# 1 End Poverty in All Its Forms Everywhere

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## Abstract


1 NO POVERTY
Poverty is the lack of resources needed to ensure dignity and survival
Hinders people from reaching their full potential
Reduces life expectancy
Increases vulnerability to economic and environmental shocks
Threatens access to health care and education
Potential
Life expectancy
Poverty
Causes and exacerbators of poverty are complex
Lack of access to financial services and products
MORTGAGE
Geographical positions of nations (shaping climate, landscapes, hydrology, and exposure to hazards)
History and past policy decisions within or beyond the country
Past
Present
Differential access to and benefits from natural resources
Water
Energy
Minerals
Soil
Cultural norms, practices and beliefs
Beliefs
Cultural norms
Practices
Weak governance and corruption
Armed conflict
Environmental degradation
Geoscientists have an opportunity and responsibility to contribute to poverty alleviation
Improve access to basic services, natural resources, and appropriate technologies
Effective and equitable disaster risk reduction
Disaster Risk Reduction
Research
Global Networks
Capacity strengthening
Community engagement
Data
Ensuring the availability of geoscience for policy, and improving its uptake

## 1.1 Introduction

As of 2015, an estimated 736 million people were living in extreme poverty, earning less than $1.90 a day, with almost half the world's population (3.4 billion people) living on less than $5.50 a day/$2000 a year (World Bank 2018). Poverty, however, is multidimensional and extends beyond simply having an adequate income. It encompasses the ability to meet human needs for food, water, sanitation, energy, education, sustainable livelihoods, and empowerment to engage in decision-making (Green 2008; Sachs 2015). Poverty is the '*lack of resources*' needed to ensure dignity and survival, be they economic, social, political, or cultural resources.

Poverty hinders individuals and communities from reaching their full potential, reduces life expectancy, and increases vulnerability to epidemics, economic depression, environmental change, and natural hazards. Poverty undermines human rights, threatening the right to work, access to health care and education, freedom of thought and expression, and the right to maintain a cultural identity (Sané 2001; UNESCO 2017). While poverty can drive innovation, pushing people to think beyond the status quo to develop new routes to access financial services or energy resources, it is associated with deeply entrenched deprivation and hardship. Lifting people out of poverty transforms *'the lives and expectations of a nation's inhabitants'* to ensure good health, physical safety, meaningful work, and connection to community (Green 2008). While this requires sufficient economic resources, it also needs social, political, natural, and cultural capital.

While extreme poverty is concentrated in sub-Saharan Africa and South Asia (Fig. 1.1), poverty affects every country. In some contexts, people lack sufficient resources to support a

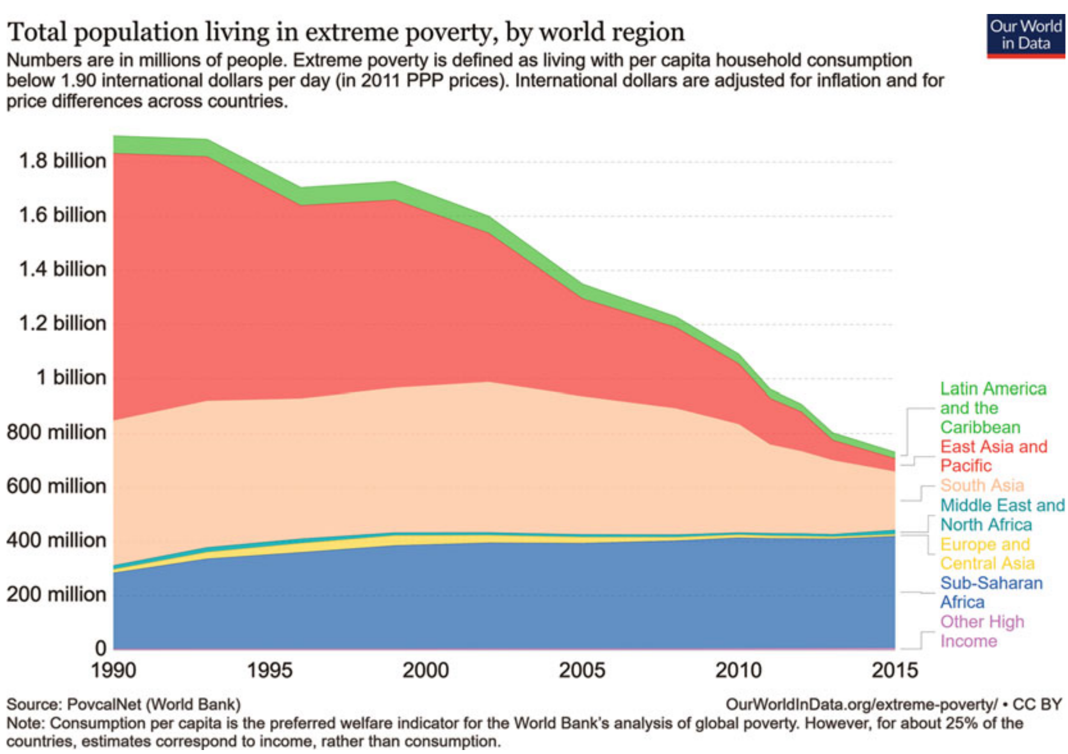


**Fig. 1.1** Total population living in extreme poverty, by world region. *Credit* Roser and Ortiz-Ospina (2017), using data from the World Bank (PovcalNet). Reproduced under a CC BY license (https://creativecommons.org/licenses/by/4.0/)

recognised standard of living (relative poverty). In other contexts, including many of the world's least developed countries, those living in poverty face a daily challenge to access the resources they need to meet immediate and basic needs (extreme poverty). The effects of such poverty are widespread, potentially degrading health, hindering education, perpetuating gender inequalities, and reducing political suffrage.

*Poverty is not inevitable*. The world has made good progress in tackling extreme poverty over the past 25 years (Fig. 1.1). Extreme poverty (those living on ~\$1.90 a day) fell by more than half between 1990 and 2015, going from 1.9 billion people to 736 million people living in extreme poverty (World Bank 2018). Progress has slowed however; the UN indicate that 6% of the global population will still live in extreme poverty by 2030 (United Nations 2019), and the Covid-19 pandemic will likely exacerbate poverty further. Progress has also been geographically uneven. Reductions in poverty since 1990 have been concentrated in East and South Asia (United Nations 2015). More than half of those still living in extreme poverty live in sub-Saharan Africa, where estimates suggest the *total* number of people living in extreme poverty is increasing rather than decreasing (World Bank 2018). In sub-Saharan Africa, 84.5% of the population still live on less than \$5.50 a day or \$2000 a year (World Bank 2018). These communities can struggle to meet basic needs, and find themselves particularly vulnerable to falling back into extreme poverty. We must, therefore, take a balanced approach to how we define, measure and interpret the poverty narrative.

When considering actions to address global poverty, we, therefore, have reasons to be positive and reasons to be cautious. **Sustainable Development Goal (SDG) 1—Zero Poverty—**aims to build on this progress and ensure we leave nobody behind, *ending poverty in all its forms everywhere by 2030*. Specific targets (Table 1.1) include ambitions to eradicate extreme poverty, reduce relative poverty, ensure equal rights to basic services and natural resources, and reduce exposure and vulnerability to economic, social, and environmental shocks and disasters.

**Table 1.1** SDG 1 targets and means of implementation

| Target | Description of Target (1.1 to 1.5) or Means of Implementation (1.A to 1.B) |
|---|---|
| 1.1 | By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day |
| 1.2 | By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions |
| 1.3 | Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable |
| 1.4 | By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance |
| 1.5 | By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters |
| 1.A | Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions |
| 1.B | Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions |

The causes of and solutions to poverty have environmental, social, and governance components. Geoscientists have a role to play in all of these, but particularly around the environmental component, the focus of this chapter. Poverty can be influenced by the physical geography or the underlying geology of a region. Environmental change, degradation, and shocks can threaten development gains and push communities below the poverty line. Poverty cycles can be broken through interventions that enable access and equal rights to clean water, natural resources, and appropriate technologies. Poverty can be a driver of environmental degradation, although it is widely accepted that individuals in wealthier countries typically have the highest ecological footprint. The poorest and other marginalised groups (e.g., indigenous communities) are often the strongest advocates of environmental protection and sustainable consumption, being the most vulnerable to environmental stresses (Broad 1994).

This chapter explores these themes and describes the role of geoscientists, outlining why the geoscience community matters when tackling poverty, and why tackling poverty matters to global security, development and environmental integrity. We characterise poverty and outline its effects (Sect. 1.2), proceeding to describe the progress made in tackling poverty (Sect. 1.3). We discuss the diverse causes of poverty and their relationship to geoscience (Sect. 1.4), and highlight ways that geoscience education, research, and innovation can reduce poverty and help society to end poverty (Sect. 1.5).

## 1.2 What Is Poverty, and What Are the Effects of Poverty?

### 1.2.1 Types of Poverty

Two primary definitions of poverty are reflected in the **SDG 1** targets:

- **Absolute** or **Extreme Poverty**: This looks at humanity as one unit and sets a standard (income level) below which humans are considered to be living in extreme poverty. The World Bank currently defines international absolute poverty as living on an income of less than \$1.90 a day (although the SDG 1 target includes the measure of 'less than \$1.25 a day'). Those living in absolute poverty typically struggle to access immediate needs such as food, safe drinking water, sanitation, health services, shelter, education, and information.
- **Relative Poverty**: This considers differing social contexts, defining a poverty level according to recognised national or regional standards. Relative poverty is, therefore, a measure of income inequality in a given region. In the United Kingdom, for example, relative poverty is currently defined as having an income below 60% of the median household income (UK DWP 2018).

Common to both absolute (extreme) and relative poverty is the idea that there is *a lack of sufficient resources required to meet everyday needs*, although resilience actually requires an ability to not only meet daily needs, but also meet future needs in the event of changing situations. While poverty is traditionally defined in terms of economic resources (e.g., income) or consumption, necessary resources go beyond money. We all need food, water, and shelter to survive. We greatly benefit from access to safe energy, health care, and education if we are to enjoy a reasonable quality of life, and build the skills required to generate an income. The desire to participate in decision-making is shared through diverse societies. Poverty is therefore lack of access to

- *Economic resources*, the financial capacity to purchase essential items.
- *Social resources*, access to basic needs such as food, sanitation, energy, shelter, health care, and education.
- *Natural resources*, access to a healthy natural environment, ecosystem services, and natural assets including geology, soil, water, and biodiversity.

- *Political resources*, a political voice or suffrage.
- *Cultural resources*, cultural opportunities, including access to information and communications.

There are interconnections and reinforcements between these resources. For example, a family lacking economic resources in a context where primary education is not free may be unable to send all of their children to school, and thus limit future opportunities for some of them. A lack of economic resources may also hinder people from exercising political suffrage, as they are unable to take time out of income-generating activities to travel to the nearest polling booth. Lack of economic resources may prevent a family from purchasing a radio and benefitting from weather information that improves their agricultural productivity.

Multidimensional poverty indices attempt to capture this holistic understanding of poverty and ensure actions do not focus solely on relieving economic deprivation (Alkire and Jaha 2018). For example, the 2018 Multidimensional Poverty Index (Table 1.2) incorporates health, education, and standard of living, with 10 indicators weighted to determine an overall poverty index (Alkire and Jahan 2018). The Multidimensional Poverty Index suggests that the percentage of the population living in multidimensional poverty in South Sudan is 91.9%, in Niger is 90.6%, and in Chad is 85.9% (UNDP 2018). These figures are significantly higher than the percentages given when solely focusing on economic deprivation, with the 2006–2016 average percentages of the population living in extreme poverty using the $1.90 definition being 42.7%, 44.5%, and 38.4%, respectively (UNDP 2018).

**Table 1.2** 2018 multidimensional poverty Index (dimensions, indicators, deprivation cutoffs and weights). Adapted from Alkire and Jahan (2018)

| Poverty dimension | Indicator | Deprived if living in the household where… | Weight |
|---|---|---|---|
| Health | Nutrition | An adult under 70 years of age or a child is undernourished | 1/6 |
| | Child mortality | Any child has died in the family in the 5-year period preceding the survey | 1/6 |
| Education | Years of schooling | No household member aged 10 years or older has completed six years of schooling | 1/6 |
| | School attendance | Any school-aged child is not attending school up to the age at which he/she would complete class 8 | 1/6 |
| Standard of Living | Cooking fuel | The household cooks with dung, wood, charcoal, or coal | 1/18 |
| | Sanitation | The household's sanitation facility is not improved (according to SDG guidelines) or it is improved but shared with other households | 1/18 |
| | Drinking water | The household does not have access to improved drinking water (according to SDG guidelines) or safe drinking water is at least a 30-minute walk from home, round trip | 1/18 |
| | Electricity | The household has no electricity | 1/18 |
| | Housing | Housing materials for at least one of roof, walls, and floor are inadequate: the floor is of natural materials and/or the roof and/or walls are of natural or rudimentary materials | 1/18 |
| | Assets | The household does not own more than one of these assets: radio, TV, telephone, computer, animal cart, bicycle, motorbike, or refrigerator, and does not own a car or truck | 1/18 |

The Social Progress Index (SPI) is another complimentary metric to Gross Domestic Product (GDP), characerising how countries provide for the social and environmental needs of their citizens (Social Progress Imperative 2018). Some countries (e.g., Bhutan) are experimenting with various forms of Gross National Happiness (GNH) as a measure of national progress beyond simple GDP increases.

### 1.2.2 Contrasting Poverty Across Settings

The precise financial resources required to meet daily needs will differ from one context to another, as the amount of local currency needed to purchase goods or services may vary. If a household in one country has an income of $500/month but is required to spend an average of $400/month on rent, they will be more vulnerable than a household in another country with an income of $500/month and an average rent of $100/month. Differences in cost of living and inflation affect the purchasing power of a household's income.

Purchasing Power Parity (PPP) enables us to consider these differences and adjust income measures accordingly. We experience this when visiting other countries and find that commodity prices are different to prices at home, once adjusted for currency exchange rates. For example, Table 1.3 shows the nominal *Gross Domestic Product (GDP) Per Capita* of three countries (Tanzania, Guatemala, and the United Kingdom), and contrasts these with the *GDP Per Capita* (adjusted for Purchasing Power Parity). In Tanzania, for example, GDP per capita reflecting PPP is 3.2 times the nominal GDP. This reflects the reduced cost of living in Tanzania.

PPP is embedded into international definitions of extreme poverty. The World Bank's International Poverty Line ($1.90 a day) was determined by contrasting national poverty measures in some of the world's poorest countries, expressed in a common currency using PPP. This means that $1.90 would purchase the exact same basket of goods regardless of the country it is purchased in, which enables a global comparison of absolute poverty.

### 1.2.3 Poverty Cycles and Traps

The complex and multidimensional nature of poverty can result in poverty cycles or traps, where poverty transmits through multiple generations and continues until there is an adequate intervention. For example, consider the situation of a family who cannot afford to send their children to school, limiting future income-generating opportunities and resulting in future families who cannot afford to send children to school. Cultural factors may also mean that the outcomes of such poverty are discriminatory, with male children getting preferential access to education over female children. Another poverty cycle can exist when pregnant women lack access to good nutrition during foetal development. This can result in babies being born with impaired growth, susceptible to infant mortality, and likely to face challenges of sickness and poverty themselves, throughout their life (Green 2008).

**Table 1.3** Contrast between GDP (nominal) per capita and GDP (PPP) per capita in select countries (Data from International Monetary Fund DataMapper 2018)

| Country | GDP (Nominal) Per Capita (US$) | GDP (PPP) Per Capita (Int$[a]) | Ratio |
|---|---|---|---|
| Tanzania | 1160 | 3680 | 1 to 3.2 |
| Guatemala | 4700 | 8710 | 1 to 1.9 |
| United Kingdom | 42040 | 47040 | 1 to 1.1 |

[a]International Dollars (Int$) are a hypothetical currency unit that would buy a comparable amount of goods and services in the cited country that a U.S. dollar would buy in the United States at a given point in time

Certain marginalised groups may be more likely to be stuck in cycles of poverty than others may, showing the links between poverty and inequalities (discussed in **SDG 10**). The poverty rates for indigenous peoples in Latin America, for example, are estimated to be twice as high as for others (Calvo-González 2016). Some of this poverty gap can be accounted for by differences in educational levels, sizes of households, access to types of work, and the rural focus of indigenous communities (Calvo-González 2016). The full extent of the poverty gap, however, is likely to be explained by inequality and discrimination (World Bank 2015), with indigenous people earning less than non-indigenous people when they have the same level of education (Calvo-González 2016).

**Box 1.1: Examples of Poverty Traps: Artisanal and Small-Scale Mining and Informal Settlements**

*Artisanal and Small-scale Mining* (ASM) is often a more viable economic activity than, for example, subsistence agriculture. The sector is believed to employ over 40 million people globally, and over 150 million indirectly (IGF, 2017) making it a major rural livelihood next to agriculture. It has the potential for higher rewards, and thus artisanal and small-scale miners may determine that there is no economic incentive for them to relocate to agriculture or other types of work or use it as a seasonal substitute to agriculture to augment their incomes (Hilson 2016). Where unemployment is widespread, those working in the ASM sector may be driven to work there with few viable alternatives. This activity is driven by downstream demand and consumption of high-value commodities such as tantalum, gemstones (such as sapphires), and gold. However, artisanal miners often lack access to markets or mainstream finance. As a result, they may become trapped in debt by taking finance from unscrupulous lenders or, in the case of artisanal gold mining, become indebted to a sole supplier of mercury who dictates their terms of access (Hilson and Pardie 2006) creating financial dependency. Capital on poor terms is compounded by below-market rates for their commodities, and therefore exacerbating rather than relieving poverty. This can hinder their ability to make a sustained, income from ASM or harness natural resources as a catalyst for economic diversification beyond mining dependency.

*Informal urban settlements* (or slums) can be a form of urban spatial poverty trap (Fig. 1.2), with a lack of natural capital (e.g., clean water) and political capital (e.g., land rights). Informality can result in poor investment and representation, exacerbating issues of poverty and degradation. Slums have defining spatial and social dimensions, with interactions between these, characterised by high population and housing densities, low standards of services and structures, and significant 'squalor' (Grant 2010). The lack of political capital, investment, and policy interest results in ongoing exclusion and the development of an urban spatial poverty trap. Housing density may result in inadequate distances between latrines and water resources (e.g., wells), resulting in contamination and disease (Kimani-Murage and Ngindu 2007). Increased exposure to water-borne diseases could limit income-generating activities and the economic opportunity to move secure environments. Informal settlements are often of substandard building quality, and it is these buildings that are most affected during natural hazards such as earthquakes (e.g., Ahmed 2014).

Once individuals are considered to be living above international poverty measures, sudden or slow-onset changes can occur that push them back into extreme poverty. Interventions to support those living *below* a poverty line are necessary, but it is important to also consider the vulnerability of those living just *above* the poverty line. People may be meeting their daily needs, but unable to set aside resources or access an adequate social security system. When changes in personal circumstances occur (e.g., illness or disability), or environmental shocks (e.g., earthquakes) and environmental stresses (e.g., climate change), these can impede an individual or community's ability to meet their needs. Tackling poverty and ending cycles of poverty is, therefore, more than ensuring sufficiency for day-to-day needs. It also needs to ensure access to social security, insurances, and an ability to set aside resources to meet future demands.

## 1.3 Progress in Tackling Poverty

### 1.3.1 Poverty from 1820 to Today

While recognising that poverty is multi-dimensional, with both monetised and non-monetised approaches to improving well-being, changing income provides an approach to track progress in tackling poverty over time. Bourguignon and Morrisson (2002) estimate that in 1820, 94% of the global population lived in extreme poverty. In 1990, 1.96 billion people were living in extreme poverty, equivalent to 36% of the global population at the time (World Bank 2018). By 2015, the number of people living in extreme poverty had reduced to 736 million (World Bank 2018), or approximately 10% of the global population. Figure 1.3 illustrates this progress in addressing extreme poverty, showing a particularly rapid decrease in the

**Fig. 1.2** Informal settlement in Jakarta Indonesia. *Credit* Jonathan McIntosh, reproduced under a CC BY 2.0 license (https://creativecommons.org/licenses/by/2.0/)

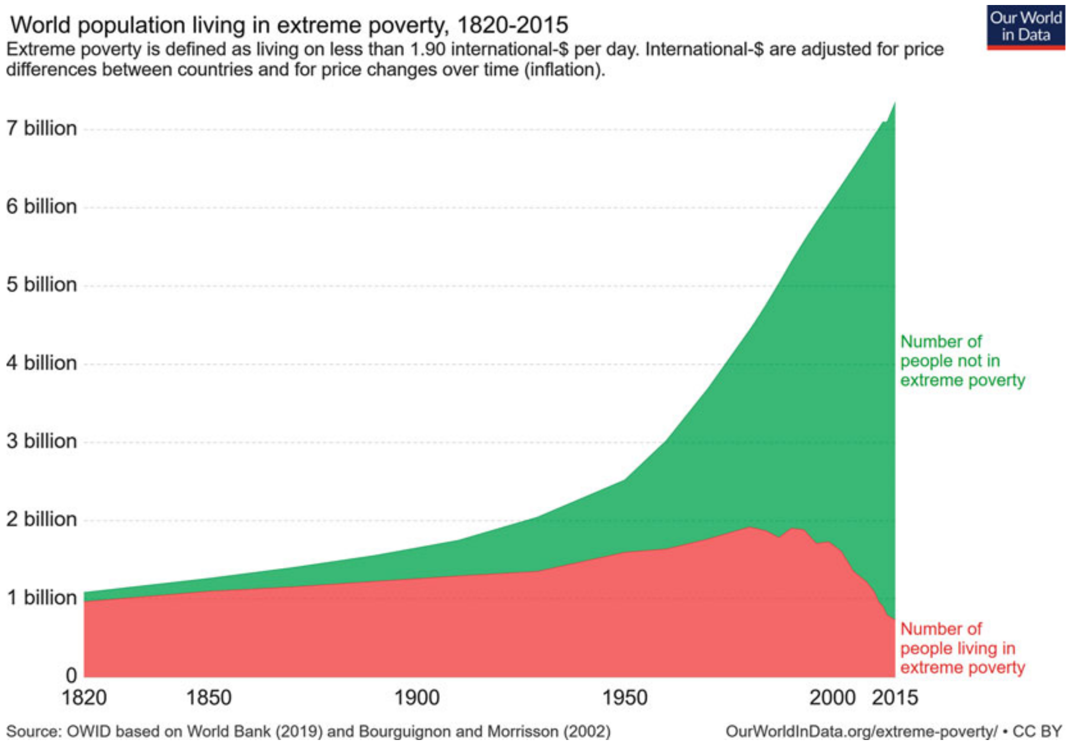


**Fig. 1.3** World population living in extreme poverty, 1820–2015. The line shows the percentage of people in extreme poverty (an income of less than $1.90 per day) while the red portion shows the absolute numbers. *Credit* Roser and Ortiz-Ospina (2017). Reproduced under a CC BY license (https://creativecommons.org/licenses/by/4.0/)

**Table 1.4** Poverty rate by region at $5.50 per day. Adapted from World Bank (2018)

| Region | 1990 (%) | 2015 (%) | Percentage Change (1990–2015) |
|---|---|---|---|
| East Asia and Pacific | 95.2 | 34.9 | −60.3 |
| Europe and Central Asia | 25.3 | 14.0 | −11.3 |
| Latin America and the Caribbean | 48.6 | 26.4 | −22.2 |
| Middle East and North Africa | 58.8 | 42.5 | −16.3 |
| South Asia | 95.3 | 81.4 | −14.0 |
| Sub-Saharan Africa | 88.5 | 84.5 | −4.1 |
| World | 67.0 | 46.0 | −21.0 |

past 50 years. More recently this progress is decelerating (United Nations 2019), with estimates that by 2030 6% of the global population will remain in extreme poverty. This does not take into account the effects of the Covid-19 pandemic. Aiming to achieve SDG 1 is therefore ambitious and requires the right support, including a sustained international commitment to eradicating poverty, policies that support inclusive economic growth, and a focus on rural regions (Chandy and Penciakova 2013).

While the progress in tackling extreme poverty as measured by $1.90 income a day is encouraging, the rate of improvement as measured by $5.50 a day is more subdued (Table 1.4). Between 1990 and 2015, there was a 21% reduction in the number of people living on $5.50 a day, compared to the 26% reduction seen

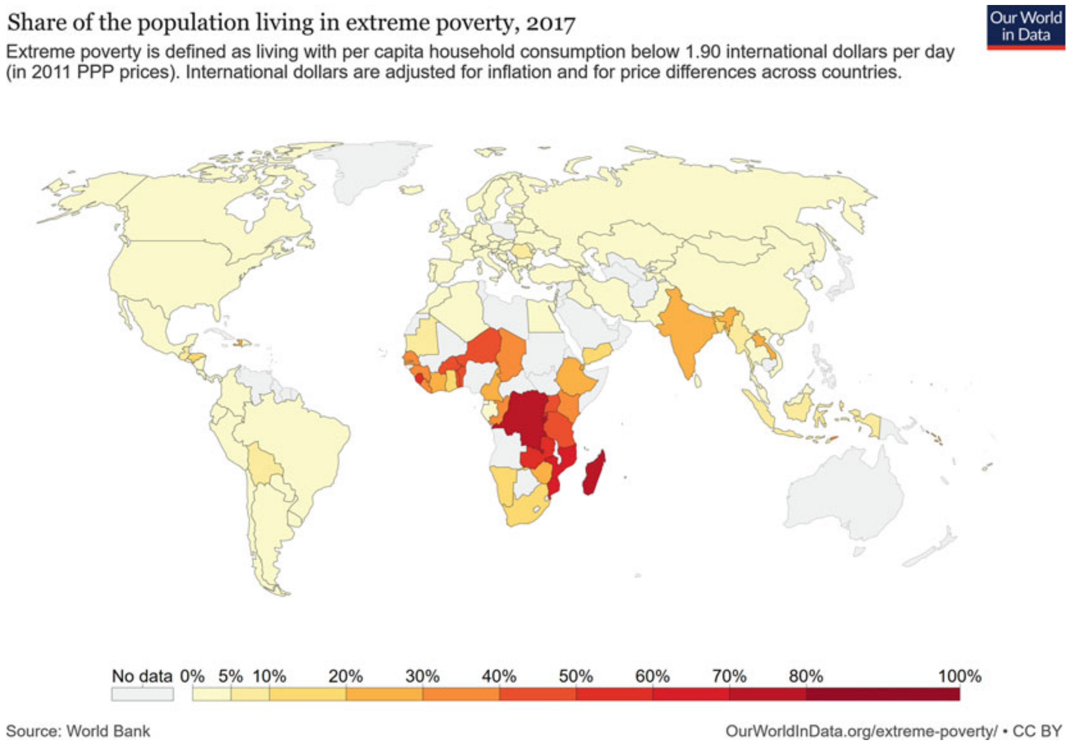


**Fig. 1.4** Share of population living in extreme poverty , 2014 (in 2011 PPP, Int$). *Credit* Roser and Ortiz-Ospina (2017), using data from the World Bank. Reproduced under a CC BY license (https://creativecommons.org/licenses/by/4.0/)

for $1.90 a day. This progress has been spatially heterogeneous with dramatic improvements in East Asia and Pacific but relatively little improvement in sub-Saharan Africa (a 4% drop between 1990 and 2015).

### 1.3.2 Geographic Distribution of Extreme Poverty

The rate of poverty reduction is extremely variable between countries. Today most wealthy nations in Europe, North America, Australia, and Japan have no people living below the World Bank's extreme poverty line. Most of the countries with the highest population share living in extreme poverty are in sub-Saharan Africa (Fig. 1.4). The Democratic Republic of Congo and Madagascar, for example, have more than 70% of their populations living below the poverty line. When it comes to the absolute number of people living in extreme poverty, India hosts more extremely poor people than any other country, about 29% (210 million people) of the world's total (PovcalNet, 2016). There is also considerable variation in poverty *within* any individual country. Extreme poverty may be concentrated in spatial pockets relating to soil conditions, conflict, or accessibility (see Sect. 1.4.2). While the relationship between urbanisation and poverty reduction is much debated (e.g., Cali and Menon 2013; Imai et al. 2017), it is clear that in most cases the majority of extremely poor people live in rural agricultural environments and most of a country's wealthier individuals live in cities. As cities continue to grow, ensuring low poverty rates in urban environments is dependent on addressing inequalities (see **SDG 10**), and ensuring sustainable and resilient urban environments (see **SDG 11**).

## 1.4 What Causes Poverty and How Does This Relate to Geoscience?

### 1.4.1 The Causes and Catalysts of Poverty Are Diverse

In any given location and context, a different combination of factors, with both natural and anthropogenic origins, may contribute to the generation or propagation of poverty. Examples include the following:

- **Access to Financial Services and Products.** A lack of access to the economic capital required to start or grow a business, purchase land, or take innovations to market can exacerbate the poverty of individuals, and stagnate economic growth (see **SDG 8**). Traditional lenders, such as banks, may not be a feasible source of economic resources for many. Innovations (e.g., microfinance and mobile money agents) are helping to address this challenge, however it persists for many.
- **Access to Markets.** Lack of physical access to markets, for example, due to insufficient infrastructure, can sustain poverty (see **SDG 9**). Poor transport infrastructure adds 30–40% to the costs of goods traded among African countries (Ayemba 2018). Approximately two-thirds of the population living in rural Africa are more than 2 km from the nearest road (Ayemba 2018), hindering access to markets.
- **Geography**. The geographical position of a nation shapes its climate, landscapes, hydrology, and exposure to geological and meteorological hazards. These factors can all affect development. Lack of direct access to oceans hinders the ability of many landlocked developing countries to benefit from trading routes, and maximise opportunities from global integration (Arvis et al. 2010).
- **Natural Resources**. Natural resources, including water, soils, and mineral/rock materials underpin social and economic development. Poverty can be triggered by a lack of, or differential access to, natural resources, or degradation of natural resources. For example, the underlying geology is one critical factor (alongside organic matter, climate, and time) that determines soil type in a given region. Different soil types are suitable for different purposes, with high inputs (therefore potentially high costs) required in some soils to sustain subsistence or commercial agriculture (e.g., grow cash crops). Differential access to natural resources may be a result of poor governance or the legacy of historical decisions (e.g., settlement of communities following conflict), as well as natural variability in the distribution of resources. Travelling long distances to collect water can take time away from education and income generation activities.
- **History**. Poverty today may result from past policy decisions within or beyond the country of interest, including imperialism and colonialism. For example, the decision to exploit hydrological resources for energy generation in Canada resulted in the degradation of fisheries resources for indigenous communities in the province of Manitoba (Hoffman 2008). This contributed to greater poverty in this community, with high welfare dependence and changes to traditional social practices (Hoffman 2008).
- **Culture**. Poverty can be catalysed by cultural norms, practices, and beliefs. For example, cultural practices or biases may determine the division of labour in a household, resulting in women and girls spending a greater proportion of their time on household chores (e.g., fetching water) than men (Blackden and Wodon 2006). This can limit their ability to take part in income-generating opportunities and exacerbate both poverty and inequalities.
- **Governance**. Weak governance, corruption, and poverty are all linked. Chetwynd (2003) found that '*corruption has direct consequences on economic and governance factors, intermediaries that in turn produce poverty*'. The prevalence of corruption and inhibition of democracy has been linked to an abundance of natural resources, particularly

**Fig. 1.5** Living in Topographical Extremes, Ladakh. In the Himalaya, Ladakh is a region of environmental extremes, with access often limited during the winter season. Communities have adapted to the environmental extremes, but remain vulnerable due to the difficult geography. *Credit* Joel. C Gill

hydrocarbons and minerals due to the high rents and export income they are associated with (Pegg 2006). This theme is discussed in detail in **SDG 16**.

- **Conflict**. Armed conflict can catalyse poverty and decimate economically productive sectors. For example, Burundi has been affected by chronic violence, contributing to poverty (Brachet and Wolpe 2005).

Each of these factors can act at diverse scales (e.g., national, community, household), with interactions between different factors and the different scales at which each factor could act. For example, the lack of individual access to financial products and services can stagnate national economic growth, and result in lower tax revenues as businesses struggle to develop and flourish. A possible consequence of this is limited ability to invest in the public infrastructure needed to overcome challenges of access, strengthen governance, or ensure achievement of the maximum social benefits of natural resources. Nations may rely on loans, with unfavourable repayment terms. It is beyond the scope of this chapter to explore all factors contributing to poverty in detail (see the *Further Reading* at the end of this chapter). Through the remainder of this chapter, we focus on those factors that primarily relate to geoscience and the sectors in which geoscientists operate. Tackling poverty, however, requires dialogue across disciplines, and coherent and integrated solutions, a theme we return to in Sect. 1.5.

### 1.4.2 Geoscience and the Causes of Poverty

Many of the factors contributing to poverty outlined in the previous section have an environmental dimension. Here we discuss

(a) physiography and spatial poverty traps, (b) natural resources, (c) climate and environmental change, and (d) environmental degradation and shocks.

**(a) Physiography and Spatial Poverty Traps**. Many of those in poverty live in '*spatial poverty traps*', specific regions where physical, natural, social, political, and/or human capital are low, with this resulting in isolation, disadvantage, and marginalisation (Bird et al. 2010). In his book '*Prisoners of Geography*', Tim Marshall outlines how the physical geography (or physiographical) context of nations shapes their political choices and decisions (Marshall 2016). For example, mountains, climate, rivers, and seas can all influence how easy it is to trade, the spread of disease, or the security of a population from external threats. Physiography is, therefore, a form of '*spatial poverty trap*', where particular aspects of the physical geography of a region suppress development efforts and make it harder to overcome poverty. Examples include the following:

- *Landlocked nations,* where lack of access to some types of physical capital (e.g., ports) result in isolation and disadvantage (Gallup et al. 1999). Examples of landlocked developing countries include Afghanistan, Burundi, Central African Republic, Malawi, Mali, Mongolia, Nepal, South Sudan, and Uzbekistan. Transporting goods via land is more than seven times as expensive as via the sea (Venables and Limão 2001). These extra costs, and lack of viable trading routes, can hinder economic growth.
- *Remote communities in mountainous regions* (Fig. 1.5), where there is also a lack of infrastructure or connectivity. Steep topography and a dynamic environment hinder accessibility and infrastructure development. **SDG 9** highlights the challenge of engineering in contexts such as Nepal, where mass movements triggered by earthquakes and heavy rain can result in a difficult construction environment. Remote communities will find it harder to trade and access services, and they are further from economic and political hubs.

Landscapes are an expression of the geological history of a region, shaped by the interplay of tectonics and climate (Allen 2008). The convergence of tectonic plates is responsible for mountain building. Some rock types (e.g., quartzite) are more resistant to erosion than softer rocks and therefore form steep, upland topography that can be difficult to transect. Spatial poverty traps cannot solely be explained in terms of geoscience, but this is a contributing and important factor.

**(b) Natural Resources**. Differential access to and benefit from natural resources can drive poverty and hinder social and economic development. For example, on a national scale, countries that lack natural resources may struggle to ensure food security or catalyse economic development. At a local scale, access to natural resources drives progress in education, gender equality, decent employment, and health, all of which can help to break poverty cycles. Where resources are prevalent, but wealth from these is not translated into pro-poor sustainable development outcomes or shared equally, poverty can continue or be exacerbated. Key natural resources that have a role in improving the lives and livelihoods in communities or nations facing poverty include soil, mineral, water, and energy:

- **Soil Resources**. Soils are derived from the chemical and physical weathering of rocks, with the chemical composition of these determined by geological processes. For example, the quartzite ridges of the Kagera region of Tanzania are challenging environments to grow crops on, being poor in nutrient-releasing minerals (FAO 2018). Geoscientists, therefore, have a role to play in supporting governments to understand soil geochemistry and the potential health and agricultural implications. Soil quality is particularly important as those living in poverty are often dependent on agriculture, particularly in a rural livelihood context, but also for their nutrient intake (see **SDGs 2** and **3**). Access to land with good quality soil may be competitive. The growth of large, commercial agro-industrial holdings in Romania is linked to low socio-economic development and reduced rural livelihoods opportunities (Popovici et al. 2018). Governments must decide how to balance the need for land for larger scale commercial activities (potentially providing employment opportunities and economic growth, but associated with monoculture or intensive farming practices, which can reduce soil quality) and preserving land to meet the needs of subsistence or small/medium-sized enterprises and future generations. A lack of natural capital (e.g., poor quality soils) may, therefore, also be a form of spatial poverty trap. Subsistence farmers who only have access to poor quality soils may regularly struggle to have a successful harvest and any surplus to trade. A 10% increase in soil quality can lead to a roughly two-percentage point decrease in poverty rates in rural areas, and in sub-Saharan Africa, a nine-percentage point reduction in poverty rates (Heger et al. 2018).

- **Mineral Resources**. A lack of domestic resources can cause a country to rely on imports of raw materials, including basic industrial minerals for construction or fertilisers. This can drive up the cost of infrastructure and agricultural produce. While the presence of mineral resources (e.g., salt, gold, cobalt) is a potential catalyst for economic development, their absence does not necessarily determine poverty. In Costa Rica, a lack of mineral resource definition during the colonial period and a subsequent and continuing ban on mining has led to the development of renewable energy resources, agriculture, human capital, eco-tourism, and high-technology-manufacturing industries. In terms of GDP and social progress, Costa Rica ranks as a high performing outlier (Social Progress Imperative 2018).
- **Water Resources**. A lack of access to clean water can be linked to poverty in many ways, primarily creating health challenges and hindering agricultural productivity which then has implications for education outcomes and economic productivity. Improved irrigation can unlock agricultural productivity and poverty alleviation through increased labour demands, higher crop yields, market-orientated production, creation of growth multipliers through the stimulation of other economic activities, reduced seasonal variability, and improved nutritional outcomes (Hanjra et al. 2009). Resolving access to water can also unlock opportunities by enhancing household and community relationships, thus stimulating economic growth in impoverished communities (Zolnikov and Blodgett-Salafia 2016). Access to clean water and safe sanitation (**SDG 6**) can help to reduce poverty (**SDG 1**) by improving health (**SDG 3**), access to education (**SDG 4**), and gender equality (**SDG 5**).
- **Energy Resources**. The International Energy Agency (IEA) estimates that approximately 1.3 billion people lack access to electricity and 2.7 billion people lack access to clean cooking facilities (IEA 2018). Dependence on solid-fuel (e.g., charcoal) for cooking can result in negative environmental and health implications (Smith 2006). Dependence on charcoal is linked to deforestation and loss of habitat Chidumayo and Gumbo (2012) and in addition charcoal collection absorbs valuable time from other productive activities such as work or education (Hammond et al. 2007). There are an estimated 4 million deaths annually attributed to air pollution (Bruce et al. 2002). Access to clean and affordable energy (**SDG 7**) is, therefore, essential in reducing poverty by improving health (**SDG 3**) and protecting life on land (**SDG 15**).

The relationship between poverty and resources is not necessarily a causal one or inevitable (Lewin 2011). The approaches used to manage soil, mineral, water, and energy resources can influence outcomes either alleviating or exacerbating poverty. A country that is well endowed with natural resources can be subject to what is commonly termed the '*natural resource curse*' where there is a failure to capture and retain value either locally or nationally. It is a global phenomenon, but not inevitable, with many contrasting case studies (McKinley and

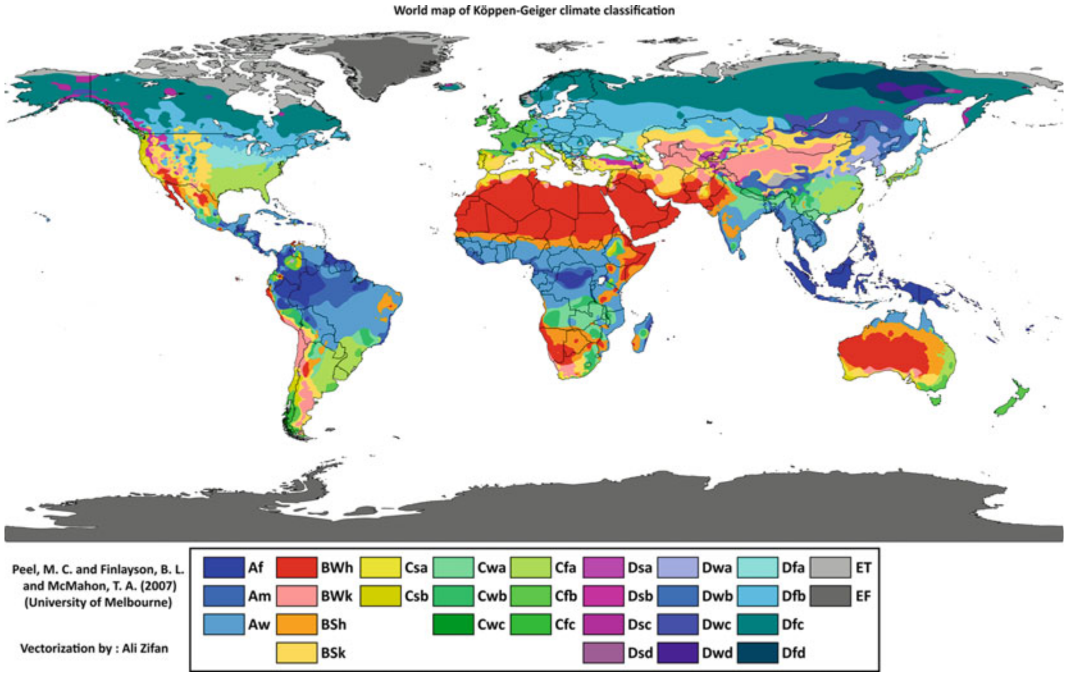


**Fig. 1.6** World Map of Köppen-Geiger Climate Classification, with A-Tropical, B-Arid, C-Temperate, D-Cold, and E-Polar. Created by Peel et al. (2016), and used under a CC BY SA 4.0 International license (https://creativecommons.org/licenses/by-sa/4.0/)

Kyrili 2008). For example, while Chile and Zambia are both copper-dependent countries, McKinley and Kyrili (2008) found that Zambia has been less successful in capturing its resource revenues due to poor fiscal policy, and opaque tax systems, royalties, and ownership. In contrast, Chile's state-owned mining company (CODELCO), effective fiscal policy, and Economic and Social Fund and Pensions Reserve Fund have strengthened their ability to avoid the resource curse. There is not one single factor that determines a country's ability to benefit from its resource potential. Rather, it is a complex combination of factors from economics, historical context, fiscal policy, effective governance and institutions, and commodity price shocks.

The social, environmental, and economic challenges surrounding natural resources are diverse and often context specific. While the impacts of poor access to and unequal benefit from natural resources may be most acutely felt at a local and national scale, the actions needed to address resource governance are a global responsibility.

**(c) Climate and Environmental Change**. Geographic variations in climate can explain differences in crop growth, disease prevalence, and water scarcity and availability (Sachs 2015). Figure 1.6 shows an updated world map of the Köppen-Geiger climate classification (Peel et al. 2007), with tropical, arid, temperate, cold, and polar regions all highlighted. Vector-borne diseases such as malaria and dengue thrive in areas that are typically warm throughout the year (i.e., tropical climates), and therefore some places are more susceptible to the diseases that exacerbate poverty than others. Sub-Saharan African countries bear the heaviest burden of malaria, with 90% of the global cases, and 92% of global malaria deaths occurring there (World Health Organisation 2016). Poverty results in greater exposure to disease, and disease perpetuates this poverty in a reinforcing cycle (Teklehaimanot and Mejia 2008). The costs of malaria fall more heavily on the very poor. In Malawi, for example, the total direct and indirect cost of malaria consumed 32% of the annual household income for very-low-income households, compared with 4.2% of households in low-to-high income categories (Ettling et al. 1994). Climate also affects water availability, influencing precipitation and evaporation. Arid regions (in contrast to temperate regions) need more investment in irrigation and water transport to fulfil domestic and agricultural needs.

Environmental change, for example, due to anthropogenic carbon emissions, may result in new climate patterns and therefore change the spatial viability of disease, crop growth, or water availability. In regions already susceptible, it could exacerbate this. For example, Rangecroft et al. (2013) note the negative effect of climate change on water supplies in the arid mountains of the Bolivian Andes, where poverty means there is limited capacity to adapt. Bolivian glaciers are estimated to have lost 50% of their ice mass over the past 50 years, resulting in concerns regarding the future availability of water resources (Rangecroft et al. 2013).

**(d) Environmental Degradation**. A common, but misguided narrative is that poverty is a major cause of environmental degradation (Durning 1989; Boyce 1994), such as biodiversity loss and reductions in the quality of air, water, and soil. It is asserted that those in poverty degrade resources and the environment in order to ensure their day-to-day survival. This analysis is both simplistic and unjust (Duraiappah 1998; Ravnborg 2003), with degradation largely resulting from the actions of non-poor individuals (Ravnborg 2003), industry and the policies and practices of developed economies. Non-poor actors generally have greater access to land and forest resources, agricultural chemicals, and irrigation (Ravnborg 2003). In contrast, environmental degradation disproportionately affects the poorest in society, exacerbates existing poverty, and increases the proportion of the population living in poverty. Examples include the following:

- Duraiappah (1998) examines select impacts of deforestation (e.g., loss of watershed protection, soil erosion, productivity drop, fuelwood shortage), and notes that each of these will affect low-income groups the most. This is due, in part, to the resultant increase in household expenditure and their lack of resources to meet these needs.
- Broad (1994) describes the onset of commercial logging in the immediate vicinity of agricultural plots of subsistence farmers in the Philippines. This logging changed the availability and quality of water and the vulnerability of soils to erosion, reducing the ability of subsistence farmers to meet their needs.
- Onwuka (2006) highlight environmental challenges associated with hydrocarbon extraction in the Niger Delta (Nigeria). The toxicity of hydrocarbons damages soil fertility, watercourses, and biodiversity in the region, exacerbating poverty due to the elimination of livelihoods (Onwuka 2006; Saliu et al. 2007).

**(e) Natural (Environmental) Hazards.** Disaster risk reduction is embedded into the SDGs. SDG **Target 1.5** highlights the need to build the resilience of those in poverty, helping to reduce the impacts of natural hazards (e.g., earthquakes, tsunamis, landslides, volcanic eruptions, avalanches, floods, droughts, tropical storms, and wildfires) on them. A hazard is a '*process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation*' (UNDRR 2017). Hazards are a key component of the risk equation (Fig. 1.7). The risk posed by a hazard is determined by who or what it affects (the exposure), and how susceptible they are to damage or loss because of the hazard (vulnerability). Poverty and inequality both contribute to disaster risk by increasing the vulnerability. In

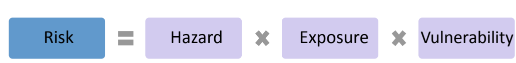


**Fig. 1.7** A common representaton of the risk equation

turn, the occurrence of a hazard will disproportionately affect those in poverty and other marginalised groups. In regions where hazards regularly occur, they can lead to poverty traps and threaten national social and economic development progress. As the economic, social, and physical impacts of hazards can transcend national borders, vulnerable communities in one country can be impacted by a hazard many miles away. For example, the eruption of the Icelandic volcano Eyjafjallajökull in 2010 had a significant economic impact in Kenya, due to the inability of horticulturalists to transport their cut flowers to Europe (Waihenya 2010).

While wealthier nations bear the largest fraction of the total economic burden of disasters, the relative impact on poorer nations is much greater (Table 1.5). By contrasting total losses from 1998 to 2017 (billions US$) with average annual economic losses (billions US$) as a percentage of GDP over the same timeframe, we note the significant variation in the top 10 countries listed. Eight out of the ten highest ranking nations, when considering the average percentage of GDP lost between 1998 and 2017, are lower income countries.

Poorer nations generally have fewer resources to cope with disasters and often rely on international financial assistance to recover. The diversion of time, resources, and personnel towards rebuilding efforts, and the loss of lives and livelihoods slows or hinders economic and human development progress, threatening efforts to alleviate poverty and promote sustainable development. For example, in January 2010, a $M_w = 7$ earthquake struck Haiti, damaging nearly half of all infrastructure in the epicentral region, resulting in 100,000–300,000 fatalities, and displacing more than a million people (DesRoches et al. 2011). The earthquake is estimated to have resulted in direct economic losses of US$8–14 billion (Cavallo et al. 2010). For a country with a 2009 GDP of US$15 billion, the ability to cope with such losses without international financial assistance is severely limited. Contrast this with the most expensive earthquake in the United States, the 1994 $M_w = 6.7$ Northridge earthquake, which costed up to US$40 billion (Petak and Elahi 2000), with GDP in the United States being approximately US$10.4 trillion at the time. So the Northridge earthquake, although much costlier, had minimal impact on the overall US economy. In Haiti, even with international financial assistance, the impact on the economy was significant. The 2010 earthquake pushed the country into a recession similar in magnitude to the 2004 coup d'état.

**Table 1.5** Absolute losses versus average annual losses due to natural hazards (1998–2017)[a]

| Total losses | | | Average annual loss relative to GDP | | |
|---|---|---|---|---|---|
| Country | Loss (billions US$) | OECD classification (2018) | Country | Percentage (%) | OECD classification (2018) |
| USA | 944.8 | High Income | Haiti | 17.5 | Least Developed |
| China | 492.2 | Upper Middle Income | Puerto Rico | 12.2 | High Income |
| Japan | 376.3 | High Income | Korea D. P. R. | 7.4 | Other Low-Income Countries |
| India | 79.5 | Lower Middle Income | Honduras | 7.0 | Lower Middle Income |
| Puerto Rico | 71.7 | High Income | Cuba | 4.6 | Upper Middle Income |
| Germany | 57.9 | High income | El Salvador | 4.2 | Lower Middle Income |
| Italy | 56.6 | High Income | Nicaragua | 3.6 | Lower Middle Income |
| Thailand | 52.4 | Upper Middle Income | Georgia | 3.5 | Lower Middle Income |
| France | 43.3 | High Income | Mongolia | 2.8 | Lower Middle Income |

[a] losses adjusted to 2017 US$. Adapted from Wallemacq and House (2018)

## 1.5 Geoscience Education, Research, and Innovation to Reduce Poverty

Understanding the *causes* of poverty can help inform the interventions required to reduce and eliminate existing poverty, and prevent future generations from suffering this injustice. Interventions may require research, policy development and implementation, and innovation. Many interventions go beyond the scope of the geoscience community, but there are important ways that geoscientists can contribute to ending poverty and meeting the targets of **SDG 1** (Table 1.1). The actions required to end poverty are inextricably linked to the actions required to make progress on other SDGs, such as water and sanitation (see **SDG 6**), reducing inequality (see **SDG 10**), and tackling climate change (see **SDG 13**).

### 1.5.1 Improving Access to Basic Services, Natural Resources, and Appropriate Technologies

**Target 1.4** highlights the need to address differential access to basic services, natural resources and appropriate technologies, recognising their potential to be a catalyst for social and economic development. These three themes are interlinked (e.g., education needs access to energy in evenings to do homework, requiring raw materials to make solar panels). Access to basic services is a necessary step towards true poverty alleviation; ensuring communities are not limited from reaching their full potential. Examples include education (**SDG 4**), health care (**SDG 3**), social welfare, transport infrastructure (**SDG 9**), affordable energy access (**SDG 7**), potable water and improved sanitation (**SDG 6**), and waste management (**SDG 12**). Many of these services are underpinned by access to natural resources (e.g., food, water, energy, minerals, and bio-resources). Given good governance, an ability to access natural resources, and the capture and retention of their full value, there is significant potential for communities or nations to use these to tackle poverty (e.g., through Sovereign Wealth Funds). Appropriate technologies, such as mobile phones, can help to improve access to basic services and management of natural resources. For example, d.light[1] and M-Kopa[2] increase access to solar energy.

Ensuring universal access to these services, resources and technologies are dependent on (i) understanding where resources can be found, (ii) accessing and making use of these resources, and (iii) sustainable management of these resources, understanding and mitigating any negative impacts on lives, livelihoods, and the natural environment (see **SDG 12**). One example is the East Africa Geothermal Energy Facility (EAGER[3]), which was established in 2015 to support governments to address barriers to the advancement of geothermal energy, recognising that this is a frontier market for traditional geothermal energy investors or private investment. It is estimated that geothermal energy could unlock the potential for 10 GW of baseload power across East Africa, a clean energy source for millions (EAGER 2019). In order to develop this sector, however, it must be de-risked, economically viable, and competitive compared to other energy sources (EAGER 2019). Part of EAGER's role is to provide a knowledge hub covering topics such as international best practice business models, exploration of geothermal reserves, and regulatory mandates.

Improving responsible production and consumption of natural resources (**SDG 12**) can contribute to poverty reduction, and ensure continued access to, and availability of, resources to meet the needs of future generations (Fig. 1.8). Is it possible however to promote social and economic development while remaining within the biophysical limits of the planet? As noted by Hickel (2018) and O'Neill et al. (2018), it is typical to observe countries in the Global South living within biophysical boundaries but failing to deliver on social indicators, meanwhile more developed countries typically exhibit

[1] www.dlight.com/about/.

[2] www.m-kopa.com/.

[3] https://adamsmithinternational.com/projects/enabling-investment-in-geothermal-power-in-east-africa-2/.

**Fig. 1.8** Agriculture in Tanzania. Understanding the underlying geology and the geochemistry of the soil can inform measures to strengthen food security (SDG 2). Geoscience also informs water management for irrigation, ecosystem protection, drinking water, and other domestic services. Image by skeeze from Pixabay

unsustainable levels of consumption while delivering on social indicators. Redistributing resource consumption can provide flexibility for emerging economies to benefit from their natural resources and stimulate the economic growth required to address social indicators, such as access to affordable energy. Certification schemes are one approach that could help catalyse responsible production, but have the potential to exclude marginalised producers unable to participate in these schemes. While recognising limitations to such approaches, there is an opportunity for geoscientists, working alongside other disciplines, to inform schemes encouraging responsible consumption and production.

### 1.5.2 Effective and Equitable Disaster Risk Reduction

Historically, international efforts to combat disasters have focused on financing disaster response and post-disaster recovery. However, in recent years the emphasis has changed to disaster preparedness and reduction (see Smith and Petley (2009) for a helpful review of different disaster paradigms). Recognising the complex reasons why disasters occur, the Sendai Framework for Disaster Risk Reduction (Box 1.2) is an internationally agreed framework aiming to reduce losses from natural hazards. Agreed at the 3rd UN World Conference on Disaster Risk Reduction in March 2015, it builds on and extends the scope of the Hyogo Framework for Action (2005–2015) to 2030. The Sendai Framework has 4 priorities for action, 7 strategic targets, and 38 indicators for measuring progress on reducing disaster losses (Box 1.2). These indicators align the implementation of the Sendai Framework with the SDGs and the Paris Agreement on climate change. The pursuit of targets in one framework can support the delivery of another.

Geoscientists, with their knowledge of the processes underpinning natural hazards and their

**Fig. 1.9** Multi-Hazard Risk in Guatemala City, Guatemala. Multiple natural hazards (e.g., earthquakes, volcanic eruptions, landslides, tropical storms, flooding) affect many of Guatemala's most vulnerable communities. Improved data and research, community engagement, and cooperation across sectors, disciplines and regions can all help to reduce disaster risk. *Credit* Joel C. Gill

impacts on society, have a critical role to play in implementing and monitoring these frameworks (Gill and Bullough 2017). Specifically:

- **Research.** Geoscientists are engaged in research underpinning policies and practice to reduce disaster risk and improve disaster management. Research can include individual PhD projects and large-scale, complex programmes with international consortia. Research can also be within one discipline to increase our understanding of a specific hazard process or landscape evolution, or cross-disciplinary research that integrates advances in the natural and social sciences to understand drivers of risk or the impact of hazards on people (Fig. 1.9). An emerging priority and research focus is understanding the impacts and complex disaster scenarios that can result from relationships between multiple hazards in a given region (e.g., Kappes et al. 2012; Gill and Malamud 2014; Duncan et al. 2016; AghaKouchak et al. 2018).
- **Global Networks and Cooperation**. Challenges remain in translating new research developments in our understanding of hazards to tools that inform our understanding of potential risk. Cross-disciplinary and international collaborations can aid this innovation. Furthermore, global networks that bring together the international earthquake or volcanic hazard community to support Sendai Framework principles of building effective, meaningful, and strong partnerships. The Global Earthquake Model (GEM[4]), for example, is an organisation of geoscientists

[4]https://www.globalquakemodel.org/.

and engineers translating scientific knowledge of active tectonics into an understanding of potential seismic hazards. In 2018, GEM released the first global seismic risk map, which combines seismic hazard with exposure and vulnerability data. Most regional hazard and risk models made by GEM are created in collaboration with local scientists and practitioners who generally have a better understanding of the local distribution of active faults and their relative hazard. Unlike many commercial hazard and risk calculators, the system is open source, which enables better training and in-country capacity building for the long-term sustainability of the maps. Other international, multidisciplinary endeavours are underway to assess and monitor global landslide and volcanic hazards (the Global Landslide Model[5] and the Global Volcano Model[6]).

- **Capacity Strengthening and Community Engagement**. Geoscientists can strengthen capacity and improve community resilience. Through collaboration and cooperation across sectors, local geohazard problems can be addressed and targeted solutions provided. For example, the Great ShakeOut[7] earthquake drill originally started as a means to engage with local schools and businesses on the earthquake hazard posed by the San Andreas Fault in California. However, since its inception, the event has expanded globally and many local ShakeOut drills are conducted around the world to inform, educate, and prepare people for potential future seismic events in their region. In 2018, over 63 million participants took part in ShakeOut drills worldwide, including in many low and lower-middle income countries, including Afghanistan, Iran, the Philippines, and Pakistan.
- **Data.** The explosion of readily available satellite data in near-real time now means that geoscientists can assess rapidly the degree and extent of damage in a disaster. In 2000, the major global space agencies signed up to the *International Charter: Space and Major Disasters*[8], a non-binding agreement that ensures satellite data is freely provided in the event of a disaster or humanitarian emergency. As of December 2018, there have been 593 activations of the Charter for emergencies including earthquake-triggered landslides in Nepal, the Ebola outbreak in West Africa, oil spills in the South China Sea, and wildfires in California.

**Box 1.2 Sendai Framework for Disaster Risk Reduction and Paris Agreement on Climate Change The seven *global targets* of the Sendai Framework are:**

(a) Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality rate in the decade 2020-2030 compared to the period 2005–2015.

(b) Substantially reduce the number of affected people globally by 2030, aiming to lower average global figure per 100,000 in the decade 2020-2030 compared to the period 2005-2015.

(c) Reduce direct disaster economic loss in relation to GDP by 2030.

(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030.

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030.

(g) Substantially increase the availability of and access to multi-hazard early

[5] https://pmm.nasa.gov/applications/global-landslide-model.

[6] https://globalvolcanomodel.org/.

[7] https://www.shakeout.org/.

[8] https://disasterscharter.org/.

warning systems and disaster risk information and assessments to the people by 2030.

**In order to meet these targets, the Sendai Framework has four *Priorities for Action***:

Priority 1: Understanding disaster risk

Priority 2: Strengthening disaster risk governance to manage disaster risk

Priority 3: Investing in disaster risk reduction for resilience

Priority 4: Enhancing disaster preparedness for effective response and to "Build Back better" in recovery, rehabilitation and reconstruction

Read more: https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030

**Paris Climate Change Agreement**

The Paris Agreement, also adopted in 2015, aims to limit global average temperature increases to well below 2 °C, while pursuing efforts to limit any increase to 1.5 °C. It also hopes to peak global emissions as soon as possible, provide adequate financing for low-income nations to build a climate-resilient future, develop adaptation strategies for a warming world, and mitigate and minimise losses from the adverse effects of climate change including extreme weather events (e.g., floods, storms) and slow onset events (e.g., droughts).

Read more: https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement.

### 1.5.3 Ensuring the Availability of Geoscience for Policy, and Improve Its Uptake

A primary means of implementation of SDG 1 is the creation of '*sound policy frameworks at national, regional and international levels*' that incorporate '*pro-poor and gender-sensitive development strategies to support accelerated investment in poverty eradication actions'* (**Target 1.B**). Policy frameworks helping to alleviate poverty could be focused on access to resources or training, or reducing exposure and vulnerability to environmental or economic shocks. These all benefit from a science input, as set out in this chapter.

The Institute of Government (2011) identified seven key characteristics of 'sound' policy: (i) clear goals that are adequately defined, (ii) informed by high-quality and up-to-date evidence, including the evaluation of previous policies, (iii) rigorously tested and determined to be realistic and resilient to adaptation, (iv) external engagement with those affected by the policy, (v) robust assessment of the options, their cost-effectiveness and risks, (vi) roles and accountabilities, and (vii) a realistic plan for obtaining timely feedback. The integration of these characteristics into policy development will help to ensure they are robust and have the intended impact.

In addition, it is essential that different policies are *integrated* and *coherent*. For example, a water policy should not conflict with a minerals governance policy, and these should work together to reinforce (not undermine) the national poverty reduction policy. Underlying many environmental challenges is a segmented policy and regulatory framework, with cross-sectoral policies and institutional partnerships required for effectiveness (UNEP 2015; Getenet and Tefera 2017). Coherent integrated environmental policies are needed to maximise impact and ensure we tackle key causes of poverty, such as environmental degradation.

**Box 1.3 Government Policy versus Legislation (details may differ by country)**

**Government Policy**. This is a statement or document outlining the vision and intended actions of a government on a specific theme (e.g., terrorism, education, environmental protection), and how its actions will benefit society. It is not legally binding, with flexibility to evolve in response to additional evidence or changing needs.

In addition to policy being developed by government and the civil service (at the request of government), other stakeholders may also design, propose, and advocate for a particular policy. For example, opposition parties, civil society groups, think tanks, academics, and private sector lobbyists may all try to inform policy (e.g., present evidence that shapes the drafting of government policy) or encourage the uptake of their own policy recommendations (e.g., encourage an elected representative to adopt that policy position as their own, and advocate for it within the national legislature).

**Government Legislation**. This is enforceable law, approved by a national legislature (e.g., parliament). The necessary legislation to implement a policy is set out in draft form, typically known as a 'bill'. The merits of this bill are scrutinised and debated by the legislature, often with amendments made to increase its quality and reduce any unintended negative consequences. The bill is then voted on, and if approved it goes through a country-specific process to be added to national legislation, becoming a law. *Regulations* may then be required to ensure this law is adhered to, and enforced.

**Example** A national government may develop a *policy* to reduce the number of people killed during earthquakes, focusing on improvements to building codes and urban planning. Professional bodies representing geotechnical specialists, geologists, urban planners, and the construction industry may submit evidence to help inform this *policy*. Civil servants then prepare draft legislation, in the form of a *Government Bill* (e.g., the Reduction in Earthquake Impacts Bill), which sets out new building codes and punishments for those failing to adhere to these codes. This *Bill* is scrutinised and debated by the national legislature. The opposition party introduces an amendment to the *Bill* that says a chartered engineer must also approve designs for new buildings. The national legislature vote on this amendment, and then the *Bill* as a whole. Both votes pass by a substantial majority, and they are then added to the national legislation, becoming enforceable *law*. The national government states that the *regulation* of this *law* is the responsibility of city/municipal governments. They then have the flexibility to develop and implement their own *regulation* procedures to inspect building projects and ensure that they abide by the new *law*.

One of the most significant roles that geoscientists can have in reducing poverty is ensuring the availability of geoscience information to inform policy development. Geoscientists must first increase their understanding of the policymaking process, and national and international priorities in poverty reduction strategies. This can help to guide research questions, as well as increase understanding of how scientists can communicate their science to policymakers. The public may have access to some meetings in national parliaments. In the UK, attending Select Committee meetings provides an opportunity to observe parliamentarians take evidence from expert witnesses (including scientists). Understanding the role of geoscience in delivering the SDGs, as set out in this book, helps us to preposition ourselves to advocate for geoscience-informed policies to tackle poverty and other sustainable development challenges.

Engaging with the policymaking process can take different forms but is likely to involve communicating in forms beyond the scientific paper (e.g., blogs, policy briefs, videos), and with disciplines outside of our area of study. In some contexts, opportunities exist for fellowships and exchanges with parliamentarians and civil servants, helping to bridge the gap between science and policy. For example, the Royal Society Pairing Scheme brings together research scientists with UK parliamentarians and civil servants. Governments or cross-party parliamentary committees may have public consultations, with the opportunity to submit evidence to inform these. Professional societies are well placed to collect the views of the geoscience community and submit a coordinated response that presents the social value of geoscience on a given topic. A further approach could be to develop enhanced research partnerships with those working in government agencies. This helps to embed the outputs of new geoscience research and innovations into government agencies.

Sound policy frameworks also require strong national scientific institutions and research communities to help inform policy development (see **SDG 16**). Improved scientific capacity in policymaking institutions (e.g., government departments, national and local legislatures) can also enrich the policymaking process. Legislators (e.g., parliamentarians) scrutinise and make decisions on diverse and complex themes, including those directly and indirectly relating to geoscience. Examples include the exploration and extraction of unconventional hydrocarbon resources, the expansion of electric vehicles, and the development of network infrastructure through environmentally sensitive regions. The ability of legislators to make wise decisions and/or hold governments to account will depend on their ability to access and interpret scientific information. This information is typically provided to legislators by their research and support staff. In contexts where required information is highly specialised or of a technical nature, it may be necessary to draw on expertise from specialist staff with scientific backgrounds.

For example, the UK Parliamentary Office of Science and Technology (POST[9]) provides independent, balanced, and accessible advice to UK parliamentarians and analysis of public policy issues related to science and technology. This includes the publication of POSTnotes[10], short summaries of public policy issues based on reviews of the research literature and expert interviews, often co-authored by scientists doing policy fellowships. Relevant examples include science diplomacy (POSTnote 568), environmental Earth observation (POSTnote 566), greenhouse gas removal (549), the water–energy–food nexus (POSTnote 543), access to water and sanitation (POSTnote 521), and deep-sea mining (POSTnote 508). From 2008 to 2012, POST ran a programme to improve parliamentary scrutiny of scientific and technological issues in Uganda. This focused on training parliamentary staff and improving links between parliamentarians and scientists in Uganda.

### 1.5.4 Capacity Strengthening and Respectful Partnerships

Underpinning all of the interventions in Sects. 1.5.1–1.5.3 is the need to mobilise resources through enhanced development cooperation. This can help to strengthen the capacity of key institutions to implement programmes and policies to end poverty in all its dimensions as indicated in **Target 1.A**. Many national agencies that are involved in supporting economic growth, enhancing human welfare, and strengthening resilience, draw upon the expertise of geoscientists (e.g., geological surveys, water resources, minerals agencies, and civil protection agencies). Development cooperation can take many forms (e.g., public–private partnerships, long-term academic collaborations), but should be characterised by effective and respectful partnerships formed to help achieve priorities identified by Global South stakeholders. See **SDG 17** for a full discussion of this theme.

[9] https://www.parliament.uk/mps-lords-and-offices/offices/bicameral/post/.

[10] https://www.parliament.uk/postnotes.

## 1.6 Key Learning Concepts

- Poverty is a lack of resources (economic, social natural, political, and cultural) to meet everyday needs. Poverty is, therefore, complex and multifaceted. Poverty hinders individuals and communities from reaching their full potential, reduces life expectancy, and increases vulnerability to epidemics, economic depression, environmental change, and natural hazards. There are different ways to measure and define poverty. Many focus on access to economic resources, with others integrating multiple dimensions of poverty.
- Factors contributing to poverty can be either environmental or social. Landlocked countries and remote communities may have limited access to markets. Communities in regions with poor soils, limited water, or unfavourable climate extremes may be more susceptible to food insecurity or diseases. Those living in regions affected by multiple natural hazards may lose development gains due to repeat disasters. Poverty traps and cycles exist, with poverty transmitted through multiple generations until there is an adequate intervention.
- Geoscientists have a unique opportunity and responsibility to contribute to poverty alleviation and have a vital role to play across government, policy, private sector, and NGOs in a range of disciplines from natural resources, hazards, governance. Geoscientists can help improve access to natural resources, while also promoting responsible consumption and production to minimise environmental degradation. Poverty and inequality contribute to disaster risk, and disasters disproportionately affect the poor. Geoscientists working on all aspects of geological hazards and risk reduction can support efforts to reduce poverty.
- Engagement with other disciplines and understanding of context is critical to inform interventions. Geoscientists should increase access to their knowledge and skills, through supporting coherent and comprehensive policies. Partnerships across sectors, disciplines, and regions can help to improve knowledge exchange and technology transfer.

## 1.7 Educational Ideas

*In this section, we provide examples of educational activities that connect geoscience, the material discussed in this chapter, and scenarios that may arise when applying geoscience (e.g., in policy, government, private sector international organisations, NGOs). Consider using these as the basis for presentations, group discussions, essays, or to encourage further reading.*

- Identify and contrast a physiographical map of eastern Africa with a map of current poverty levels. Identify and discuss geographical and geological features that may influence the extent of poverty.
- Consider the impact of the arrival of a mineral exploration company on a local community in Zambia. Divide into four stakeholder groups including *host government*, *the company*, *the community,* and *migrant artisanal gold miners* working in the region. Debate the potential positive or negative outcomes of the exploration company's presence in the community. Consider themes such as the natural resource curse, infrastructure, knowledge and technology transfer, access to resources, and local procurement. How can geoscientists advocate for positive outcomes?
- Consider you are a senior civil servant in the national government, tasked with reducing all forms of poverty. What steps could help to *increase access to science in Government decision-making*, and how may this influence your strategy for poverty reduction?
- Imagine you are a poor farmer, and your cattle are your primary assets. You live on the slopes of a volcano. What might influence your decision-making process about how to respond to warnings of volcanic unrest, and

requests to evacuate? What measures could support you to protect your life, assets, and livelihood?

## Further Reading and Resources

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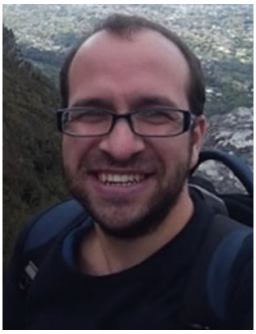

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