

GREEN economy Assessment Study



Burkina Faso





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Citation

UNEP. (2014). Green Economy Assessment Study – Burkina Faso

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LIST OF ABBREVIATIONS

10 centile A2-BAU	Worst-case climate change scenario with no green investments
10 centile A2-Green	Worst-case climate change scenario with green investments
BAU	Business-as-usual
Dmnl	Dimensionless (i.e., proportional)
ECOWAS	Economic Community of West African States
GDP	Gross Domestic Product
GE	Green Economy
GEAS	Green Economy Advisory Services
Ha	Hectare
HDI	Human Development Index
kW	kilo Watt
kWh	kilo Watt hour
MEDD	Ministry of Environment and Sustainable Development
Medium B1-BAU	Intermediate climate change scenario with no green investments
Medium B1-Green	Intermediate climate change scenario with green investments
MI	Millennium Institute
PNIEDD	National Environment Investment Plan for Sustainable Development
REDD	Reducing Emissions from Deforestation and Forest Degradation
SAM	Social Accounting Matrix
SCADD	Strategy of Accelerated Growth and Sustainable Development
T21 Burkina Faso	Burkina Faso T21 model for Green – GE Economy Analysis
T21	Threshold 21 model
UNEP	United Nations Environment Programme
US\$	United States Dollar

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ACKNOWLEDGEMENTS

This study was commissioned by the United Nations Environment Programme (UNEP) under the ‘Green Economy and Social and Environmental Entrepreneurship Development in Africa’ Project. The project was managed by Joy Kim, Senior Economic Affairs officer under the overall guidance of Steven Stone, Chief of the Economics and Trade Branch and Desta Mebratu, Deputy Director, Regional Office for Africa.

UNEP would like to thank Zhuohua Tan, Matteo Pedercini, Birgit Kopainsky and a modeling team from the Millennium Institute for their valuable contribution and research input.

Joy Kim, Richard Scotney, Mamadou Moussa Diakhite and Jose Pineda contributed to the report. Administrative support was provided by Fatma Pandey, Rahila Somra and Désirée Leon. The report was edited by Ricardo Apollon and the layout was prepared by Michel Favre. Original cover and layout design by Thomas Gianinazzi.

The report also benefited from the support of Mr Oumar Diaye of the United Nations Development Programme, as well as inputs from the Government of Burkina Faso. In particular, guidance was provided by the Secrétariat Permanent du Conseil National pour l’Environnement et le Développement Durable (SP-CONEDD), including Mr Rasmané Ouedraogo, Mr Georges Yameogo and Mr Kouka Ouedraogo.

UNEP is grateful for the financial support provided by the European Union in the framework of the project “Green Economy and Social and Environmental Entrepreneurship Development in Africa”.



EUROPEAN UNION



EXECUTIVE SUMMARY

INTRODUCTION AND OBJECTIVE

Burkina Faso has maintained consistently strong macroeconomic performance in spite of multiple shocks and regional uncertainty, with an average growth of 5.9% from 2000 to 2012. Yet, with a per capita gross domestic product (GDP) of US\$1,298.00, Burkina Faso has a major challenge in strengthening the foundations of its socio-economic development. Concurrently, the country is experiencing several severe losses of natural resources, for instance degradation of land and water resources, soil erosion and deforestation. These are further compounded by constant flooding and cyclic droughts, shortage of energy along with significant economic costs.

Faced with these challenges, the Government of Burkina Faso has taken several national-level initiatives, for instance the Strategy of Accelerated Growth and Sustainable Development (SCADD) and the National Environment Investment Plan for Sustainable Development (PNIEDD). In conjunction with the above-mentioned, the Burkina Faso Ministry of Environment and Sustainable Development (MEDD), in collaboration with the United Nations Environment Programme (UNEP) and by means of technical assistance from the Millennium Institute, MEDD has embarked on a Green Economy Assessment to support governmental policies aiming at achieving a sustainable development with low dependences and impacts on the environment.

This Green Economy Scoping Study for Burkina Faso has been prepared under the scope of UNEP's Green Economy Initiative (GEI), which was launched in 2008. The overall goal of this study is to facilitate Burkina Faso to seize the opportunities that transitioning to Green Economy can offer. Based on solid arguments and economy-wide analysis, this study provides a framework for green investments in Burkina Faso, which will kick-start the country's transition towards a low-carbon, resource efficient economy.

PRIORITY SECTORS

This study focuses on six priority sectors: agriculture, livestock, forestry, water, energy and mining. These sectors were identified through consultation with stakeholders on their prospective of these sectors' potential contribution involvement in the country's economic growth and job creation, reduction of poverty and overall transition to Green Economy. Burkina Faso is a rural-based economy and the agriculture sector employs in the order of 90% of the total working population. The referred to and the former five identified priority sectors play a decisive role in ensuring the country's food security, employment, governmental revenues and overall national economy.

However, given the growing pressure on the country's already strained natural resources, it is clear that the current level of resources utilization is anything but unsustainable. The situation is further aggravated by climatic concerns such as, a shortage of rainfall in addition to subsequent draught and floods. These concerns threaten the economic security of the country. A variety of policy measures are needed to ensure the development of a low-carbon, resource efficient economy in Burkina Faso.

GREEN INVESTMENTS

The transition to Green Economy can offer a number of important benefits for Burkina Faso. The country already faces several serious losses of natural resources. In addition, socio-economic development is likely to be significantly affected by climate change. The quantitative analysis of this study demonstrate that in order to put Burkina Faso on the path of sustainable development, it is necessary to consider the natural environment as a determining factor of production as well as of economic stability and long-term prosperity. Only by doing so, will Burkina Faso be able to preserve, improve and if required, restore the natural capital as a critical economic asset together with a source of public welfare; especially for the underprivileged whose livelihood depend on nature.

Four comparative scenarios are simulated in this study. These scenarios are: (i) intermediate climate change scenario with no green investments (Medium B1-BAU); (ii) intermediate climate change scenario with green investments (Medium B1-Green); (iii) worst-case climate change scenario with no green investment (10 centile A2-BAU); and (iv) worst-case climate change scenario with green investments (10 centile A2-Green). The greening scenarios consider additional 2% of GDP for green investment in the identified priority sectors from 2013 to 2050.

Overall Economic Development

Greening the economy is likely to generate higher GDP growth rates. The implementation of green policies will result in GDP reaching \$37-41 billion by 2050, 22-23% higher than in a business as usual scenario. During that 38 year period, GDP is expected to be at an annual rate of 5.1-5.3%.

Agriculture and Land

By means of the various green investments in the agricultural and environmental sectors, it is possible to mitigate the effects of climate change on the agriculture.

In the crops production sector, by 2050 an average of 25% more cereal production will be available to each person in Burkina Faso in the green scenarios, compared to the BAU scenario, as a result of improved crop yield and reduced land degradation.

In addition, the recovery of degraded agricultural land in the Green Economy scenarios further reduces the pressure of expanding agricultural areas to feed the growing population, thus contributing to the reduction in deforestation.

The green investments in intensification of livestock and soil recovery will lead to higher productivity of land and more grazing land available, which will enable livestock production to reach US\$ 47 billion and 58 billion in 2050, more than 40% higher than the BAU scenario.

Under the BAU scenario, the forestry sector will experience continued loss of forest capital along with reduced forestry production.

This reduction will be significantly mitigated by the increased forest areas from green investments in reforestation and valorisation of non-timber forest products. The mitigation will be furthered with investments in the energy sector (in reduced use of wood for energy) and in agriculture sector where intensification and soil recovery will lessen pressure on forestland, as discussed above.

Furthermore, the agricultural sector will also benefit from environmental investment in construction of dams that will increase water supply for cultivation activities and expand irrigated area, subsequently reducing vulnerability of the agricultural sector to climate change. On the other hand, this may well cause eminent water deficiency in other sectors.

Energy and Emissions

In the Green Economy scenarios, the energy sector will witness both the promotion of renewable energy and the replacement of traditional combustibles on the supply side and energy efficient buildings on the demand side. The share of electricity generation from renewable sources increases significantly in the order of 20% in 2012 to 60% in 2050, in the green scenarios.

Additionally, the use of traditional combustibles designed for cooking will be gradually phased out credit to the installation of solar cookers and improved cookers as well as to the use of gas for domestic energy sources.

On the demand aspect, the green investments aspire at promoting energy efficient buildings, particularly in improving air conditioning, which would result in a net total saving of electricity for air conditioning of almost 1 billion kWh.

Despite the higher electricity demand, the Green Economy policies of expanding electricity supply from renewables will lessen the country's dependence on electricity imports (with net imports cut by half by 2050) and improve energy security.

Primarily driven by the steadfast economic development, total CO₂ emissions from fossil fuel consumption will be higher in the Green Economy

than the BAU scenarios by 10%. However, when considering CO₂ emissions per unit of GDP produced, emission intensity is 10% below with respect to the BAU.

Poverty reduction and other social indicators

With the implementation of Green Economy strategies, the proportion of population below poverty line is expected to decline below 20% by 2030, which will be 4% lower than the baseline by 2050, meaning over a million additional people will be lifted out of poverty. This is attributed to the positive influence of green investments, exemplified by higher real per capita national income.

The Green Economy scenarios will also stimulate total employment, reaching 27.6-27.7 million by 2050, thus creating 0.16 million more jobs than the corresponding BAU scenarios.

The lower poverty rate and more employment will potentially reduce engagement of the local population in the informal mining sector that is driven mainly by paucity. In the interim these informal jobs may be relocated to new positions in renewable energy or other green sectors.

With the increased crops productivity and harvested area under the Green Economy scenarios, the average cereal production per capita (as a proxy for nutrition level) will increase significantly by 30% (Medium B1-GE scenario) and 50% (10 centile A2-GE scenario) by 2050 as opposed to the current level, an increase of 26% compared to the BAU scenarios. Additional benefit of elongated life expectancy by 1.2-1.3 years by 2050 than the BAU scenarios is projected, thus reaching 68.1-68.5 years on average.

Moreover, the number of school entrance will increase marginally (1% in 2050), allowed by higher education expenditure per capita (allowed by higher GDP and thus total government expenditure) and average household income level.

In summary, the combination of green investments in sustainable agriculture production, in sustainable use along with preservation of natural resources (land and energy in particular) and in climate change adaptation measures will lead to significantly stronger growth not only in the invested sector but also in the

overall economy. These investments will also reduce the country's dependence on environmental resources or foreign imports and its vulnerability to potential climate change impacts. Further efforts would be needed to mitigate the increasing demand for resources driven by stronger economic development in the longer term. Additional social benefits such as reduced poverty rate and improved average income level, increased employment, improved nutrition, health and education, among others, are also observed.

THE ROLE OF GOVERNMENT

The state has a crucial role to play in the transition of Burkina Faso to a Green Economy. Along with creating an amiable environment for securing financing from both public and private sectors, the Government should also ensure the implementation of a range of complementary policies and programmes in the identified priority sector. The aim is to create the necessary incentives to stimulate the private sector and to change people's perceptions.

TOWARDS A GREEN ECONOMY

Burkina Faso is expected to generate multidimensional benefits from green investments. To kick-start its transition to a Green Economy, the country can take advantage of different financing instruments or programmes that have already been initiated or in the process of initiation both at the national and international levels. It is therefore important for Burkina Faso to prioritise the establishment of a coherent policy framework, increasing green investments, developing the market for green products and improving the communications with the public.



1 INTRODUCTION

1.1 GREEN ECONOMY IN THE CONTEXT OF BURKINA FASO

With a per capita gross domestic product (GDP) of US\$1,298,¹ Burkina Faso has a major challenge in strengthening the foundations of its socio-economic development. At the same time, the country is experiencing some severe loss of natural resources, for instance degradation of land and water resources, soil erosion and deforestation. Constant flooding and cyclic droughts, shortage of energy and significant economic costs further compound these. Faced with these challenges, the Government of Burkina Faso has taken several national-level initiatives, for instance the Strategy of Accelerated Growth and Sustainable Development (SCADD) and the National Environment Investment Plan for Sustainable Development (PNIEDD). In conjunction with the aforesaid, Burkina Faso's Ministry of Environment and Sustainable Development (MEDD), in collaboration with the United Nations Environment Programme (UNEP) by means of technical assistance from the Millennium Institute, MEDD has embarked on a Green Economy Assessment to support governmental policies aiming at achieving a sustainable development with low dependence and impacts on the environment.

Undeniably, greening the economy appears to be the most appropriate pathway for Burkina Faso, to ensure sustainable development and poverty eradication. This assumption is in line with how UNEP conceptualizes 'Green Economy': it is a system of economic activities related to the production, distribution and consumption of goods and services that result in "improved human wellbeing and social equity, whilst significantly reducing environmental risks and ecological scarcities" (UNEP, 2011). Green investments in key sectors of a country generate growth and gains in natural capital, produce higher GDP growth, create new jobs, reduce poverty and overall move the country toward a low-carbon, resource-efficient economy (UNEP, 2011).

The path toward achieving green growth is multifaceted, requiring a clear understanding of this multi-sector issue over a long-term period. Furthermore, priorities vary amongst countries, and it is needed to identify the sectors in order to prioritize and evaluate the effects of investing in Green Economy. For Burkina Faso, this quantitative assessment of the potential impacts of green investment and policies was conducted by the Millennium Institute.

1.2 OBJECTIVE AND STRUCTURE OF THIS REPORT

This Green Economy Scoping Study for Burkina Faso has been prepared under the scope of UNEP's Green Economy Initiative (GEI), which was launched in 2008. The overall objective of this study is to facilitate Burkina Faso to seize the opportunities that transitioning to Green Economy can offer. Based on solid arguments and economy-wide analysis, this study provides a framework for green investments in Burkina Faso, which will kick-start the country's transition towards a low-carbon, resource efficient economy.

Section 2 of this study presents the country profile, which includes Burkina Faso's macroeconomic, social and environmental profiles as well as the country's political and institutional landscape. This is followed by a discussion on the priority sectors that have been identified to play a vital role in greening Burkina Faso's economy. In Section 4, the details of the quantitative analysis, together with the model structure and the greening scenarios are presented. Section 5 describes the scenarios and green policies, whilst Section 6 provides a detailed analysis of the simulation results. Section 7 concludes the study.



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2 COUNTRY PROFILE

Burkina Faso is a land-locked Sahelian country in West Africa, surrounded by Benin in the South-West, Cote d'Ivoire, Ghana and Togo in the South; Mali in the North and Niger in the East (Figure 1). Until 1984, it was known as the Republic of Upper

Volta. The country is governed by a parliamentary republic type of government. Box 1 presents some stylized facts of the country. The latter parts of this section discuss Burkina Faso's economic, social and environmental aspects as well as its policy landscape.

FIGURE 1 GEOGRAPHICAL LOCATION OF BURKINA FASO



Box 1. Stylized facts on Burkina Faso

Area	274.2 thousand km ²
Capital	Ouagadougou
Government type	Parliamentary republic
Legal system	Civil law based on the French model and customary law
Legislative branch	Unicameral National Assembly
Judicial branch	High courts (Supreme Court of Appeals and Constitutional Council) and subordinate courts (Appeals Court, High Court, first instance tribunals, district courts, specialized courts and village courts)
Currency	West African CFA franc (XOF)
Languages	French (official), native African languages belonging to Sudanic family spoken by 90% of the population
Climate	Tropical; warm, dry winters; hot, wet summers
Natural resources	Manganese, limestone, marble; small deposits of gold, phosphates, pumice, salt
Environment (current issues)	Recent droughts and desertification severely affecting agricultural activities, population distribution and the economy; overgrazing; soil degradation; deforestation
Major exports	Gold, cotton, livestock
Major imports	Capital goods, foodstuffs, petroleum
Main trading partners (export)	China 25.9%, Turkey 24.8%, Belgium 5.2% (2012)
Main trading partners (import)	Cote d'Ivoire 17.6%, France 15.2%, Ghana 4.8%, Togo 4.4% (2012)

Source: CIA (2014)

2.1 MACROECONOMIC PROFILE

With a gross national income (GNI) per capita of \$670.00 (Atlas method, current US\$), Burkina Faso is classified as a low income country (World Bank, 2014). However, it has maintained consistently strong macroeconomic performance in spite of multiple shocks and regional uncertainty, with an average growth of 5.9% from 2000 to 2012. Economic activity remained fervent in 2013, with inflation declining on a year-on-year basis as food prices dropped comparative to its pinnacle in 2012.

The current account balance has a deficit of 0.8% of GDP in 2012, but it was projected to increase to 3.5% in 2013 due to the lower international gold and cotton price combined with higher volumes of fuel imported for the generation of electricity. Gold production has grown from negligible amounts in 2007 to almost 40 tons in 2012 making Burkina Faso the fourth-largest gold producer in Africa. In the same year, gold production accounted for 76% of exports, 19% of fiscal revenues and 5.5% of real GDP growth. Table 1 presents a number of key macroeconomic indicators for Burkina Faso.

TABLE 1 MACROECONOMIC PROFILE

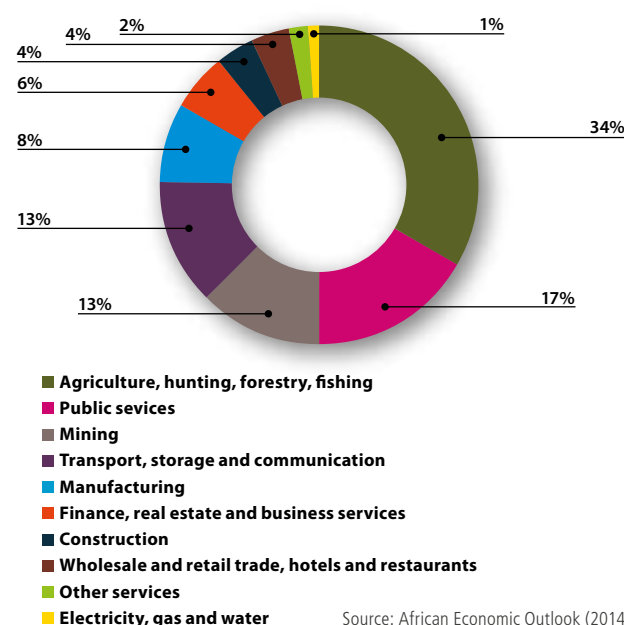
Indicator	Year	Burkina Faso
GDP (2005 PPP \$ billions)	2012	21.4
GDP growth (annual %)	2000-2012	5.9
GDP per capita (2005 PPP \$)	2011	1298
FDI net flows, (% of GDP)	2007-2011	0.37
Current Account Balance (% of GDP)	2010	-1.97
Net Official Development Assistance Received, % of GNI	2012	10.8
Expenditure in Research and Development, % of GDP	2012	0.2
Unemployment rate, % of labour force	2012	3.3
Human Development Index, 0-1 (1=highest)	2012	0.343

Source: World Bank (WDI), UNDP and OECD-DAC

Burkina Faso's economy is dominated by the tertiary sector (43.2% of GDP). The sector is predominantly composed of public services (17.0% of GDP in 2011) and transport and communication (12.6%) (African Economic Outlook 2014) (see Figure 2). Employment in these public services and formal sectors, however, did not exceed 200,000 persons in 2005, whilst the informal sector employs 70% of non-agricultural labours (AfDB and OECD, 2008). The secondary industry is backboned by the mining sector, which primarily extracts gold: enhanced investment increased its share in the national GDP from 0.5% in 2007 to 12.9% in 2011 (African Economic Outlook 2014). However, growth of the sector drastically slowed down to 0.7% in 2012 from 39.4% in 2011 probably due to the depletion of extracted resources as well as the delay in the start of operation in the Bissa Gold Mine. Agriculture is also one of the major economic sectors in Burkina Faso. In 2011, agriculture, together with hunting, fishing and forestry accounted for approximately 34% of the

country's GDP (African Economic Outlook 2014).

FIGURE 2 GDP BY SECTOR



Since mid-2000's, Burkina Faso has experienced a surge in investments, which indicates an improvement in the country's business environment. For example, in 2007, its investment increased by a remarkable 38.4%, especially in mining, telecommunication and real estate sectors (AfDB and OECD, 2008). Subsequent increase in gross fixed capital formation in the private sectors triggered investment growth of 6.7% in 2012 (African Economic Outlook 2014). Several ongoing investments in infrastructure, for instance Donsin Airport and the Bagré Growth Pole, will continuously contribute to the economic growth in 2013 and 2014.

2.2 SOCIAL PROFILE

Growing by nearly 2.9% annually over the last five years, the total population has reached 16.9 million in 2013 (World Bank 2014). A majority of the population inhabits in the rural areas, with over 80% dependent on subsistence agriculture for

their jobs and livelihoods (Schlegelmilch et al. 2010). The rank of Human Development Index in 2012 was 183 amongst 186 countries, whilst the score has slowly improved over the years (UNDP 2014). Labour force over the age of 15 has also steadily increased. The relatively high economic growth has been translated to higher social (poverty reducing) spending, which increased in the order of 30% of total spending. Progress towards MDGs has been notable in several areas, although income and multidimensional poverty are still very high (44.6% and 84%, respectively). In 2012, the government took measures to strengthen social safety nets, especially in the context of the food crisis (involving the subsidized sale of cereals in areas affected by the food crisis). Inequality has also declined, from 46.5% in 1998 to 39.8% in 2009.² Educational attainment is a significant challenge in Burkina Faso, where only 2% of the population has secondary education and only 28.7% of the adult population is literate. Table 2 presents a number of key social indicators for Burkina Faso.

TABLE 2 SOCIAL PROFILE

Indicator	Year	Burkina Faso
Poverty rate, population living under PPP \$1.25 a day	2009	44.6
Multidimensional poverty, population living under multidimensional poverty	2010	84
Adult literacy	2005-2010	28.7
Population with at least secondary education, (% ages 25 and older)	2010	2
Homicide Rate, (per 100,000 people)	2004-2011	18
Under Five Mortality Rate, (deaths per 1,000 live births)	2010	176
Income Gini Coefficient	2009	39.8
Access to electricity (% of population)	2011	13.1
Population, million people	2012	17.5
Urban Population (% of total)	2012	27.4
Total dependency ratio (per 100 people ages 15–64)	2012	90.5

Source: UNDP and World Bank

2.3 ENVIRONMENTAL PROFILE

Burkina Faso faces severe losses of natural resources, for instance degradation of land and water resources, soil erosion and deforestation.³

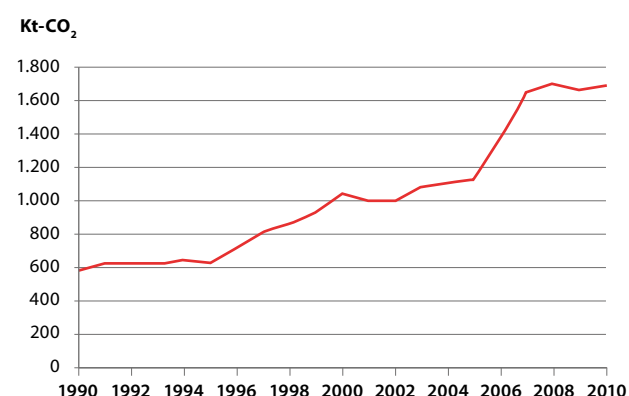
Constant flooding further compounds such dynamics and cyclic droughts, causing famine, lack of energy and significant economic costs. Table 3 presents a number of key environmental indicators for Burkina Faso.

TABLE 3 ENVIRONMENTAL PROFILE

Indicator	Year	Burkina Faso
CO ₂ emissions per capita (t-CO ₂)	2010	0.1
Carbon dioxide emissions per capita (average annual % growth)	1970-2008	4.2
Forest area (% of land area)	2010	20.6
Forest area (% change)	1990-2010	-17.5
Fresh water withdrawals (% of total renewable water resources)	2003-2012	7.9
Endangered species (% of all species)	2011	2.7
Agricultural land (% of land area)	2009	43.7
Ecological Footprint, global hectares per person	2007	1.32
Biocapacity, global hectares per person	2007	1.3

Source: World Bank (2014), UNDP and Global Footprint Network

Accompanying with the rapid economic and population growth, total CO₂ emissions has increased from 587 kt-CO₂ in 1990 to 1,683 kt-CO₂ in 2010 (see refer to Figure 3), whilst CO₂ emissions per capita still remains low at 0.1 t-CO₂ per person in 2010 (the 14th lowest in the world) (World Bank 2014). 60% of Burkina Faso's GHG emissions can attribute to land and forest degradation (AfDB 2014). The PM10 concentration has decreased from 144 mg/m³ in 1990 to 64 mg/m³ in 2010 in spite of steady urbanization (ICPD 2014), while the amount of collected municipal waste has increased from 246 thousand tonnes in 1996 to 666 thousand tonnes in 2009 (UNSD 2014).

FIGURE 3 TOTAL CO₂ EMISSION

Source: World Bank (2014).

Long-term average renewable water resources in Burkina Faso are estimated as 12.5 billion m³ per year (FAO 2014a). Considering the total freshwater withdrawal (i.e. approximately 1.0 billion m³ in 2011) and the share of agricultural sectors (i.e. 70% of

total water withdrawal), agriculture sectors consume 5.6% of the national available water resources. In the mid-and-long term, water intensity (in m³/GDP) in agricultural sectors has been reduced. Irrigated areas have expanded rapidly from 24.3 thousand hectares in 1992 to 54.3 thousand hectares in 2011 (FAO 2014a) as a result of policies, action plans and support by the dam construction to accelerate growth and secure food self-sufficiency. Consequently, the total water withdrawal more than doubled from 0.4 billion m³ in the 1990s to 1.0 billion m³ in the 2000s (World Bank 2014). By 2025, the level of withdrawal may reach 2.0 billion m³ (SHI and UNESCO 1999). Meanwhile, available water resources have decreased due to siltation and dryness of domestic basins and lakes that are caused by agriculture and inappropriate water use as well as water pollution that are triggered by the use of chemical fertilisers and pesticides in cotton production (Bambio 2013). The issue of water stress in Burkina Faso will be exacerbated and severer competition of water use between domestic and agricultural sectors can be anticipated.

Together with overexploitation of fuel woods, expanding agricultural lands from 35% of national territory in 1990 to 44% in 2010 gives serious pressure on forest covers, which have shrunk from 25% to 20% over the last 20 years (World Bank 2014). Extensive farming practice has negative impacts on soil fertility and caused water and wind erosion by 50% and in addition to 20% of the country terrain respectively (Bambio 2013). Approximately 19% of the land is unsuitable for

any types of agricultural practices and 10 % is inappropriate for farming due to lack of rainfall.

2.4 POLICY AND INSTITUTIONAL LANDSCAPE

To address the country's socio-economic and environmental challenges, the Government of Burkina Faso recognizes the need to sustainably manage the environment for socio-economic development. A national long-term vision study entitled "Burkina 2025," was endorsed since 1995 with the support from its technical and financial partners. Aiming for building a nation of solidarity, progress and justice under the Vision for Burkina Faso's Future to 2025, the Poverty Reduction Strategy Paper (PRSP) was implemented between 2000 and 2010. Thereafter, A Strategy for Accelerated Growth and Sustainable Development 2011 – 2015 (SCADD) was adopted

(OECD, 2013). In order to achieve the Millennium Development Goals (MDGs) by 2015, the SCADD formulated eight relevant targets including the achievement of a real GDP average growth rate of 10% (IMF 2012). Additionally, the Government adopted the National Environment Investment Plan for Sustainable Development (PNIEDD) for the period of 2013 to 2017 to support the operation of SCADD.

Development of the pillars of accelerated growth was identified as one of four key strategies under the SCADD, focusing on the promotion of growth pole, the development of promising sectors and promotion of niche business clusters along with the promotion of pro-poor growth to effectively eliminate poverty (IMF 2012). Potential areas for growth poles, including agro-poles, mining areas, a special economic zones, etc., will be identified and financially supported by the government once they are selected with a view to attract internal as well external investors.



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In doing so, establishment of a promotion fund and a coherent framework-involving key stakeholders will be undertaken. Intended for reinforcement, the most promising sectors and niches (i.e. agriculture, crafts, forestry, wildlife and sanitation), dynamic networks amongst companies and business structures will be investigated based on the existing action plans and recommendations for a number of sectors. With a goal to promote pro-poor growth, the Government will identify and implement measures to create jobs and provide higher income to the underprivileged, especially in the sectors of agriculture, infrastructure and craft.

Energy supply remains one of the most binding constraints to growth in Burkina Faso, whilst implicit subsidies create ongoing fiscal liabilities. However, authorities plan to accelerate interconnection with grids in Ghana and Niger, as well as expand domestic thermal-generation capacity and making the tariff schedule more progressive.⁴

Overall, Burkina Faso has already taken several initiatives that are already in the direction

toward a low carbon economy. To further assist the Government in this transition, the Burkina Faso Ministry of Environment and Sustainable Development (MEDD), in collaboration with the United Nations Environment Programme (UNEP), have initiated a Green Economy Assessment to support government policies with the objectives of achieving a sustainable economic development with low dependences and impacts on the environment, which also contributes to social equity.

To understand and analyse this intricate multi-sector and long-term concern, the Millennium Institute (MI) was commissioned to conduct a quantitative assessment of the potential impacts of green investment and policies in Burkina Faso, using an integrated and dynamic tool, the Threshold 21 (T21) model. Ahead of developing the model, a consultation workshop between national stakeholders and the MI experts was held in May 2013 to identify the main objectives, priority green sectors and major policies in the country for transition to a Green Economy.



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3 PRIORITY SECTORS

The current scoping study on Burkina Faso's Green Economy focuses on six priority sectors: agriculture, livestock, forestry, water, energy and mining. The sectors were not chosen randomly. A consultation workshop with relevant stakeholders was organized in May 2013 to identify the key sectors that have the potential to contribute in the country's economic growth, job creation, reduction of poverty, along with overall transition to Green Economy. Through a participatory approach, the key stakeholders have identified the aforementioned six priority sectors. A brief overview of these sectors, discussing their importance in Burkina Faso's economy and the challenges they face, is presented below.

3.1 AGRICULTURE

The agriculture sector plays a critical role in all the aspects of Burkina Faso's economy, society and environment. Despite the fact that this sector's contribution to the country's overall growth decreased from 4.6% in 2012 to 1.9% in 2013, the agriculture sector still accounted for the highest share (19%) in the country's total GDP in 2013 (African Development Outlook, 2014). The major agricultural products include cotton, peanuts, shea nuts, sesame, sorghum, millet, corn, rice and livestock (CIA 2014). The productivity of agriculture, expressed by value added per worker; conversely, is substantially low; US\$308.00 (in constant value of 2005 US\$) (World Bank 2014).

The Agriculture sector employs as high as 90% of the total working population (Millennium Institute, 2012). The sector, nevertheless, has large impacts on natural resource use (i.e. 70% of the total freshwater withdrawal is consumed by agricultural sectors in 2011). The Agriculture sector is extremely vulnerable to weather volatilities; diminutive rainfall in many parts of the country was the major reason behind the poor performance of this sector in 2012. Whilst the country has potential for the agriculture sector development, the sector confronts several growth-delay challenges including inadequate access to land, agricultural inputs, poor infrastructure and financing,

inadequate agricultural extension and degradation of natural resources (OECD, 2013).

3.2 LIVESTOCK

As a rural-based low-income economy, Burkina Faso relies quite significantly on livestock, which accounted for 7.5% of the country's GDP in 2005. In 2011, the density of livestock in the country was 6.12 per hectare, with poultry birds comprising almost 56% of total (FAOSTAT, 2014). The density and type of livestock are important indicators of emission of nutrients as well as GHGs, pressure on agricultural land and impact on the environment. In Burkina Faso, nearly all the livestock is maintained by the underprivileged section of the society, i.e., pastoralists and smallholder farmers. Improving this sector, therefore, can contribute to improving the country's poverty situation (FAO, 2005). Major concerns in this sector include, amongst others, the depletion of grazing resources as a consequence of climatic issues, for instance droughts and floods, overgrazing which may also lead to the degradation of soil and the outbreak of animal diseases such as swine flu (Millennium Institute, 2012).

3.3 FORESTRY

In Burkina Faso, the forestry sector plays a major economic, social and cultural role. Back in 2000, forest area covered 62,480 km², which was in the region of 23% of the country's total land area (World Bank, 2014). However, a decreasing trend is clearly discernible; by 2011, forest coverage came down to 55,890 km², or over 20% of land area. Deforestation rate as of 2012 stands at 107,626 ha/year (Ministry of Environment and Sustainable Development, 2012). According to Burkina Faso Ministry of Environment and Sustainable Development, the core rationale behind this rapid deforestation and degradation of forest is agricultural expansion, overgrazing and over-exploitation of wood for energy (Ministry of Environment and Sustainable Development, 2012). Deforestation is further aggravated by the country's

rapid population growth. It is also anticipated that changes in rainfall patterns and temperatures are likely to generate anthropogenic deforestation, with adverse impacts on forest ecosystems and rural population who depend on forest for their livelihood. Underscoring the gravity of the problems, Burkina Faso launched its Reducing Emissions from Deforestation and Forest Degradation (REDD) programme in 2010 and the Readiness Preparation Plan for REDD was completed in 2012.

3.4 WATER

Burkina Faso is a water-scarce country and faces challenges in ensuring access to water for its population. Despite some progress in achieving its Millennium Development Goals (MDGs), as of 2011, 20% of its total population and 26% of the rural population, do not have access to improved water sources (World Bank, 2014). Renewable internal freshwater resources per capita for the same year are roughly 781 cubic metres. Water-borne diseases are prevalent in communities devoid of adequate access. However, the country is likely to confront even more aggravated water-related challenges in future. The Sahelian region of Africa, where most of the population is located, is facing a declining trend in rainfalls, resulting in more intense draughts and flooding during heavy rain which affect rainfall-dependent agriculture and livelihood. This has already been the root cause for rural to urban migration in Burkina Faso (USAID, 2010).

3.5 ENERGY

Burkina Faso's energy situation is characterized by low level of per capita energy consumption, which was 0.180 TOE in 2008 (Millennium Institute, 2012). Since 2012, only 13.1% of the total population had access to electricity, worsening from 14.6% in the preceding year (World Bank, 2014).

More than 80% of the country's energy supply comes from biomass, mostly firewood and charcoal. The situation is more severe in the rural areas where almost all the consumed energy is based on biomass. At present, firewood consumption is as high as 0.69 kg per person per day (IRENA, 2014). The use of alternative energy, basically LPG, is limited to urban

areas and persistently very low – only 0.4% of urban consumption.

Overall, the energy system of Burkina Faso appears to be based on unsustainable natural resources. Thus, climate change is a major concern for the country's energy sector, because the production, processing, transportation, distribution and consumption of energy in the current manner will produce alarming levels of gaseous, liquid (Millennium Institute, 2012).

3.6 MINING

The mining sector is an essential component in Burkina Faso's economic and social development in addition to playing an important role in the national economy. With its rich natural resources, the country is emerging as one of the most attractive destinations for mining in Africa (Vankempen, 2013). The contribution of gold industry to the economy is substantial and growing; its share in the GDP was in the order of 4% (including informal activities in 2011 (UNDP/UNEP, 2011). The production of gold continued to increase. In 2009 gold constituted 43% of the country's exports, making it the leading source of foreign earnings. The gold industry generates 9,000 direct and 27,000 indirect employments. The other minerals exploited in Burkina Faso include cement, dolomite, granite, marble, phosphate rock, pumice with related volcanic materials and salt (Bermúdez-Lugo, 2009). As of 2012, the mining sector accounts for 12.7% of Burkina Faso's total GDP (Kabore, 2012). A number of new mining projects have opened or are expected to open over the years following 2012. The Government estimates that the contribution of the mining industry to GDP could double by 2015 (Kabore, 2012).

However, the mining industry also generates negative impacts on Burkina Faso's environment and natural resources. According to a study, the costs of environmental damages (water, soil, inefficiencies) from the gold industry alone could be in the region of 0.28% of the country's national GDP (UNDP/UNEP, 2011).

4 METHODOLOGY AND MODEL TECHNICAL SPECIFICATIONS

4.1 OVERVIEW OF MODEL STRUCTURE

The Threshold 21 (T21) is a System Dynamics based model designed to support integrated long-term national, regional and global development planning. The model integrates in a single framework, the economic, the social and the environmental aspects of development. Its transparency and level of aggregation make it ideally suited to support comprehensive analysis of different governmental strategies. T21 can also serve as a complement to budgetary models and other short-medium term planning tools by providing facilitating the alignment of such tools with the longer-term development goals of the country.

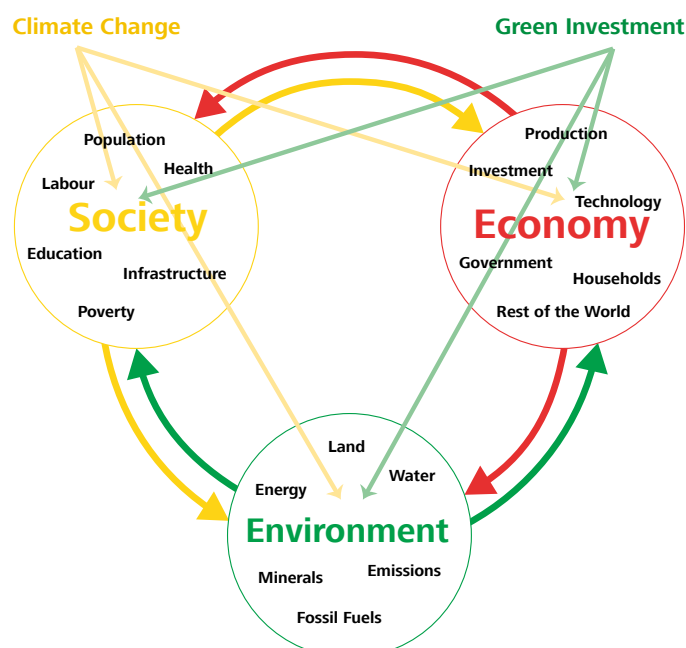
The T21 model for Burkina Faso is further expanded to disaggregate the specific priority sectors (such as a disaggregated mining sector from other industries); to represent the green policies analysed in this report (as is in section 3.2); and to include the impacts of climate change in the model.

The Green Economy components have been incorporated for this study through a participatory

process with a variety of stakeholders by expanding the priority sectors and adding the green policies in the model (see Appendix 1 for a list of stakeholders and representatives and Appendix 2 for the causal diagram of the agriculture sector that are developed with the stakeholders at the workshop). In addition, the effects of climate change were added to the model through consultation with national experts.

The T21 model Burkina Faso – GE not only integrates direct effects of climate change and green policies in the integrated structure, but also indirect effects in all sectors are taken into account. In other words, a change caused by a direct effect – for example in the area of the water in the environmental sphere – affects other variables in other areas such as agriculture (in the sphere of economy), which in turn affects poverty (in the social sphere). Therefore, the initial effect propagates through the system, whilst creating potential feedback effects. Figure 4 below provides a high level representation of the integrated structure of the model.

FIGURE 4 OVERVIEW OF THE INTEGRATED STRUCTURE OF T21 MODEL BURKINA FASO – GE



Source: Authors.

4.2 SECTORS OF THE T21 BURKINA FASO – GE

The T21 Burkina Faso – GE model is composed of more than thirty dynamically interacting sectors, which are further grouped into three main spheres

– society, economy and environment – along with other sectors to estimate key indicators and to embody the climate change concerns and Green Economy policies. Table 4 provides an overview of the spheres and their sectors in the T21 – Burkina Faso.

TABLE 4 SECTORS AND SPHERES OF THE T21 BURKINA FASO – GE MODEL

SOCIAL SPHERE	ECONOMIC SPHERE	ENVIRONMENTAL SPHERE
Population Sector 1. Population 2. Fertility 3. Mortality**	Production Sector 11. Aggregate production & income 12. Agriculture 13. Agricultural green policies* 14. Livestock & forestry production 15. Industry (other than mining) 15b. Mining* 16. Services (other than tourism) 16b. Tourism*	Land Sector 24. Land** 25. Traditional energy use*
Education Sector 4. Primary education		Water Sector 26. Water demand 27. Water supply 27b. Dams*
Health Sector 5. Access to basic health care 6. Health & Climate*		Electricity Sector 28. Electricity demand** 29. Electricity supply 29b. Renewable electricity*
Infrastructure Sector 7. Infrastructure	Households Sector 17. Households accounts	
Labour Sector 8. Employment** 9. Labour availability	Government Sector 18. Government revenue** 19. Government expenditure** 20. Public investment & consumption 21. Gov. balance & financing 22. Government debt	Fossil Fuel Sector 30. Oil & gas demand 31. Oil & gas supply
Poverty Sector 10. Income distribution		Emissions Sector 32. Fossil fuel & GHG emission
INDICATORS 33. MDGs 34. HDI & GDI 35. Development Indicators*	ROW Sector 23. Balance of payments	CLIMATE CHANGE & GREEN POLICIES 35. Climate change impacts* 36. Floods* 37. Green Economy policies*

Note: The sectors with * are additional sectors for T21 Burkina Faso – GE; the sectors with ** are existing sectors with additional components for T21 Burkina Faso – GE

Source: Authors.

➤ The **social sphere** contains detailed population dynamics organized by gender and age cohort. Fertility is a function of the level of income and education. Mortality rates are determined based on the level of income and the level access to basic health care. Access to education and health care services, employment and basic infrastructure are also represented in this sphere. Access to basic social services is used – in addition to income – to determine poverty

levels in a broad sense. Social development is highly connected to economic performance. With economic conditions improving, higher expenditure is allocated to health care and education, amongst others, increasing labour productivity and supporting economic growth. The impacts of climate change on health (especially on malaria and meningitis) are added to the model, which further affects life expectancy and mortality rate.

➤ The **economic sphere** contains the main production sectors (agriculture, industry and services), where production is characterized by functions of Cobb – Douglas. The factors of production are resources, labour, capital, technology and inclusive factor productivity. Specific issues, such as mining, tourism, extension agricultural or livestock are normally included in sub-modules of production where relevant. A Social Accounting Matrix (SAM) is used to represent the flow economic and balance supply along with demand in each sector. The Government generates taxes based on economic activity and allocates spending key category. Public spending affects overall economic performance and delivery of public services. Budget standard categories are exploited and the IMF key macroeconomic balances are incorporated in the model in addition to the current account with capital flows (including debt management). The additional green investments in various areas are linked to baseline investment as well as government account sector which tracks the flows of government revenue, expenditure and financing. In addition, the green agricultural policies are added to the model and linked to agricultural productivity. The mining and tourism sectors are disaggregated from the other industry and services sectors.

➤ The **environmental sphere** estimates the stocks of natural resources, both renewable and non-renewable whilst tracking their consumptions and the impact of the depletion of these resources on the production and other factors. The effects of soil erosion and other forms of environmental degradation are also examined as well as impacts on other sectors, such as agricultural productivity and nutrition. For example, the green policies in land recovery are linked to agricultural land, which further affects crops and livestock production. Deforestation or reforestation as well as carbon storage in forests are also captured in the land sector. Other concerns discussed are the supply and demand of fossil fuels, electricity (from renewables and water) with water (including natural resources and dam construction policies. These concerns further affects agricultural productivity) and greenhouse gas emissions. The environmental sphere takes account of cross-sector components of traditional combustible energy consumption that are linked to both energy and forest land sectors.

The simulation of different scenarios using the T21 Burkina Faso – GE model enables integrated assessment of social, economic and environmental impacts of green investments and policies.



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5 DESCRIPTION OF SCENARIOS AND GREEN POLICIES

5.1 SCENARIOS DEFINITION AND UNDERLYING ASSUMPTIONS

Based on discussions with the stakeholders at the consultation workshop in Burkina Faso in May 2013 (See Appendix), four scenarios are simulated as in

bi-dimensional matrix described in Table 5. The two dimensions considered are: (1) policy implementation: business-as-usual (BAU, or baseline) scenarios or green investment scenarios and (2) climate change: intermediate climate change (medium B1) scenario or worst-case climate change (10 centile A2) scenarios (IPCC, 2007).

TABLE 5 FOUR SCENARIOS SIMULATED IN THIS ANALYSIS

Scenarios	BAU policies	Green policies
Intermediate climate change (medium B1)	Intermediate climate change scenario with no green investments	Intermediate climate change scenario with green investments
Worst-case climate change (10 centile A2)	Worst-case climate change scenario with no green investments	Worst-case climate change scenario with green investments

More specifically, the four scenarios simulated include:

- 1. Medium B1-BAU** scenario (Intermediate climate change scenario with no green investments): assuming intermediate global climate change scenario (Medium B1), with continuation of current trends and no changes in the policies planned
- 2. Medium B1-Green** scenario (Intermediate climate change scenario with green investments): assuming intermediate global climate change scenario (Medium B1), with additional 2% of GDP for green investment from 2013 to 2050
- 3. 10 centile A2-BAU** scenario (Worst-case climate change scenario with no green investments): assuming worst-case global climate change scenario (10th per centile A2), with continuation of current trends and no changes in the policies planned
- 4. 10 centile A2-Green** scenario (Worst-case climate change scenario with green investments): assuming worst-case global climate change scenario (10th per centile A2), with additional 2% of GDP for green investment from 2013 to 2050

Based on discussions at the consultation workshop, all the additional green investments (of 2% of GDP per annum between 2013 and 2050) in the green

scenarios above are assumed to be funded by public investment, which are financed through additional grants. The additional investment in the green scenarios is distributed across the selected green sectors as discussed in section 3.2.

5.2 SECTOR-SPECIFIC GREEN POLICIES

Green investments are allocated across the six identified priority sectors, with the goal of reaching strong economic growth yet taking into account environmental objectives. The shares of allocation of green investments to each of these sectors are presented in Table 6.

TABLE 6 GREEN INVESTMENT ALLOCATION BY SECTOR

GE sector	Green scenarios
Crop cultivation	40%
Livestock	15%
Forestry	5%
Water	5%
Energy	30%
Mining	5%
Total	100%

Source: Authors.

For each of these sectors, key policy areas have also been identified. The major policy areas in each sector are listed in Table 7.

Due to the integrated characteristics of the model, the investments in the priority sectors will further affect the other sectors, such as health and poverty among others, because of cross-sector relationships.

TABLE 7 POLICY AREAS IMPLEMENTED IN THE GREEN SCENARIOS

Sector	Policy
Crop cultivation	Substitution of chemical fertilizer and pesticide with natural fertilizers and bio-pesticides
	Promotion of agricultural extension services
	Reduction of agricultural land degradation
Livestock	Intensification of livestock
	Reduction of grazing land degradation
Forestry	Reforestation
	Valorisation of non-timber forest products
	(Reduced use of wood energy, as direct effect of Energy sector policies)
Water infrastructure	Construction of dams and irrigation infrastructure
	Renewable electricity: solar PV and hydropower
Energy	Reducing consumption of traditional combustibles by installing solar cookers or improved cookers, or using gas for cooking
	Energy efficient buildings that save electricity for air conditioning
Mining	Contributing to promote renewable electricity

Source: Authors.



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5.3 POLICY IMPACTS IN THE MODEL

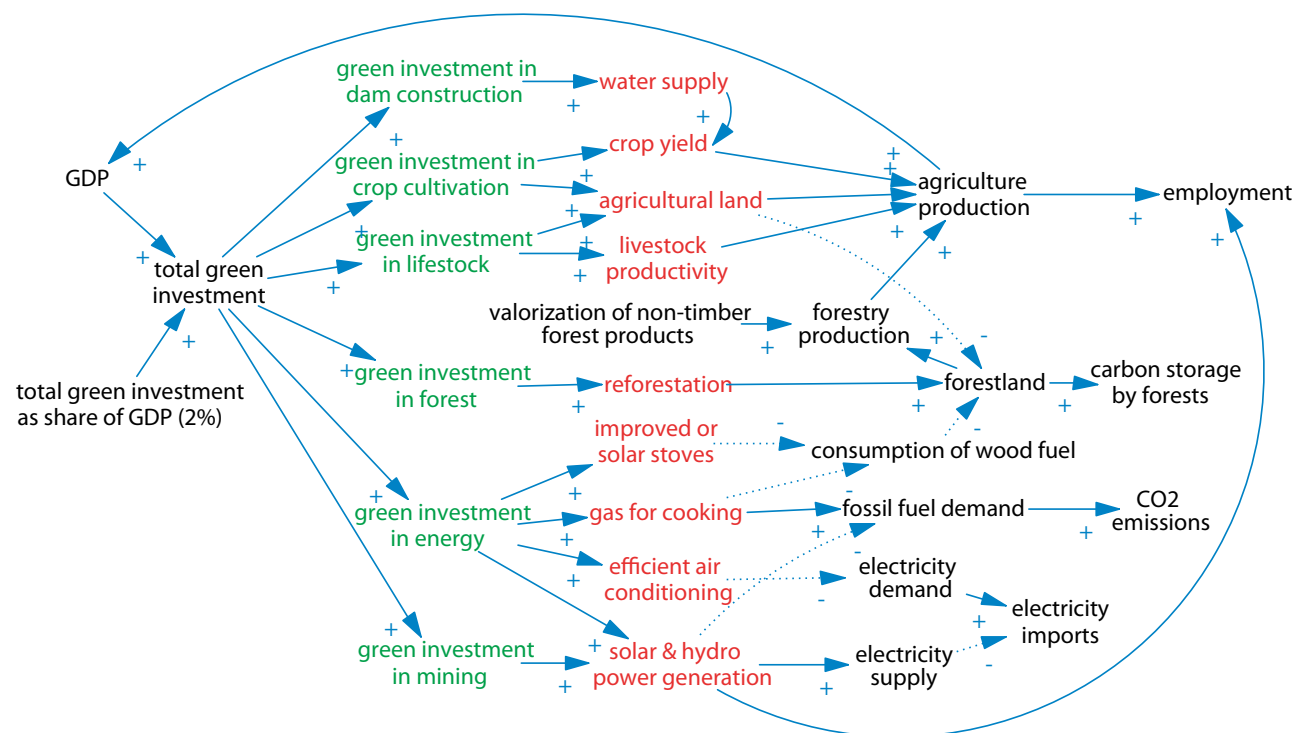
The cross-sector relations in the model allow for inclusion of indirect impacts in the system. Figure 5(a) presents a summary of the principal impacts, direct (linked directly by an arrow) and indirect (linked by a few arrows), of the Green Economy investments with policies that are described above. Therefore synergies and side effects emerging within and across sectors can be identified.

Two examples of policy synergies comprise (1) coupling reforestation with reduced deforestation by means of phasing out fuel wood consumption, thus leading to an increase of forestland. This policy furthers the benefits from reduced expansion of agricultural land from forests credit to agricultural intensification and soil recovery policies; (2) energy availability of the country would be enhanced through both the promotion of renewable energy (higher electricity supply) and energy efficiency measures (lower electricity demand). In addition, the promotion of renewable energy would also contribute to reduced fossil fuel

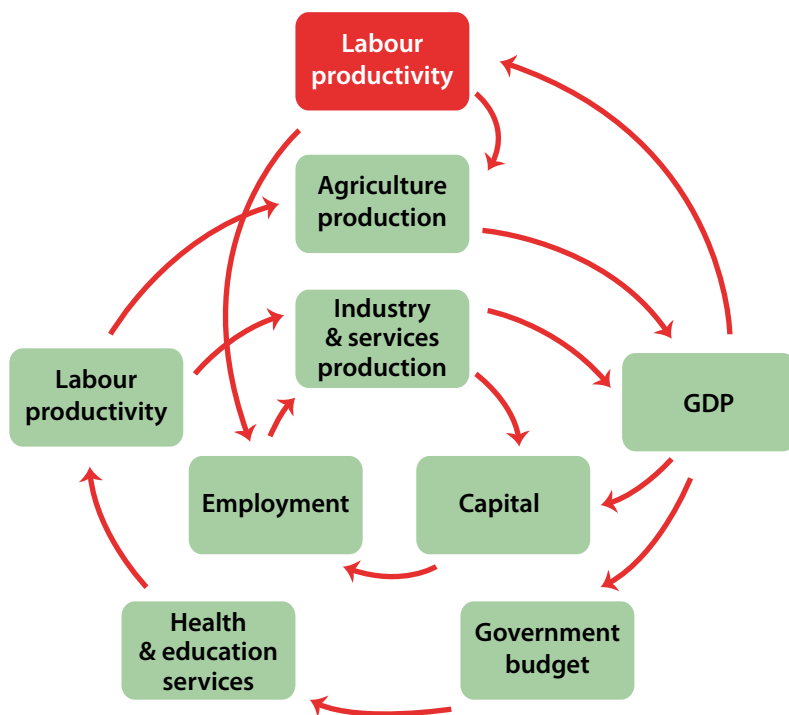
consumption and thus emissions, whilst the larger forest area would increase carbon storage capacity, both of which would potentially reduce carbon concentration in the atmosphere of the country. Other synergies or offsets can be found between agriculture and water sectors.

In addition, the policy impacts are further passed along in the course of interactions across sectors in the model and create feedback loops in the system. Figure 5(b) shows some of the key feedback loops in the system. For instance, green investments would potential increase agriculture production (as is discussed above, amongst other implications) and GDP, which increases not only household income but also Government revenue. The higher Government revenue, positively affects investment and the consequently higher capital level would enhance agricultural and other production sectors. In the meantime, the total Government expenditure, amongst other factors, would potentially increase life expectancy (through health expenditures) and literacy rate (through education expenditures), both of which would have positive influence on labour productivity and thereby sector production.

FIGURE 5 (A) TOP GRAPH: MAIN DIRECT (IN RED) AND INDIRECT IMPACTS OF GREEN ECONOMY INVESTMENTS (IN GREEN) IN THE MODEL; (B) BOTTOM GRAPH: DIAGRAM OF A NUMBER OF KEY FEEDBACK LOOPS IN THE MODEL



Notes:
Plain arrows with "+" symbols represent a positive relation where cause and effect change in the same direction;
Dotted arrows with "-" symbols represent a negative relation where cause and effect change in the opposite direction.



Source: Authors.

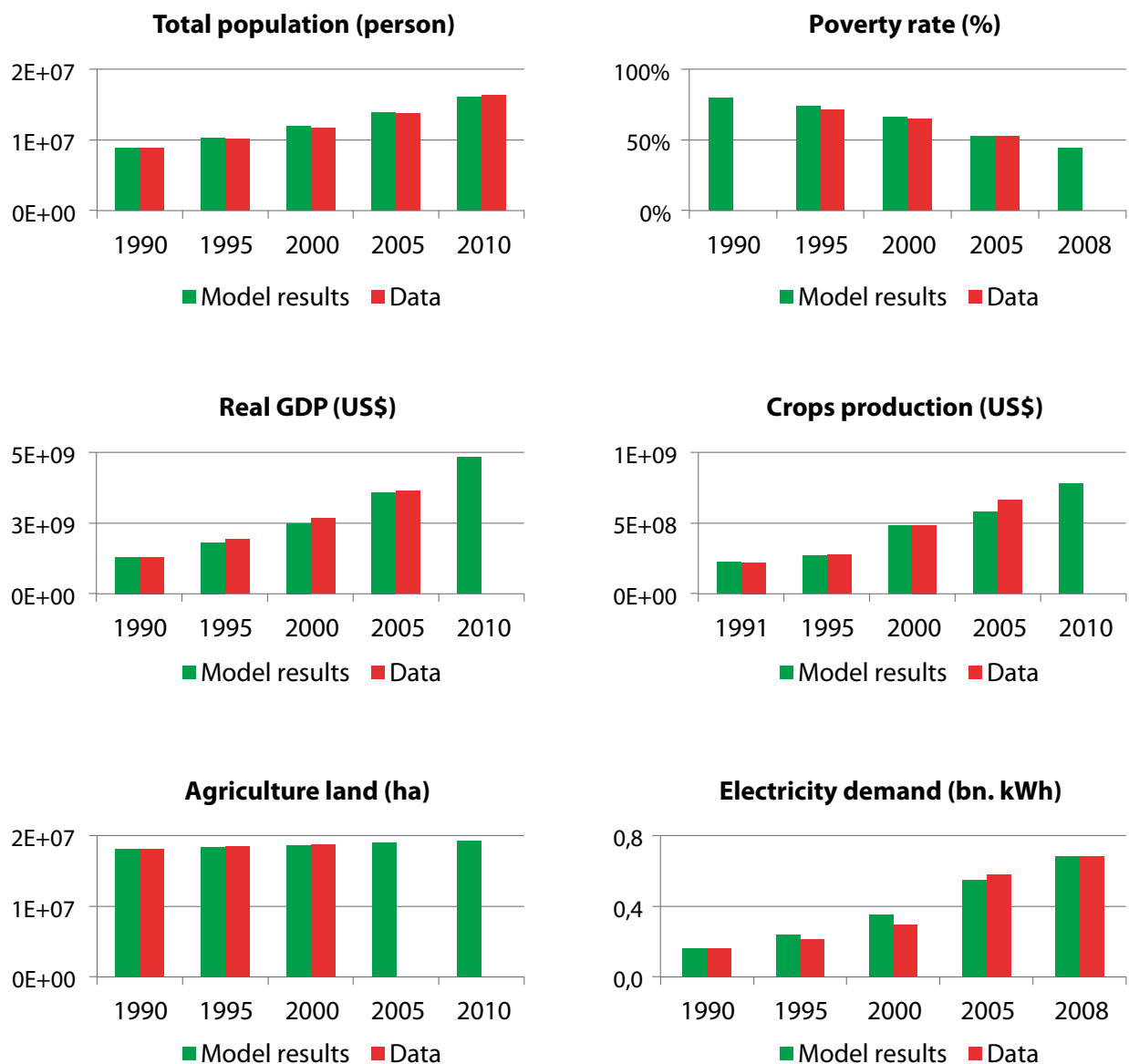
6 ANALYSIS OF SIMULATION RESULTS

6.1 HISTORICAL TRENDS AND MODEL VALIDATION

The model results of key indicators during the historical period (usually from 1990 to 2011) are

compared with the corresponding data for Burkina Faso, to calibrate and subsequently validate the model. A comparison between model results and historical data is presented below for selected key social, economic and environmental indicators.

FIGURE 6 COMPARISON OF MODEL RESULTS OF KEY INDICATORS IN HISTORICAL PERIOD WITH DATA FOR BURKINA FASO



Source: Authors' estimates based on modelling results

As illustrated in Figure 6, total population in Burkina Faso increased by 88% from 8.8 million in 1990 to 16 million in 2011. Total real GDP grew, on average, more than 6% per annum between 1990 and 2001. GDP reached around 5 billion US\$ in 2011 (2001 constant prices),⁵ four times the 1990 level. This led to the decline in poverty rate from almost 80% to below 45% in 1990. The Agriculture sector has been the stronghold of the country's economy, employing more than 90% of total formal employment in the country. Its contribution to GDP increased from 27% in 1990 to 33% in 2011. As the source for food security of the population, crop production have more than tripled from 1990 to 2011, with cereal yield two-thirds higher than the 1990 level. However, being highly vulnerable to climatic impacts, in particular precipitation, the growth of agriculture production and the GDP, experienced high fluctuations during this period.

Pressure on natural resources increase as population and GDP grows. The agricultural land expanded gradually from 18.2 million ha in 1990 to 19.3

million ha in 2011, which is an increase of more or less 55 thousand ha per annum on the average mainly from forest area. Electricity demand increased significantly by five times in this period to reach more than 0.8 billion kWh in 2011, causing growing demands on energy availability and ever-increasing costs of energy imports.

6.2 ANALYSIS OF SCENARIO RESULTS

6.2.1 Overall Economic Development

Comparing the economic development of the four scenarios, GDP will continue to increase at an average annual growth rate of 4.6% (under worst-case climate change – 10 centile A2) and 4.8% (under intermediate climate change – Medium B1) between 2012 and 2050 in the BAU scenarios. The implementation of green policies will cause GDP to reach US\$ 37 billion and 41 billion in 2050 under the 10 centile A2-Green and Medium B1-Green scenarios respectively, 22%-23% above

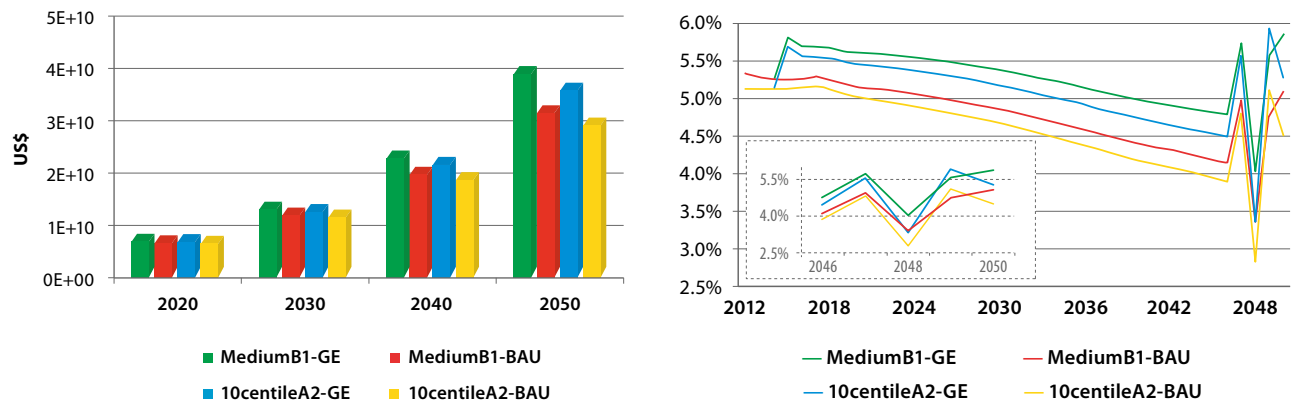


the corresponding BAU cases, with an annual rate of 5.1% and 5.3% on average over the 38-year period. (Figure 7 and Table 8).

As illustrated in Figure 7, in the case of potential economic losses as a result of adverse climate

change impacts, especially the projected fluctuations of precipitation as well as temperature at the end of simulation (2046 – 2050)⁶, GDP growth in the green scenarios is expected to be less volatile than in the BAU scenarios, thus showing sustained recovery.⁷

FIGURE 7 REAL GDP AT MARKET PRICE (RIGHT) AND REAL GDP GROWTH RATE (LEFT)



Source: Authors' estimates based on modelling results



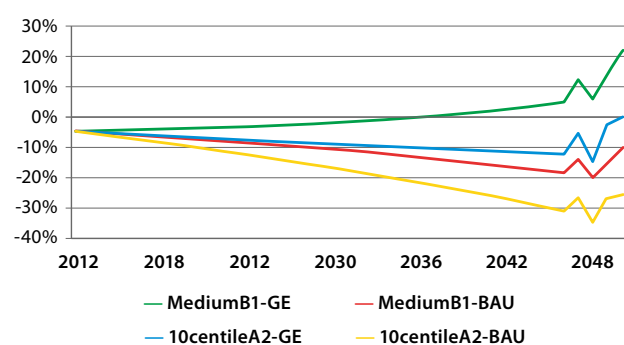
TABLE 8 RESULTS OF REAL GDP AT MARKET PRICE, REAL GDP GROWTH RATE AND REAL GDP PER CAPITA

Scenarios	Real GDP (Billion \$)		Real GDP growth rate (%)		Real GDP per capita (\$/person)	
	2020	2050	2020	2050	2020	2050
Medium B1-GE	8.44	40.49	5.6%	5.9%	389	891
Medium B1-BAU	8.17	32.98	5.2%	5.1%	377	730
10 centile A2-GE	8.33	37.31	5.5%	5.3%	384	823
10 centile A2-BAU	8.07	30.60	5.0%	4.5%	372	679

Source: Authors' estimates based on modelling results

6.2.2 Agriculture and Land

The agriculture sector, which employs close to 90% of the total population, is highly vulnerable to potential climate change impacts, being 30% to 10% below the case of no climate change. However, with the various green investments in the agriculture and environmental sectors, it is possible to mitigate the effects of climate change in the agriculture sector (crop cultivation, livestock and forestry). The intermediate scenario with green investments eventually surpasses the scenario devoid of climate change, as shown in Figure 8.

FIGURE 8 AGRICULTURE PRODUCTION COMPARED TO BAU SCENARIO WITH NO CLIMATE CHANGE


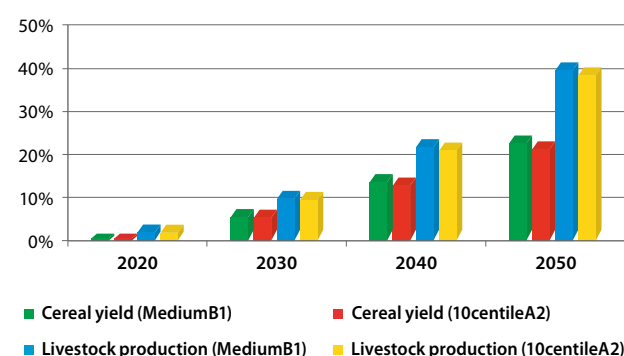
Source: Authors' estimates based on modelling results

By 2050, in the crop production sector, an average of 25% more cereal production will be available to each person in Burkina Faso in the green scenarios, compared to the BAU scenario, due to improved crop yield and reduced land degradation. Such results are achieved through the implementation of agricultural extension services, promotion of organic agriculture and soil recovery. Cereal yield is projected to be at 3.3 and 3.8 tons per ha in the green scenarios in

2050, 23% and 24% above the corresponding BAU cases (Figure 9).

In addition, the recovery of degraded agricultural land in the Green Economy scenarios further reduces the pressure of expanding agricultural areas to feed the growing population, thus contributing to the reduction in deforestation.

The green investments in intensification of livestock and soil recovery will lead to higher productivity of land along with more grazing land available, which will enable livestock production to attain US\$ 47 billion and 58 billion in 2050, more than 40% higher than the BAU scenario (Figure 9).

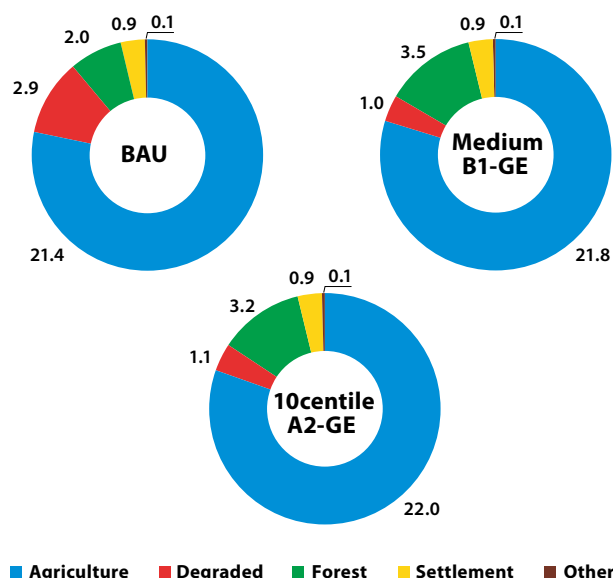
FIGURE 9 CEREAL YIELD AND LIVESTOCK PRODUCTION IN GREEN ECONOMY SCENARIOS RELATIVE TO THE BAU SCENARIO


Source: Authors' estimates based on modelling results

The forestry sector will experience continued loss of forest capital and reduced forestry production in the BAU scenario. This reduction will be significantly mitigated by the forest areas from green investments in reforestation and valorisation of non-timber forest products, along

with investments in energy sector (in reduced use of wood for energy) and in agriculture sector (in agriculture intensification and soil recovery and thus reduced pressure on forestland, as is discussed above) (Figure 10).

FIGURE 10 LAND ALLOCATION IN 2050 (MEASURED IN MILLION HA), IN THE BAU AND THE GREEN ECONOMY SCENARIOS



Source: Authors' estimates based on modelling results

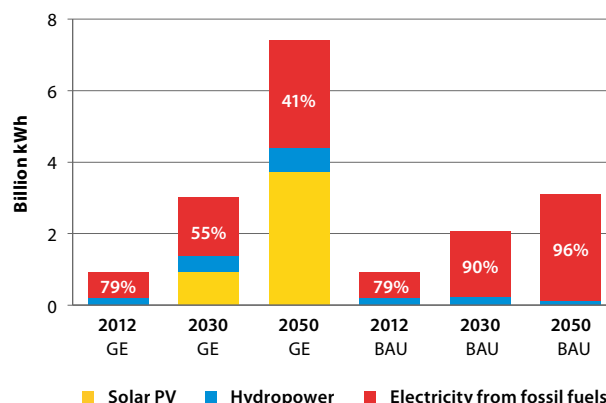
Furthermore, the agricultural sector will also benefit from environmental investment in construction of dams that will increase water supply for cultivation activities and expand irrigated area. The environmental investment in construction reduce vulnerability of the agricultural sector to climate change, nevertheless this could result in eminent water demands in other sectors.

6.2.3 Energy and Emissions

In the Green Economy scenarios, the energy sector will witness the promotion of renewable energy and the replacement of traditional combustibles on the supply side and energy efficient buildings on the demand side.

The investments in green electricity supply would heighten the green energy power generation capacity to 0.19 million kW from hydro and 2 million kW from solar PV by 2050. Thus electricity generation from renewables will be more than 4 billion kWh in 2050 in the green scenarios, as opposed to a mere 0.1 billion kWh in the BAU due to the end of lifetime of power plants. The share of electricity generation from renewable sources increases significantly from nearly 20% in 2012 to 60% in 2050 in the green scenarios (Figure 11).

FIGURE 11 ELECTRICITY SUPPLY MIX (AND % OF POWER FROM NON-RENEWABLES IN PARENTHESES), IN MEDIUM CLIMATE CHANGE (MEDIUM B1) SCENARIOS



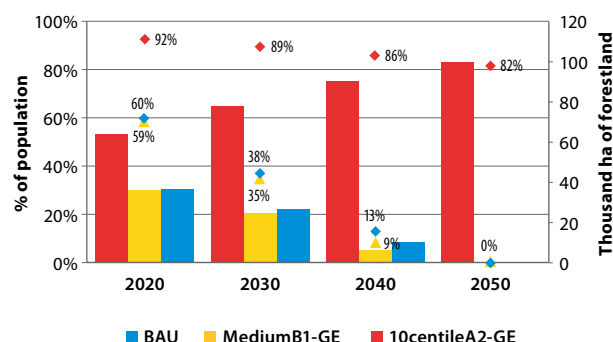
Source: Authors' estimates based on modelling results

© Ollivier Girard for Center for International Forestry Research (CIFOR).



Additionally, the use of traditional combustibles for cookery will be gradually phased out owing to the installation of solar cookers and improved cookers as well as the use of gas for domestic energy sources. Figure 12 shows the proportion of population depending on traditional combustibles and the area of forestland for wood fuel over time. As is illustrated in the figure, implementation of this measure will save up to nearly 100 thousand ha of forest area for wood fuel in the BAU scenarios in 2050, accruing up to 2.2 million ha between 2012 and 2050. Thus, setting up of solar cookers as well as improved cookers will contribute to a reduction of 16-16.5 thousand tons in CO₂ emissions from deforestation in 2050, which offsets the additional 287 tons of CO₂ emissions compared to the baseline due to the increased use of gas for cooking.

FIGURE 12 PROPORTION OF POPULATION USING WOOD FUEL (LEFT AXIS) AND FOREST CLEARING FOR WOOD FUEL (RIGHT AXIS)



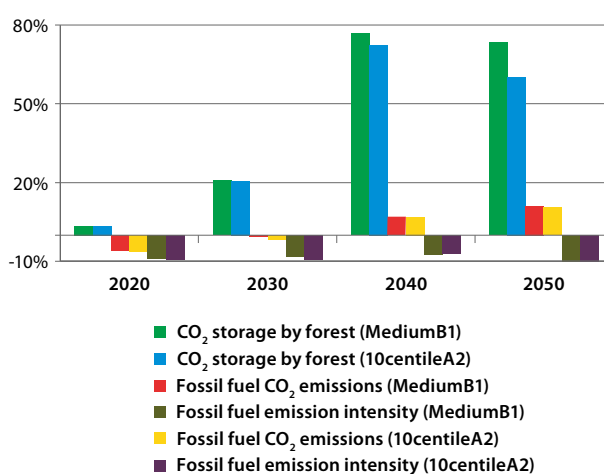
Source: Authors' estimates based on modelling results

On the demand side, the green investments aim at promoting energy efficient buildings, particularly in improving air conditioning, consequential of a net total saving of electricity for air conditioning of virtually 1 billion kWh. However, the effect of economic growth on electricity demand is superior to the demand reduction from efficiency improvements, therefore total electricity demand will still be higher than the BAU scenario.

Despite the higher electricity demand, the Green Economy policies of expanding electricity supply from renewables will diminish the country's dependence on electricity imports (with net imports cut by half by 2050) and improve the energy security though the amount of net import is still expected to increase over time in all scenarios.

Primarily driven by the fervent economic development, total CO₂ emissions from fossil fuel consumption will be higher in the green scenarios (in the region of 8 million tons) than the BAU scenarios (roughly 7 million tons) by 10%. However, when considering CO₂ emissions per unit of GDP produced, emission intensity is 10% below in the BAU case. In addition, the larger forest area in the green scenarios will lead to just about 0.2 million tons of CO₂ storage by forests. (Figure 13)

FIGURE 13 CO₂ STORAGE BY FOREST, EMISSIONS FROM FOSSIL FUELS AND EMISSION INTENSITY, IN GREEN ECONOMY SCENARIOS RELATIVE TO THE BAU SCENARIO



Source: Authors' estimates based on modelling results

6.2.4 Social indicators

By means of the functioning of Green Economy strategies, the proportion of population below poverty line is expected to decline below 20% by 2030, which will be 4% lower than the baseline by 2050. This is attributed to the positive influence of green investments, exemplified by higher real per capita national income.

The Green Economy scenarios will also stimulate total employment, reaching 27.6-27.7 million by 2050, thus creating 0.16 million more jobs than the corresponding BAU scenarios. The lower poverty rate and more employment will potentially reduce engagement of the local population in the informal mining sector, driven for the most part by poverty. Meanwhile, these informal jobs may be relocated to new positions in renewable energy or other green sectors. More data and research on the country's mining sector would be indispensable to estimate the

quantitative implications of Green Economy transition on the mining sector.

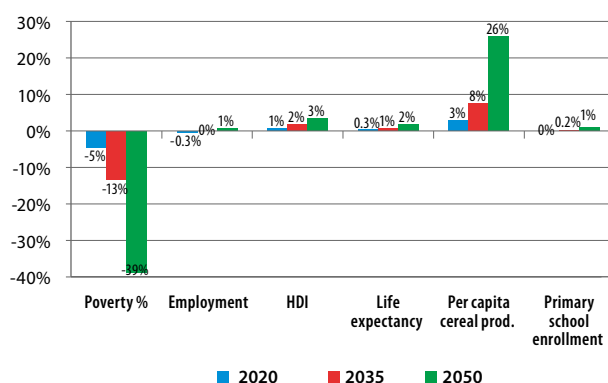
Provided the population's health, credit should be given to the increased crops productivity and harvested area, the average cereal production per capita (as a proxy for nutrition level) will increase significantly by 30% (Medium B1-GE scenario) and 50% (10 centile A2-GE scenario) by 2050 from the current level and by 26% compared to the corresponding BAU scenarios. An elongated life expectancy by 1.2-1.3 years by 2050 than the BAU scenarios is expected in Burkina Faso, reaching 68.1-68.5 years on average.

Additionally, the number of school admission will increase marginally by virtually 1% in 2050, allowed by higher education expenditure per capita (allowed by higher GDP and total Government expenditure) and average household income level.

As a result of these improvements especially in health of the population, Human Development Index (HDI) of Burkina Faso will improve by 3.5%-3.7%.

A comparison of results of these main social indicators discussed above between the Green Economy scenario and the BAU scenario is summarized in Figure 14 below, using the case of a medium climate change (Medium B1).

FIGURE 14 RESULTS OF THE MEDIUM B1-GE SCENARIO RELATIVE TO THE MEDIUM B1-BAU CASE



Selected indicators: poverty (proportion of population below poverty line), employment, HDI, life expectancy, nutrition (cereal production per capita) and education (school enrolment)

Source: Authors' estimates based on modelling results



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7 CONCLUSIONS

Socio-economic development in Burkina Faso is likely to be significantly affected by climate change, despite the fact that GDP will still continue to grow during most years. The implementation of green investments will lead to strong economic growth and will mitigate the vulnerability to climate change, implying lower economic losses.

The agriculture sectors including crop production, livestock and forestry that are the primary source of income and nutrition for the majority of the Burkina Faso population, will largely benefit from green investments. In the worst-case climate change scenario, the green investments will potentially offset the impacts of climate change on agriculture production, whilst in the intermediate climate change scenario such investments are expected to lead to an even more higher production value than in the no climate change scenario. Such higher level of production leads to better nutrition and higher average farmer income as well as lower poverty rate, amongst other positive socio-economic impacts. Increases in agriculture production are driven by improvements in productivity determined by green policies such as the promotion of organic agriculture and extension services, the intensification of livestock, dam construction. The larger supply of agricultural land was made available through the reduction of land degradation, because of reforestation and the reduction of combustion of fuel wood for energy. The improved yield and recovery of degraded land further reduces the pressure of agricultural land expansion from forestland, showing synergy within the (agriculture) sector and across sectors (energy sector).

In the energy sector characterized by high dependence on traditional combustibles and low use of renewables in the BAU scenario, green strategies will bring about more modern and renewable energy supply, which will also lead to electricity saving on the demand side and reduction in electricity imports. Despite the fact that total demand for electricity and fossil fuel, as well as CO₂ emissions from fossil fuel are projected to be higher than the baseline to support the stronger green growth, emission intensity is lower in the more resource-efficient

green scenarios. Furthermore, the larger forest area supports the storage of larger amounts of CO₂.

In terms of social aspects, the green transition in the country will lead to higher level of households' income and lower poverty rate, leading to improved life expectancy, higher school entrance and higher HDI. This, together with job creation in renewable sectors, will also potentially reduce the share of informal employment, in sectors such as mining.

In summary, the combination of green investments in sustainable agriculture production, during sustainable use and preservation of natural resources (land and energy in particular) and along with climate change adaptation measures will lead to significantly stronger growth not only in the invested sector but also in the overall economy. These investments will also reduce the country's dependence on environmental resources or foreign imports and its vulnerability to potential climate change impacts, whilst further efforts would be needed to mitigate the increasing demand for resources driven by stronger economic development in the longer term. Additional social benefits such as reduced poverty rate and improved average income level, increased employment, improved nutrition, health and education, amongst others are also observed.

With reference to data for Burkina Faso not being available on some policy costs and impact coefficients, values from other international sources (for instance job creation multiplier for renewable electricity generation from US studies) or for relevant policies (for instance transition cost from extensive to intensive agricultural system used a proxy for livestock intensification cost) are used. As a result of Burkina Faso's deficiency of specific data on some policies or on the informal mining sector, more research and data collection in these areas would be needed in order to provide more specific and insightful policy recommendations.

NOTES

¹ The data is in 2005 \$, purchasing power parity (PPP). Source: World Bank (WDI 2013).

² See IMF (2014). <http://www.imf.org/external/pubs/ft/scr/2014/cr1443.pdf>. See also <http://www.africaneconomicoutlook.org/en/countries/west-africa/burkina-faso/>

³ Deforestation since 1990 represents a loss of more than 17%. See UNDP (2013).

⁴ See IMF (2014). <http://www.imf.org/external/pubs/ft/scr/2014/cr1443>.

⁵ All real economic values in US dollars are measured in 2001 constant prices.

⁶ The fluctuations shown in the results are caused by the expected increased climate volatility, especially temperature and precipitation extremes. The model used consistent time series of precipitation and temperature data throughout the simulation period, provided by the Laboratoire d'Analyse Mathématique des Équations (LAME) of the Université de Ouagadougou. The future projections are based on the potential results under various climate scenarios using ten climate models by the Université de Cape Town for the three climate zones of Burkina Faso (Dori, Ouagadougou and Bobo-Dioulasso).

⁷ For these variables, we used the observed data for the past (1990 – 2010) and for the future (2046 – 2050) projections from the University of Cape Town handled by BLADE (see Chapter 2).

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APPENDIX

APPENDIX 1. LIST OF PARTICIPANTS OF THE CONSULTATION WORKSHOP IN BURKINA FASO

TABLE 9 PARTICIPANTS AT CONSULTATION WORKSHOP

(a) Day 1

STRUCTURES	NOMBRE	TOTAL
Présidence du Faso - Engagement Nationaux - CAPEs	1 1	2
Premier Ministère Département Economie Rurale et Environnement	2	2
Assemblée Nationale - Commission Environnement et développement(CODE) Commission - Economie et Finance	2 2	4
Conseil Economique et Social	2	2
Ministère de l'Environnement et du Développement Durable Cabinet du MEDD : un Conseiller Technique et le Secrétaire Général - DEP - DCPM - DGFF - Chargé d'étude du SG/MECV - DAJC ARSN CNSF IGS - BUNEE - DGPEDD - APFNL - OFINAP - ENEF - DGPA - Directeur de l'Economie Environnementale et des Statistiques - SP/CONEDD (directeurs et points focaux conventions (CC, BD, LCD, RAMSAR), MDP et DCIM - Présidents Commissions spécialisées CONEDD - IPE - PASF - PIF	2 2 1 3 1 1 2 3 2 2 1 1 2 2 3 1 1 1	31
Ministère de l'Economie et des Finances - Direction Générale de l'Economie et de la Planification - Secrétariat Permanent du Conseil National de la Statistique - HDGCooP - Direction Générale du Budget - Secrétariat Technique National de la SCADD - Secrétariat Permanent de l'Initiative Transparence dans les industries extractives - Secrétariat Technique des Budgets Programmes - INSD - Direction Générale de l'Aménagement du Territoire et d'appui à la Décentralisation - Projet PGRLA - Direction Générale des Impôts - ENAREF	3 1 1 2 2 1 2 4 3 2 1 1 1	24

STRUCTURES	NOMBRE	TOTAL
Ministère des Enseignements Secondaire et Supérieur • UFR FASEG • IDR/Bobo • Labo de mathématique • CEDRES	1 1 1 1	4
Ministère des mines des carrières et de l'énergie • DEP • DG des mines	1 1	2
Ministère de la Recherche Scientifique et de l'innovation • INERA • DEP	1 1	2
Ministère de l'Administration territoriale et de la Sécurité • Direction Générale des Collectivités Territoriales • DEP	1 1	6
Ministère de l'éducation nationale • DEP • Direction générale des statistiques scolaires	2	
Ministère de la santé • DEP • Direction générale des statistiques sanitaires	2	
Ministère des Ressources animales • Direction des Études et de la Planification • Direction générale des pêches et de l'aquaculture	1 1	2
Ministère de l'Agriculture et de la Sécurité Alimentaire • SP/CPSA • Direction des Statistiques agricoles	1 1	2
Ministère de l'Industrie du Commerce et de l'Artisanat • Chambre de Commerce d'Industrie et d'Artisanat • Direction Générale du Commerce	1 1	2
Ministère de la jeunesse, de la Formation Professionnelle et de l'Emploi • Direction générale de la promotion de l'emploi • Direction générale de la formation professionnelle	1 1	2
Ministère de la Promotion de la Femme et du Genre • SP-CONAP	2	2
Ministère de la Culture et du Tourisme • ONT • Direction générale de l'hôtellerie	1 1	2
Ministère de l'habitat et de l'Urbanisme • Direction de l'urbanisme et du foncier • DEP	1 1	2
Ministère des Infrastructures	1	1
Institutions Internationales • UEMOA : Département Environnement et Développement Rural • CILSS • Autorité du Liptako Gourma	1 1 1	3
ONG/Associations/ Projets • NATURAMA • AMBF • PNGT • SPONG • Confédération Paysanne du Faso	1 1 2 1 1	6

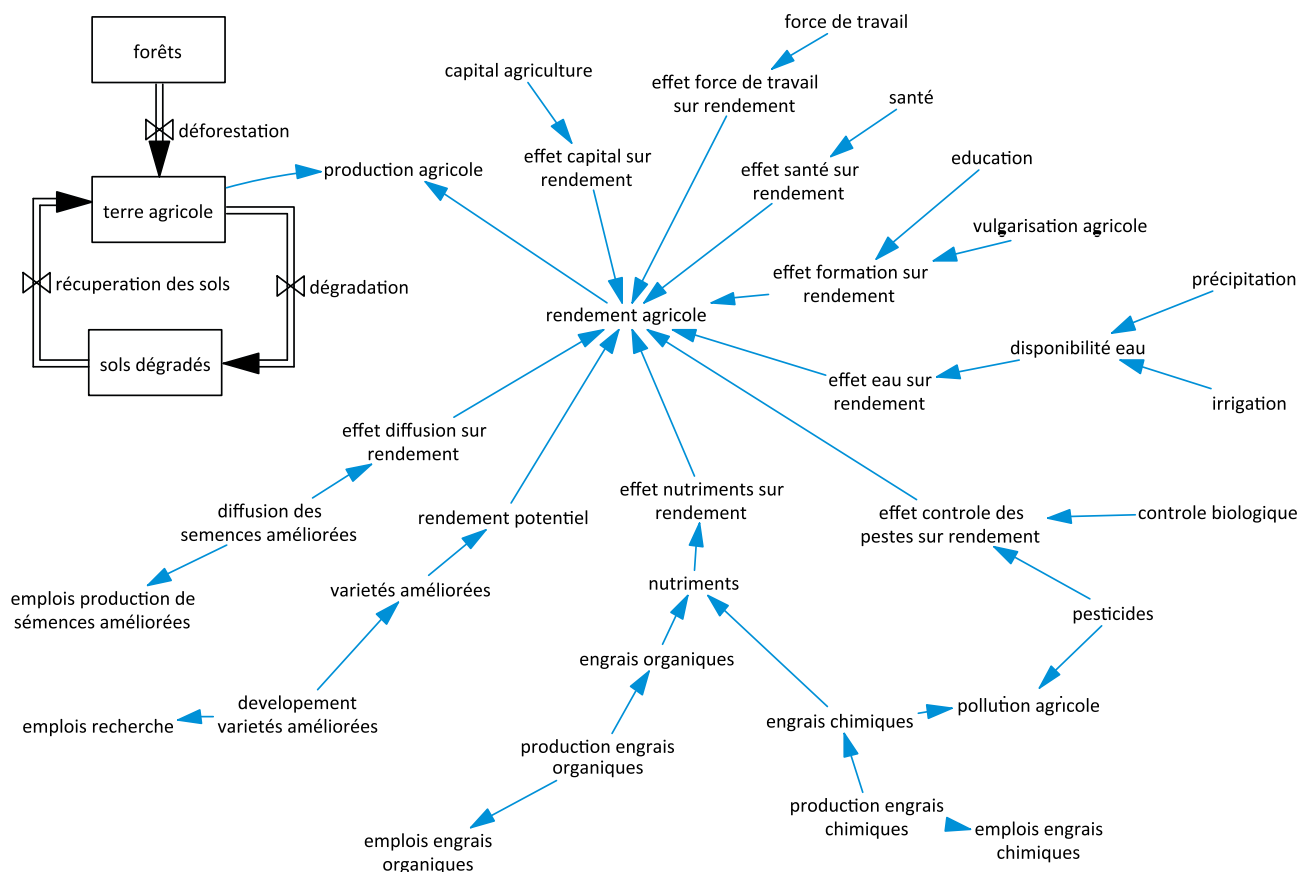
STRUCTURES	NOMBRE	TOTAL
Union Nationale des Producteurs de coton • Conseil National du Patronat Burkinabé • Association des Banques et Etablissements Financiers • La Maison de l'Entreprise • Groupement Professionnel des Industriels • Association des régions du Burkina • Tree Aid	1 1 1 1 1 1	6
Organismes de Coopération (Technique et Financier) • PNUD • FAO • ZiE • UICN/BN • CIFOR	2 1 1 1 1	6
TOTAL		115

(b) Day 2 and 3

N°	STRUCTURE	NOMBRE DE PARTICIPANTS
01	Présidence du Faso • CAPES	1
02	Ministère de l'Environnement et du Développement Durable • DEP(2) • APFNL(1) • Directeur de l'Economie Environnementale et des Statistiques(2) • DCIM (2)	7
03	Ministère de l'Economie et des Finances • Direction Générale de l'Economie et de la Planification(1) • Secrétariat Technique National de la SCADD(1) • Secrétariat Technique des Budgets Programmes(1) ; • INSD(3) • HENAREF(1)	7
04	Ministère des Enseignements Secondaire et Supérieur • UFR FASEG(1) • IDR/Bobo (1) • Labo de mathématique (1) • CEDRES (1)	4
05	Ministère des mines des carrières et de l'énergie • HDEP	1
06	Ministère de la Recherche Scientifique et de l'innovation • HINERA	1
07	Ministère de l'Agriculture et de la sécurité Alimentaire • Direction des statistiques agricoles Ministère de la santé • Direction générale des statistiques sanitaires	1 1
08	Ministère de l'éducation nationale • Direction générale des statistiques scolaires	1
09	• Alain KiHzerbo • Aki Kogachi • M. Issaka NIANGAO • Prof. Touré • Mme Directrice Béatrice Tassimbedo • Prof Seydou Eric TRAORE • Rasmane Ouedraogo (Coordonnateur IPE) • Oumar Ndiaye (PNUD/PNUE)	8
Total		32

APPENDIX 2. CAUSAL MAPPING OF AGRICULTURAL SECTOR IN BURKINA FASO

FIGURE 15 CAUSAL MAPPING OF THE KEY RELATIONSHIPS ASSOCIATED TO THE AGRICULTURAL SECTOR. DEVELOPED DURING THE CONSULTATION WORKSHOP







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