Reducing emissions may lead to job losses in some industries, which could negatively affect the economy and indirectly constrain health care	-1	Invest in renewable energy and support for retraining of workers transitioning out of fossil fuel industries

KEY POINTS

In general, a reduction in fossil fuel combustion will simultaneously mitigate climate change and reduce air pollution: both outcomes will benefit health

While the main focus remains on the long-lived greenhouse gases, short-lived climate pollutants also matter for health

On average, the co-benefits from undertaking simultaneous mitigation may be greater in low- or medium-income countries than high-income countries; however, both are necessary

Urban transport, industries, thermal plants and burning of agricultural fields is a key source of emissions and air pollution; the avoid-shift-improve framework can help structure and prioritise urban mitigation policies

While understanding the chemistry behind the interaction of air pollution and climate is important, so are considerations of available technologies, means of implementation and governance

KEY INTERACTIONS

Climate change interacts with health in many ways and the scope for climate action is very broad. The focus of this section is on the interaction between the health impacts of air, water and soil pollution (3.9) and the integration of climate change measures into national policies, strategies and planning (13.2). Emissions, which affect both the climate and local air quality, largely derive from the combustion of fossil fuels. Therefore, reducing fossil fuel combustion will act to mitigate climate change and reduce air pollution.

Abating air pollution is a recurring international environmental policy driver with ongoing problems in cities from Paris to Beijing. Accordingly, efforts to control harmful emissions such as sulphur dioxide (SO₂) have a long history (Kanada et al., 2013) although ironically, it is now clear that the widespread abatement of sulphur is removing a (temporary) climate cooling influence (ACP, 2014). Short-lived climate pollutants include particles and aerosols such as black carbon and tropospheric ozone (UN, 2015a). Black carbon results from various domestic and industrial processes such as diesel combustion (for vehicles and electricity generation), cooking with biomass, and brick production (ACP, 2014). Each of these pollutants contributes to smog, carries a risk to human health risk when inhaled, and contributes to climate change.

Mitigating climate change as well as reducing air pollution can be achieved through action in the transport sector. There is a wide array of potential solutions for reducing carbon emissions, ranging from urban intensification that facilitates better public transport and healthy physical activity, to switching fuels for existing modes of private transport (Dalkmann et al., 2014). Well planned non-motorised transport provision can have positive impacts on greenhouse gas emissions and on local air quality. Mitigating climate change, while reducing

air pollution, can also be achieved through regulation to limit emissions from electricity and heat generation, especially coal, as well as industrial and manufacturing processes. The range of strategies can be conceptualised through the avoid-shift-improve framework, which is a way of understanding the co-benefits of policies in the broader context of a sector and how it relates to technologies and behaviour when different policies have different challenges and timescales for implementation, and analysis can help structure and prioritise policy packages in a given sector (Doll and Puppim de Oliveira, 2017).

Given the alignment between climate and air pollution objectives, many studies have looked into the co-benefits of aligned policies (Howden-Chapman et al., 2007; Bell et al., 2008; Bollen et al., 2009). One review (Nemet et al., 2010) found that on average the co-benefits (valued in US\$ per tonne CO₂) from undertaking simultaneous mitigation were greater in low-income countries than high-income countries. This was because there are greater marginal health benefits from reducing (initially) higher levels of air pollution, than from reducing air pollution levels in places where there is relatively low air pollution.

Understanding the atmospheric chemistry behind the interaction of air pollution and climate is an important first step in designing policies for aligning health gains from air pollution reduction with climate change mitigation. This needs to be complemented by considerations of available technologies, means of implementation, and governance, in order to minimise the risk of misaligning climate and air pollution objectives, while ensuring policy measures contribute to local municipal or regional policy goals.

The interaction between policies aimed climate change mitigation (13.2) and health-enhancing air pollution measures (3.9) is broadly enabling and potentially reinforcing. In some cases, it may be indivisible. However, within certain sectors, care must be taken to ensure that some

options do not inadvertently constrain or counteract the target. Fuel switching policies in particular must be examined from the perspective of precursor emissions, and their long-term effects if deployed over a large scale. There are also impacts on air pollution from a changing climate. Seasonal effects on air pollution are well-known and a dry or cold climate may cause more severe air pollution events.

KEY UNCERTAINTIES

Uncertainties remain as to the effect/strength of some policy measures.

KEY DIMENSIONS

Time: Health benefits from consequential air quality gains will have a faster effect on health than carbon emission reduction *per se*. The latter will be a critical long-term influence on global health. Some measures with both carbon mitigating and air pollution reducing effects, such as improving vehicle fuel efficiency, are subject to ‘rebound’ over time. Some influential carbon reduction measures, particularly policies to alter urban form to minimise car travel and maximise active travel and use of public transport, will take decades to have full effect, as cities grow and change.

Geography: While greenhouse gas reduction measures have more global benefits, gains from air quality improvements are more local. Context influences the relative benefits and costs of policy measures, with air pollution reduction yielding higher benefits in low-income countries than high-income countries.

Governance: Attention to governance is important to minimise the risk of misaligning climate and air pollution objectives, while ensuring policy measures contribute to local municipal or regional policy goals. Coordination is vital (even internationally) as air pollution emitted in one location may be transported and have an impact on other locations.

Technology: Public policies must take into account changing technologies that impact on climate change mitigation and adaptation.

Directionality: Largely unidirectional: mitigating climate change immediately through improvements in air quality. The transition to an economy less dependent on fossil fuels may cost some jobs in the short-term, which may have knock-on effects on health and on health spending. These could be serious in areas dependent on fossil fuel extraction, although offset by job gains elsewhere; but in the long term, health gains are likely to substantially outweigh such costs.



KEY INTERACTIONS SDG 3 WITH OTHER GOALS

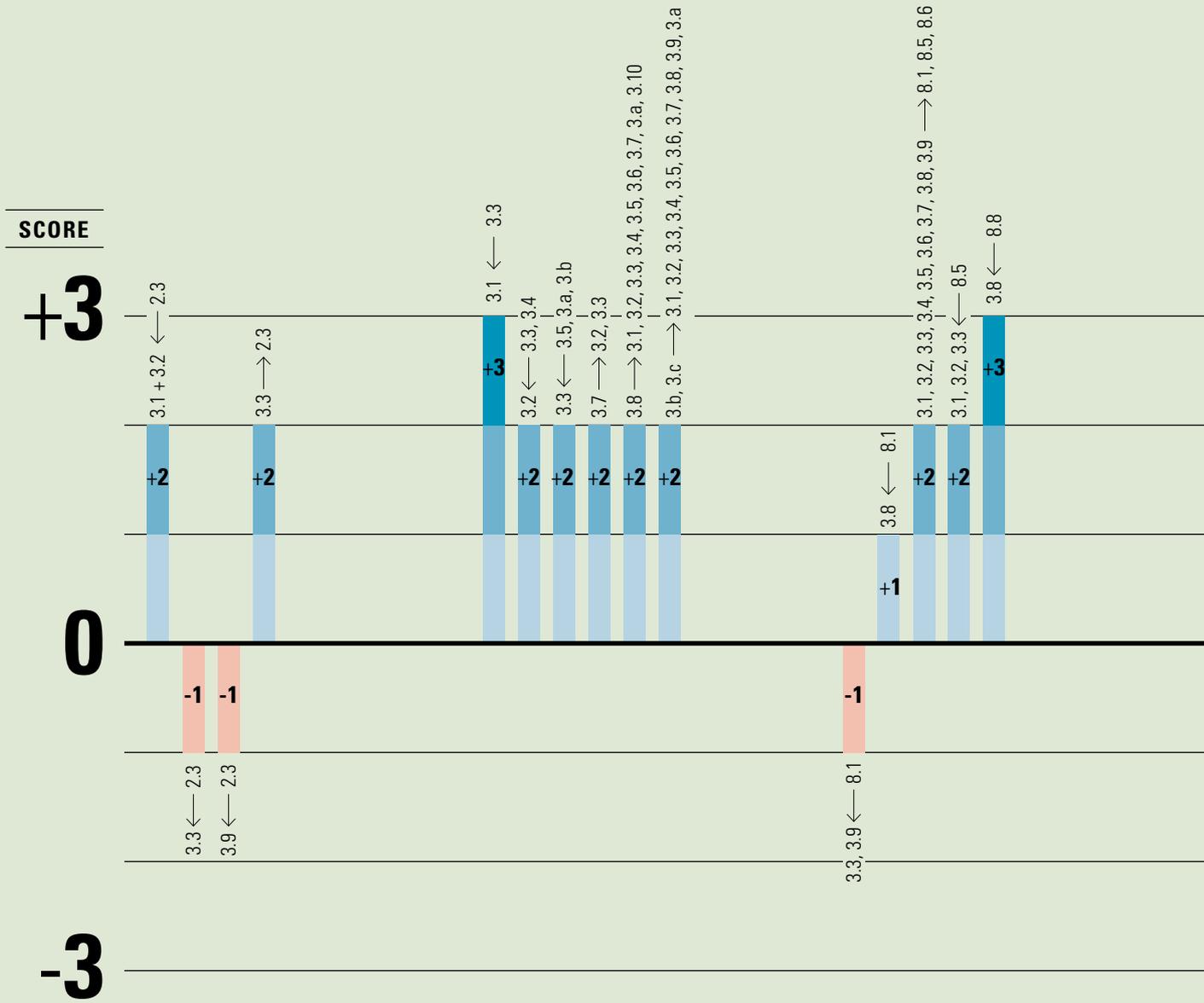
+ **SDG 2**



+ **SDG 3**



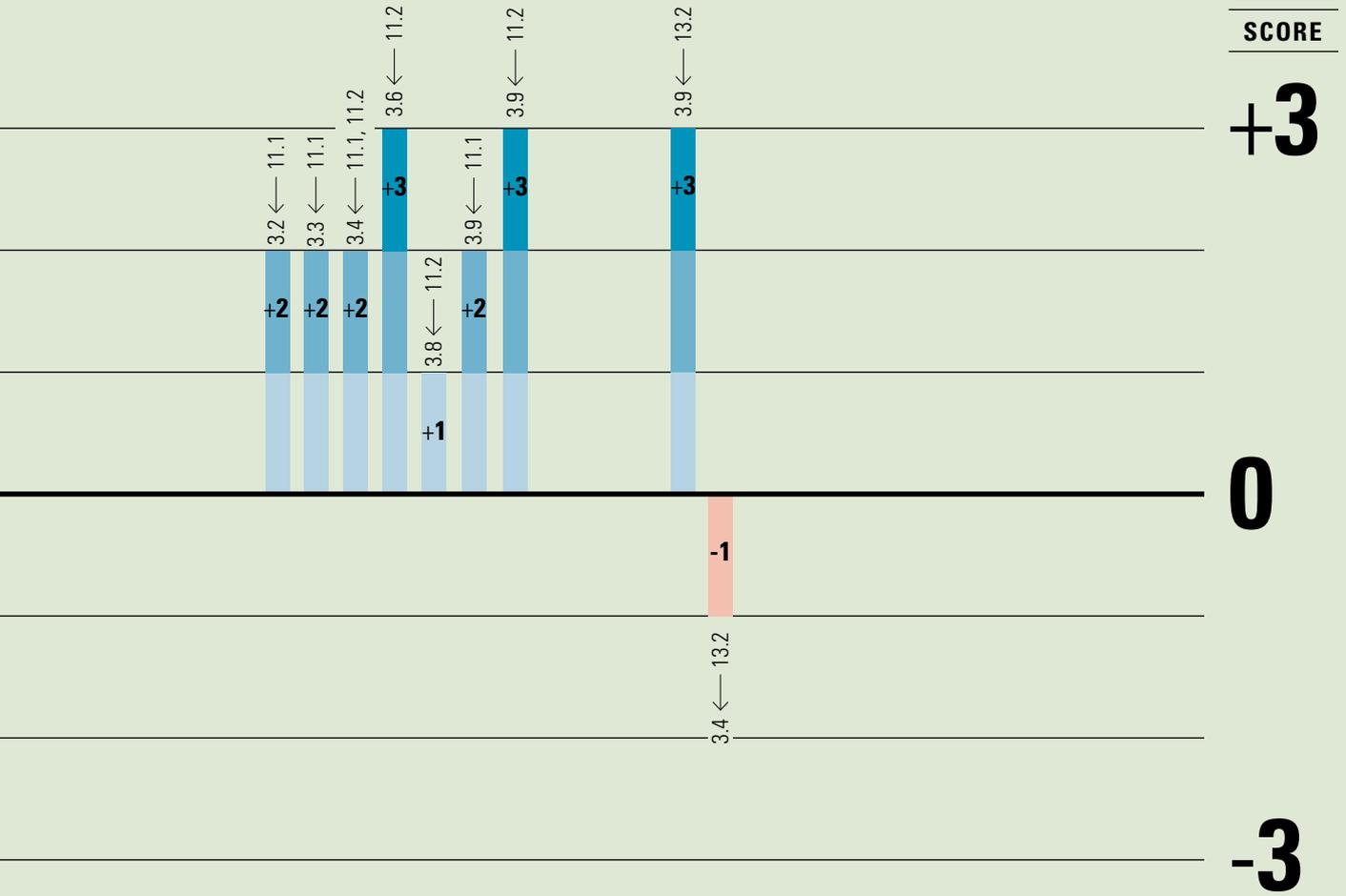
+ **SDG 8**



+ SDG 11



+ SDG 13



KNOWLEDGE GAPS

The preceding sections have illustrated some of the many interactions between SDG3 and the other SDGs. These interactions can be positive, negative, or neutral, uni- or bi-directional, short- or long-term, and often depend on geography, governance and technology. For some interactions, the state of science is not yet advanced enough to provide accurate and reliable assessments. As science advances and the evidence base grows, more comprehensive assessments should be possible, enabling significant improvements to SDG implementation strategies at regional, national and local scales. In general terms, integrated research, monitoring and data analyses will be needed in combination with targeted capacity development to fill existing knowledge gaps. The section provides a non-exclusive list of knowledge gaps that have been identified in relation to the complex web of trade-offs involving the SDG3 target interactions described in this chapter.

3 + 2 (2.3)

Careful case-by-case analysis is needed concerning how intensifying agricultural production is expected to affect the environment, including the expansion of pathogen habitats and the degradation of waterways

3 + 3

More research is needed to strengthen the evidence base for connections between SDG3 targets; for example, the connection between air pollution and maternal mortality rates is only beginning to become clear. However, standalone programmes may detract resources from broader aspects of the health system

3 + 8

Economic growth occurs differently in different contexts: some forms of growth are environmentally and socially damaging, while others (e.g. growth in the supply of infrastructure for renewable energy) are generally not. Expanding understanding of the specific contexts and policies mediating the interdependency between growth and long-term health and well-being is important for minimising critical trade-offs. Further research is needed on the relationship between income gains, employment and health at higher levels of development, given observed diminishing returns at high levels of wealth and income for the rich and the engendering of a sense of relative social and economic deprivation among the poor

3 + 11 (11.1)

More work is needed on the health impacts of quality, compact city environments with high access to amenities and a mix of

land uses, including public spaces. Better knowledge is needed on how increasing the volume of energy efficient, quality dwellings contributes to health in various contexts, such as the quality and security of existing housing including slum dwellings in different climates

3 + 11 (11.2)

More research is needed on how new housing developments and redevelopments can best foster health-promoting transport choices, including active transport, public transport and new modes such as car sharing

3 + 13 (13.2)

Better understanding is needed about the alignment between air pollution measures and climate change mitigation measures, for example, how can such measures contribute to low-carbon urban developments including more sustainable housing, transport and urban form. Air pollution is a complex issue arising from multiple (diffuse or point) sources both locally and from surrounding areas. Better information is required on how many of these pollutants can be mitigated through climate change actions in different localities

CONCLUDING COMMENTS

With so many interactions between targets, it is clear that government-led actions and policies will be important for ensuring that positive outcomes are achieved as frequently as possible and negative outcomes are minimised or avoided. This requires the development of policy frameworks that take a systemic, integrated, holistic perspective. For example, it is helpful to focus on interlinked policy goals of cities to gain insights for policy to advance health and well-being outcomes. Governments could usefully engage in policy experimentation to address increasingly urgent climate change issues. Some governments have demonstrated the importance of linking diverse policy measures to create mutually reinforcing measures for change. It is important that planning agencies make use of systems thinking to develop a more integrated view of outcomes that increase health and well-being (Chapman et al., 2016). It may also help to understand where existing vested interests may be working against the achievement of particular targets, and where business and civil society partners can collaborate with policies of local and national governments. Pro-active engagement and enhanced coordination across government departments and ministries, as well as across different levels of government (from international to national to local), and between state and non-state actors including business and non-government organisations, will be required for this to happen effectively. Given the diverse levels of interactions, the persistent 'silo approach' to policymaking, does not serve the achievement of the health targets well.

Building on these general considerations, the six summary tables in the target-level interactions section provide options for how policy could address the specific target interactions in practice. Although addressed to specific target interactions, many of these policy options are also relevant for other interactions.

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