Environmental Issues in Ethiopia and Links to the Ethiopian Economy

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Report Summary

Ethiopia has a high-level strategy to pursue agriculture-based industrialisation with a goal of achieving middle income country status by 2025 with no net increase in carbon emissions. As an economy currently heavily dependent on agriculture and forest resources, and with a historical legacy of widespread, severe environmental degradation, environmental issues are a significant obstacle to the successful achievement of this goal. The historical and ongoing destruction and degradation of the soil and forest resources on which this development strategy depends represents a major policy and practical challenge. With the exception of climate change, the major environmental issues affecting Ethiopia are soil erosion and land degradation, deforestation and forest degradation, water scarcity, biodiversity loss, and various types of pollution. Whilst environmental issues are often considered separately, they are closely interlinked and studies increasingly attempt to consider them in an integrated manner, challenging as this is for researchers. Analysis of the research literature demonstrates unequivocally that environmental degradation is widespread and severe in Ethiopia. In particular, the impacts of agriculture and deforestation – especially on soils – have been severe and increase the vulnerability of many people to food and water insecurity. A range of other environmental issues also present significant –and in many cases increasing – challenges for policy and management. These issues, their links to the Ethiopian economy, and their implications for economic growth, are the subject of this rapid, desk-based study.

To date, studies of environmental degradation in Ethiopia have tended to focus on the serious impacts of agriculture, especially on soils, which have been severe and which increase the vulnerability of many people to food and water insecurity. Soil erosion and land degradation have been particularly severe in the Ethiopian highlands due to the combined effects of population growth, intensive agricultural and pastoral use, the cultivation of marginal land, commercial timber-getting, high natural vulnerability to soil erosion, and inadequate soil conservation practices. Deforestation and forest degradation are another prominent environmental issue in Ethiopia, with most of the country's forests already lost and the remaining areas of cloud forest being depleted at a rapid pace, despite their importance for livelihoods, agroforestry, ecosystem services and ecological resilience. Attempts have been made to address the issue of water scarcity in Ethiopia, including through the construction of micro-dams, although those in turn may increase the prevalence of disease. Larger dams can cause eutrophication of reservoirs, soil erosion and earthquakes, in addition to changing patterns of disease. Water and energy are closely linked issues in Ethiopia, given the strategy to significantly increase hydroelectric power generation. The Grand Ethiopian Renaissance Dam is projected to bring substantial economic and social benefits to the Blue Nile Basin region but this will likely come with significant environmental impacts (altering local and even regional hydrology, ecology and patterns of sedimentation and siltation). The Gibe III dam will likely have similar effects for the Omo River. Biodiversity loss is occurring at an unprecedented rate in Ethiopia, primarily through habitat degradation and destruction, disease and over-exploitation of animal and plant populations, with disproportionate impacts on poor people and with implications for livelihoods, sustainable development and green growth. A range of pollution issues – affecting air, water and land – occurs in Ethiopia, with particular concerns expressed about urban and indoor air quality due to high reliance on biomass stoves for cooking, and also about industrial pollution.

These environmental issues are closely interlinked, and are also closely linked to the Ethiopian economy in a variety of ways. In broad terms, Ethiopia's natural resources and ecosystem services are important resources for economic growth and development, yet

environmental issues – if severe – also have the potential to preclude or reverse that growth and development. Ethiopia's planned rapid growth and development transition, however, is likely to be achieved at the cost of considerable environmental degradation unless effective environmental management measures are integrated into development planning.

The *transport sector* is an under-researched area, but an effective transportation network and competitive transport services are important if Ethiopia's development trajectory is to be achieved. However, an expanding transport sector is likely to impose significant environmental costs (primarily through greenhouse gas emissions and local air pollutants) in the absence of effective environmental controls, and transport development in Ethiopia needs to be integrated within an overall strategy for sustainable development and green growth.

Industry in Ethiopia comprises both heavy and light industries; these can contribute substantially to economic growth but can also inflict potentially severe environmental impacts (primarily through greenhouse gas emissions and local air, water and land contaminants). Industrial pollution can have potentially serious implications for health and for economic growth – especially through its effects on the health of workers, women and children. Preventing those impacts requires effective environmental monitoring and management, linked with agreed environmental standards and performance indicators.

Urban housing and construction is likely to remain a sector in which strong growth occurs in Ethiopia, driven by strong demand for housing and other infrastructure in urban areas as Ethiopia pursues its rapid development trajectory. Currently, housing construction has a substantial environmental impact due to timber demand, especially in peri-urban and resettlement areas.

In relation to *water and energy*, Ethiopia's programmes and plans to increase electricity production through dam construction are projected to increase energy and agricultural production, promote economic development and facilitate flood control. However, those benefits are likely to come at the cost of considerable environmental, ecological and socio-economic changes unless effective planning, research and monitoring are undertaken.

Ethiopian *forests* are already severely degraded, but the remaining areas of forest can make a strong contribution to economic growth by creating income and boosting GDP through biodiversity conservation and trade as well as through the maintenance of ecosystem services. However, there may also be some livelihood impacts where some human activities are displaced from protected areas. Maintaining intact forest cover is important for water resource management, and there is likely to be a benefit to orienting policies to farm level conditions.

Agriculture remains central to the Ethiopian economy and is critical to the success of Ethiopia's agricultural-development-led industrialisation strategy. Yet agriculture is dependent on soil and land quality, which are highly degraded. Land degradation has the potential to preclude or reverse the gains made – or projected to be made – through agriculture-based industrialisation, and environmental vulnerability remains high in this respect. Soil erosion and land degradation – along with other related environmental issues – need to be considered throughout the planning and implementation of agricultural intensification programmes in Ethiopia.

SECTION 1

Introduction

1.1 Introduction

Ethiopia has a high-level strategy to pursue agriculture-based industrialisation to achieve middle income country status by 2025 with no net increase in carbon emissions. As an economy currently heavily dependent on agriculture and forest resources, and with a historical legacy of widespread, severe environmental degradation, environmental issues are a significant consideration for the successful achievement of this high-level goal. Moreover, the historical – and ongoing – destruction and degradation of the soil and forest resources on which this development strategy depends represents a major policy and practical challenge. With the exception of climate change, the major environmental issues affecting Ethiopia are soil erosion and land degradation, deforestation and forest degradation, water scarcity, biodiversity loss, and various types of pollution. Whilst environmental issues are often considered separately, in reality they are closely interlinked and studies increasingly attempt to consider them together, challenging as this is for researchers. Analysis of the research literature demonstrates unequivocally that environmental degradation is widespread and severe in Ethiopia. In particular, the impacts of agriculture and deforestation – especially on soils – have been severe and increase the vulnerability of many people to food and water insecurity. A range of other environmental issues also present significant – and in many cases increasing – challenges for policy and management. These issues, their links to the Ethiopian economy, and their implications for economic growth, form the subject of this study.

1.2 Aims of the study

This report presents the results of a rapid desk-based study to review evidence and to identify apparent gaps in evidence on the main environmental issues in Ethiopia and their links to the Ethiopian economy. It aims to identify their importance for, and links to, the Ethiopian economy – especially for sustainable growth, and particularly in key sectors which have been identified as being important for structural transformation in the country, such as agriculture and light manufacturing industry. This study highlighted the implications of these environmental and resource issues for six key ministries: transport, industry, urban housing/construction, water and energy, forestry and agriculture. The study has:

(a) identified the key environmental issues in Ethiopia and their main causes;

(b) examined the importance of environmental factors and natural resources for the Ethiopian economy (especially for sustainable growth in key sectors for structural transformation, such as agriculture and light manufacturing); and

(c) highlighted the main implications of environmental and natural resource issues for six key Ethiopian ministries (transport, industry, urban housing/construction, water and energy, forestry and agriculture).

The evidence reviewed was primarily from the last five years, with a focus on peer-reviewed material and supported with grey literature as appropriate. A qualitative review and assessment of evidence (and identification of the main evidence gaps) was undertaken.

1.3 Outline of the report

This report first provides a brief methodology (Section 2). It then outlines the major current environmental issues in Ethiopia (Section 3), covering land-use change (including forest and soil degradation), agricultural impacts, the impacts of local and regional pollution (air, water and land contamination), urban environmental impacts, the impacts of industrial activities, the effects of transport and infrastructure development, waste disposal/management, and the effects of natural resource degradation and depletion. Next, the report examines the links between those environmental issues and the Ethiopian economy (Section 4), including consideration of the natural resource base and implications for economic growth, especially for sustainable growth in the key sectors/ministries mentioned above. The most important implications for development policy and management, as well as the main areas in which further research is required, are then drawn together in the Conclusion (Section 5). An annotated bibliography and case studies are included (Section 6) and a full reference list is provided (Section 7).

1.4 Scope of the study

Climate-related issues are beyond the scope of this report, which focuses instead on non-climate environmental issues including soil erosion and land degradation, deforestation and forest degradation, water scarcity, biodiversity loss and various types of pollution.

SECTION 2

Methodology

I conducted a rapid desk-based review and qualitative assessment of relevant literature published during the last five years on the subject of environmental change and environmental degradation in Ethiopia, and on links to the Ethiopian economy. I searched academic databases – including the Athens, Academic Search Premier, EBSCOhost, Economic and Social Data Service (ESDS), IngentaConnect and International Bibliography of the Social Sciences (IBSS) databases – to identify relevant peer-reviewed publications. I supplemented these sources with further resources obtained through personal archives of references and relevant grey literature sources. I reviewed, analysed and assessed these sources qualitatively to identify evidence of the current main environmental issues in Ethiopia; to outline their main causes; and to examine their links for the Ethiopian economy. I searched specifically for material relating to the key sectors of agriculture and light manufacturing industry, and for the six ministries identified above. I also identified areas of the literature where evidence appears to be lacking and where further research could be undertaken. Some relevant case-study material was identified and reviewed, and an annotated bibliography and a full list of references were compiled as the study progressed.

SECTION 3

Environmental issues in Ethiopia

This section presents a brief overview of the main current environmental issues in Ethiopia. Whilst climate change is a major global environmental issue with profound implications for the Ethiopian environment and economy, it is beyond the scope of this study and so is not covered here. The remaining major environmental issues affecting Ethiopia include soil erosion and land degradation (encompassing impacts on forests, agricultural and pastoral land), deforestation and forest degradation, water scarcity, biodiversity loss and various types of pollution issue. Environmental degradation is widespread in Ethiopia, although it is unevenly distributed and takes different forms in different parts of the country.[1] To date, studies of environmental degradation in Ethiopia have tended to focus on the serious impacts of agriculture, especially on soils, and of deforestation. This emphasis is unsurprising given the enormous economic and social importance of the agricultural and pastoral sectors for the country, and the close links between deforestation and soil erosion. Moreover, given the concentration of agricultural and pastoral activities in the Ethiopian highlands, those areas have inevitably been the main focus of concern about environmental degradation in the country. As Birhanu has acknowledged, the success of environmental management in Ethiopia is closely related both to ecological conservation in the Ethiopian highlands and to the sustainable development of Ethiopia's agricultural sector and of its economy more generally.[2] More recently, however, other environmental issues – and other parts of the country – have come to greater prominence in the research literature, including urban areas. Environmental degradation may be exacerbated by population growth in areas where resources are already scarce, which can lead to further division of resources, over-use of divided land and/or inappropriate use of environments that are unable to meet the demands placed on them.

3.1 Soil erosion and land degradation

Land degradation may be defined as the loss of productive and ecosystem services provided by land resources. It is defined by the United Nations Convention to Combat Desertification (UNCCD) as the reduction or loss of the biological or economic productivity and complexity of pastoral, agricultural and wooded land due to soil erosion, soil impoverishment (such as nutrient depletion) and/or the loss of natural vegetation. Much of the world's land surface area is degraded, particularly in sub-Saharan Africa where it is critical to the livelihoods of poor farmers.[3] Soil erosion and land degradation in Ethiopia – and their connections with agriculture – are a prominent environmental concern, as this is one of the most important causes of low and declining agricultural productivity, ongoing food insecurity and rural poverty in the country.[4] Around 85 per cent of Ethiopia's population rely heavily on subsistence agriculture for their livelihoods, and their activities contribute to the increasing degradation and vulnerability of soil resources.[5]

1 Birhanu (2014)
2 Birhanu (2014, p. 24)
3 Nkonya et al. (2008, p. vi)
4 Gashaw et al. (2014, p. 98); MoARD (2010)
5 Gebreyesus and Kirubel (2009)

Soil erosion occurs naturally due to processes of erosion by water and wind in the landscape, but it is increased by several orders of magnitude above background rates by human actions. Land-use change – especially the removal of forest cover (see Section 3.2) and riparian vegetation – exposes the underlying soil, which may then be rapidly removed by heavy rainfall, overland flow during flooding, or by the action of the wind. This runoff of topsoil has knock-on effects downstream as it leads to the siltation of watercourses and to ecological change in watercourses and wetland ecosystems. The use of intensive farming practices on cleared land, with inadequate soil conservation measures, also results in accelerated soil erosion. Moreover, once the topsoil has been lost to erosion, the remaining soil has a diminished capacity to store water, with the effect that subsequent rainfall runs off the land more rapidly, causing further erosion and potentially leading to more frequent and more severe flooding events. The removal of topsoil by accelerated erosion also alters the characteristics and structure of the remaining soil, leading to leaching of chemical species downwards through the soil profile and in some cases leaving impoverished, infertile soils that may also be more prone to waterlogging. A further issue is that cleared land is more prone to soil-water evaporation and upward transport of salts through the soil profile, leading to salinisation and the formation of infertile, blighted land. Soil biodiversity is reduced as a result of all of these processes, and the capacity for the remaining soil both to support vegetation cover and to regenerate declines.

Particular concern about environmental degradation in Ethiopia to date has therefore focused on the impacts of soil erosion due to agriculture – especially in the northern Ethiopian highlands, which were historically a naturally productive environment, but which have been heavily used for agriculture and are now heavily degraded.[6] Since around half of Ethiopia's land area is mountainous and/or steeply-sloping, environmental issues typical of those occurring in highlands are a prominent feature of the Ethiopian context. In the northern Ethiopian highlands, unsustainable patterns of land use in a vulnerable, semi-arid, mountainous environment that receives intensive rainfall have resulted in severe land degradation since around 1965.[7] That land degradation has included the physical loss of soil due to erosion by water and wind (as evidenced by gully formation), as well as by the loss of soil fertility due to loss of soil nutrients (for instance, through runoff) and as soil structures and characteristics change (for instance, through leaching). Around 90 per cent of Ethiopia's arable land is found in the Ethiopian highlands – and around 90 per cent of the Ethiopian population and around 60 per cent of its livestock live in those areas – making them an important focus both for development and for environmental management. Whilst such upland areas are naturally prone to relatively high rates of denudation due to their steep slopes and high rainfall rates, this natural vulnerability has been dramatically exacerbated by recent changes in land-use (especially deforestation to clear land for agriculture) and by more intensive livestock grazing and cultivation, including the cultivation of marginal, sloping land (which is inherently more prone to erosion). An increasing human population in the Ethiopian highlands, additional forest degradation due to firewood collection and commercial harvesting, and a relative lack of effective soil conservation practices in agriculture are other factors that have combined to exacerbate the problem of soil erosion and land degradation in these areas.[8]

Therefore, in the Ethiopian highlands, the combined effects of population growth, intensive agricultural and pastoral use, cultivation of marginal land, commercial timber-getting, precarious environmental conditions, and a relative lack of soil conservation practices, mean that land degradation has been particularly prolonged and severe. In the 1980s, for instance, the Food and Agriculture Organization of the United Nations (FAO) estimated that the average annual soil loss from agricultural land in the Ethiopian highlands was around 100

6 Hurni et al. (2010)
7 Frankl et al. (2011, p. 238)
8 Temesgen et al. (2014a, 2014b, 2014c)

tons/hectare, and that around three-quarters of the land in the Ethiopian highlands was so degraded that its productive use was dependent on the use of soil conservation measures.[9] Studies have estimated that historical soil erosion rates on cultivated slopes in the (highland) Upper Kolla and Woina Dega Zones have been high, at around 4.3 mm/year, compared with lower rates of around 2.3 mm/year in the (lowland) Lower Kolla Zone.[10] Although scientific soil conservation practices have been promoted in Ethiopia since the 1970s, their uptake, implementation, coverage and effectiveness have been limited to date.[11] Consequently, the loss of soil productivity has led to reduced farm income and to food insecurity, particularly among the rural poor, thereby perpetuating and worsening poverty, as has been reported for Limo Woreda, in Hadya Zone.[12] Soil erosion and land degradation also exacerbate poverty indirectly, by increasing the labour required to forage for natural resources. Overall, in Ethiopia, the loss of soil has dramatically reduced land productivity and biodiversity; and it has had knock-on effects for downstream water quality as sediment and nutrient run-off have led to siltation, sedimentation and eutrophication. Consequently, there have been losses of the resources and ecosystem services on which many people's livelihoods depend, together with a reduction in the natural regenerative capacity of those resources.

3.2 Deforestation and forest degradation

Deforestation has also been a serious environmental issue in Ethiopia, and its effects persist today. Some historical reconstructions estimate that forest cover in Ethiopia has been reduced from around 40 per cent to around 3 per cent over the course of the last century.[13] The pattern of deforestation has been uneven, with some regions – particularly the Ethiopian highlands – being almost completely deforested.[14] In the south central Rift Valley of Ethiopia, natural forest cover has declined dramatically from 16 percent in 1972 to 2.8 per cent in 2000, corresponding to an annual forest loss of around 1,440 hectares in that area.[15] A recent assessment suggests that Ethiopia's remaining cloud forests are being depleted at a rate of eight per cent per year.[16] Deforestation is closely linked to the issue of soil erosion and land degradation (see Section 3.1), but is an important environmental issue in its own right because it leads to the loss of important forest resources on which livelihoods may depend; it affects local microclimates (and even regional climates, in some cases); and it causes other environmental issues in turn, particularly biodiversity loss and soil erosion. Deforestation is a major driver of soil erosion and land degradation, with potentially long-term consequences for land productivity, as it is unlikely that the soils lost as a result of deforestation will regenerate on the decadal timescale.[17] Forest clearance and forest degradation has occurred in Ethiopia for several reasons. Most significantly, forest clearance has been undertaken in order to open land for agriculture (including plantations) and grazing, partly driven by resettlement programmes during the 1980s.[18] In addition, harvesting for fuel wood and timber for commercial purposes, including supplying the construction industry, has led to the rapid depletion of forest resources. Such harvesting of forest resources may be informal, commercial or illegal, with both local use of wood products and export of timber to urban centres.

9 FAO (1986)
10 See Gamachu (1988)
11 Gashaw et al. (2014)
12 Shibru (2010)
13 For instance, see Berry (2003); Wassie et al. (2010)
14 Eshetu (2014)
15 Dessie and Kleman (2007)
16 Reichhuber and Requate (2012)
17 For example, see Ramankutty et al. (2007)
18 See Kassie et al. (2014)

Deforestation and forest degradation are exacerbated by population growth and migration patterns (for instance, migration to the southwest of the country), which has increased demand for fuelwood, timber and other forest products. Deforestation is also exacerbated by soil erosion and grazing, which reduce the rate of forest regeneration. Soil erosion, in particular, leads to the removal of fertile topsoil, the reduction of soil-water and groundwater storage capacity, and the exacerbation of flooding as runoff is concentrated spatially and temporally.[19] Further issues related to deforestation and forest degradation include the loss of carbon sequestration capacity, with implications for climate change, and the loss of medicinal plants, with implications for future pharmaceutical use.[20] Particular issues of forest degradation are associated with farmers' practices in the management of agricultural landscapes, as Gemechu et al. (2014) have shown for southwestern Ethiopia, where a forest-agriculture mosaic landscape is maintained by a variety of practices by smallholder farmers: removal of trees from arable fields; planting of trees along field boundaries; conservation of trees in shade coffee fields; and planting of exotic trees. Other practices – such as the allocation of land to migrants along lands bordering forests, have also contributed to reduced forest area in the southwest of the country.[21] El Ouaamari and Cochet have examined the role of coffee-oriented development policies in the agriculture of the southwest Ethiopian highlands, identifying some implications for the management of the forests in the area. They have shown that the recent development of very large private coffee estates, as well as coffee certification projects, have contributed to farmers' dispossession from critical forest resources essential to households' food security.[22]

3.3 Water scarcity

Scarcity of water resources occurs as a result of the reduced availability of water, the over-abstraction of water and/or the contamination of existing supplies. Again, the environmental issues are closely interrelated, with water availability or scarcity being related to hydrological patterns which have been altered – and in some cases highly disrupted – by changes in vegetation cover and soils.[23] Those patterns, of course, are mediated by a range of social and institutional factors. Locally, water availability and water resource security may require the use of appropriate water and soil conservation practices (such as constructing stone terraces on agricultural land), but although such techniques have been widely introduced over several decades their sustained use has been less than had been hoped.[24] Larger scale hydrology may be altered by hydroelectric power schemes such as the construction of the Grand Ethiopian Renaissance Dam on the Blue Nile River, which may alter patterns of water availability and security across the region.[25] Water scarcity in rural areas of Ethiopia takes two main forms: low coverage levels and poor water quality, and these have implications for human and animal health, for economic and social life, and for ecosystem functioning. As Bogale and Urgessa have acknowledged, in rural parts of Ethiopia many women and children still spend many hours a day collecting water, time that could be better spent in education or productive employment.[26] Some evidence suggests that water availability may be better in towns (such as Dukem), however.[27]

19 See Bishaw (2001)
20 See Mesfin et al (2009)
21 Gemechu et al. (2014)
22 Ouaamari and Cochet (2014)
23 Gebrehiwot et al. (2014)
24 Amsalu and de Graaff (2008)
25 See Rahman (2013)
26 Bogale and Urgessa (2012)
27 Mohammed et al. (2013)

Recent research indicates that some initiatives designed to improve water security – such as micro-dams – may have had the effect of increasing disease prevalence in nearby villages.[28] The Ethiopian government is attempting to increase electricity generation in the country significantly, mainly through the construction of dams; yet whilst dams may have economic benefits they can also alter the composition and density of disease vectors and intermediate host species, increase the incidence of malaria schistosomiasis (and possibly lymphatic filariasis), and cause eutrophication of reservoirs, soil erosion and earthquakes.[29] There is also evidence that dams and commercial irrigation schemes can increase soil and water degradation, vulnerability to drought, and food insecurity in riverine and lacustrine areas downstream of dams, and dams in Ethiopia are also vulnerable to high soil erosion rates and earthquakes.[30] These findings suggest that dam construction and water resource development programmes in Ethiopia require ongoing and in-depth research and planning together with detailed environmental monitoring.

Inadequate water supplies are also prominent issues in urban areas, although this may be more frequently due to contamination of supplies than to absolute shortage. The principal biological pathogens that are present in urban areas in Ethiopia are waterborne (such as the organisms responsible for causing cholera and dysentery) or are carried by insect/animal vectors that use sources of water as part of their lifecycles (causing malaria and dengue fever, for instance). The urban poor are vulnerable to these infectious diseases as informal settlements in and around urban areas commonly lack adequate provision of potable water, sanitation, drainage and solid waste collection services and facilities.[31] Adequate provision of infrastructure and services (whether public, private, NGO or community-based activity) is required to improve water security and to reduce the spread of infectious diseases in poor urban areas of Ethiopia.

3.4 Biodiversity loss

Biodiversity loss is another major environmental challenge in Ethiopia. Biodiversity is a critical – if sometimes overlooked – aspect of ecosystem services and biosphere integrity which underpins all aspects of economic, social, political and cultural life.[32] Biodiversity encompasses both wild and domesticated/crop species; the overall trends in biodiversity are of precipitous declines, particularly in tropical environments. Biodiversity loss is defined as a reduction in genetic, species and ecosystem diversity, and it is now occurring at an unprecedented rate. Biodiversity loss leads to depleted ecosystem services (such as provision of freshwater, food and fuel) and in turn affects human health, livelihoods, income and wellbeing.[33] Since the poorest people are frequently those most directly dependent on adequate local ecosystem services such as freshwater supplies, fuelwood provision and flood protection, there is a direct link between biodiversity loss and poverty, and poor people are disproportionately affected by biodiversity loss.[34] Biodiversity loss occurs primarily through habitat degradation and destruction (such as deforestation; see Section 3.2) and through the spread of disease, but it also occurs through direct mortality to animal and plant populations (for instance, through hunting, poaching and collecting). All of these issues are current concerns in Ethiopia, with important implications for livelihoods, sustainable development and green growth. The relationship between biodiversity loss and poverty is not straightforward, and many of the linkages between poverty and biodiversity are not yet fully

28 Amacher et al. (2004)
29 Yewhalaw et al. (2014)
30 Yewhalaw et al. (2014, p.364)
31 Smith (2013)
32 Millennium Ecosystem Assessment (2015); Reid and Swiderska (2008)
33 Roe et al (2011); Turner et al. (2012)
34 Millennium Ecosystem Assessment (2005, p.6); Haines-Young and Potschin (2010); IUCN/DFID/EC (no date)

understood.[35] Nevertheless, there is frequently considerable spatial overlap between areas of high biodiversity and high poverty, creating a rationale for pursuing both poverty alleviation and biodiversity conservation simultaneously in countries such as Ethiopia.

Some recent research has focused on crop biodiversity in Ethiopia, and has highlighted the value – and the comparative stability – of crop biodiversity in the country, and the importance of crop genetic diversity for drought resilience.[36] Wild biodiversity is more problematic, with significant tensions generated between the need for rural communities to secure their livelihoods and the need for effective biodiversity conservation, for instance through the creation and maintenance of protected areas (such as elephant sanctuaries).[37] To date, there has been little progress in reversing the overall decline of biodiversity, despite the existence of many environmental management policies and initiatives.[38] In contrast to this overall picture of decline, some evidence suggests that urban biodiversity may be improving in some parts of equatorial Africa, particularly as a result of small-scale urban agriculture (including both urban livestock production and small mixed crop-livestock farming).[39]

3.5 Pollution issues

Pollution issues encompass a broad range of types of air, water, soil and land pollution, with the result that these resources are contaminated by anthropogenic substances and their ability to provide sustainable ecosystem services may be compromised. Air pollution includes the emission of black carbon (soot), aerosols, nitrogen oxides, sulphur oxides, volatile organic compounds, lead and other forms of particulate matter, as well as the problem of acid deposition. Those emissions are disproportionately from urban, industrial and transportation sources, although some important forms of rural air pollution also occur (particularly particulate matter released from biomass burning). These and other pollutants are responsible for significant human mortality and morbidity as well as for multiple ecological effects, such as impaired plant growth and reduced agricultural productivity. Recent research has highlighted the continuing heavy dependence on, and inefficient use of, biomass resources in Ethiopia, which have contributed to the loss of forest resources (Section 3.2) and to indoor air pollution and poor health through the use of traditional cooking technology. This is despite the efforts made by government and other institutions to promote the adoption of new cooking technologies, which had met with only limited success.[40]

Water pollution includes both point-source and diffuse release of multiple pollutants ranging from agricultural fertilisers and pesticides to municipal and industrial effluents. These in turn cause health impacts and a wide range of environmental problems, including eutrophication (due to nutrient enrichment of water bodies), harmful algal blooms, the creation of anoxic 'dead zones' in lakes, and impacts on fisheries and livelihoods. Water pollution may occur as a result of discrete catastrophic events – such as accidental industrial discharges – and these may have profound consequences for ecosystems, fisheries, tourism and livelihoods at local and even regional scales. Pollution of freshwater, groundwater, soil and land resources encompasses many point-source and diffuse types of contamination – that in some cases may be severe (for instance, due to inappropriate release of hazardous waste), but again these are generally localised events. Some exceptions to these for which the evidence base is particularly sparse include the pollution of air, water and soil by substances

35 See Billé et al. (2012); Fasse and Grote (2013)
36 Chavas and Falco (2012); Falco and Yesuf (2010); Falco and Chavas (2009); Bangwayo-Skeete et al. (2012); Bezabih and Sarr (2012); Samberg et al. (2010)
37 Tessema et al. (2010); Seifu and Beyene (2014); Kebede et al. (2014)
38 See, for example, Kidane-Mariam (2013)
39 Lee-Smith (2010)
40 Beyene and Koch (2013); Gebreegziabher et al. (2012)

for which the regulatory frameworks are currently embryonic – such as for nanoparticles, micro-plastics and pharmaceuticals – and for which potentially widespread pollution may now be occurring in the absence of effective environmental regulation, monitoring or management, with unknown consequences.[41]

In urban areas of Ethiopia, chemical pollutants hazardous to human health may accumulate in harmful concentrations. Combustion of fossil fuels, as well as poorly-regulated industrial processes, release sulphur and nitrogen compounds, volatile organic compounds, heavy metals and other pollutants that cause respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease and/or triggering asthma attacks.[42] Industrial chemical pollutants such as methylmercury, polychlorinated biphenyls (PCBs), and toluene are neurotoxic and recognised causes of subclinical brain dysfunction and neurodevelopmental disorders; these are found in potentially harmful concentrations in urban areas.[43] Occupational exposure occurs in large factories and small workshops; domestic exposure occurs when biomass/coal is used for cooking and heating homes; and vehicle traffic creates ambient air pollution in urban areas. Chemical pollutants may impact more severely on urban poor populations as both unhealthy working conditions and the use of biomass fuels in indoor cooking stoves and heaters are characteristic features of a typical urban poor lifestyle.[44]

41 For example, see Caplain et al. (2006), Bakshi et al. (2008)
42 Kampa and Castanas (2008)
43 Gradnjean and Landrigan (2006)
44 Kjellstrom et al. (2007)

SECTION 4

Links to the Ethiopian Economy

This section presents a brief overview of the main ways in which the environmental issues identified above (Section 3) are linked to the Ethiopian economy. It focuses on the implications for sustainable growth in key sectors for structural transformation, such as agriculture and light manufacturing), and is organised around consideration of the themes relevant to six key Ethiopian ministries (transport, industry, urban housing/construction, water and energy, forestry and agriculture), which are discussed in turn below. Ethiopia's economy is in rapid transition following the adoption of a rapid growth and development trajectory, based on an agricultural-development-led industrialisation strategy, with the aim of achieving middle-income country status by 2025.[45] This transition, however, is likely to be achieved at the cost of considerable environmental degradation unless effective environmental management measures are integrated into development planning. While the links are considered separately, by sector/ministry, below, the issues themselves are tightly interrelated and are increasingly investigated together in academic research.

Issues of environmental degradation may raise a range of other economic and social issues, including conflict between user groups, each of which may depend heavily on the availability of, and access to, environmental resources for their livelihoods and/or survival. In the Ethiopian context, these conflicts may be acute between the large refugee population resident in the country (around 750,000 persons). This area requires dedicated research; whilst some work has been undertaken on the 'environment-conflict nexus', including an investigation of resource management regimes in an Ethiopian refugee camp, but there is scope for further research into the role that better governance can potentially play in places resource scarcity, environmental degradation and conflict intersect.[46]

4.1 Transport

It has been acknowledged that empirical research characterising transportation markets in developing countries is scarce, and this is a significant research gap.[47] Yet an effective transport network is essential for market development in Ethiopia, which is in turn an integral part of development initiatives, poverty reduction and economic growth. Transport is a critical issue for key industries in Ethiopia, such as agriculture (see Section 4.6), in which improved transportation links offer farmers better access to markets to sell produce and labour, and to purchase inputs (such as fertilisers).[48] In export-oriented activities, such as the growing Ethiopian industry producing cut flowers for export, improvements in road transport infrastructure are required in order to reduce the postharvest loss of perishable produce.[49] However, transport is also associated with environmental issues that may be severe in places and that may constrain economic and social development. Modes of transport based on fossil fuels contribute to climate change and local air pollution, with implications for human health and ecological change. Construction of roads, railways and airports leads to land clearance, soil erosion, land degradation, ecological change and biodiversity loss.

45 Martin (2005)
46 Rancourt et al. (2014, p. 198)
47 Rancourt et al. (2014, p. 198)
48 Bhatta and Fanta (2014)
49 Aman (2014); Mano et al. (2011)

Moreover, new road development tends to open new areas to increased levels of environmental impact (including by illegal activities, such as logging); they can facilitate higher rates of natural resource exploitation; and they can act as routes for the transmission of disease.

Therefore, transport development in Ethiopia needs to be integrated within an overall strategy for sustainable development and green growth; this is now in progress with the Climate-Resilient Green Economy (CRGE) initiative. Climate-resilient transport infrastructure projects include the construction of an electric rail network (with the Addis Ababa Light Railway Transit (AA-LRT) now open), with significant potential for emissions reductions through switching freight transport from road to electric rail. Improvement in the fuel efficiency of road transport also has considerable potential to drive emissions reductions, particularly in Addis Ababa. Moreover, some evidence suggests that policies stimulating competition between transportation carriers may be as important as road infrastructure investments in facilitating transportation in Ethiopia.[50]

4.2 Industry

Research into the environmental impacts of industry in Ethiopia is scarce, and this represents an important research gap, although some environmental impact assessments have been produced for key industrial developments in the country. Industry in Ethiopia comprises both heavy industry (such as oil and gas production in the Ogaden region of eastern Ethiopia; see Section 4.4) and light manufacturing (such as the leather industry), and these have different types and magnitudes of environmental impact). Heavy industry involves significant natural resource extraction and/or imports, as well as generally high emissions of greenhouse gases, local air pollutants and soil and water contaminants. Light industry, in contrast, may have a smaller environmental footprint although may involve the use of particular resources or pollutants with distinctive environmental consequences (for instance, hazardous effluent from tanning processes, such as at Bahir Dar, including the discharge of heavy metals).[51]

There is considerable overlap between the industrial and agricultural sectors in Ethiopia, and strategies for improving industrial production typically require improvements in the efficiency of agriculture and livestock production. Many forms of light manufacturing (such as horticulture, textiles and leatherwork) are based on deep value chains, which are ultimately dependent on agriculture and livestock production. Hence the environmental impacts that affect agriculture (see Section 4.6) also have implications for industry.

4.3 Urban housing and construction

Urban growth and development has significant environmental impacts in Ethiopia, in particular through land-use change and through demand for construction materials. Wood products have historically been widely used in the construction of houses, with around 72-74 per cent of housing units in both rural and urban areas being constructed using wood and mud.[52] Moreover, there are strong linkages between urban and rural areas through the use of wood for fuel: Gebreegziabher et al. have shown that urban Ethiopian households are dependent on rural areas for around 85 per cent of their fuel needs, with significant implications for deforestation and forest degradation. In turn, this demand leads to growing fuel scarcity and higher firewood prices, with the result that an urban energy transition to cleaner energy sources is required (see Section 4.4).[53] Urban areas are foci of domestic,

50 Rancourt et al. (2014)
51 Kibret and Tulu (2014); see also Asfaw (2014); Asfaw et al. (2012)
52 Mekete (1996), cited in Birhanu (2014)
53 Gebreegziabher et al. (2012)

industrial and transport activities, with the result that air and water pollution, as well as municipal waste generation, are concentrated in these areas. The highest concentrations of ambient air pollution in the world now occur in developing country cities, including Addis Ababa. Urban air pollution includes the release of black carbon (soot), aerosols, nitrogen oxides, sulphur oxides, lead and other forms of particulate matter, as well as the creation of ozone at surface level. These and other pollutants are responsible for significant human mortality and morbidity as well as for multiple ecological effects, such as impaired plant growth and depleted freshwater ecosystems. However, levels of monitoring and reporting of pollution levels and air quality standard breaches is very low.

Household air pollution due to biomass fuels – which is strongly poverty related – is a known risk factor for acute respiratory infection in children in developing countries, and household air pollution from burning biomass fuel is increasingly recognised as a major global health concern.[54] Biomass smoke is associated with chronic obstructive pulmonary disease (COPD); recent research has confirmed that wood smoke and poverty contribute to reduced lung function in rural Africans and that COPD is common in this population.[55] Poor health induced by air pollution in turn leads to economic and social impacts, including impaired education, employment, livelihoods and wellbeing. Reducing air pollution in Ethiopian urban areas requires policies related to energy, transportation and urban planning, as well as to forestry and agriculture, with particular consideration given to the impacts of each strategy on poor communities. Such cross-sectoral integration also requires a strong focus on urban environment and urban poverty in the post-2015 development agenda.

Peri-urban areas are also important places in which environmental issues are now prominent in Ethiopia. These areas include transitional land which has been previously used mainly for agriculture, but which is increasingly targeted for in-migration and which is experiencing the development of informal settlements in which environmental issues may be particularly acute.[56] Urban and housing construction issues are an often overlooked cause of mortality and morbidity in such areas.[57] These issues impact most severely on peri-urban poor populations who often live in shelters made from flammable materials (such as wood) with many people to a room and open stoves. The use of biomass-based construction materials – combined with limited or absent planning and construction standards – contributes to unhealthy and unsafe working environments for many urban and peri-urban poor people in Ethiopia. Urban growth and urbanisation in developing countries – including Ethiopia – means that strong and growing demand exists for urban housing construction.[58] 'Slum upgrading' refers to initiatives to improve housing conditions in urban and peri-urban areas, and to reduce the impact of environmental hazards on urban poor populations. Lack of planning, overcrowding, land tenancy issues and lack of infrastructure and public services are cross-cutting issues that require a coordinated approach to their management. Due to these interrelated issues, urban poverty programmes are ideally designed to reduce environmental hazards. Community participation and acceptance is acknowledged to be an essential element of these initiatives if they are to be successful.

4.4 Water and energy

Natural resources are clearly closely related to both the water and energy sectors, with a range of links between environmental issues and the Ethiopian economy. Ethiopia plans a very rapid, five-fold increase in its electricity power supply, based on the construction of large hydropower dams. Hence the most prominent contemporary water issue is the

54 Emmelin and Wall (2007)
55 Fullerton et al. (2011)
56 Adam (2014)
57 See Dimitriou and Gakenheimer (2011)
58 UN Habitat (2014)

hydrological changes that will accompany the construction of these large dams, such as the Grand Ethiopia Renaissance Dam (GERD), an initiative that has recently been projected to generate basin-wide economic benefits and to improve welfare in the Eastern Nile basin.[59] The GERD is primarily intended for hydroelectric power generation, however, rather than to improve water security, and the likely hydrological and microclimate impacts of the dam remain unknown in their details, but will lead to changes in local (and even regional) hydrology, ecology and patterns of sedimentation and siltation. Additional, and broadly similar, dam-related impacts will probably accompany the construction of the hydroelectric Gilgel Gibe III Dam on the Omo River, including diversion of downstream flow from the socially and ecologically important Lake Turkana, with a potential loss of ecosystem services and livelihoods that are dependent on that ecosystem.[60] Fears have been expressed that the construction of large hydropower dams could increase the transmission of malaria, through transforming ecosystems and creating new vector breeding habitats. Some research has found that children living in proximity to the Gilgel-Gibe reservoir are at higher risk of contracting malaria compared to those living farther away, meaning that disease prevention and control programmes will be required in the vicinity of this reservoir (and others).[61]

A further dam-related environmental impact for which research is scarce is their effect on wildlife (together with other parts of the downstream ecosystem) where these require pulses of river flow for their lifecycles, and which would otherwise become dependent on the maintenance of artificial flood simulation programmes. Moreover, the extent of the hydrological, regional climate and ecological changes that can accompany large dam construction means that there is significant potential for these environmental issues to drive transboundary conflicts, displacement and dispossession of people, and long-term migration between regions. No recently published research into these issues was found. However, there is some evidence to suggest that farmers who are relocated after inundation of their land have situated their new farms either on steep slopes or in flood-prone areas. This relocation to more marginal land has led to a suite of other environmental impacts, including the removal of trees and forests, and the conversion of grassland and bush-land into agricultural land (with insufficient use of soil conservation techniques). Farmers have also relocated close to other bodies of standing water and/or swamps, thereby becoming exposed to seasonal fluctuations in water levels that may inundate crops, grazing land and settlements.[62] Some evidence has shown that the increasing demand for cropland and grazing land, combined with inappropriate land management practices, has the effect of increasing soil erosion and reservoir sedimentation, with knock-on effects for livelihoods, food security and power generation in the future.[63]

More broadly, water resource issues in Ethiopia are closely interrelated with other environmental issues, particularly agriculture, energy, food security and climate change; some or all of those issues are increasingly considered together in studies of the food-energy-water nexus, for instance. Water and energy, in particularly, are closely related to each other and to economic development (and green growth) in Ethiopia. Energy use in Ethiopia currently comprises more than 90 per cent traditional biomass use; however, this dependence is changing towards increasing electricity production predominantly from large-scale hydropower plants, with the aim to improve access to modern energy sources.[64]

59 Kahsay et al. (2015); Block and Strzepek (2010)
60 International Rivers (2013)
61 Yewhalaw et al. (2009)
62 Tefera and Sterk (2008, p. 72).
63 Tefera and Sterk (2008). An assessment of siltation and eutrophication changes associated with the Gilgel Gibe dam was published by Devi et al. (2007), showing that these were major environmental challenges associated with the initiative. An earlier study, by Hurni et al. (2005), presents some of the background to these changes.
64 Karlberg et al. (2015)

Ethiopia has some reliance on fossil fuel energy production – such as in the oil and gas industry of the Ogaden region of eastern Ethiopia – yet is aiming to achieve middle-income country status by 2025 without increasing net carbon emissions, and hydropower is regarded as a necessary part of this strategy. Indeed, Ethiopia's planned hydroelectric power development is part of a climate resilient development strategy that may result in the country becoming a regional exporter of green energy. Ethiopia's programmes and plans to increase electricity production through dam construction are projected to increase energy and agricultural production, promote economic development, and facilitate flood control. However, those benefits are likely to come at the cost of considerable environmental, ecological and socioeconomic changes unless effective planning, research and monitoring are undertaken (see Section 3.3).[65]

4.5 Forestry

As mentioned above, Ethiopia is heavily reliant on biomass for energy (fuelwood, crop residues, charcoal and dung) and on wood for construction purposes, with consequent severe impacts on forest resources (see Section 3.2). Whilst forest resources have been severely depleted in Ethiopia, particularly in the highlands, and although ongoing rates of forest clearance remain high in remaining areas of cloud forest, there is at least now a clearer appreciation of the economic value of intact forest resources and some attempts to manage combined forest-agriculture ecosystems in a sustainable manner. Recent approaches to forest management have focused on the need to manage forests, land and water together in an integrated manner, using landscape management assessment and planning techniques.[66] These techniques attempt to implement best management practices in the locations where they are needed most, although their use may be significantly hindered by their complexity and by the lack of necessary baseline data. Many challenges in forest management in Ethiopia arise because of social and institutional factors, such as uncertainty over property rights (as in Mejengir Zone, Gambella Regional State), and in principle better forest resource management could be achieved with progress in resolving such disputes.[67] Forest cover and water resource management in the north-western highlands of Ethiopia have been explored in a recent study which found that spatial scale is an important consideration in this relationship: strong correlations between forest cover and hydrology at smaller scales indicates that land management policies should be oriented to farm level conditions. This is particularly important given that adequate water availability is critical for the food security of the subsistence farmers who comprise 86 per cent of the population in this region.[68]

Forest resource management is also closely linked to biodiversity, with positive linkages to the Ethiopian economy by creating income and boosting GDP through biodiversity conservation and trade as well as through the maintenance of ecosystem services. These benefits need to be set against some negative economic linkages (such as impacts on local people's incomes through reduced access to protected areas, and sometimes through the loss of cultural and traditional values). Although the relationship between biodiversity and economy is not straightforward, recent research has shown that biodiversity acts as an emergency lifeline and/or a social 'safety net', preventing people falling into – or further into – poverty, and that these securities are eroded by biodiversity loss.[69]

65 Yewhalaw et al. (2014)
66 For instance, see Tamene et al. (2014)
67 Girma and Beyene (2015); Guillozet (2014)
68 Gebrehiwot (2015, p. 128)
69 Roe et al. (2011, pp. 2, 8)

4.6 Agriculture

As mentioned above, the Ethiopian economy is based primarily on agriculture, which accounts for around 50 per cent of GDP and employs about 85 per cent of the labour force. Moreover, agriculture accounts for 90 per cent of total foreign exchange earnings, with coffee alone contributing about 60 per cent of total export value. Agriculture also provides about 70 per cent of the raw material for the food processing, beverage and textile industries in the country.[70] The Ethiopian government is pursuing an agricultural-development-led industrialisation strategy, and the links between agriculture, industry and environment are clearly integral to the success of such a strategy. Yet plans to intensify and transform agriculture, increasing yields and economic returns, depend on appropriate management of the environmental impacts that have historically been associated with agricultural expansion and intensification. In particular, land and water resource degradation due to soil and nutrient loss, pollution and sedimentation are serious environmental problems that are likely to increase in the short- to medium-term unless effective monitoring and management is instituted. It is now acknowledged that integrated landscape planning and management tools are essential to minimise land and water degradation. However, whilst many soil-water-landscape studies have been published during the last twenty years, progress in developing operational tools for supporting landscape planning is still limited, partly because of the complexity of the linkages involved and partly because of data shortages.[71]

Commercial agriculture – especially the phenomenon of 'land grabbing' – clearly may have profound environmental impacts on soils, vegetation, water resources, wildlife and biodiversity, and obvious knock-on effects for ecosystem services and livelihoods.[72] Some evidence suggests that these impacts are most profound for pastoralists, who are disproportionately excluded as a result of changing patterns of land use.[73] However, these depend on the precise activities conducted and the extent to which environmental protection is adequately conceived, planned for, implemented, monitored and reported. There is considerable scope for further research into the precise implications of commercial agriculture and 'land grabs' for environmental change in Ethiopia.

The connections between watershed management practices in the Blue Nile Basin and sustainable agriculture have been explored recently, in a study which acknowledged that the trade-off between short-term welfare and long-term agricultural development in the Ethiopian highlands represents a challenge to successful economic development in a predominantly agriculture-based economy.[74] This study showed that investments in sustainable land and watershed management (SLWM) (including terraces, bunds and check dams) had a significant effect in increasing the value of production at the plot level, although there are some caveats as mentioned above (see Section 3.3). Although various terminologies are found in the research literature – and various approaches, instruments and techniques for improving the sustainability of agriculture in Ethiopia exist – these generally share a common focus on improving agricultural yields alongside conservation of land, forest and water resources (for instance, through community-based participatory watershed management).

Soil erosion and land degradation are critical issues that must be addressed if agriculture-based industrialisation is to drive economic growth in Ethiopia. Soil erosion and land degradation can lead to food scarcity, loss of income, resource conflicts and further environmental degradation as remaining productive land is exploited more heavily. In turn,

70 Birhanu (2014); see also Federal Republic of Ethiopia, Ministry of Agriculture and Rural Development (2010)
71 Tamine et al. (2014)
72 Cotula et al. (2009)
73 Lavers (2012)
74 Schmidt and Tadesse (2014)

the implications of land degradation for food security, in particular, lead to malnutrition and poor health. Therefore land degradation has the potential to preclude or reverse the gains made – or projected to be made – through agriculture-based industrialisation: by reducing agricultural income nationally, by increasing the national poverty rate, and by slowing poverty reduction. In areas particularly prone to land degradation, such as the Ethiopian highlands, further research is required to investigate the potential for alternative livelihood strategies to promote rural development while reducing the impact of intensive land-uses.[75] In one such area – the Central Rift Valley area of Ethiopia – environmental vulnerability is high. Recent research has shown that land degradation has occurred in this area for a combination of reasons: population and livestock growth in regions of limited resources; unsustainable farming techniques; the Ethiopian land tenure system; and the persistence of poverty. Consequently, the level and area of Lake Abiyata are falling, and ongoing land degradation has reduced agricultural productivity, in turn causing worse food insecurity and poverty in the area.[76] All of this points to the need for soil erosion and land degradation – along with other related environmental issues – to be considered throughout the planning and implementation of agricultural intensification programmes.

[75] Adhikari (2013)
[76] Meshesha et al. (2012)

SECTION 5

Conclusions

As a result of this rapid desk-based study, the following conclusions may be drawn:

1. Environmental issues are severe, broad-ranging and interlinked in Ethiopia

With the exception of climate change, the major environmental issues affecting Ethiopia are soil erosion and land degradation, deforestation and forest degradation, water scarcity, biodiversity loss, and various types of pollution. Environmental degradation is widespread and severe in Ethiopia, although it is unevenly distributed and takes different forms in different parts of the country. To date, studies of environmental degradation in Ethiopia have tended to focus on the serious impacts of agriculture, especially on soils, which have been severe and which increase the vulnerability of many people to food and water insecurity. Moreover, although environmental issues have tended to be considered in isolation, in reality they are closely interlinked and studies increasingly attempt to consider them together, as in various conceptions of the 'nexus' of environmental challenges.

2. Soil erosion, deforestation, and land and degradation are key environmental issues

Soil erosion and land degradation have been particularly severe in the Ethiopian highlands due to the combined effects of population growth, intensive agricultural and pastoral use, the cultivation of marginal land, commercial timber-getting, precarious environmental conditions and inadequate soil conservation practices. Deforestation and forest degradation are another major environmental issue in Ethiopia, with most of the country's forests already lost and the remaining areas of cloud forest being depleted at a rapid pace, despite a growing awareness of their importance for livelihoods, agroforestry, ecosystem services and ecological resilience.

3. Water and energy are also important – and increasing – environmental issues

Attempts have been made to address the issue of water scarcity in Ethiopia, including through the construction of micro-dams, although these in turn create environmental problems such as the increased prevalence of disease. Larger dams can cause eutrophication of reservoirs, soil erosion and earthquakes, in addition to changing patterns of disease. Water and energy are closely linked issues in Ethiopia, particularly in view of the strategy to significantly increase hydroelectric power generation. The Grand Ethiopian Renaissance Dam is projected to bring substantial economic and social benefits to the Blue Nile Basin region but this will likely come with significant environmental costs that are currently unknown.

4. Biodiversity loss is an important and relatively neglected environmental issue

Biodiversity loss is occurring at an unprecedented rate, as it is in tropical environments worldwide. Biodiversity loss occurs primarily through habitat degradation and destruction, disease and over-exploitation of animal and plant populations. Biodiversity loss leads to depleted ecosystem services, with disproportionate impacts on poor people and with important implications for livelihoods, sustainable development and green growth.

5. *Pollution issues continue to threaten population health*

A range of pollution issues – affecting air, water and land – occurs in Ethiopia, with particular concerns expressed about urban and indoor air quality due to high reliance on biomass stoves for cooking. There is an urgent need to continue to improve population health through a transition to cleaner sources of domestic energy. Pollution arising from commercial and industrial sources is increasingly regulated through environmental management policies and instruments, although much greater regulatory and monitoring capacity is needed.

6. *Environmental issues are closely linked to the Ethiopian economy*

These environmental issues are closely linked to the Ethiopian economy in a variety of ways. In the broadest terms, Ethiopia's natural resources and ecosystem services are important resources for economic growth and development, yet environmental issues – if severe – also have the potential to preclude or reverse that growth and development. Ethiopia's economy is intended to follow a rapid growth and development trajectory, based on an agricultural-development-led industrialisation strategy, in order to achieve middle-income country status by 2025, ideally with no net increase in carbon emissions. This transition, however, is likely to be achieved at the cost of considerable environmental degradation unless effective environmental management measures are integrated into development planning.

7. *In relation to the key sectors/ministries, there is scope for further research*

(a) The *transport sector* is an under-researched area, but an effective transportation network and competitive transport services are important if Ethiopia's development trajectory is to be achieved. However, an expanding transport sector is likely to impose significant environmental costs (primarily through greenhouse gas emissions and local air pollutants) in the absence of effective environmental controls, and transport development in Ethiopia needs to be integrated within an overall strategy for sustainable development and green growth.

(b) *Industry* in Ethiopia comprises both heavy and light industries; these can contribute substantially to economic growth but can also inflict potentially severe environmental impacts (primarily through greenhouse gas emissions and local air, water and land contaminants). Industrial pollution can have potentially serious implications for health and for economic growth – especially through its effects on the health of workers, women and children. Preventing those impacts requires effective environmental monitoring and management, linked with agreed environmental standards and performance indicators.

(c) *Urban housing and construction* is likely to remain a sector in which strong growth occurs in Ethiopia, driven by strong demand for housing and other infrastructure in urban areas as Ethiopia pursues its rapid development trajectory. Currently, housing construction has a substantial environmental impact due to timber demand, especially in peri-urban and resettlement areas.

(d) Ethiopia's programmes and plans to increase electricity production through dam construction are projected to increase *energy* and agricultural production, promote economic development and facilitate flood control. However, those benefits are likely to come at the cost of considerable environmental, ecological and socio-economic changes unless effective planning, research and monitoring are undertaken.

(e) Ethiopian *forests* are already severely degraded, but the remaining areas of forest can make a strong contribution to economic growth by creating income and boosting GDP through biodiversity conservation and trade as well as through the maintenance

of ecosystem services. However, there may also be some livelihood impacts where some human activities are displaced from protected areas. Maintaining intact forest cover is important for water resource management, and there is likely to be a benefit to orienting policies to farm level conditions.

(f) *Agriculture* remains central to the Ethiopian economy and is critical to the success of Ethiopia's agricultural-development-led industrialisation strategy. Yet agriculture is dependent on soil and land quality, which are highly degraded. Land degradation has the potential to preclude or reverse the gains made – or projected to be made – through agriculture-based industrialisation, and environmental vulnerability remains high in this respect. Large-scale commercial agriculture, in particular, has the potential to cause profound environmental degradation in the absence of adequate environmental planning, management, monitoring and reporting. Soil erosion and land degradation – along with other related environmental issues – need to be considered throughout the planning and implementation of agricultural intensification programmes in Ethiopia.

SECTION 6

Annotated Bibliography and Case Studies

El Ouaamari, S. and Cochet, H. (2014) 'The role of coffee in the development of southwest Ethiopia's forests: farmers' strategies, investor speculation, and certification projects', *Society and Natural Resources*, Vol. 27, Issue 2, pp. 200-214.
This article examines the role of coffee in the agriculture of the south-west Ethiopian highlands, in the context of recent large-scale investments in the coffee industry (including large private coffee estate developments, smallholdings and coffee certification projects). The authors argue that smallholder farmers in the region prioritise staple crops, and allocate land and labour to coffee only once food production objectives have been achieved. The authors also highlight the diversity of local poor farmers, who are often treated as a homogeneous group in development projects designed to boost farmers' income through coffee production, even though they have differentiated farming strategies. The study attempts to explain why coffee certification initiatives have apparently failed to improve local populations' livelihoods, instead exacerbating socio-economic inequalities and even helping to dispossess farmers from critical forest resources essential to households' food security.

Gashaw, T., Bantider, A. and Silassie, H. G. (2014) 'Land degradation in Ethiopia: causes, impacts and rehabilitation techniques', *Journal of Environmental and Earth Science*, Vol. 4, No. 9, pp. 98-104.
This study focuses on the issue of land degradation, which it identifies as the most common environmental problem in Ethiopia and one which is responsible for low and declining agricultural productivity, ongoing food insecurity and rural poverty. The study shows that land degradation also affects plant health, water availability and biodiversity levels. The authors identify the main causes of land degradation as rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production. The authors also acknowledge that land degradation in Ethiopia is also affected by topography, soil types and agro-ecological factors. The study demonstrates that physical conservation structures have been widely used to try to reduce land degradation, but that the use of vegetative measures is very limited – so there may be considerable potential for these to contribute to land management and soil conservation strategies in the future.

Gebrehiwot, S. G. (2015) 'Forests, water and food security in the northwestern highlands of Ethiopia: knowledge synthesis', *Environmental Science and Policy*, Vol. 48, pp. 128-136.
This study investigates the spatial and temporal relationship between forest cover and water in the north-western highlands of Ethiopia, together with its implications for food security. Whilst temporal correlations were weak, spatial associations (between land cover and low flow features such as grasslands and woodlands) were stronger. Based on interviews with community members, the author found that the impacts of land cover change were more pronounced in smaller watersheds, which is consistent with observational studies on small scale watersheds and farm level plots. The author concludes that the stronger relationships between forests and hydrology at smaller scales implies that land management policies should be oriented to farm level conditions, where water is vital for the food security of subsistence farmers. This group comprises the large majority (86 per cent) of the total population in the highlands.

Gemechu, A., Börjeson, L., Senbeta, F. and Hylander, K. (2014) 'Balancing ecosystem services and disservices: smallholder farmers' use and management of forest and trees in an agricultural landscape in southwestern Ethiopia', *Ecology and Society*, Vol. 19, Issue 1, pp. 520-535.
Addressing the challenge of forest management in an agricultural landscape is the subject of this article, which examines smallholder farmers' practices in the management of agricultural landscapes. Those practices influence biodiversity, with knock-on effects for livelihoods, ecosystem service provision and conservation. The study area was an agriculture-forest mosaic landscape in south-western Ethiopia, in which trees and forests were managed with respect to a few specific ecosystem services and/or environmental attributes that were regarded as desirable or undesirable. The study identified specific practices (such as the planting of trees on field boundaries; the removal of trees from arable fields; the preservation of trees in semi-managed forest coffee; the maintenance of patches of shade coffee fields in the agricultural landscape; and the establishment of wood-lots with exotic trees) which resulted in the restructuring of the forest-agriculture mosaic. The study also highlighted strategies used by farmers to reduce crop damage by wild mammals (such as baboons and bush pigs), including migration and allocation of migrants on lands along forests, which have contributed to reductions in forest and tree cover. The authors concluded that it is helpful to articulate ecosystem processes in terms of services and disservices in evaluating landscape management strategies and practices.

German, L., Mazengia, W., Taye, H., Tsegaye, M., Ayele, S. et al. (2010) 'Minimizing the livelihood trade-offs of natural resource management in the Eastern African Highlands: policy implications of a project in 'creative governance'', *Human Ecology*, Vol. 38, No. 1, pp. 31-47.
In this article, the authors draw attention to the need for effective formal or informal natural resource governance in the highlands of Eastern Africa, which have high population densities and tightly coupled interactions between adjacent landscape units and users. Yet the authors argue that many natural resource management and development problems – that require or would benefit from collective solutions – remain unresolved. The authors argue that many of the more intractable governance problems can be traced to underlying trade-offs, which may include a loss of livelihood options for at least some households, leading to governance break-down. The article recommends that future policy for improved landscape governance should couple institutional reforms with livelihood alternatives that reduce the burden of good governance on households.

Kidane-Mariam, T. (2013) 'The World Bank and Africa: a historical overview of shifting paradigms and strategies of environmental and habitat management', *Arab World Geographer*, Vol. 16, No. 4, pp. 377-415.
This critical article examines the role of the World Bank in producing development, environment and habitat-management paradigms and strategies in Africa in the post-independence period. The author argues that the World Bank has created a discourse in which African developmental, environmental, human settlement and natural-resource management problems have been framed, constructed and deconstructed within global development and ecological discourses, management paradigms, strategies and practices. Yet the author argues that environment and habitat-management paradigms and strategies sponsored and promoted by the World Bank have yet to create strong, effective sustainable management capacities in the region. This is attributed to the uncritical, mechanistic adoption of policy and analytical tools such as environmental assessments (EAs), country environmental assessments (CEAs), national environmental action plans (NEAPs), national environmental support programs for NEAPs (NESPs), country environmental strategy papers (CESPs), regional environmental strategies (RESs). The author argues that the mainstreaming of environmental agendas in national development and environmental management policies and strategies has done little to halt or reverse environmental deterioration in Africa. Nor have the integrated urban-development projects, programmatic

urban projects, and water and sanitation projects promoted and supported in Africa resulted in significantly improved and sustainable institutional development and capacity building in urban management, the paper argues.

Schmidt, E. and Tadesse, F. (2014) 'Sustainable agriculture in the Blue Nile Basin: land and watershed management practices in Ethiopia', *Environment and Development Economics*, Vol. 19, Issue 5, pp. 648-667.
This article focuses on the trade-off between short-term welfare and long-term agricultural development in the highlands of Ethiopia, which represents a challenge to successful economic development in a predominantly agriculture-based economy. The authors evaluated the impact of sustainable land and watershed management (SLWM) on the value of production at plot level, demonstrating that plots that received SLWM investments (terraces, bunds and check dams) were significantly more productive (although they acknowledge that the costs of these investments may also be significant).

SECTION 7

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