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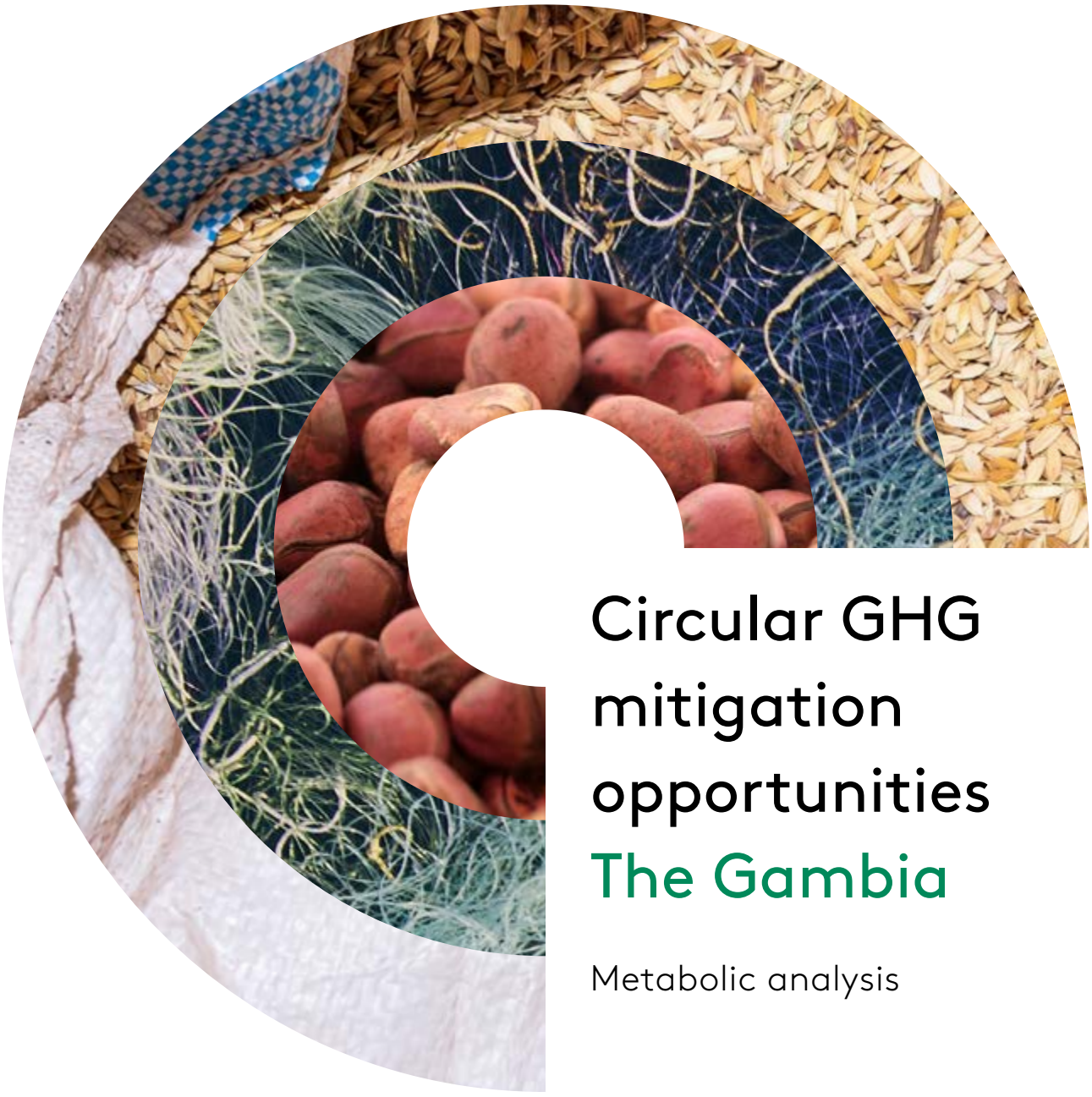

Circular GHG mitigation opportunities

The Gambia

Metabolic analysis

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Version 1.0 (April 2021)

Circular GHG mitigation opportunities The Gambia

Metabolic analysis

April 2021

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Foreword
Government of The Gambia

The Gambia recognizes that domestic fossil fuel use and territorial emissions are not the only determinants of a country's footprint. Since an estimated 65% to 70% of global greenhouse gas emissions stem from materials management, avoiding excessive materials use is crucial to fighting climate change. Therefore, The Gambia is dedicated to making basic choices regarding the types of materials to prioritize, the efficiency with which they are used and the durability of the products in which they are applied

In addition, the most carbon-intensive materials used in The Gambia are imported. Thus, part of the country's carbon footprint is created abroad. Since The Gambia's waste management system is ill-prepared to handle some of the goods and materials brought into the country these imports also create waste issues. As a result, their disposal has a significant adverse impact on the quality of the country's natural assets.

The short value chains that provide Gambians with food, consumables, fuels and construction materials directly expose the population to changes in the quality of the country's soils, fish stocks, forests and watersheds. This metabolic analysis makes that very explicit and emphasizes the urgency of efforts to mitigate climate change and preserve the natural assets which embody the country's culture and its natural beauty. Those assets are the very foundation of The Gambian economy and its ability to provide a promising outlook for future generations.

The Gambia's first Nationally Determined Contribution was recognized for its ambition. In the second version, we aspire to both preserve domestic natural assets and reduce emissions in the international value chains of imported goods and materials. Given that 20 to 30 percent of a country's carbon footprint, on average, is associated with imported goods and services, effective climate change mitigation is only possible when countries cooperate and take responsibility along value chains, even if they extend far beyond national borders. The Gambia's second Nationally Determined Contribution also aims to leverage cross-sectoral mitigation opportunities and target systemic drivers of greenhouse gas emissions, rather than simply seek incremental improvements.

Hon. Lamin B. Dibba
Minister of Environment,
Climate Change and
Natural Resources

Effective climate change mitigation is only possible when countries cooperate and take responsibility along value chains, even if these value chains extend far beyond national borders

The Gambian waste management system is not designed to handle many types of imported goods and materials

Foreword
UNDP

This metabolic analysis shows that circular mitigation opportunities can reduce territorial greenhouse gas emissions from The Gambia by 31 percent, while reducing the aggregate carbon footprint of imported goods and materials by another 28 percent. Promising co-benefits of the circular greenhouse gas mitigation measures include a 37 percent reduction in solid waste disposal and the high, or very high, job creation potential of 10 of the 20 measures proposed.

The circular economy thus offers The Gambia an opportunity to combine economic development with reduced greenhouse gas emissions, while safeguarding and, even, restoring the quality of its natural assets. It can preserve and, perhaps, expand forest stock, preserve fish breeding grounds, and halt the deterioration of soil quality and declining yields while improving resilience to climate change. This is important as approximately 80 percent of the Gambian population relies on subsistence agriculture and fishing for their livelihood.

The analysis also opens the door to collaboration along international value chains. The Gambia imports more than 36 percent of the materials used in the country. When these materials arrive, they have already left a carbon footprint associated with the greenhouse gases emitted in their countries of origin. Imported products and materials generally continue following a linear path in The Gambia and end up in unregulated dumpsites. However, The Gambian waste management system is not designed to handle many types of imported goods and materials.

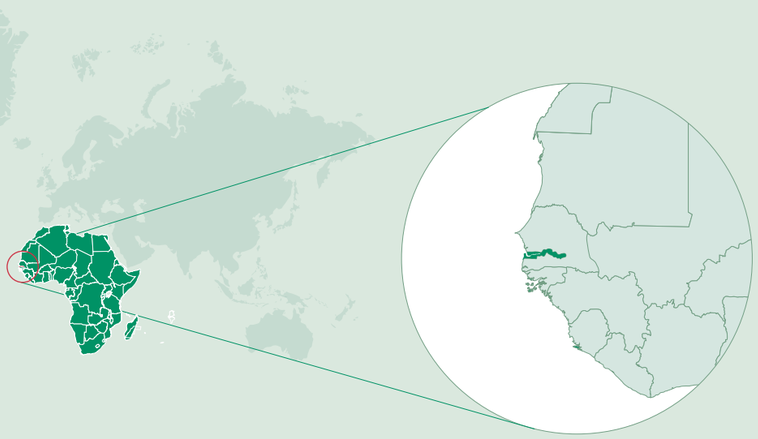
Prioritizing national resources and making producers responsible for the full life cycle of their products can reduce the volume of solid waste. In addition, this allows The Gambia to address its international carbon footprint. In general, around 30 percent of a nation's carbon footprint is embedded in imported goods and materials. However, efforts to reduce these emissions are poorly incentivized as such schemes usually focus on territorial emissions alone. These embedded emissions can be an important part of a systems approach that aims at reducing greenhouse gas emissions since this approach analyses the full value chain of carbon-intensive products and their potential substitutes.

The analysis in this report reveals the importance of international collaboration in addressing territorial emissions and the greenhouse gas emissions embedded in products that cross national borders. The mitigation ambition expressed in the Paris Agreement can be achieved only if international collaboration pursues ways to leverage circular economy approaches to also reduce the carbon footprint of products that cross international borders.

United Nations Development Programme
Resident Representative, The Gambia

Aissata De
United Nations
Development Programme
Resident Representative
The Gambia

The Gambia



72%

Agriculture in The Gambia is the main source of income for about 72 percent of the population

Fisherman repairing net

Rice fields

Water well

17%

Nature-based solutions can reduce GHG emissions by 17 percent in 2030

51%

Fifty-one percent of buildings in The Gambia are built of mud, stone and compressed earth

Executive Summary

This metabolic analysis report is the result of a comprehensive analysis of resource flows and their impact on the quality of natural assets in The Gambia. The analysis served as the basis for a stakeholder process to identify circular greenhouse gas (GHG) mitigation opportunities. It is the first of its kind outside of the OECD context. The report supports an update of The Gambia's GHG mitigation commitments under the Paris Agreement.

Our global emissions are inevitably tied to our use of material resources. Recent reports from Circle Economy,[1] the Ellen MacArthur Foundation,[2] Material Economics[3] and Shifting Paradigms[4] have pointed to the GHG mitigation potential of reducing excessive resource use and waste disposal. Still, most of these reports focus on OECD countries, which have particularly high per capita GHG and material footprints or take a global perspective. The circular GHG mitigation potential in low and medium-income countries has not been examined extensively. Thanks to the United Nations Development Programme (UNDP) Nationally Determined Contribution (NDC) Support Programme this is gradually changing.[5]

Although this report focusses on the Gambian context, it aims to inspire other countries to choose a circular low-carbon development pathway that values regenerative materials, human resources, creativity and knowledge. By stepping away from growth models based on monetizing finite resources and overexploiting the commons,[6] a circular low-carbon development pathway seeks to preserve natural assets to serve current and future generations alike. The efficient use of national resources that are regenerative or of secondary origin also allows countries to improve their trade balance.

This report distinguishes the territorial GHG footprint of The Gambia from the global GHG footprint of all national consumption, including GHG emissions that can be attributed to products and materials that are imported into The Gambia. By doing so, The Gambia broadens its actionable GHG mitigation prospects from its territorial emissions alone to all global GHG emissions that can be attributed to the country. With this approach, this report hopes to inspire all parties to the Paris Agreement to take action on both their territorial GHG emissions and their upstream GHG emissions in international value chains.

Twenty-five percent of The Gambia's national consumption-based GHG footprint consists of emissions embodied in imported goods and materials. The country's case thus confirms that global warming can be kept below 2 degrees Celsius only through strong and well-supported

international collaboration along the value chains of products that cross international borders.

Aligning with environmental and socio-economic development priorities

Organic material flows play an important role in The Gambia, as agriculture and fisheries represent 22 percent of the country's GDP and provide subsistence to an estimated 70 percent of the population. With agriculture responsible for 57 percent of GHG emissions, organic resource extraction and organic waste management provide clear focus areas for circular mitigation action.

The identification of circular GHG mitigation opportunities should be aligned with environmental and socio-economic development priorities. The Gambia's environmental priorities are to improve climate resilience in the agricultural sector, protect watersheds by increasing the forest area under community management, and preserve natural assets by reducing waste accumulation and the excessive extraction of primary resources.

An accelerated transition to a circular economy should also be aligned with socio-economic development priorities. Part 1 of this report concludes that for The Gambia, these priorities are to create jobs; increase the country's self-reliance by reducing the monetary trade deficit; expand the tax base; develop the private sector; and, strengthen the country's position as a regional trade hub.

Systems analysis to connect climate action with key development priorities

Development is too often accompanied by a gradual decrease in the quality of ecosystems and the deterioration of natural resources such as soils, marine environments, fish stock and forest standing stock. The identification of circular economy opportunities for The Gambia combines an analysis of material use and flows with an analysis of trends in the quality and volume of natural assets. The analysis of stocks sheds light on whether the extraction and disposal of materials have a positive or negative effect on the ability of the country's natural assets to regenerate and serve future generations. This report refers to that combined review of both flows and stocks as a metabolic analysis, while material flows are analysed both in material tonnes and in their embodied GHG footprint in tonnes of CO_2 equivalents (tCO_2e). In the metabolic analysis, the flows and stocks of materials are considered a system.

The objective is to identify GHG mitigation opportunities that extend beyond the climate mitigation commitments that The Gambia outlined in its first (NDC), or Paris Pledge.

Consumption in The Gambia is 45 percent circular

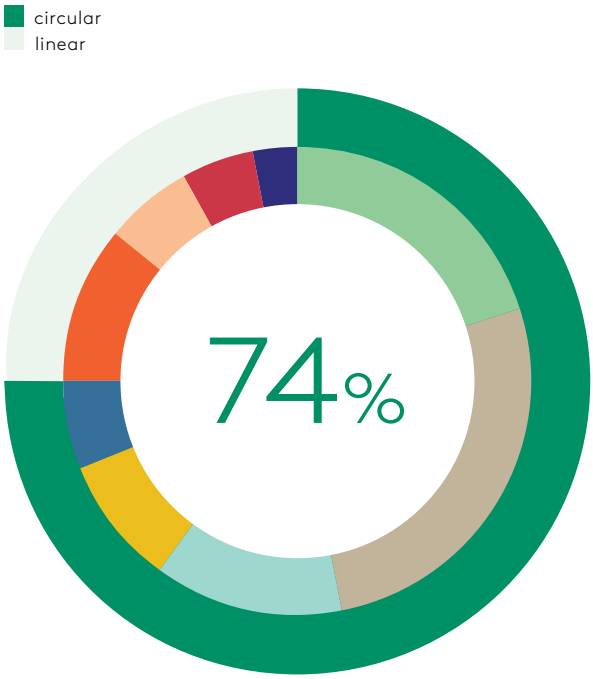
The circularity of The Gambia can be calculated by distinguishing 251 national material flows and assessing whether each is circular or linear. The consumption-based circularity gap for The Gambia specifies the share of domestic consumption from renewable or secondary resources, and for which materials are recovered at the end-of-life phase. Consumption in The Gambia is estimated to be 45 percent circular. This is attributed primarily to largely sustainable and, even, partly organic agricultural and forestry sectors, the use of largely renewable firewood, materials recycling, product reuse, and the use of regenerative construction materials. On the other hand, most imported products follow a linear trajectory. The waste management system is ill-equipped to handle imported products when they are discarded after use. Imported fossil fuels are also treated as linear because they contribute to GHG emissions and substantial amounts of organic materials are lost through the solid waste management and sewage system.

See figure 1A and 1B on page 12 and 13
To determine that consumption in The Gambia is 45 percent circular, each of the 251 material flows in the analysis has been classified as either circular or linear.

On the other hand, production in The Gambia is considerably more circular – estimated at 74 percent – than consumption. When analysing the circularity of production, imports are excluded and

FIGURE 1 A

Production



- Agricultural and food residues applied on land
- Regenerative firewood
- Regenerative food with nutrient recovery after consumption
- Reuse
- Recycling (< 1%)
- Regenerative materials (applied in LTU)
- Unsustainable food production and/or food without nutrient recovery
- Resources landfilled
- Non-CO_2 GHG emissions
- Exports subject to 74% circularity of production

Excluding the Raw Material Equivalents (RME) of imports and including the RME of exports but corrected for re-exports

only products from The Gambia are accounted for, including those that are exported. Since imported goods and materials have a low degree of circularity, national production is more circular than national consumption.

Imported goods and materials account for 25 percent of the consumption-based GHG footprint

Analysing the carbon footprint of consumption in The Gambia helps to prioritize interventions that can reduce the GHG emissions, whether they occur in The Gambia or elsewhere. For 2020, national GHG emissions are estimated at approximately 4.9 million tCO_2e. Upstream emissions generated during the production of imported goods and materials total an additional 1.2 million tCO_2e. The average carbon footprint of imports, measured in tCO_2e per tonne imported product, is considerably higher than that of domestic production. That is because the Gambia imports relatively carbon-intensive products, such as construction materials, vehicles and fossil fuels. It should be noted that fossil fuels have an upstream carbon footprint and also contribute to domestic GHG emissions when combusted.

Around 85 ktonnes CO_2e of territorial emissions are related to the production of goods and materials that are exported to serve consumers in other countries; some of them are re-exports. When assessing consumption-based emissions, emissions generated in The Gambia from the production of products that benefit consumers abroad may be deducted from The Gambia's consumption-based emissions. Still, efforts to reduce territorial emissions may also reduce the carbon footprint of exported products, allowing foreign consumers to consume products with a reduced carbon footprint.

See figure 2, page 16

Circular GHG mitigation brings a net zero GHG economy within reach

The circular economy offers an opportunity for The Gambia to combine economic development and job

creation with reduced GHG emissions, improved climate resilience and reduced reliance on imports. The circular economy can help safeguard and restore the quality of the country's natural assets, notably the soils, forest stock and fishing grounds on which large parts of The Gambia population rely for their subsistence needs. In a circular future, the country should continue to prioritize sourcing materials from regenerative, rather than depletive, sources and avoid waste.

The measures proposed in the first Nationally Determined Contribution, complemented by nature-based solutions proposed by UNDP and additional circular mitigation opportunities, can reduce GHG emissions in The Gambia from a baseline level of 6.4 $GtCO_2e$ to around 1.06 $GtCO_2e$ by 2030. This estimate accounts for overlap, as the first NDC included circular mitigation potential of 0.22 $GtCO_2e$ for the period 2021 to 2025. The Nature-based solutions have 0.28 $GtCO_2e$ overlap with the circular mitigation potential.

See figure 3, page 17

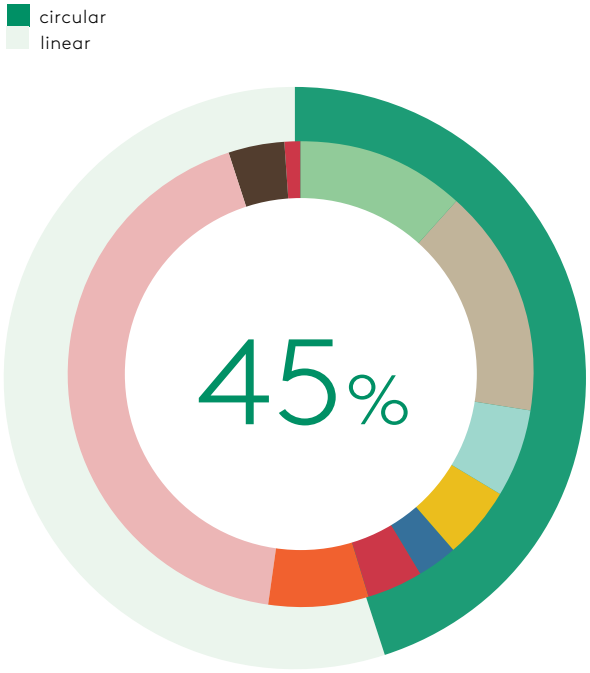
This metabolic analysis provides the research and analysis that underpins the updating and broadening of the scope of The Gambia's NDC. Several organizations are involved in this effort. The International Renewable Energy Agency (IRENA) and Local Governments for Sustainability (ICLEI) are already identifying ways to reduce greenhouse gas emissions from the energy and the transport sectors. Therefore, this metabolic analysis focuses on other sectors, notably agriculture, forestry, fishing, industry, construction, public and commercial services.

Twenty circular economy opportunities in The Gambia and their co-benefits

Twenty circular GHG mitigation opportunities are proposed within the sectors addressed. Taken together, they can reduce national GHG emissions by 36 percent, reduce The Gambia's international carbon footprint by 38 percent and reduce national solid waste volumes by 37 percent. These percentages address only the sectors and GHG emissions within the scope of this analysis. The 20 opportunities would also lower government expenditures on fertilizer

FIGURE 1 B

Consumption

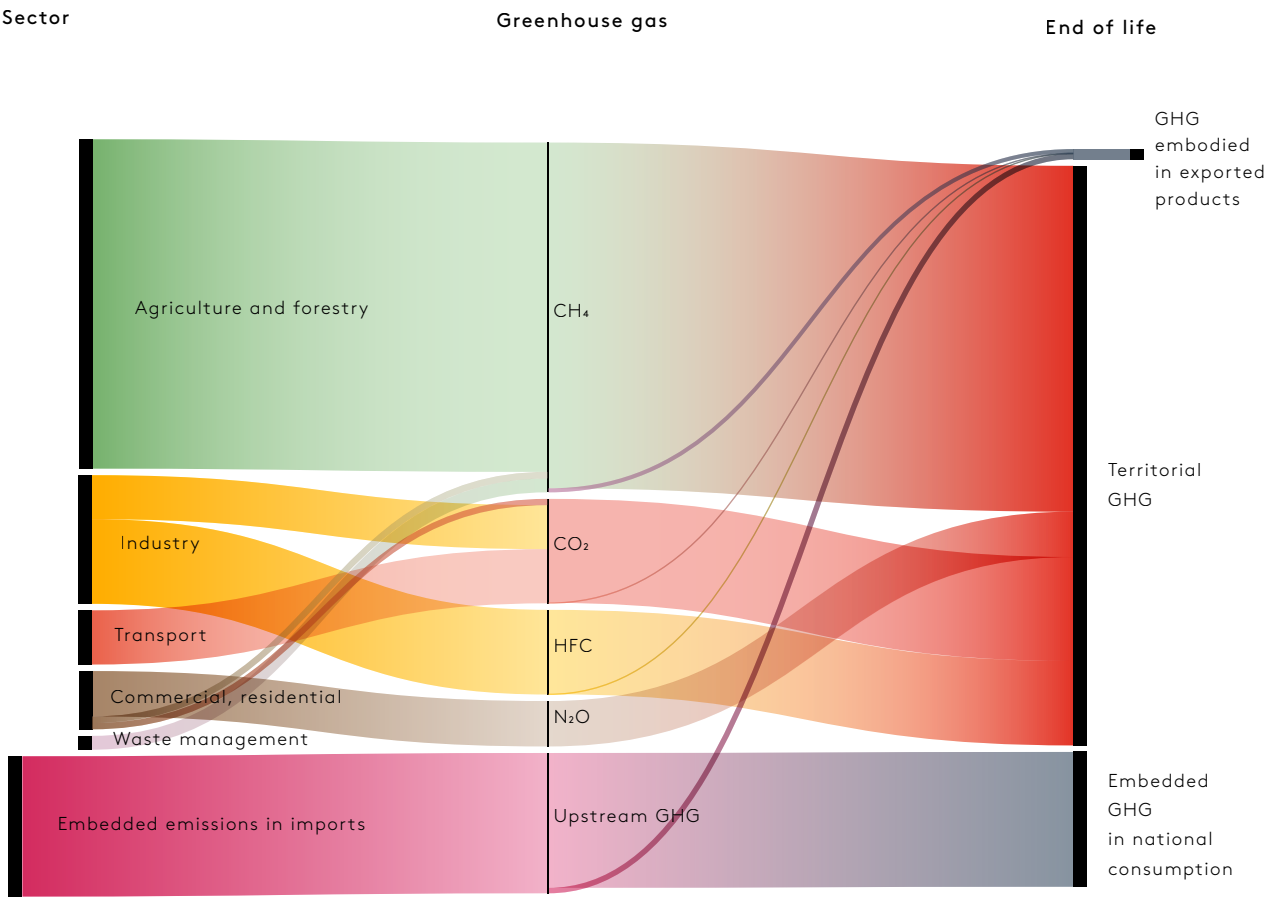


- Agricultural and food residues applied on land
- Regenerative firewood
- Regenerative food with nutrient recovery after consumption
- Reuse
- Recycling (< 1%)
- Regenerative materials (applied in ITU)
- 8.6% circular imports (global circularity)
- Unsustainable food production and/or food without nutrient recovery
- Resources landfilled (< 1%)
- 91% linear imports (global circularity)
- Fossil fuel use
- Non-CO_2 GHG emissions

Including the RME of imports, corrected for re-exports and excluding the RME of exports

FIGURE 2

Territorial GHG emissions from The Gambia and GHG emissions embedded in imported and exported goods and materials.



subsidies, shift the tax base away from labour to encourage job creation, and reduce the trade deficit by $116 million, or 7 percent of import volumes.

Combined with the measures already proposed in The Gambia's NDC and nature-based solutions, such as peatland restoration and reforestation, total mitigation potential could reach 83 percent when removing overlap between the NDC and the circular greenhouse gas mitigation opportunities identified.

Six of the 20 circular GHG mitigation opportunities identified are in food value chains, representing 52 percent of domestic circular mitigation potential. In addition, 10 of the 20 opportunities have a high or very high job creation potential. The opportunities identified are structured by sector and then ranked based on their GHG mitigation potential within both The Gambia and international value chains. The co-benefits covered include the estimated potential impact on primary resource extraction, waste production, reduced reliance on imports and job creation.

$MtCO_2e$/year

Estimated GHG mitigation potential in the first NDC, in the circular economy (CE) mitigation opportunities identified in this report and in the nature-based solutions proposed by UNDP.

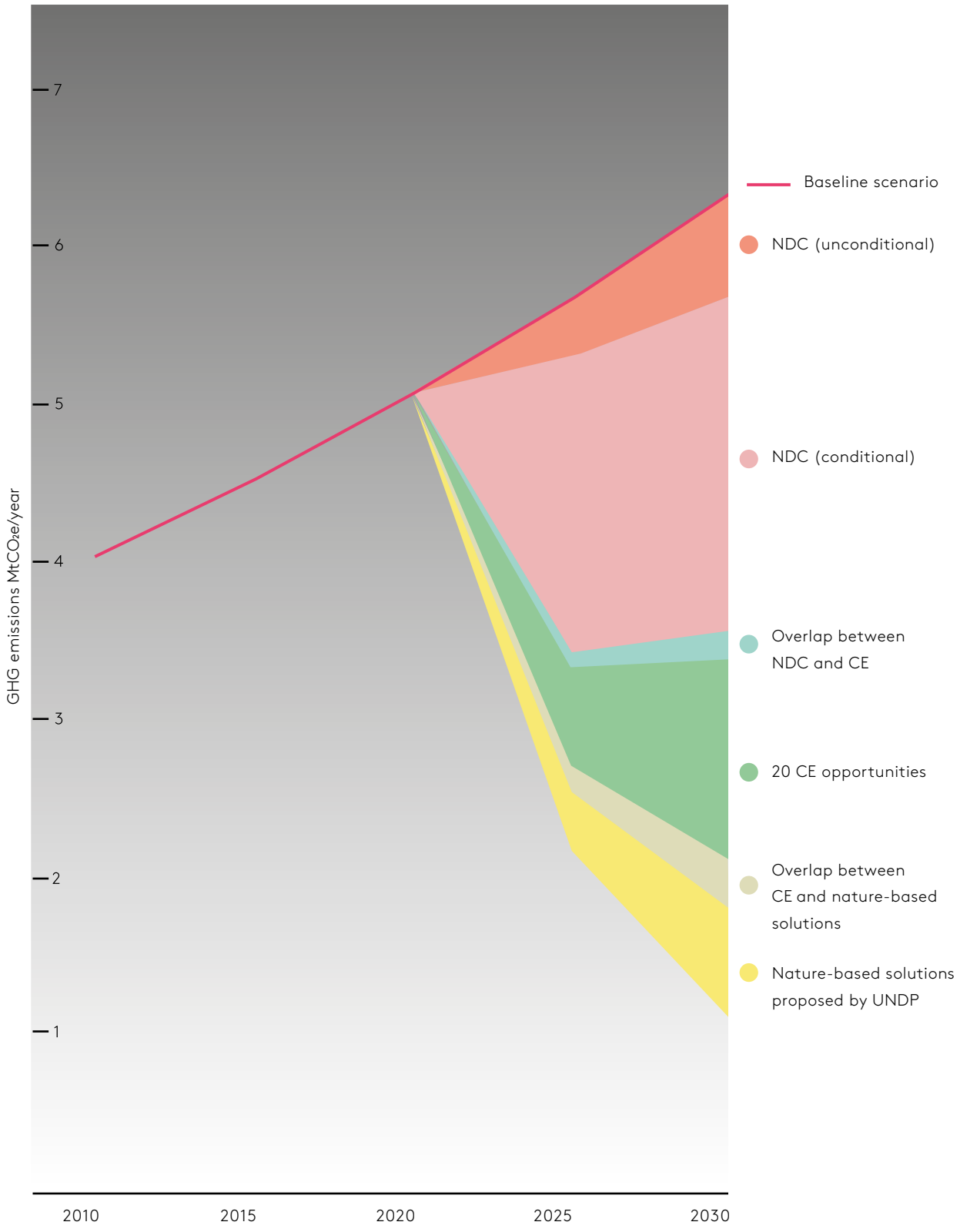
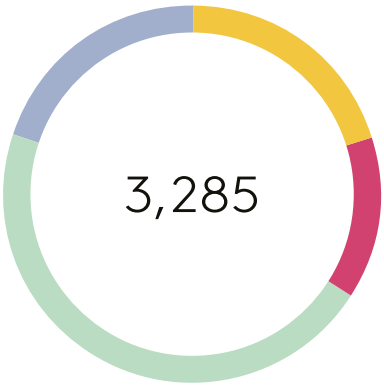


FIGURE 4

Circular mitigation option	Estimated GHG mitigation potential by 2030 tCO₂e		Costs	Solid waste avoided t/year	RME extraction avoided t/year	Imports reduced mil $/year	Job potential
	Domestic	International					
Practice multi-strata agroforestry	423,000	64,000	Medium	0	164,000	34,000,000	High
Adopt climate-smart agriculture	205,000	51,000	Medium	0	60,000	51,000,000	Very high
Improve livestock productivity	196,000	1,000	Medium	9,000	n/a	200,000	Medium
Use improved cookstoves	153,000	0	Medium	0	147,000	0	Medium
Reduce food losses	90,000	9,000	High	59,000	45,000	3,500,000	Medium
Recover organic waste	77,000	0	Low	64,000	n/a	0	Medium
Use firewood from agroforestry	27,000	28,000	Low	0	233,000	8,600,000	High
Practice circular procurement	10,000	10,000	Medium	n/a	n/a	n/a	Medium
Use local construction materials	0	110,000	Low	0	0	n/a	High
Pursue circular energy transition	0	6,000	High	0	1,000	0	Low
Incorporate passive building design	n/a	n/a	Low	0	n/a	0	Low
Substituting HFC23	705,000	0	High	n/a	n/a	n/a	Low
Implement extended producer responsibility	0	29,000	High	18,068	26,000	n/a	Low
Avoid pollution from fish meal	n/a	n/a	Medium	n/a	n/a	0	High
Strengthen informal sector manufacturing	0	0	Low	n/a	n/a	n/a	Very high
Use biogas from waste management	50,000	0	High	n/a	n/a	n/a	Medium
Align the tax regime	9,000	11,000	Low	0	10,000	11,100,000	Very high
Encourage access to ICT as a service	0	10,000	High	0	9,000	7,600,000	High
Implement artisan plastics recycling	0	0	Low	12	1	0	Low
Promote ecotourism	0	0	Low	n/a	n/a	n/a	High
Total	**1,944,000**	**329,000**		**150,000**	**694,000**	**116,000,000**	
Share of total	**31%**	**28%**		**37%**	**18%**	**7.1%**	
Share of total in scope	**36%**	**38%**					

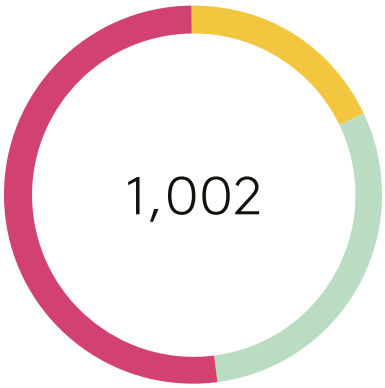
Sourcing by sector

kt / year



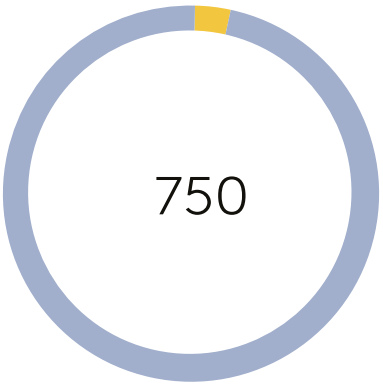
AGRI-FOOD

65%



CONSTRUCTION

20%



INDUSTRY

15%

1 Current situation, developments and ambitions

1.1 Reader's guide

This report describes The Gambia's current situation, trends and development ambitions and relates them to circular economy opportunities. It prioritizes opportunities that also offer GHG mitigation potential. However, because The Gambia already has an exceptionally low carbon and material footprint, the analysis seeks to respond to a broader set of development aspirations. The recommendations are based on an analysis of resource use, asset use and waste disposal in the country. The report is structured as follows.

PART 1: Current situation, developments and ambitions: This part describes the current situation in The Gambia and important trends into the future. It also provides an overview of relevant trends and developments in infrastructure, import and export, demographics and land use in The Gambia and highlights The Gambia's policies and development ambitions that align well with a transition to a more circular and low-carbon future.

The description of the environmental situation points out where material value is lost in the form of emissions into the air, water and soil. The socio-economic situation describes which sectors or economic activities are most important to The Gambia in terms of added value and jobs.

PART 2: Thinking in flows and stocks: Part 2 maps out the material resources used in The Gambia, distinguishing domestic products from imports. Data visualization helps explain how the use of products, materials and semi-fabricated products relate to GHG emissions in The Gambia and the international value chains of imported goods and services.

No country starts from scratch in the transition to a circular economy. Therefore, Part 2 also describes a selection of existing circular economy initiatives. They provide the basis from which to expand or develop new initiatives that rely on similar principles and enabling conditions.

PART 3: Circular economy strategies: Stakeholders and experts from The Gambia identified and selected the most promising circular opportunities, which are described in this section. The strategies were selected based on their ability to:

- preserve natural assets by reducing waste accumulation and reducing the excessive extraction of primary resources;
- reduce GHG emissions within The Gambia and in those countries that supply The Gambia with valuable products and materials;
- create and preserve jobs; and,
- improve the trade balance.

The Gambia has an exceptionally low carbon and material footprint, so the analysis seeks to respond to a broader set of development aspirations

Key definitions

Socioeconomic metabolism

'The set of all anthropogenic flows, stocks, and transformations of physical resources and their respective dynamics assembled in a systems context'.[7] In the context of this analysis, The Gambia's metabolism refers to the flows and stocks of material resources, energy and waste.

Circular Economy

'Looking beyond the current 'take, make and dispose' extractive industrial model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimizing negative impacts. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital'.[8]

Systems approach

'A focus on the development of an integrated perspective that includes all levels, rather than on the isolated search for ready-made solutions to sub-problems'.[9]

Secondary resources

Once 'waste' has been collected and prepared for recycling, it has become a new resource. It is then a secondary resource, which differs from a primary resource that originates from extractive industries, such as mining.

Nationally Determined Contribution

Countries' submissions to the United National Framework Convention on Climate Change (UNFCCC) of their mitigation commitments for 2030, or beyond, under the Paris Agreement.[10]

Products that flow

Most materials entering the economy every year typically reach their end of life within a year. Examples are food products and their packaging.[11]

Products that last

The other materials become produced stock or long-term stock and are typically in use for longer than a year. Examples are capital equipment, buildings and infrastructure.[12]

Natural assets

'Natural assets are assets of the natural environment. These consist of biological assets (produced or wild), land and water areas with their ecosystems, subsoil assets and air'.[13]

1.2 The Gambia at a glance

As the smallest country on the African continent, The Gambia covers 10,688 km². It extends as a narrow land strip roughly 748 km inland from the Atlantic Ocean and follows the meandering Gambia River. Sharing borders with Senegal, The Gambia has a coastline of 80 km.14,15 Its major cities are either on or near the coastline in the western part of the country. The largest city is Serekunda, with 340,000 inhabitants, followed by Brikama with 77,700 inhabitants, and the smaller towns of Bakau and the capital, Banjul.[16]

1.3 National development ambitions

The Gambia National Development Plan (2018-2021)[17] describes the country's development priorities and ambitions. Some of them also provide a basis for the further low-carbon growth of the economy, guiding the identification of circular economy opportunities.

The core elements of the National Development Plan reflect The Gambia's aims to:

- reduce the negative trade balance;
- stimulate private sector development. The Plan considers the private sector to be a key driver of increased labour productivity and human resource development in the country;
- invest in its younger generation through, among other activities, education, entrepreneurship programmes and job creation by supporting the uptake of information and communications technology (ICT). It also seeks to enhance the role of the Gambian diaspora in national development;
- expand the tax base and reform private sector taxation;
- increase the forest area under community management and,
- improve climate resilience.

The Government of The Gambia already encourages energy efficiency and renewable energy, having adopted a zero-import tax for renewable energy equipment and efficient lighting appliances. It also eliminated licence fees for renewable energy operators in the power sector. In addition, it discourages the import of older vehicles, with a higher tax rate for those more than 10 years old.[18]

1.4 National trends and developments

Sixty-two percent of The Gambia's population lives in cities. The Gambian population overall grows by 3 percent per year on average. By contrast, the rural population is growing by only 1.2 percent and this rate is continuing to decline.[19] While the growth of the urban population exceeded 6 percent at the end of the 20th century, urban growth rates are gradually declining towards the national average.

Addressing youth unemployment and a general lack of career opportunity is a main development priority for The Gambia. Younger people are finding that the skills they gained in school do not match those required by the job market. This, combined with an overall shortage of employment opportunities, resource degradation, poor quality of services in rural areas and a desire to be part of the modern urban world, drives migration to Europe.[20]

To create new job opportunities, the Government of The Gambia has prioritized three business sectors for further development: nuts and agro-processing, tourism and ICT. Linking them to improving general living conditions in The Gambia and helping to create work opportunities for its youth, the country targets actionable projects that contribute to the development of:

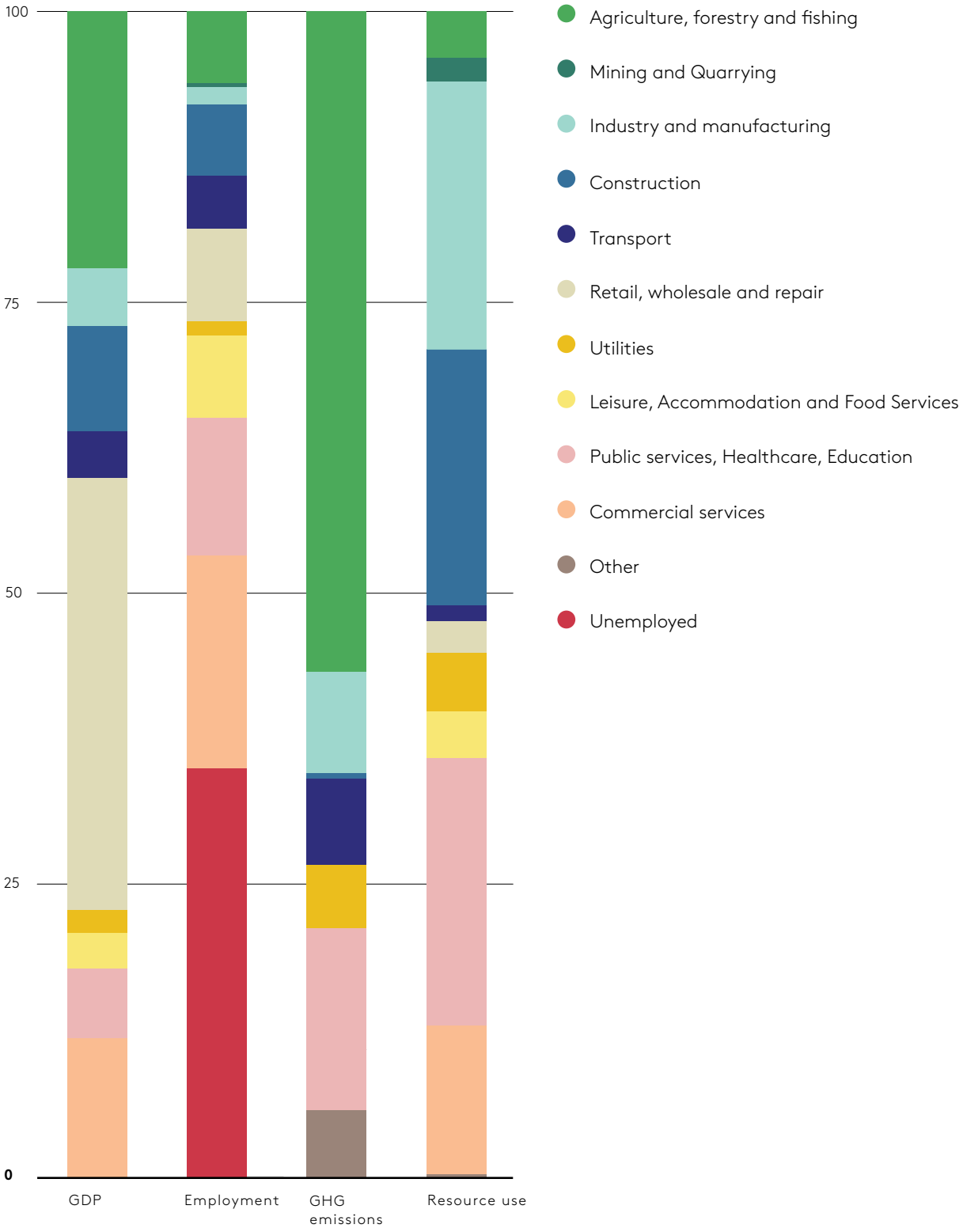
- employment and entrepreneurship;
- education and skills development;
- health and wellbeing; and
- rights, governance and youth empowerment.[21]

1.5 Social, economic and environmental data by sector

According to the Gambia Bureau of Statistics, retail and wholesale trade make the largest contribution to the gross domestic product (GDP).[22] Most formal employment is in commercial services. On the other hand, the country's economy is primarily agrarian and some sources estimate that subsistence

FIGURE 5

Breakdown of gross domestic product, employment, GHG emissions and resource use per sector



agriculture and fisheries support 70 percent of the population.[23,24] In addition, an estimated 22 percent of GDP comes from remittances.[25]

Sources disagree on the contribution from various sectors to GDP and employment. According to the Sustainable Consumption and Production Hotspot Analysis Tool (SCP-HAT), the agriculture, forestry and fishing sectors produce 7 percent of GDP,[26] while the Gambia Bureau of Statistics places this value at 22 percent (figure 5).

Some analysts have found that the agricultural sector employs about 46 percent of the active workforce,[27] while others estimate it at only 9 percent.[28] Furthermore, according to the WTO, the tourism sector contributes approximately 16-20 percent of GDP and has been the largest foreign exchange earner. According to the Gambia Bureau of Statistics, leisure, accommodation and food service generate only 3 percent of GDP (figure 5). These differences can, perhaps, be explained by different ways of allocating the contribution of the informal economy.

Unemployment is a key issue in The Gambia, with just 35 percent of the labour force formally employed. Unemployment is a concern across all levels of education. Of those formally employed, most work in commercial services (32 percent), public services (17 percent), retail, wholesale and repair (11 percent), and leisure, accommodation and food services (10 percent). The informal sector provides a living to many who are officially unemployed. According to national statistics, 31 percent of informal workers are active in services, 14 percent in wholesale and retail trade, 11 percent in agriculture and 10 percent in construction.[29]

Figure 5 shows that with agriculture and forestry responsible for 57 percent of production-based GHG emissions, organic resource extraction and organic waste management are clear focus areas for mitigation action. Industry and manufacturing account for 18 percent of emissions, followed by utilities (9 percent) and households (8 percent). Household emissions are composed of methane and nitrous oxide from firewood use. Power sector emissions reflect the dominance of heavy fuel oil use for generating electricity.[30]

See figure 5, page 24

According to the SCP-HAT, the largest end consumers of resources in the country are industry (23 percent), construction (22 percent), and public services (22 percent).[31] Secondary sectors, such as construction and industry, are generally countries' larger resource users. The tool does not explain why public services are such a large user and the detailed analysis of flows in Part 2 of this report does not confirm that finding. In general, services tend to have a small resource footprint.

1.6 Infrastructure and trade relations

The Gambia aims to strengthen its position as a regional trade hub, supported by its location on the coast and the river and by its harbour infrastructure. Parts of the Gambia River are also accessible to ocean-going ships. To develop its position as a re-export hub for West Africa, The Gambia has adopted liberal trade policies and joined the Economic Community of West African States (ECOWAS), which connects the country to a market of 350 million people. The Gambia also benefits from preferential duty-free access to the European Union under the Everything but Arms scheme, as it is recognized as a least developed country.

The country has a large trade deficit. In 2018, the value of imports totalled US$1.64 billion,[33] or approximately 14 times the value of exports. The dominance of imports stems from The Gambia's limited production base, so it must import most of the commodities and food that it needs. Products produced domestically serve primarily domestic consumers or are exported informally.[34]

The Gambia applies a common external tariff to all trading partners and imported goods are subject to ECOWAS and African Union levies. Some essential commodities are duty free; some raw materials and capital goods are taxed at 5 percent; consumer goods are taxed at 20 percent; and specific goods for economic development are taxed at 35 percent.[35] Import levies constitute the main source of the country's indirect tax revenues.[36] However, this source is eroding and has reduced government revenue since, in practice, many commodities are classified in a lower tax regime to avoid paying higher rates. The Gambia levies export taxes only on precious metal scrap and waste. In the past, it has banned timber exports.

The main export products are groundnuts, timber and fish products. The main imports are fossil fuels, food products, construction materials and textiles.

The primary re-exported products include sugars and sugar confectionery, vehicles and vehicle parts, electrical machinery and equipment, and fabricated fibres and clothing.

According to national statistics, The Gambia exports primarily to other African countries in the region. International data sources confirm that its main export partners are India and China, which, together, absorb 55 percent of export value.[37]

The Gambia is participating in China's Belt and Road Initiative and has approved the construction of a road linking Basse, Fatoto and Koina, including two bridges (one is 250 metres long and, the other, 170 metres).[38] The Saudi Fund for Development has also provided funding to improve the road network.[39] These infrastructure developments will require significant amounts of construction materials.[40]

The electrification rate in The Gambia is around 60 percent, a significant increase compared to 30 percent in 2000.[41] The country has 1.77 million mobile internet subscriptions, compared to some 4,000 broadband cable internet connections.[42] This indicates that mobile infrastructure has overtaken the development of fixed internet connections.

1.7 Climate change and environmental challenges

Climate change poses an immediate threat to the Gambian economy. As most Gambians rely on agriculture for their subsistence, increased flooding and droughts immediately affect a large part of the population. Since only one-third of the country is more than 10 metres above sea level, coastal areas are vulnerable to sea level rise.[43]

Climate change and migration are linked. Agriculture provides a living for 70 percent of the population but is threatened by climate change, which aggravates both droughts and flooding, damaging farmland, settlements and livestock.[44] Other environmental challenges include land degradation, coastal erosion, loss of forest cover and biodiversity, ineffective management of waste and pesticides, deforestation due to illegal logging and bushfires, sand mining,[45] and illegal settlements.[46] As circular economy opportunities are identified, options that address these issues must receive priority.

One of the important environmental challenges facing The Gambia relates to the pollution of marine environments that provide subsistence to a large part of the population. Foreign investors building fish meal factories along the coast, based on contracts signed during the previous president's term, have been accused of failing to comply with environmental legislation.[47]

An estimated 90 percent of The Gambia's population has access to clean drinking water. The volume of available renewable water sources totals 9,000 million cubic metres, while annual extraction is approximately 100 million cubic metres per year.[48] Sewage system blockages pose health threats. In rural areas, 82 to 86 percent of inhabitants use pit latrines, while the rest have flush toilets. Hand-dug wells are the primary source of drinking water in rural areas.[49]

The Gambia is committed to further reducing its already low carbon footprint. It submitted its first Nationally Determined Contribution (NDC) in November 2016. The Climate Action Tracker recognized the mitigation ambition expressed in this document as one of the world's most ambitious and one of the few that is in line with the Paris Agreement goal of 1.5 degrees.[50] The NDC aims for an unconditional reduction of 3 percent by 2030, while measures targeting a 45 percent reduction are conditional upon international financial support and technology transfer.

See figure 6, page 28

1.8 Conclusion – Part 1

Identification of circular economy opportunities will focus on the primary sectors: agriculture, forestry and fishing for their contribution to GHG emissions and potential to address food insecurity. Industry, construction and services will also be assessed. Industry is relevant based on its resource use and GHG emissions, while the construction sector consumes large volumes of resources. Services are important as they provide labour (public, commercial services and tourism), contribute to GDP (retail, wholesale and repair, public and commercial services) and use resources (public and commercial services).

Imports have a relatively high carbon footprint, while the footprint of exports is low. Therefore,

where possible, circular mitigation opportunities should also reduce upstream GHG emissions related to the import of goods and services.

In addition, a large part of the population relies on smallholder agriculture or fishing activities for their daily subsistence, thus underscoring the importance of natural assets in The Gambia in preserving and creating jobs. This calls for preserving soil quality, fish stocks and forest stock, which help to protect critical watersheds. Circular economy interventions should target threats to these assets, including the overexploitation of soils, forest and fish stocks, pollution from industries, municipal solid waste and wastewater.

Organic material flows play an important role in The Gambia, as agriculture and fisheries represent 22 percent of the country's GDP and provide subsistence to an estimated 70 percent of the population. National ambitions to improve climate resilience, increase the forest area under community management, increase the share of renewables in the energy mix and reform the tax regime align well with the ambition to make The Gambia more circular.

Part 1 concludes that the circular economy strategies identified should aim to support:

1. Job creation, in particular for younger generations. In a circular economy, human, rather than natural, capital is the main source of national revenue. The Gambia already has a large services sector that can serve as the foundation for future growth. On the other hand, the informal economy and subsistence agriculture provide a living to many Gambians, and both should be at the forefront when identifying circular economy opportunities.

2. Mitigation action in agriculture and building climate-resilient food value chains. As 57 percent of GHG emissions come from agriculture, organic resource extraction and organic waste management are clear areas of focus for mitigation action.

3. Waste avoidance, as inadequate waste management and disposal harms the quality of natural assets in The Gambia and threatens the country's future productive capacity.
4. Improving the country's self-reliance. The Gambia imports products that it could produce. Substituting imports with local products would also improve the country's trade balance.

5. Systemic and innovative solutions, harnessing traditional knowledge, science, research and technology for resilient and environmentally-friendly solutions.[52]

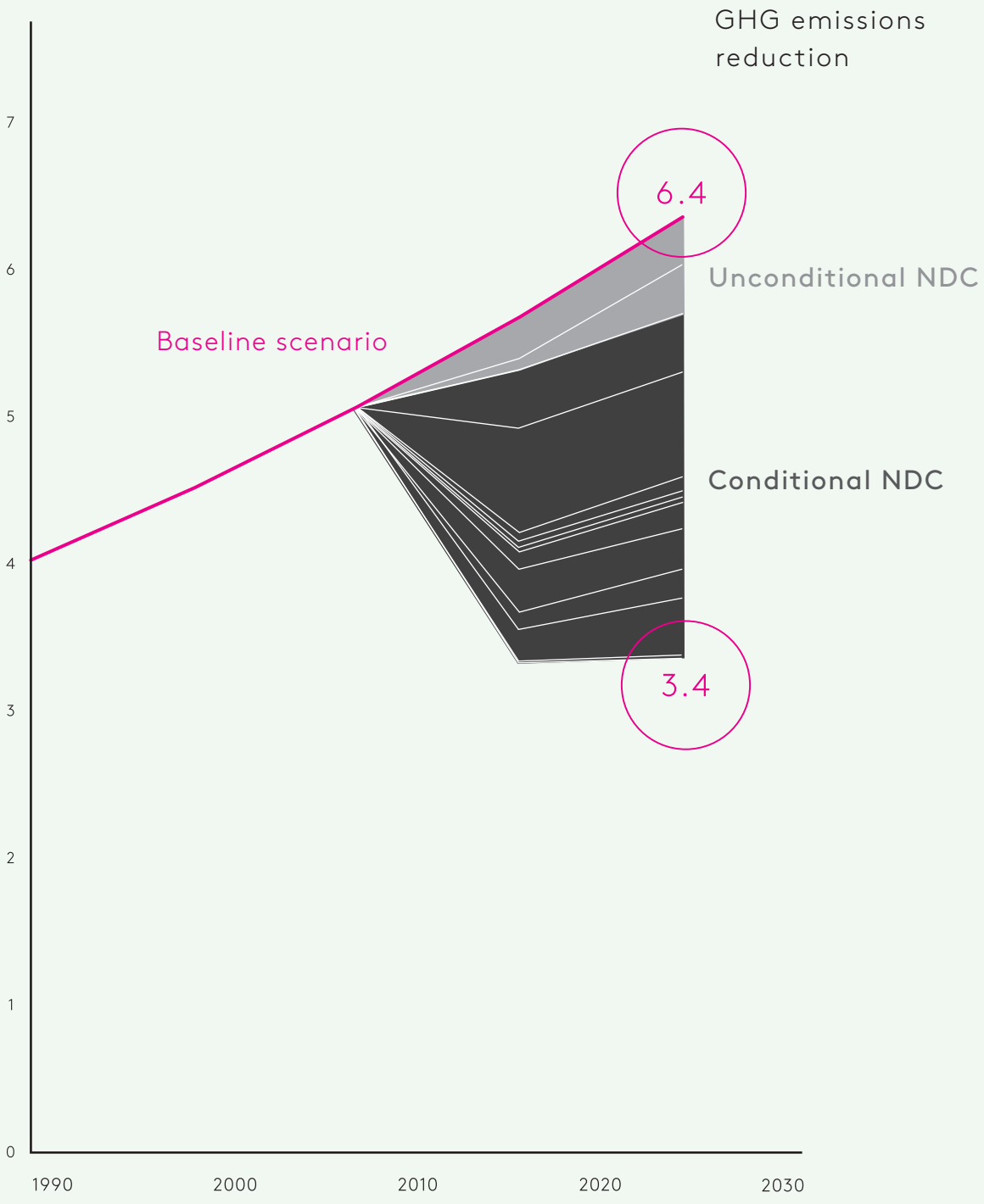
6. Expanding the tax base and reforming private sector taxation.[53]

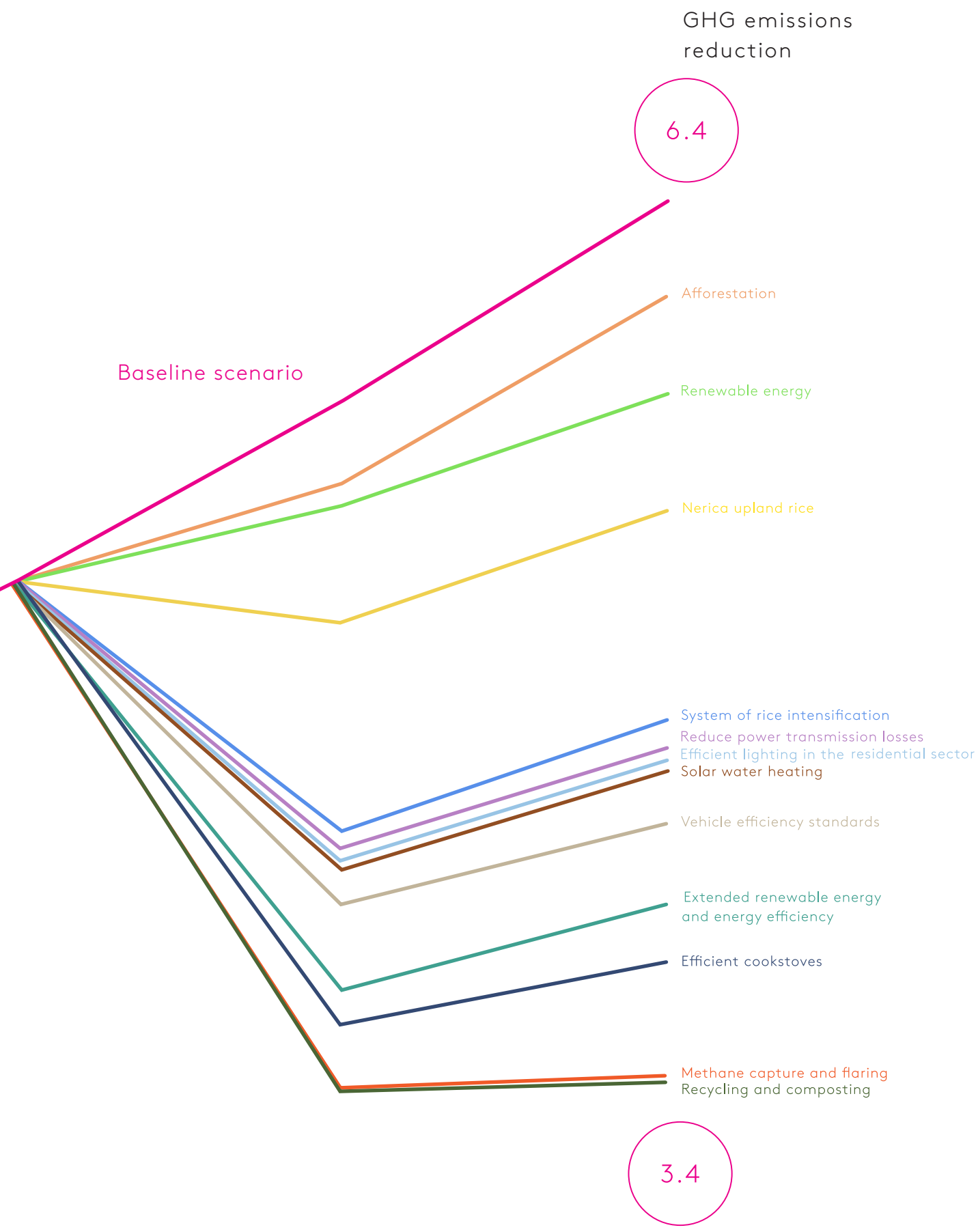
7. Private sector development. This includes improving The Gambia's position as a trading partner and West African hub, while ensuring that economic activities – in particular, export-oriented – remain within the carrying capacity of the country's ecosystems.

FIGURE 6

Greenhouse gas emission reductions
in the first NDC between 1990 to 2030

$MtCO_2e$/year




GHG emissions reduction
6.4
Baseline scenario
Afforestation
Renewable energy
Nerica upland rice
System of rice intensification
Reduce power transmission losses
Efficient lighting in the residential sector
Solar water heating
Vehicle efficiency standards
Extended renewable energy and energy efficiency
Efficient cookstoves
Methane capture and flaring
Recycling and composting
3.4

2 Thinking in flows and stocks

2.1 Reader's guide

PART 1 showed that the primary sectors – industry, construction and services – are the largest resource users and main sources of GHG emissions. The economic activities that are most relevant in socio-economic terms are agriculture, fishing, industry and services. This underscores the importance of developing services while protecting the natural assets that provide food resources.

PART 2 examines material flows and their impact on the quality of natural resources and the accumulation of material stocks in national vehicle fleets, transport infrastructure and buildings.

Shifting from sectoral silos to flows and stocks, this part describes The Gambia's economic system through a metabolic analysis, which combines a material flow analysis and a stock dynamics analysis. The latter examines both the development of built stock or products that last and the impact of economic activities on natural assets, such as maritime and terrestrial resources.

In addition, because no country starts from scratch in the transition to a circular economy, Part 2 also describes existing circular economy initiatives, based on the key enablers and strategies listed in Box 2. These initiatives provide a basis for further progress.

2.2 Metabolic analysis to understand a circular future

The resource and energy efficiency of an economy is more than the sum of the efficiencies of all its components. Decoupling economic growth from resource and energy use requires understanding how individual components operate. However, above all, it involves providing an overview of how individual elements interact and work together to deliver a diverse set of services to society.

Mapping the flows and stocks of a supranational entity, country or government subdivision shifts the focus from environmental issues and short-term priorities to the performance of the overall system and 'the development of an integrated development perspective that includes all levels and sectors'.[54] This requires large quantities of data on resource use and assets to observe how flows of minerals, biomass, metals, fuels, water and assets, such as buildings, vehicles and means of production, work together to respond to individuals' needs. Data visualization helps stakeholders develop a consensus on the current situation and, based on that consensus, explore the most promising circular economy opportunities.[55]

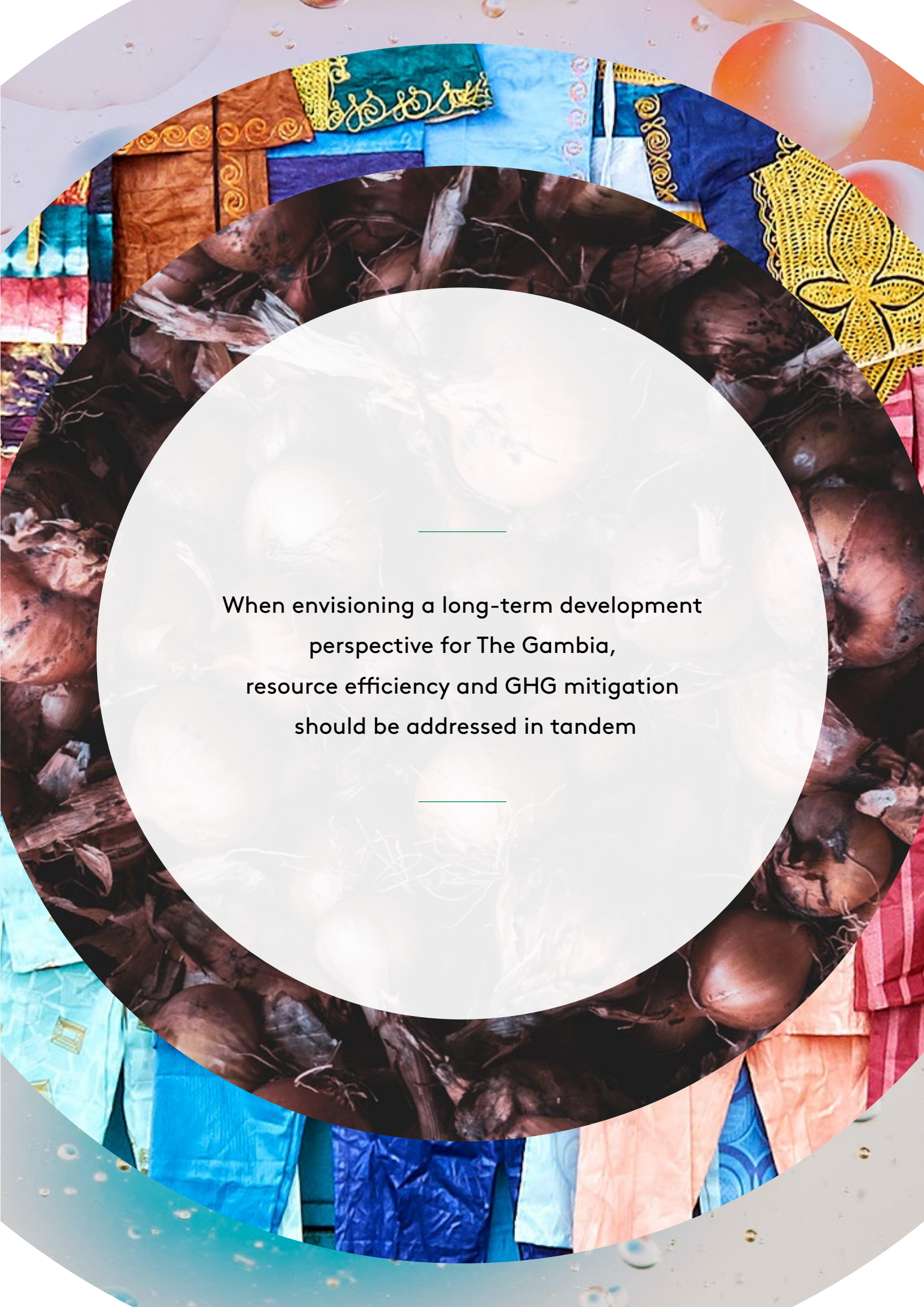
Circular economy strategies and enablers

To define a common language for the circular economy, Circle Economy, an NGO, has mapped the terms and definitions used by over 20 organizations, from non-governmental organizations (NGOs) to government agencies, academia and consultancies. Three strategies and four enablers emerge from these terms and definitions.

See box 2, page 32

2.3 Resource use and climate change

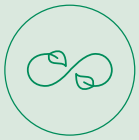
When envisioning a long-term development perspective for The Gambia, resource efficiency and GHG mitigation should be addressed in tandem. A major share of the finite resources that the country uses are fossil fuels that contribute to climate change. In practice, most are used to extract, transport and process materials and products. An estimated 67 per cent of global greenhouse emissions



When envisioning a long-term development perspective for The Gambia, resource efficiency and GHG mitigation should be addressed in tandem

Circular economy

3 strategies



Prioritize regenerative resources

Ensure that renewable, reusable, non-toxic resources are used efficiently as materials and energy

Sustain & preserve what's already there

Maintain, repair and upgrade resources in use to maximize their lifetime and give them a second life through take-back strategies, where applicable

Use waste as a resource

Use waste streams as a source of secondary resources and recover waste for reuse and recycling

4 enablers

Team up to create joint value

Work together throughout the supply chain, internally within organizations and with the public sector to increase transparency and create shared value[60]

Design for the future

Adopt a systemic perspective during the design process to employ the right materials for appropriate lifetime and extended future use

Rethink the business model

Consider opportunities to create greater value and align incentives by reconsidering business models; for example, by replacing a sales model with one based on providing a service or sharing assets

Incorporate digital technology

Track and optimize resource use and strengthen connections between supply chain actors through digital, online platforms and technologies

are related to materials management.[56] As a result, only the mutually reinforcing combination of low-carbon development and resource efficiency can put the world on a 2^{0}C or, even, a 1.5^{0}C pathway.[57]

The circular economy also makes economic sense. For some sectors, decoupling resource use from economic growth will bring GHG emissions in line with the ambition to keep global warming at 2^{0}C.[58] This opens a development perspective through which reduced dependency on material resources and fossil fuels can create the financial savings that accelerate economic development. The public debate over the immediate costs of climate change mitigation often overlooks the fact that the economic benefits of resource efficiency and low-carbon development exceed the near-term costs of shifting to a 2^{0}C emissions pathway.[59]

2.4 Mapping resource flows, stocks and embedded emissions

Material flows distinguish among biomass, minerals, metals, fossil fuels, GHG emissions and water. The flows have been quantified with statistical data from the Gambia Bureau of Statistics. They cover extraction, import, processing and production, consumption (products that flow), construction and vehicle fleet expansion (products that last), waste management and export.

Data gaps were addressed by drawing on additional statistical sources, such as the Food and Agricultural Organization and other UN bodies, academic and other sources. By connecting the flows at product level and breaking them down into different resource types, these flows were traced from their origin to their final destination. Since the aggregated mass of all materials must be maintained during the conversions, comparing the flow totals in each part of the value chain allowed for cross-checking.

Material flows

BIOMASS flows include food products of vegetable and animal origin and the wood, rubber and paper used to make products such as furniture, construction materials and packaging.

MINERALS are mostly mineral construction materials, such as cement, tiles and bricks. They also include oil-based products, including chemicals, fertilizers and the bitumen used in road construction.

METALS include raw and processed metals and their products, ranging from iron plates to copper wiring, vehicles, machinery and metal building structures. Water flows include the rivers and rainwater that flow from the islands into the ocean, part of which is cleaned and used as drinking or irrigation water and discharged.

FOSSIL FUELS are gas, liquid and solid fuels (primarily gasoline in The Gambia). They are used primarily in the transport sector and to generate heat and electricity.

EMISSIONS are GHG emissions, most of which are carbon dioxide or CO_2, followed by methane or CH_4.

Four sources of materials are distinguished. Imported refers to materials and products imported into The Gambia. These originate from wells, quarries, mines or fields located outside the country.

FINITE EXTRACTION refers to materials and products produced or extracted from national mines, wells, quarries, forests, agriculture and fishing. Where materials are extracted from sources in a way that depletes their stocks, such as sand extraction or wood harvests that lead to a decline in forest stock, they are referred to as depletive.

SECONDARY SOURCING refers to secondary resources from recycling and reused products. This often involves using organic residues as soil enhancers and recovering recyclable materials from national waste streams.

REGENERATIVE SOURCING refers to forest and fish products from stocks that are stable or show improvement over time and agricultural products where soil quality is also stable or improving. In addition to mapping the materials used, the analysis also shows what happens to waste or products after they are used.

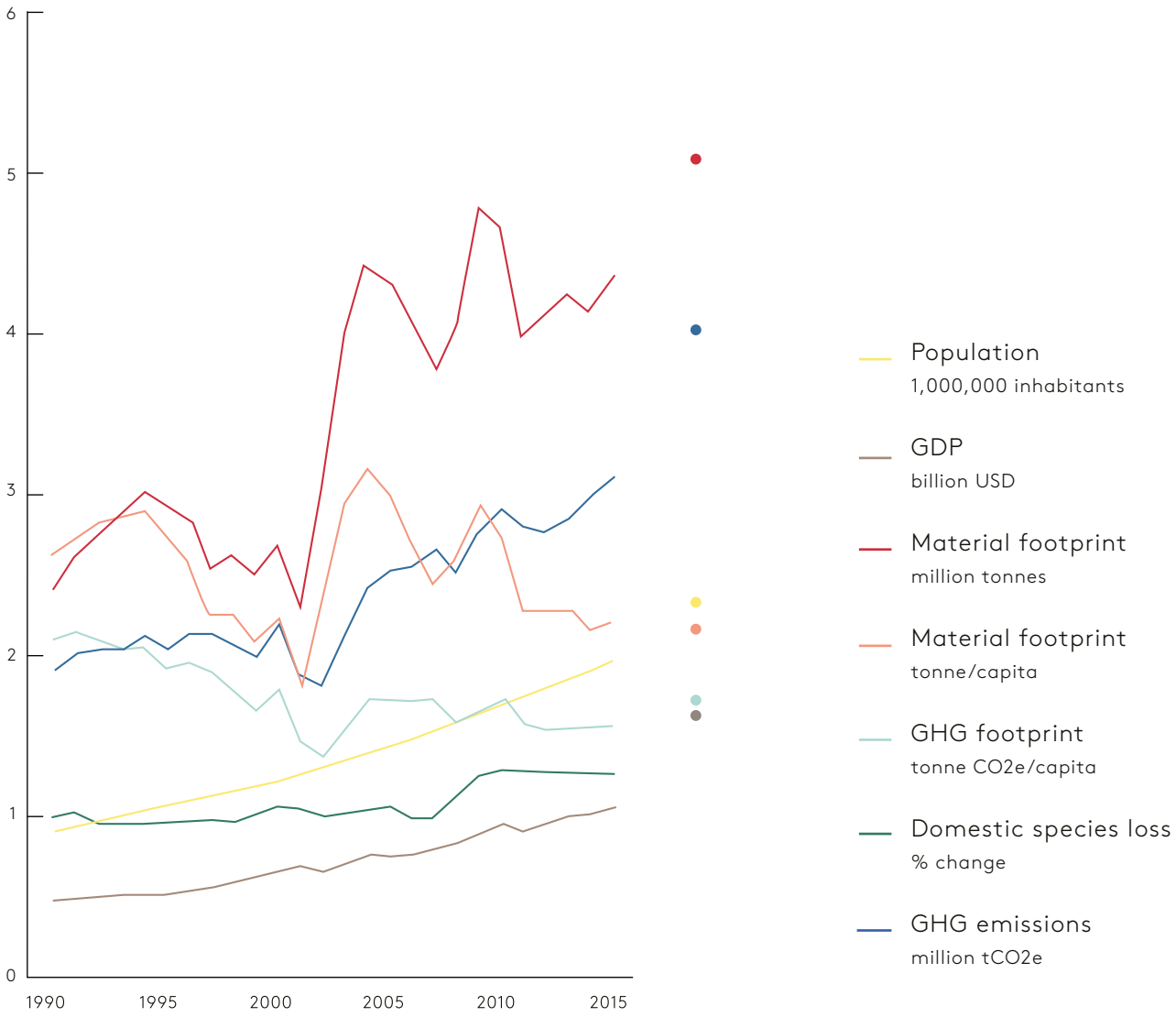
SOLID WASTE refers to secondary resources or wastes that are dumped or partially burned and then dumped in a dumpsite. As a result of the mixing of resources and their degradation over time, considerable value is lost. In addition, organic material that is dumped decays under anaerobic conditions and causes methane emissions, a potent GHG.

LONG TERM USE (LTU or products that last) refers to the use of materials over a long period, as in a new

FIGURE 7

Historic trends in population, economic development and environmental impact

The Gambia 1990 — 2015



building, vehicle or infrastructure.
EXPORTED refers to products and materials that are exported to other countries.

DISCHARGED refers to the discharge of treated or untreated wastewater into surface water.

NUTRITION refers to that part of organic material or food that people and animals use as a source of water, energy, protein or minerals.

SOIL ENHANCERS refers to materials that are applied on land to retain soil fertility and/or enhance soil organic carbon.

RECYCLED refers to waste that is recovered for processing and then reused. Throughout the recycling process, value that was embedded in the original product is lost. Recycling is thus a suboptimal waste treatment method, although better than landfilling.

Finally, four types of GHG EMISSIONS are identified and quantified.

TERRITORIAL EMISSIONS are those produced in The Gambia. They are created by the combustion of fossil fuels or the anaerobic digestion of organic materials. Embedded emissions are those produced outside the country during the production of goods and materials that are then imported.[61]

EXPORTED EMISSIONS are associated with goods and materials that are exported.

UPSTREAM EMISSIONS refer to those associated with imported goods and materials that are consumed in The Gambia and attributed to the country's consumption-based emissions.

Stocks and national assets

Just as a company's health cannot be assessed by looking only at its cash flow, its metabolic situation cannot be assessed by looking only at its material flows. A country may invest in or safeguard its natural assets, which would make them more attractive and productive in the future. It may also draw on those assets, which would prevent it from sustaining current production levels in the future. In keeping with the business analogy, the latter can be considered a form of asset stripping. Likewise, understanding the impact of economic activity on a country's national assets, including biodiversity, pollination services, water quality and soil fertility, requires a form of natural capital accounting.[62] There are different ways to account for natural capital or assets. This analysis relies partly on the United Nations Environment Programme's (UNEP) Inclusive Wealth Index (IWI), which distinguishes among three kinds of capital: human, capital and natural. The Index shows dominant trends in the quality or quantity of the types of assets that are the source of The Gambia's wealth.

2.5 Historic trends in material use and emissions

The UNEP's SCP-HAT provides an overview of trends in material and land use. The Gambia's per capita material footprint is relatively stable, while land use per capita has even decreased. With relatively stable per capita material, carbon and land footprints, the country has been able to sustain an increase in population and GDP without increasing the relative environmental impacts. In absolute terms, however, the material, land and GHG footprints are increasing.

See figure 7, page 34, Historic trends in material, land and GHG footprint, species loss, population and GDP growth[66]

With the gradual loss of species, The Gambia is experiencing a gradual loss of biodiversity. This trend is not unique to the country, as the natural world and its vital contributions to people are deteriorating worldwide. The main causes of biodiversity loss are land use change, climate change, pollution and population growth, along with economic incentives that favour continuous expansion of economic activity over conservation and restoration.[63]

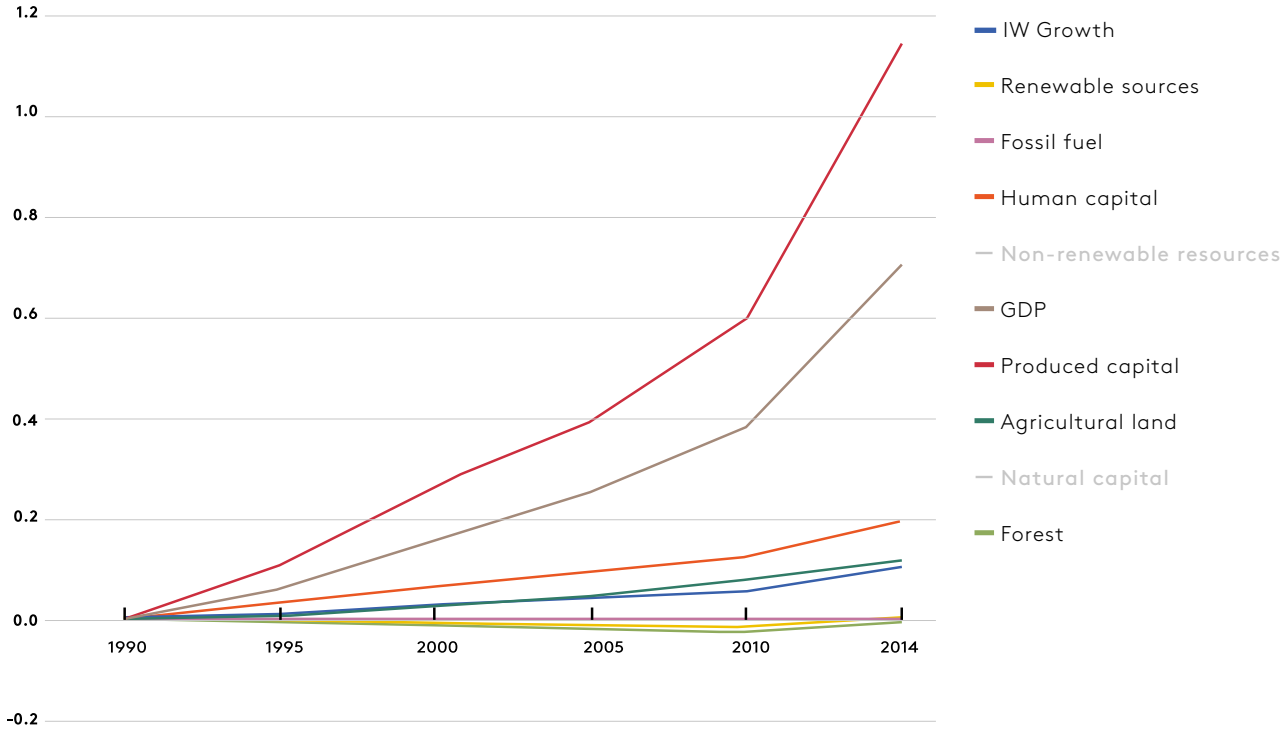
The Hotspot Analysis Tool confirms that population growth in The Gambia is exceptionally high. Population doubled between 1998 and 2018, reaching around 2,335,504 in 2018.[64] An estimated 1.6 Gambians per 1,000 inhabitants migrate,[65] with approximately 4,000 people leaving the country each year.

The 2018 data points follow from the metabolic analysis. Data from multiple sources have been combined for this analysis and the material flows in subsequent sections, with priority to sources from The Gambia, provided primarily by the government, its statistics bureau or project partner organizations in the country. Prioritizing national statistics and information ensures that the opportunities

FIGURE 9

Wealth Index The Gambia

1990 — 2014, in percentages %



identified in Part 3 are based on the same data on which the Government of The Gambia and other stakeholders in the country base their decisions. Most resources relied on 2018 data, but older data had to be used for some areas where more recent information was lacking.

When comparing the 1990-2015 data from the SCP-HAT to the 2018 metabolic analysis, the 2018 population and the per capita GHG footprint show that the trends identified in the SCP-HAT are continuing. Only the material footprint identified in the metabolic analysis for 2018 is significantly higher than the 2015 SCP-HAT value, also when considering historical trends. The difference is in the biomass value, which, in the metabolic analysis, is higher than the value calculated by the SCP-HAT.

2.6 Resource use along product value chains

This overview of material use in The Gambia shows all materials used in tonnes per year. Reading figure 8 from left to right, starting with the 'Source' column, the chart shows that the volume of materials extracted from regenerative resources in The Gambia is roughly the same as the total volume imported. The colour of the flows shows that most of the materials used are biomass, which are extracted primarily from the agriculture, forestry and fishing sectors. Imports are mostly biomass as well.

The middle column, 'Product category,' illustrates how these materials are applied or used. It shows that most imported minerals and a significant share of metals are used in construction. Vegetable products, followed by firewood as part of fuels, make up the lion's share of resource use in The Gambia.

The 'Final output' column on the far right shows that most materials used end up as solid waste in landfills and dumpsites, in addition to some long-term applications, such as new buildings and infrastructure and some exports. A significant share of the biomass weight is consumed and provides nutrition, but a relatively large share is discharged untreated or becomes solid waste in landfills or dumpsites. Exports consist primarily of groundnuts, fish meal, firewood, garments and re-exported empty containers.

A large share of the final output represents the

accumulation of built stock or products that last in long-term use and short-cycle CO_2. The latter refers to the use of renewable biomass as an energy source. The share of GHG emissions appears small in this visual, but that is partly because it reflects actual tonnes emitted without accounting for the global high warming potential of certain GHGs.

See figure 8, page 38: Flow chart with all products and materials in use in The Gambia on an annual basis. Annual flow totals 5.04 million tonnes/year, excluding water.[67] [68]

2.7 Quality of natural assets and stocks

All flows have an origin and a destination. Some contribute to the quality of the ecosystem from which they originate or at their destination, while others do not. Flora and fauna can recover from extraction, such as fishing, forestry and agriculture, unless the ecosystem's regenerative capacity is exceeded, soils are depleted or extraction methods damage them. Other natural stocks, such as mineral deposits, cannot be replenished. Extracting mineral deposits, such as fuels, ores and sand, is depletive, creating revenue only in the short run – referred to as resource rents – and during the economic lifetime of the product in which the resource is used.

At the end of a flow, organic residues can be used to enrich soils. When organic material decomposes in landfills, it can also cause eutrophication of surface waters or methane emissions. This section reviews trends in natural asset quality, providing insight into the ability of these assets to support life and prosperity in The Gambia now and in the future.

Natural resource rents compose only a small part of The Gambia's GDP – 6 percent for the period 2015 to 2017 and 2.5 percent in 2018 – and are generated by exploiting forest resources.[69]

Various sources confirm that deforestation is a concern in The Gambia, with forest stock declining at a rate of 56 hectares per year,[70] despite the 34,000 hectares of forest land protected and another 6,462 hectares under community management. Community-managed forests are often less vulnerable to deforestation and some sources report that forest stock is increasing. [71] Still, population growth, and the associated increasing demand for land and firewood, are important drivers of deforestation,[72] which, in turn, aggravates desertification.[73]

Fish stocks are also under pressure. According to official statistics, total catch does not exceed the sustainable level of around 70,000 tonnes per year.74 On the other hand, around 35 fish species are threatened in The Gambia.[75]

The issue is the sustainability of the development of natural assets in The Gambia, which is what the IWI seeks to measure. Unlike GDP, the IWI focuses on whether countries 'are developing in a way that allows future generations to meet their own needs .. [E]ach generation must bequeath to the next as large a productive base as it inherited from its predecessor'.[76] It does that by assessing a country's stock of assets, distinguishing among its manufactured, human and natural capital.

The Gambia's IWI is declining, as is the index for another 14 countries globally. In The Gambia, this is because investments in produced capital to develop health, education and natural capital cannot keep pace with population growth. This suggests that when determining the circularity of consumption in The Gambia, the calculation should take into account that not all production from forests, agriculture and fisheries can be considered regenerative or circular.

See figure 9, page 36

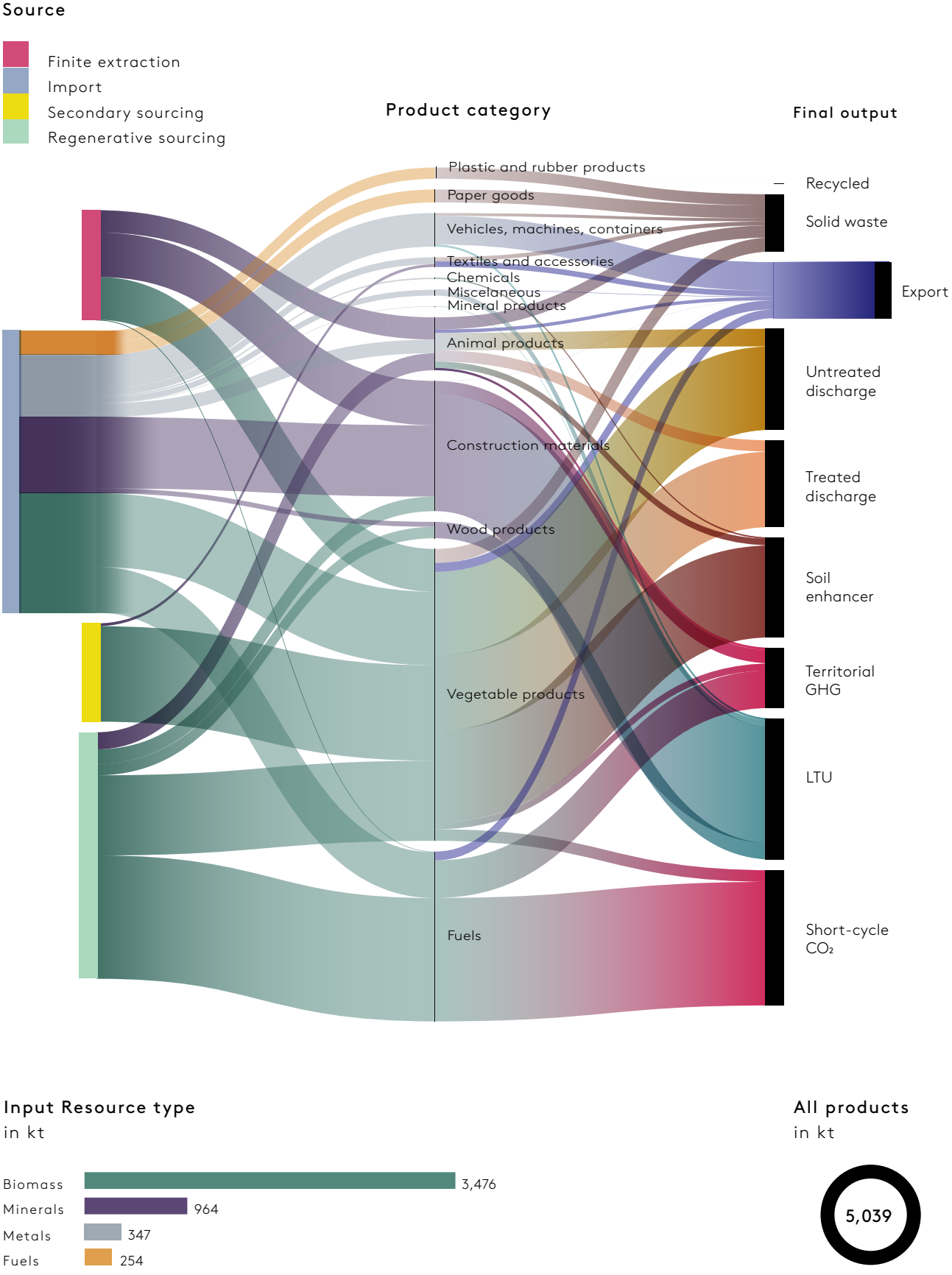
2.8 Consumption in The Gambia is 45 percent circular

The circularity of The Gambia can be calculated from the data underlying the visual presentation of more than 250 material flows. The country's consumption-based circularity gap specifies the share of domestic consumption from renewable or secondary resources. Its material footprint totals 5.0 million tonnes, which is the total amount of materials used in the country annually, regardless of origin or destination (excluding water and air). Domestic extraction of materials, which refers to the extraction of minerals, fish, forestry products and agricultural products and the volume that is recycled or reused, totals 3.1 million tonnes.

To determine the raw material footprint of consumption, the raw material footprint of imports is added and that of exports is subtracted. Annual imports stand at 1,927 ktonnes. However, delivering this volume of products to The Gambia requires extracting and using a much greater quantity of

FIGURE 8

All Materials
in kt



Input Resource type
in kt

All products
in kt

materials. Therefore, the imported amount should be adjusted to reflect its raw material equivalent (RME), which is 3.9 million tonnes. Likewise, the raw material equivalent of the 0.39 million tonnes exported from The Gambia should be deducted from the country's total material use, for a raw material footprint of 0.43 million tonnes in exports.

The raw material footprints of exports and imports are calculated by relating close to 100 types of commodities to their specific raw material equivalent. As a result, the average raw material equivalent of exports differs from that of imports. Indeed, the average raw material equivalent of imports is significantly higher than that of exports. This is because the range of products exported are mostly agricultural commodities, fish and firewood. These products have a relatively small material footprint, while imports are mostly processed food products, machines, construction materials and fossil fuels with a higher average raw material footprint.

The corrected raw material footprint of consumption in The Gambia is 6.1 million tonnes. Of the raw material footprint of imports, 8.6 percent is estimated to be circular, in line with the global average reported in the 2020 Global Circularity Gap. In The Gambia, significant amounts of used clothing have been classified as circular.

The domestic sourcing of materials is classified as circular when the materials are of regenerative or secondary origin and are retained within the system or cycled back as secondary inputs. Comparing forestry production with the annual loss of forest stock shows that 94 percent of forest products are regenerative. In other words, their extraction does not exceed the annual increment of forests.[77] Fish extraction in The Gambia is assumed to be circular where it involves artisan, rather than commercial, fisheries.[78] Agriculture is considered circular when no fertilizer or pesticides are applied. If the extrapolated annual yield of a specific food commodity is declining, the annual decline is considered linear. While fertilizer and pesticide inputs per hectare are very low in The Gambia,[79] only the yield decline is accounted for.

Taking all this together, circularity of consumption in The Gambia is thus estimated at 45 percent. This is attributed primarily to a largely sustainable and, even, partly organic agricultural and forestry sectors, the use of largely renewable firewood, recycling and reuse, the use of regenerative construction materials, and the 8.6 percent of imports that are circular. The remaining imported goods and materials follow a linear pathway. In addition, the limited recovery of organic nutrients from solid waste and wastewater means that some biomass flows are linear, even when these materials originate from regenerative sources.

On the other hand, production in The Gambia is considerably more circular – at 74 percent – than consumption. When analysing the circularity of production, imports are excluded and only products from The Gambia are accounted for, including those that are exported. Since imported goods and materials have a low degree of circularity, national production is more circular than national consumption.

See figure 10+11 Circular and linear material flows in The Gambia, page 40 and 41

The Circularity of National Consumption and Production

This metabolic analysis for The Gambia applies a relatively new metric to estimate the circularity of national consumption and production. This value allows The Gambia to set a benchmark from which to track progress in the transition to a circular economy.

The approach to calculating the circularity gap follows the rationale developed for the Global Circularity Gap Reports,81 which builds on earlier work by Haas et al.,[82] Krausmann,83 Wiedman[84] and the International Resource Panel.[85]

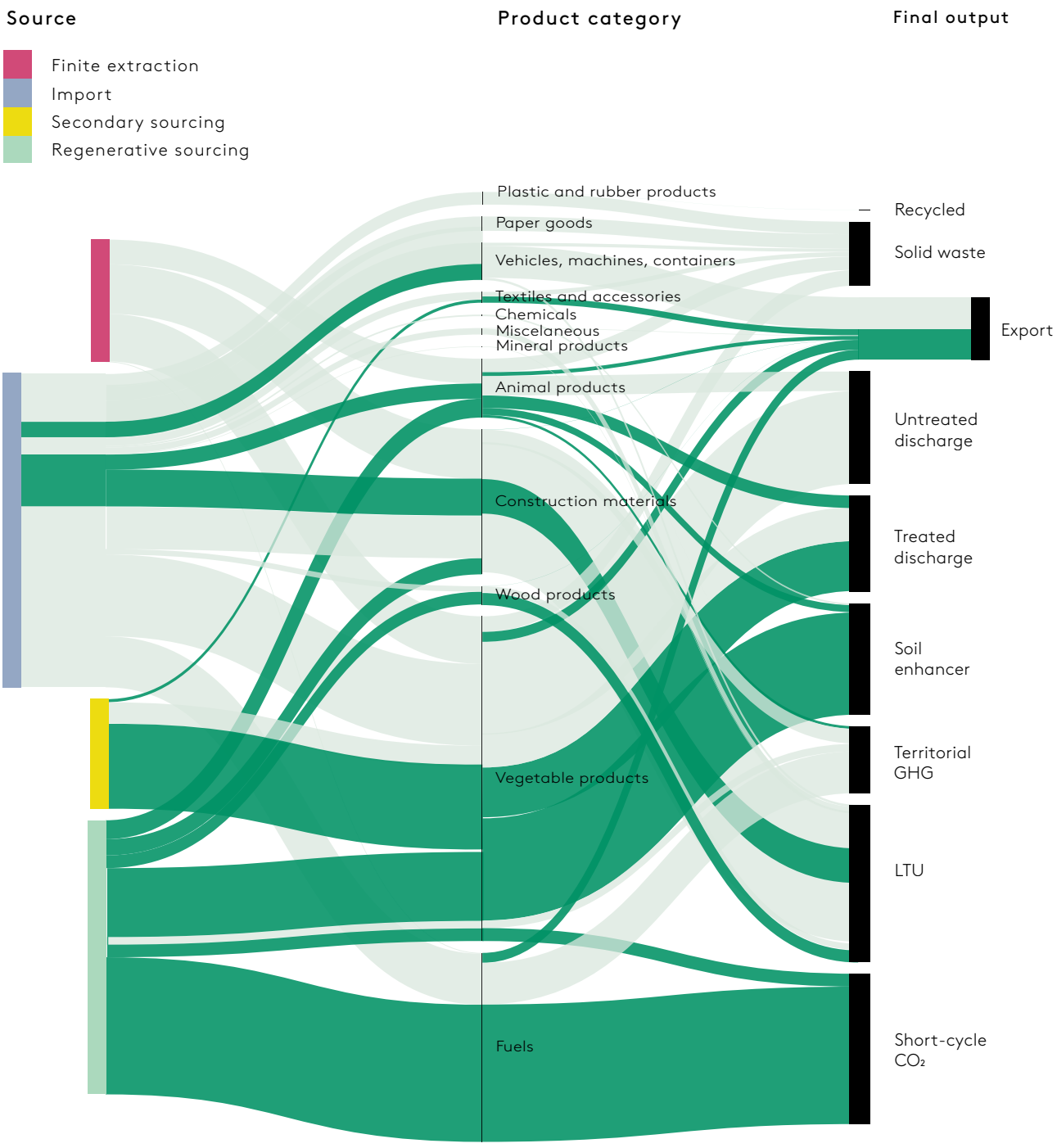
The Gambia's approach to calculating the circularity of consumption differs from that adopted in Norway's circularity gap report, which defines circularity as 'measuring the share of cycled materials as part of the total material inputs into a national economy every year'. [86] However, the use of regenerative and imported secondary materials are determining factors in The Gambia's material footprint. Prioritizing regenerative resources is a key element of the circular economy (see Box 2) and should be captured in the circularity estimate.

By including regenerative resources, this metric seeks to include photosynthesis in the equation. Photosynthesis harnesses renewable energy from the sun and turns it into valuable biomass in

FIGURE 10

All Materials

in kt

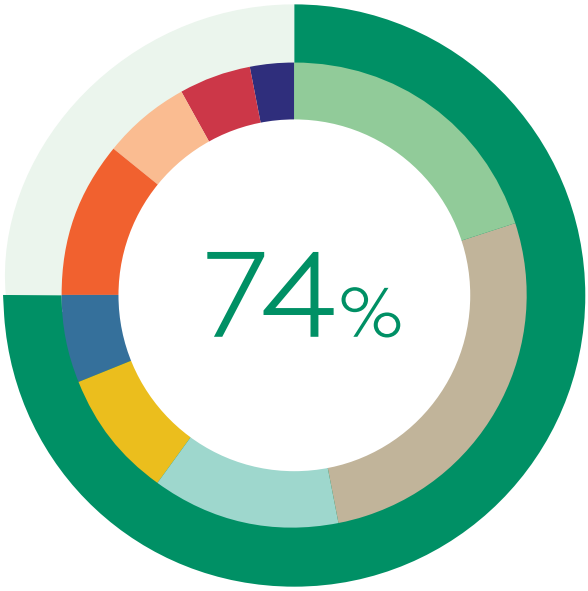


RME Import

RME Export

Production

circular
linear

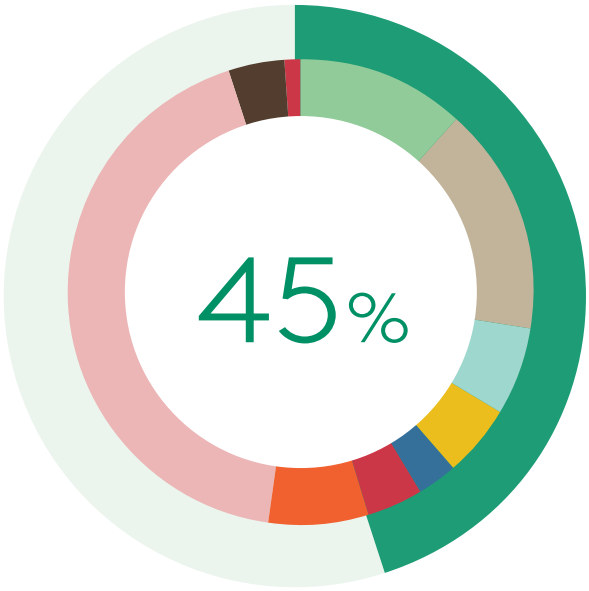


- Agricultural and food residues applied on land
- Regenerative firewood
- Regenerative food with nutrient recovery after consumption
- Reuse
- Recycling (< 1%)
- Regenerative materials (applied in LTU)
- Unsustainable food production and/or food without nutrient recovery
- Resources landfilled
- Non-CO_2 GHG emissions
- Exports subject to 74% circularity of production

Excluding the Raw Material Equivalents (RME) of imports and including the RME of exports but corrected for re-exports

Consumption

circular
linear



- Agricultural and food residues applied on land
- Regenerative firewood
- Regenerative food with nutrient recovery after consumption
- Reuse
- Recycling (< 1%)
- Regenerative materials (applied in ITU)
- 8.6% circular imports (global circularity)
- Unsustainable food production and/or food without nutrient recovery
- Resources landfilled (< 1%)
- 91% linear imports (global circularity)
- Fossil fuel use
- Non-CO_2 GHG emissions

Including the RME of imports, corrected for re-exports and excluding the RME of exports

forests, marine environments and agriculture. This biomass can be considered regenerative when the natural assets from which it originates – that is, the forest stock, fish stock[87] and soil quality – are stable or improve in quality and quantity over time. The metric thus combines an analysis of natural stocks (to determine whether they are degrading or improving) and an analysis of material flows. Flows are considered circular only when they are of secondary or regenerative origin and are cycled after the use phase.

As a result, the 45 percent circularity of domestic consumption in The Gambia represents the share of all materials used, including the raw material equivalents of imports from regenerative or secondary resources, and cycled back into the economic system after use. These include the following materials:

- Food products, including food, food waste and losses, and agricultural residues of regenerative origin whose nutrients are applied on land or otherwise stay within the terrestrial, marine or forest environment from which they originate;
- Construction wood that does not contribute to deforestation and firewood whose extraction does not contribute to forest degradation or deforestation; and,
- Minerals, metals and fossil fuel-based products of secondary origin and that are recycled after their use, regardless of whether the materials are recycled in The Gambia or exported for recycling abroad. This applies primarily to plastics, scrap metal, glass and mineral oil residues and to mineral construction materials, such as compressed bricks, that are used in buildings in a way that allows them to be returned to the land; and,
- Imported secondary materials.

By contrast, flows are considered linear when they are composed of food that originates from overfishing, deforestation or agricultural practices that lead to soil degradation or require high fertilizer and pesticide inputs. They are also considered linear when, after consumption, their nutrients and organic materials are lost to surface waters or the sea, become GHGs or contribute to eutrophication. The latter occurs when more nutrients enter the marine environment than are extracted through fishing. For the raw material equivalents of imports, 8.6 percent circularity has been assumed, which is equal to the global average, unless imported goods and materials are clearly of regenerative or secondary origin.[88]

This metric is relatively new and being applied for the second time in The Gambia. Please share any suggestions for improvement or refinement with Shifting Paradigms.

2.9 GHG emissions in The Gambia and embedded in product imports and exports

Analysing the carbon footprint of consumption in The Gambia helps to prioritize interventions that can reduce the country's GHG emissions and the carbon footprint of national consumption.

National GHG emissions for 2020 are estimated at approximately 4.9 million tCO_2e.[90] Upstream emissions generated during the production of imported goods and services total 1.2 million tCO_2e. The average carbon footprint of imported goods and materials, measured in tCO_2e per tonne imported product, is considerably higher than that of domestic production. That is because the Gambia imports relatively carbon-intensive products like construction materials, vehicles and fossil fuels. It should be noted here that fossil fuels have an upstream carbon footprint, while also contributing to domestic GHG emissions when combusted.

Around 85 ktonnes CO_2e of territorial emissions are related to the production of goods and materials that are exported for consumption; some of them are re-exports. When assessing consumption-based emissions, those generated in The Gambia from producing products that benefit consumers abroad may be deducted from The Gambia's consumption-based emissions. Still, efforts to reduce territorial emissions may also reduce the carbon footprint of exported products, allowing foreign consumers to consume products with an even lower carbon footprint.

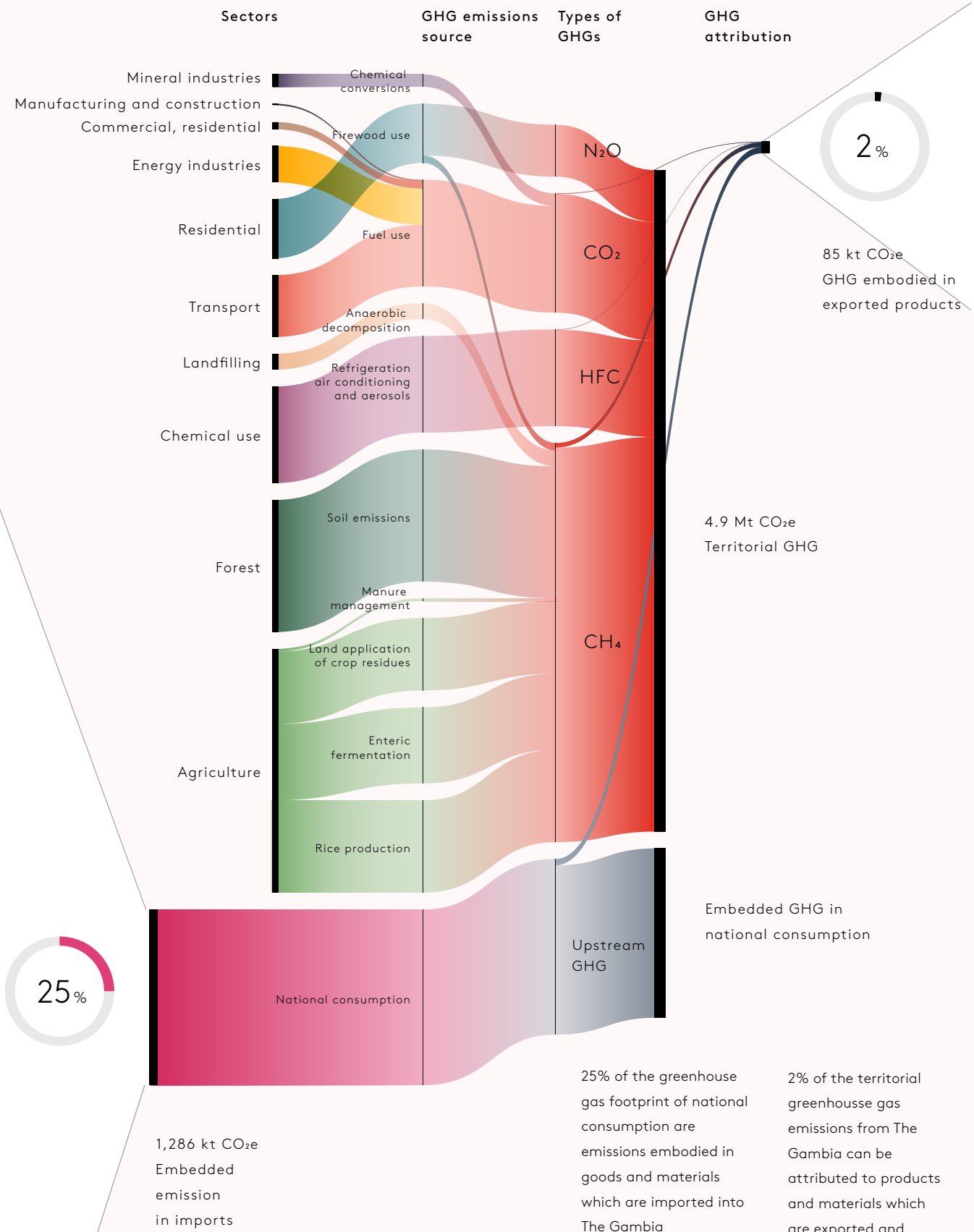
The country's GHG emissions are primarily methane (CH_4) from agricultural activities, such as the land application of crop residues, enteric fermentation of livestock and rice production. Emissions from fuel use include carbon dioxide (CO_2) emissions from the combustion of imported fossil fuels, and methane and nitrous oxide (N_2O) emissions from the combustion of firewood. Other sources include hydrofluorocarbon (HFC) emissions from the use of chemicals for refrigeration, air conditioning and as aerosols.

See figure 12/13, page 43-44, GHG emissions

FIGURE 12

GHG emissions from The Gambia

in kt Co2e



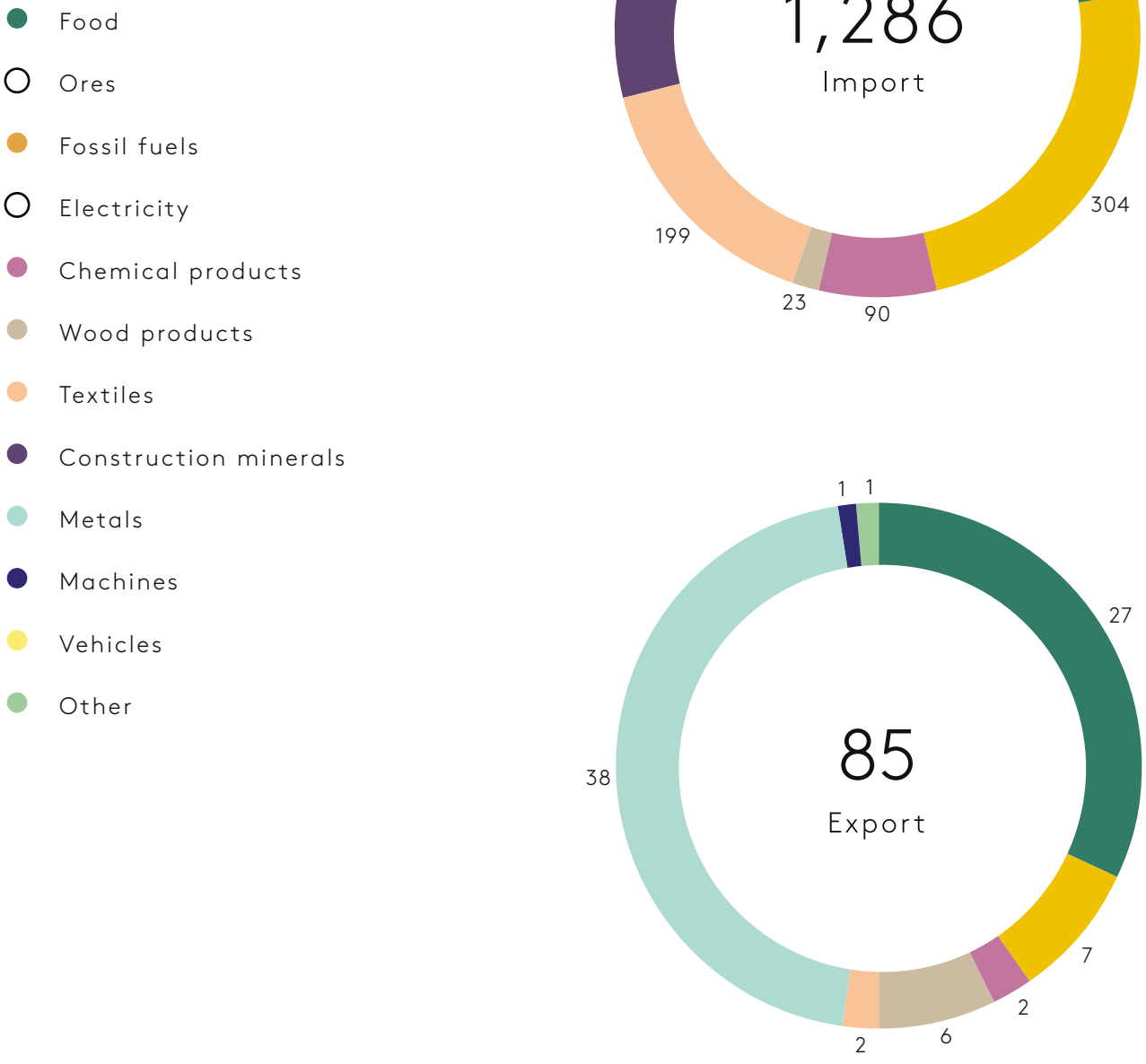
25% of the greenhouse gas footprint of national consumption are emissions embodied in goods and materials which are imported into The Gambia

2% of the territorial greenhousse gas emissions from The Gambia can be attributed to products and materials which are exported and consumed abroad

FIGURE 13

Embodied GHG

kt CO_2e/year



from The Gambia and embedded in imported and exported goods and materials.[91]

2.10 Food value chains

The Gambia's primary sectors contribute 7 percent of GDP and provide 9 percent of employment. However, sources other than the Gambia Bureau of Statistics indicate that the agricultural sector employs 46 percent of the labour force and is a source of livelihood for 80 percent of the rural population.[92] Agriculture, forestry and fisheries provide the population with valuable nutrients.

AGRICULTURE: The Gambian agricultural sector meets around 50 percent of national food demand. The country is particularly dependent on imports for rice, its national staple food. The Gambia's own production meets approximately 6 percent of domestic rice demand, while production growth for most products is not keeping pace with population growth. Yields are declining[93] and domestic production is increasingly vulnerable to the impacts of climate change, specifically declining average rainfall. These developments all drive imports up and expose the country to price fluctuations on international markets.[94]

Despite government subsidies on imported mineral fertilizers, The Gambia's agricultural sector uses few synthetic inputs. Sub-Saharan African countries apply an average of 16 kg of fertilizer per hectare of arable land, compared with 1.2 kg/ha per year in The Gambia.[95] In addition, the use of insecticides and pesticides is low, estimated at around 1,000 tonnes per year.

In The Gambia, rice was commonly cultivated along riverbanks. Under this production system, surrounding forests absorbed surplus water, releasing it when water levels fell. The system was sustainable and productive, but the practice has declined due to drought, salination, population growth, farm mechanisation and monocropping. In some cases, rice fields have become barren lands.[96] The country's main cash crops are now groundnuts and cotton.

FORESTRY: Around 1.4 million people, or 78 percent of The Gambia's population, live close to a forest. The country's forests supply most of the population with valuable products, such as firewood, food, animal fodder and construction materials. Forest cover increased during the period between 1980 and 2000, perhaps because of the introduction of community managed forests. Forest cover has declined in the last two decades.[97]

Gambian forests have been under threat by uncontrolled forest land burning, the collection of firewood, and the expansion of residential areas and farms. Forest cover totals around 43 percent, including a mangrove system of some 64,000 hectares. The country's 66 national forest parks cover approximately 34,000 hectares and community forests total an estimated 6,500 hectares.[98] The Gambia relies on imported forest products from Senegal for charcoal and some imports of re-exports. Considering the national forest increment, The Gambia can barely support the export of forest products, prompting the government to impose a ban on the re-export of forest products in 2014.[99]

FISHING: Most fish in The Gambia is brought ashore by artisanal fisherman. Twenty fish companies operate in the country and 11 of them have invested in fish factories. Seven of these factories meet the requirements for exporting to the European Union. To develop the potential of The Gambia's fish stock, the government is expanding its research capacity so that it can develop policies that allow for sustainable growth. Some species are over-fished, while others can support higher extraction levels. Post-harvest losses are high. [100]

In addition, the clear demarcation of coastal areas where artisanal fishing can be practiced and where industrial fishing is prohibited aims to avoid conflict between the two.[101]

2.11 Material flows in food value chains

The food value chains, including packaging, represent 65 percent of all material flows in The Gambia. This detailed overview of material flows from agriculture, forestry and fishing shows that most food products consumed in The Gambia are produced within the country. An estimated 35 percent of food products are imported. The agricultural sector consumes 43 percent of all water, used for irrigation. Post-harvest losses of food, shown in the 'product' column as food waste and bycatch, are significant.

Firewood is an important energy source for The Gambia. Expressed in tonnes, 77 percent of the fuel consumed in The Gambia is firewood. Since only a

small portion contributes to deforestation, firewood can be largely considered regenerative.

The GHG emissions in this graph are expressed simply in tonnes, rather than tonnes of CO_2e. Methane and nitrous oxide emissions from agriculture and use of firewood and HFC from refrigerators represent 51 percent of territorial emissions. Where HFC emissions are generated by refrigerators, they are allocated to the primary sectors. Where they are considered aerosols, they are allocated to industry.

See figure 14, 48 and 49
Materialflows in food value chains[102]

2.12 Current circular economy initiatives in food value chains

Existing circular economy initiatives in The Gambia's primary sectors focus on the use of organic residues, regenerative agriculture and the promotion of organic agricultural production. An illustrative, but not exhaustive, list of circular economy initiatives in The Gambia is presented below.

The Essence of Africa

Organic Moringa tree products from The Gambia and Namibia

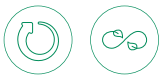
The Essence of Africa is a brand supported by organic farmers in The Gambia. The company also provides training s in organic farming as part of vocational training curricula.[103]

Food & Organics Trading

Connecting African superfood farmers with international markets

The Gambian-based Food & Organics Trading supports farmers in West African countries with training and financial empowerment so that they can produce high quality food products for local and international markets. Women are the main target as they play a major role in agricultural enterprises.[104]

Tanji port



Growing seedlings on fish and groundnut shells

At the port of Tanji, groundnut shells and fish waste are composted and placed in old cement bags, which are used to grow seedlings.[105]

MyFarm

Agricultural resilience with market diversification

MyFarm, in Sukutu, applies alternative agricultural techniques at a 2.5-hectare site and produces a more diverse range of products. MyFarm also seeks to inspire farmers to diversify their product offerings and trains children and youth in advanced agricultural production techniques. The technologies used involve producing and applying charcoal to improve soil water retention, biodigesting, composting, solar cooking, using groundnut shells as substrate and installing hydroponic systems that can be used in urban settings.[106]

Franco Inn

Tourism that benefits local residents

Many tourist accommodations are owned by foreigners, which limits the benefits that The Gambia's population can enjoy from tourism revenues. Franco Inn is closely associated with cultural activities that the local population organizes and in which visiting tourists can participate.[107]

Special Programme for Food Security (SPFS)

Improving food security with community organizations

The FAO has worked with community organizations to enhance food security through activities such as water harvesting and improved and diversified production targeting poultry, small ruminants, aquaculture, mushrooms, exotic fruits, cashew and rice.[108]

International Fund for Agricultural Development

The Gambia national agricultural investment programme

IFAD is developing a private sector policy framework to improve agricultural input service delivery and support private investment with the government as facilitator and catalyst.[109]

Njawara Agricultural Training Centre

Training farmers on regenerative agriculture and reducing food loss

The Njawara Agricultural Training Centre[110] trains farmers to produce and apply manure from crop residues to reduce the use of synthetic fertilizers. It also provides cold storage and irrigation facilities.[111]

Food and Agricultural Organisation

Reforestation and cookstove efficiency

The FAO trains people to build efficient cookstoves with local materials, such as mud. It has also supported the reforestation of 1,250 hectares and placing forests under community management.[112]

Konoto forests

Community-managed agroforestry

Since 1990, the Gambian government has been transferring forest ownership to communities, which are currently managing 10 percent of Gambia's forest area. Community agroforestry initiatives led to an expansion of forest area, combined with increased crop production.[113]

African Development Bank

Improving livestock productivity

Africa is losing many indigenous livestock breeds as farmers struggle to cope with climate change. The African Development Bank is supporting farmers to improve livestock productivity and thus preserve breeds.[114]

UNIDO

Improving quality and compliance along the onion value chain

UNIDO supports initiatives in The Gambia to support the competitiveness of food value chains and previously invested $5 million in food processing industries.[115] It is now supporting efforts to improve the performance and growth of onion production, processing, regional trade and exports.[116] Other projects seek to phase out hydrochlorofluorocarbon (HCFC) and HFC refrigerants under the Montreal protocol, promoting renewable energy investments in small and medium enterprises, supporting the dissemination of improved cookstoves and efficient lamps, refrigerators and air conditioning.[117]

Material flows in food value chains

in kt

Source

- Finite extraction
- Secondary sourcing
- Import
- Regenerative sourcing

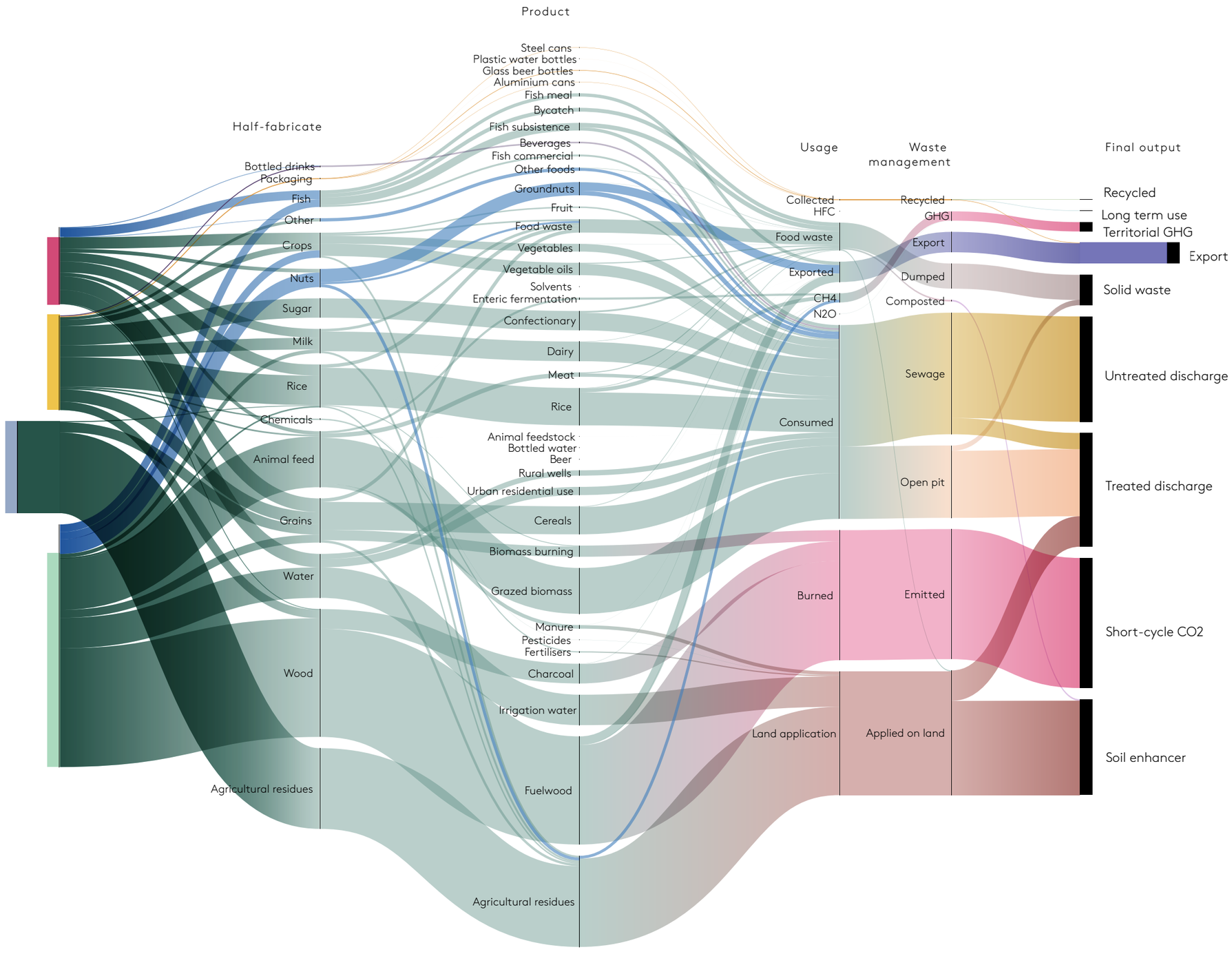
450
14%

653
20%

3,285
100%

673
20%

1,508
46%



Input Resource type

in kt

2.13 Construction

Construction in The Gambia contributes 6 percent of GDP and provides 8 percent of jobs. According to estimates by the World Green Building Council, floor area across Africa will more than triple in the period between 2017 and 2060, driving a huge increase in demand for construction materials.[118]

The Ministry of Works and Infrastructure plans for approximately $70.3 million in annual investment to maintain and build roads, sewage systems and public buildings. Such public infrastructure investments create emissions totalling around 96,000 tCO_2e, from construction and the production of construction materials, while requiring the extraction of 240,000 tonnes of raw materials.

2.14 Material flows in construction

The total material use in construction is estimated to be 1.0 million tonnes per year. Roughly half of that is from domestic extraction and half from imports. Imports include primarily minerals and metals, while domestic extraction is composed primarily of minerals and biomass. The large volume of imported wood-based construction materials is mostly re-exported.

The relatively large use of regenerative resources in construction contributes significantly to The Gambia's circularity. By applying regenerative materials in long-term applications, such as new buildings and infrastructure, the country lowers its carbon footprint considerably. Using wood as a construction material reduces the use of carbon-intensive materials such as concrete and steel. However, calculations do not yet reflect that The Gambia also stores carbon in so-called harvested wood products by using long-lasting wood construction materials in its construction sector.

See Figure 15, page 52 and 53
Materialflows in construction[119]

Approximately half of the minerals are imported. The remainder are locally sourced construction materials, such as compressed bricks. However, the volume of locally sourced construction materials is difficult to determine with certainty. However, the volume of locally sourced construction materials is difficult to determine with certainty. Also the volume of demolition and construction waste is difficult to estimate as it is mixed with municipal solid waste.

2.15 Current circular economy initiatives in construction

The construction sector supports several inspiring initiatives that promote sustainable construction, relying primarily on traditional knowledge of building design and tapping into locally available materials.

Earthworks Construction

Compressed stabilized earth bricks as a construction material

Earthworks Construction, based near Kartong, produces compressed earth bricks, which are stabilized with lime or cement.[120]

Gambia Virai Arquitectos

Ecological house at the seaside near Tujereng

This family home with separate tourist accommodation in Tujereng was sited to minimize the impact on existing vegetation. Compressed earth blocks were used as construction materials and the layout of a traditional Casamance house inspired the architecture, involving the use of passive design principles to regulate the indoor climate.[121]

Tunbung Art Village

Building with compressed earth bricks and raising environmental awareness

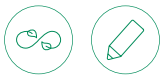
Tunbung Art Village is designed to embrace, rather than exclude, the environment. While trees are kept intact, all buildings are constructed within the shade of existing vegetation, using compressed earth bricks as the main construction material. The bricks are strong enough to hold concrete beams and support a second floor. The brick press is also rented out to other villages.[122]

Build with Gambia

Building with earth

A group of volunteers joined forces with the people of Karsi Kunda, a village in the far east of The Gambia, to experiment with different ways to produce construction materials using local resources, including glass bottles and earth. As part of the project, local construction companies were trained in concepts such as passive design, biomimicry, design thinking and human-centred design.[123] The result was a dormitory using adobe bricks.[124]

Sandele Foundation

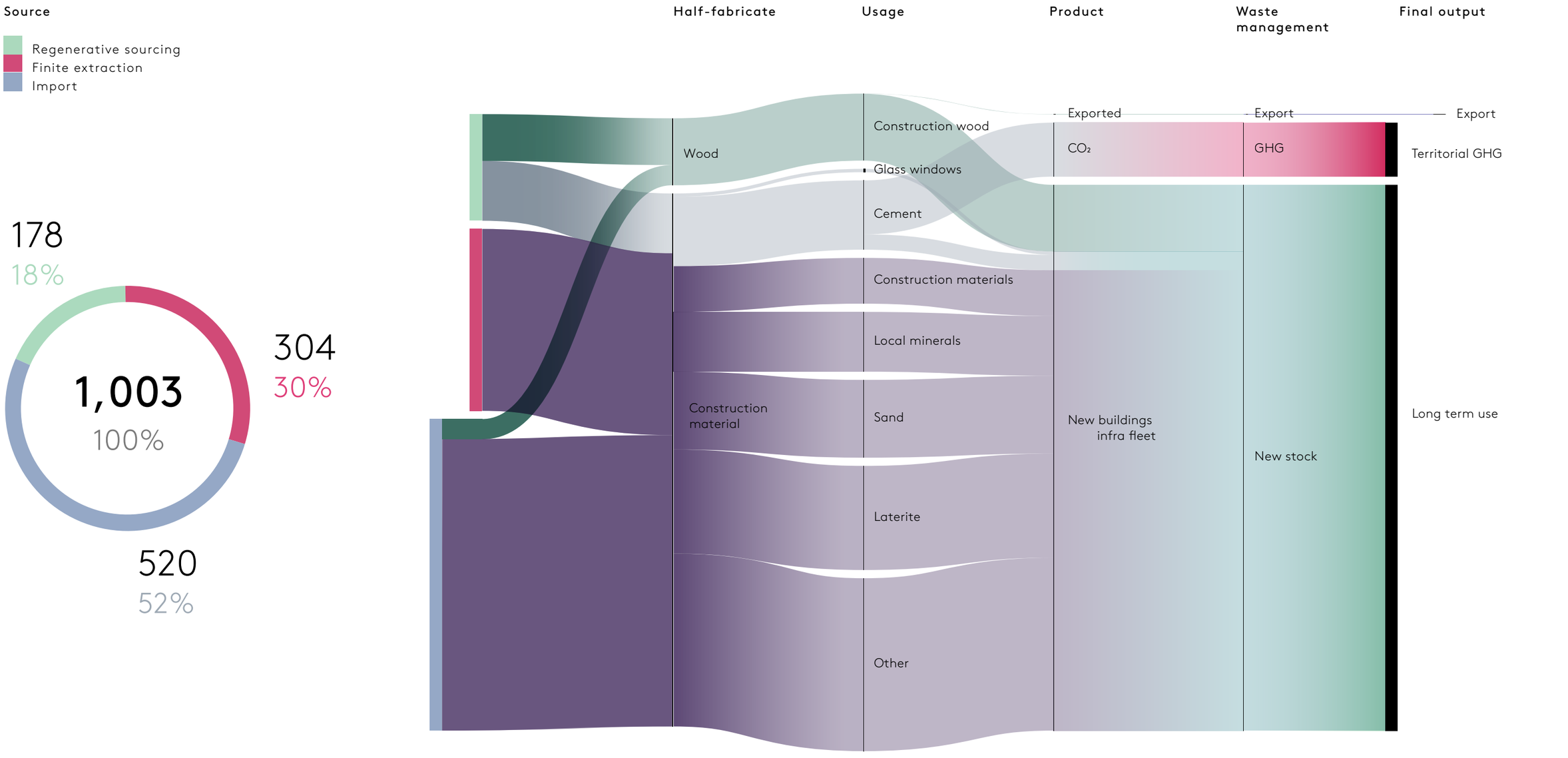


Ecovillage Network

Sandele Foundation in Kartong has an Ecovillage Network that promotes and trains communities on sustainable housing (a hotel built using sustainability and the ecotourism concept).

FIGURE 15

Material flows in construction
in kt



Input Resource type
in kt

2.16 Industry

Industry in The Gambia contributes 19 percent of GDP and provides 2 percent of employment. Most industrial activities are in food and wood processing,[125] including water bottling, Banjul Breweries' operations (which include production of beer under the JulBrew brand),[126] fish processing and the extraction of vegetable oils from groundnuts.[127]

Other industrial activities relate to furniture production[128] and foam mattress assembly,[129] plastic piping production,[130] metalwork,[131] window assembly,[132] production of paving blocks, slabs, air vents,[133] detergents and beverages[134] and the packaging of imported cement. The Gambia does not operate cement kilns inside the country.[135]

2.17 Material flows in industry

Total material use in industry is 938 ktonnes per year, significantly less than in the primary sectors and construction. The flows confirm that industrial activity in The Gambia uses primarily imported materials. A significant share of industrial products that are imported are re-exported. The export of empty shipping containers demonstrates the ample export capacity, which is likely available at low cost. It can be used to export regenerative goods and materials from The Gambia or for reverse logistics, whereby products are returned to the manufacturer when they reach the end of their life. In addition, the country imports large volumes of secondary textiles, which helps avoid primary resource extraction. While the garment sector relies on secondary textiles, recyling rates for paper and cardboard are relatively low.

Finally, most industrial GHG emissions relate to CO_2 emissions. Here, too, emissions are expresed in actual tonnes, not in tCO_2e.

See Figure 16, page 56 and 57
Material flows in industry[136]

2.18 Current circular economy initiatives in industry

Circular economy initiatives in the industrial sector focus on metals and plastics collection and recycling, organic waste composting, and developing local food processing capacity.

Serekunda industrial estate

20 percent recycled content in HDPE pipes

At the Serrekunda Industrial Estate, water pipe manufacturers use HDPE 20-gallon containers to add an estimated 20 percent of recycled content to their products.

Julbrew

Deposit scheme on glass bottles

Thanks to a deposit of 10 dalasi ($0.20) per glass bottle, The Gambia's Julbrew brewery recovers a significant part of its glass bottles for reuse.[137]

Gambia Chamber of Commerce and Industry

Business incubator for agro-processing

The Gambia's Chamber of Commerce and Industry developed a business incubation centre at the TradeFair Center in Brusubi Institutional Estate. The Government of India has provided the incubator six pieces of agro-processing equipment, which the Center will use for training purposes.[138] Expanding food processing activities in The Gambia will allow the country to harvest and apply its own agricultural residues.

WasteAid

Turning waste plastics into paving tiles

WasteAid trained 30 people in Gunjur village to produce plastic paving tiles from waste plastics, which are stronger and more durable than concrete tiles.[139] This is one example of how WasteAid helps communities develop their own waste management solutions by forming social enterprises.[140]

Jal Yassin Enterprise Ltd.

Home-based food processing company

Jal Yassin Jah-Mbye started her food trading and processing company from her home. The company currently employs several women and is engaged in trading, cereal popping and mango drying. The company prioritizes local production and promotes awareness of the nutritional qualities of Gambian food.[141]

Isatou Ceesay

Fashion from plastics cooperative

The entrepreneur Isatou Ceesay established a women's fair trade cooperative in Njau. The cooperative produces new products from plastic waste and has drawn international attention.[142] By reducing plastic waste, the cooperative can help prevent malaria as waste often blocks waterways and standing water attracts mosquitos.[143] [144]

Climate Technology Centre and Network

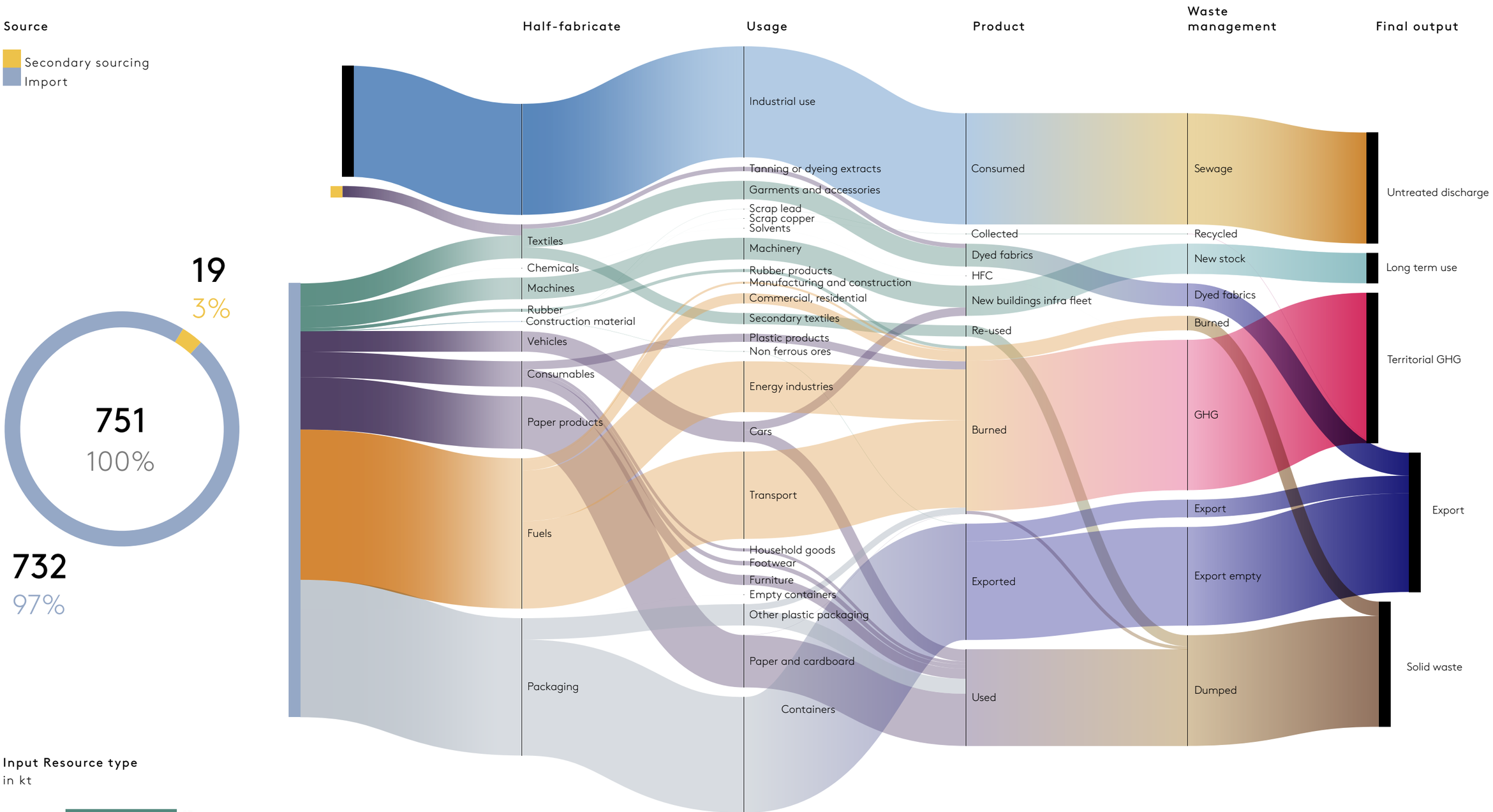
Briquette production from organic waste

To develop a sustainable value chain for fuels, the Climate Technology Centre and Network is training women across The Gambia to produce and use briquettes from agricultural waste[145]

FIGURE 16

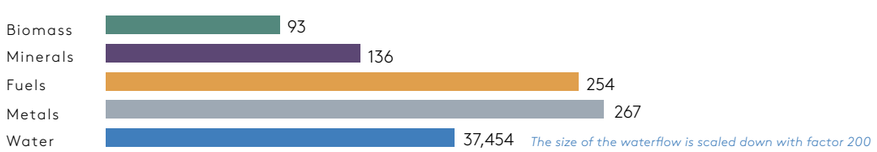
Material flows in industry

in kt



Input Resource type

in kt



The size of the waterflow is scaled down with factor 200

2.19 Public, commercial and financial services: current circular economy initiatives

Public, commercial and financial services, including tourism, provide 43 percent of GDP and 58 percent of employment in The Gambia. The service sectors are also an important source of foreign exchange earnings.[146]

Circular initiatives are not limited to highly material-intensive sectors. The service sectors also play an important role in accelerating the transition to a circular economy.

Although The Gambia is an important tourist destination, the leisure industry contributes only 4 percent of GDP and 10 percent of employment. Commercial and, even, public services have considerably more socio-economic weight.

Ocean Heroes

Beach clean-ups

The GREAT Institute, a research centre for marine science, environmental issues and climate change, organizes beach clean-ups. In addition to clearing marine litter from The Gambia's environment, the initiatives raise awareness of the adverse impact of plastics on marine ecosystems.[147]

IEB

Solar panel programme

The European Investment Bank invests in connecting all educational and health centres in The Gambia to solar power. The project involves installing 20 MW of solar capacity and 400 kilometres of distribution lines.[148]

Food & Organics Trading

Developing utility services in rural Gambia

Food & Organics Trading supports investments in irrigation infrastructure in the rural village of Sami Madina.[149]

Kemo Fatty

Improved management of Bakoteh dump site

Waste scavengers met near the Bakoteh dump site to seek ways to improve site management and reduce environmental and health impacts on surrounding residential areas.[150]

Commercial services: Transport and storage, wholesale, retail trade and vehicle repair

Farm Fresh

Retail sale of Gambian fruits and vegetables and organic products Farm

Fresh delivers fresh fruits and vegetables, including a range of Gambian products, to homes.[151] The company also offers organic Moringa plant products.

Financial services: Finance, insurance and real estate

Green Climate Fund

Climate-resilient agriculture and forestry with ecosystem-based adaptation

UN Environment is implementing a $25.5 million grant programme to restore degraded forests and agricultural landscapes and support ecosystem-based adaptation in The Gambia. The programme is intended to rehabilitate 10,000 hectares of degraded forestland and restore 3,000 hectares of abandoned and marginal agricultural land.[152]

2.20 Conclusions – Part 2

Consumption in The Gambia is 45 percent circular, due primarily to the large share of regenerated materials used. The majority of imported products follow a linear trajectory.

Most of the material used is biomass; agriculture, forestry and fisheries are important sectors in terms of material use. The Gambia uses wood as a primary source of energy and as a construction material. However, at the end of the product's life, significant organic waste flows contribute to surface water pollution and the emission of landfill gas. This is where opportunities for the circular economy and GHG mitigation overlap.

Clearly, initiatives have already been undertaken in The Gambia that rely on circular economy principles. Increasing the country's circularity further can build on what is already being done.

The Gambia is building up considerable produced stock in the form of new infrastructure where governments and international development partners have an important role. Their joint procurement power can help drive the transition to a circular economy.

3 Circular economy strategies and next steps

3.1 Introduction

Part 1 described the ambitions, trends and developments that will have a material impact on resource use in The Gambia. **Part 2** presented the outcome of an analysis of resource use, waste production and the quality of natural assets.

Part 3 combines the results of the data analysis in the previous sections and suggestions from experts consulted into a series of recommendations on circular economy strategies. The strategies tap into the larger flows of secondary resources and existing underused assets. Other strategies aim to replace the use of primary resources where their production, use or disposal is particularly harmful to human health or the environment.

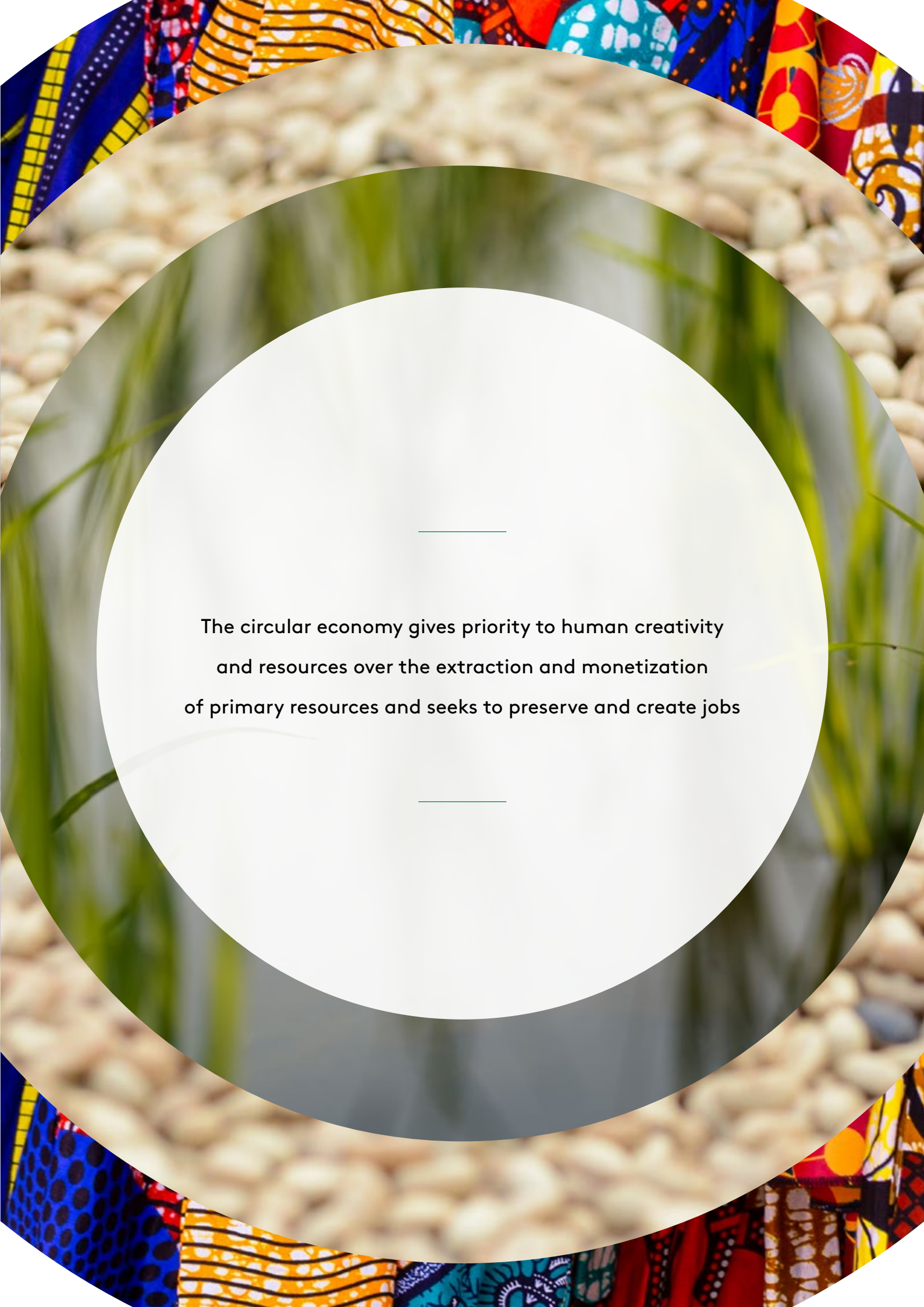
The conclusions of Parts 1 and 2 provide direction for identifying circular GHG mitigation opportunities in Part 3. Identifying these opportunities focuses on the primary sectors, industry, construction and services, as the power and transport sectors are already covered by parallel initiatives by the International Renewable Energy Agency (IRENA) and Local Governments for Sustainability (ICLEI).

Following the findings from Parts 1 and 2, priority should be given to those circular mitigation opportunities that create jobs, preserve natural assets, reduce GHG emissions within The Gambia and in those countries that supply it with valuable products and materials, and improve the trade balance.

3.2 Jobs and skills

The circular economy gives priority to human creativity and resources over the extraction and monetization of primary resources and seeks to preserve and create jobs. Jobs are preserved primarily by securing the regenerative capacity of natural assets. This is particularly important because a large share of the Gambian population depends directly on the quality of the country's forests, soils and marine resources. In addition to agriculture and fishing, the tourism sector depends directly on healthy and attractive ecosystems, as pollution makes the country a less appealing tourist destination. In a circular economy, additional jobs are created by using secondary resources[153] that were lost previously and by improving maintenance, repair and product design.

In the transition to a circular economy, jobs are both created and displaced. Jobs upstream in extraction are often displaced by jobs further downstream in maintenance, repair and recycling. However, The Gambia primarily produces products from regenerative resources. Products that rely on depletive resources, such as fossil fuels, metals



The circular economy gives priority to human creativity and resources over the extraction and monetization of primary resources and seeks to preserve and create jobs

and minerals, are largely imported. With a few exceptions, such as employment linked to commerce in minerals, fertilizers, pesticides and, perhaps, cement, the circular economy has the potential to create new jobs. Some may come at the expense of jobs in linear value chains in other countries. New employment may be created in repair activities, agronomics, trading and transport of secondary resources, and the production of circular food products to substitute for food imports.

The job potential of each measure has been assigned to categories ranging from low to very high, as the data needed to quantify them accurately is lacking. Job potential is low when the measure replaces, rather than creates, domestic jobs or when the investment is capital intensive, rather than labour intensive. Job potential is high when the measure can create new jobs and safeguard existing ones in the wake of climate change and future degradation of natural assets. Circular mitigation options with a high job potential typically target agriculture, forestry, and the informal manufacturing and repair industries.

3.3 Circular mitigation strategies

Twenty circular GHG mitigation strategies are proposed within the sectors covered by the analysis. Taken together, they can reduce national GHG emissions by 36 percent, while also reducing The Gambia's international carbon footprint by 38 percent. These percentages address only the sectors and GHG emissions within the scope of this analysis. When implemented, these opportunities would reduce national solid waste volumes by 37 percent. Altogether, the opportunities identified will reduce government expenditures on fertilizer subsidies, shift the tax base away from labour to encourage job creation and reduce the reliance on imported goods and materials, thereby reducing the trade deficit by $116 million, or 7 percent of import volumes.

Six of the 20 circular GHG mitigation opportunities identified are in food value chains, representing 52 percent of domestic circular mitigation potential. In addition, 9 of the 20 opportunities have a high or very high job creation potential.

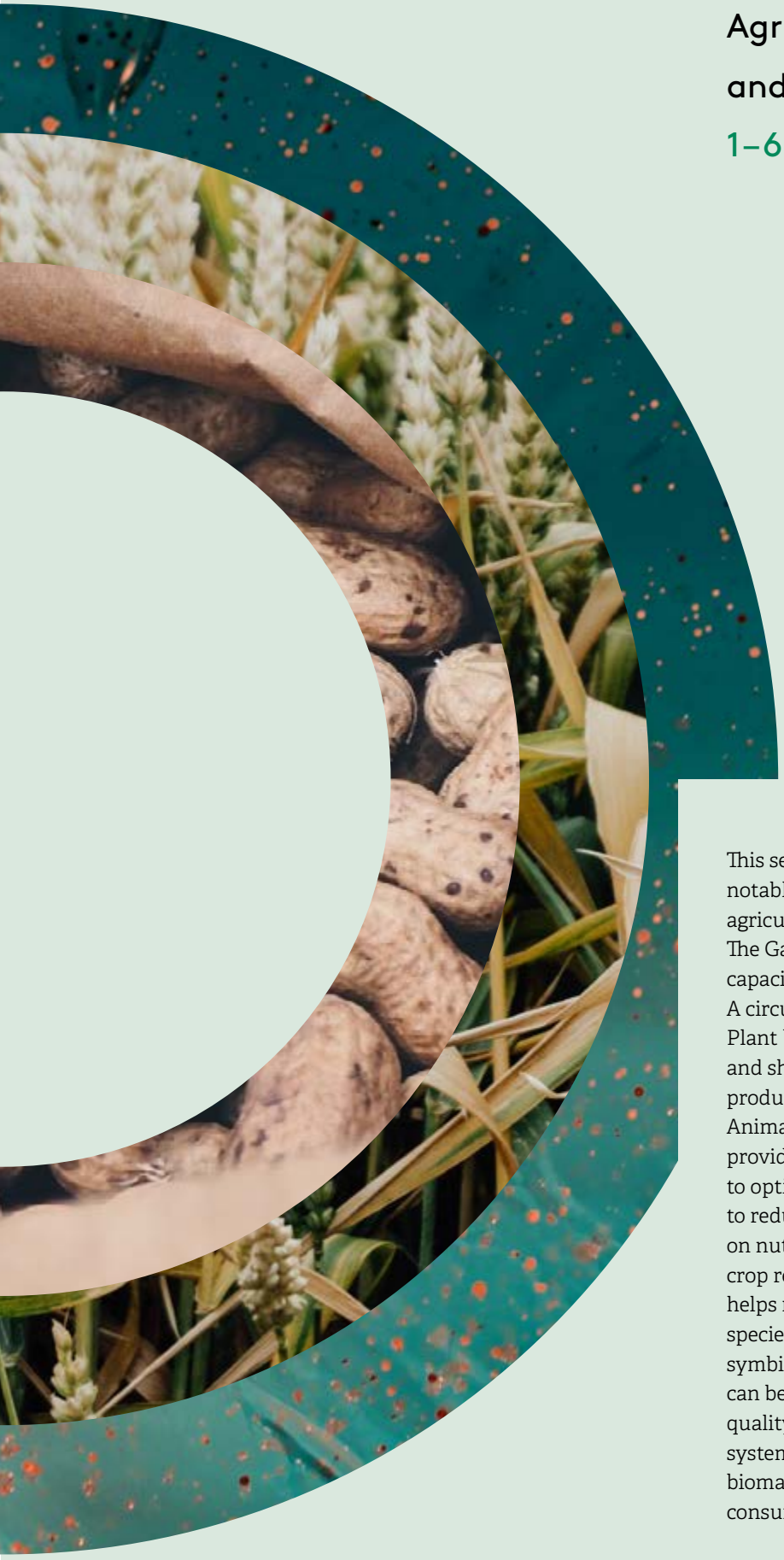
The opportunities identified are structured by sector and then ranked based on their GHG mitigation potential within both The Gambia and international value chains. The co-benefits covered include an estimate of the potential impact on primary resource extraction, waste production, reduced reliance on imports and job creation.

The GHG mitigation potential has been estimated for 2030, assuming that the proposed opportunities are realized between 2020 and 2030. The emission levels used to estimate the reductions are based on the latest GHG emissions inventory in the Third National Communication, which includes 2010 data. The emission reductions are quantified by assuming that all emissions recorded in the 2010 inventory increasing proportionally towards 2030 are based on the emissions growth scenario described in the 2011 Nationally Appropriate Mitigation Actions.154 Although both the latest inventory and the latest emissions growth projections are relatively old, they are the most recent estimates available of The Gambia's GHG emissions.

Combined with the measures already proposed in The Gambia's NDC and nature-based solutions, such as peatland restoration and reforestation, total mitigation potential could reach 83 percent when disregarding the overlap between the NDC and the circular greenhouse gas mitigation opportunities identified.

FIGURE 8

Circular mitigation option	Estimated GHG mitigation potential by 2030 tCO₂e Domestic	International	Costs	Solid waste avoided t/year	RME extraction avoided t/year	Imports reduced mil $/year	Job potential
Practice multi-strata agroforestry	423,000	64,000	Medium	0	164,000	34,000,000	High
Adopt climate-smart agriculture	205,000	51,000	Medium	0	60,000	51,000,000	Very high
Improve livestock productivity	196,000	1,000	Medium	9,000	n/a	200,000	Medium
Use improved cookstoves	153,000	0	Medium	0	147,000	0	Medium
Reduce food losses	90,000	9,000	High	59,000	45,000	3,500,000	Medium
Recover organic waste	77,000	0	Low	64,000	n/a	0	Medium
Use firewood from agroforestry	27,000	28,000	Low	0	233,000	8,600,000	High
Practice circular procurement	10,000	10,000	Medium	n/a	n/a	n/a	Medium
Use local construction materials	0	110,000	Low	0	0	n/a	High
Pursue circular energy transition	0	6,000	High	0	1,000	0	Low
Incorporate passive building design	n/a	n/a	Low	0	n/a	0	Low
Substituting HFC23	705,000	0	High	n/a	n/a	n/a	Low
Implement extended producer responsibility	0	29,000	High	18,068	26,000	n/a	Low
Avoid pollution from fish meal	n/a	n/a	Medium	n/a	n/a	0	High
Strengthen informal sector manufacturing	0	0	Low	n/a	n/a	n/a	Very high
Use biogas from waste management	50,000	0	High	n/a	n/a	n/a	Medium
Align the tax regime	9,000	11,000	Low	0	10,000	11,100,000	Very high
Encourage access to ICT as a service	0	10,000	High	0	9,000	7,600,000	High
Implement artisan plastics recycling	0	0	Low	12	1	0	Low
Promote ecotourism	0	0	Low	n/a	n/a	n/a	High
Total	**1,944,000**	**329,000**		**150,000**	**694,000**	**116,000,000**	
Share of total	**31%**	**28%**		**37%**	**18%**	**7.1%**	
Share of total in scope	**36%**	**38%**					



Agriculture, fishing and forestry

1–6

This section focusses on organic material flows, notably food and forestry products. A circular agricultural, fishery and forestry sector in The Gambia would operate within the regenerative capacity of the soils, fish grounds and forests. A circular food system is based on three principles: Plant biomass is the basic building block of food and should be used by humans first. Organic by-products should be cycled back into the food system. Animals should be used for what they can best provide. These three principles refer to trying to optimize yields without synthetic inputs in order to reduce emissions per unit area. Such systems rely on nutrient inputs from the application of manure, crop residues or food waste and food losses, which helps maintain or increase soil carbon levels. Legume species that fix atmospheric nitrogen through symbiosis with rhizobia bacteria in root nodules can be used to fix nitrogen. This recognizes soil quality as the basis of a productive agricultural system. In addition, animals have a role in cycling biomass that is unsuitable for direct human consumption into the food system.[155]

3.4 Strengthening community-based multistrata agroforestry

Strategy description

Community-based forestry activities in The Gambia have helped to expand forest area and increase crop production.[156] In addition, the government aims to expand forest areas under community management from 12 percent to 75 percent.[157] The Department of Forestry has dedicated a unit to community-based forest management and has turned over some 80 forests to communities for co-management. The ecosystem-based adaptation project (Green Climate Fund) is working to strengthen this programme.[158]

Several initiatives seek to combine agricultural and forestry activities to improve food security.[159] This circular mitigation strategy aims to strengthen these initiatives to increase tree cover in The Gambia, both in urban and rural areas. Trees help retain water, improve drought resilience, provide food to rural populations in case of shortages and provide shade in cities.[160]

The profits per hectare of multistrata agroforestry are, on average, more than 10 times those of non-agroforestry food production.[161]

Preserving and expanding tree cover is in line with the UN Environment initiative to rehabilitate 13,000 hectares of forests, protected areas, wildlife areas and farmland.[162] Multistrata agroforestry combines an overstory of taller trees and an understory of one or more layers of crops. It aims to maximize the use of space; while the blend of suitable species varies by region and culture, it can be optimized to provide food.[163]

The Association of Farmers, Educators and Traders (AFET), which takes a more decentralized approach, has 130 groups in villages across the country. Its members practice vegetable gardening and small-scale food processing, while encouraging people to grow trees, such as cashew and mangoes, and producing compost.[164] Tree planting in both rural and urban areas may not create new areas that meet the criteria for forest cover, but they are important in improving livelihoods and resilience.

Agroforestry has been part of the country's traditions.[165] Combining useful trees with crops helps protect soil nutrients and soil moisture and avoid erosion, while storing more carbon than in a monoculture cropping system.[166] [167]

International examples

The Embu district in Kenya was largely deforested in the mid-20th century. With the development of commercial coffee plantations, regional market conditions and improved agroforestry species were introduced in the 1990s and 2000s. This increased both crop productivity and whole farm income. It also prompted the region to import firewood as the value of trees in the region increased.

1	Domestic	International
GHG mitigation potential tCO_2e/year	423,000	64,000
Solid waste avoided t/year	0	0
IPCC sectors targeted	3B1 Forest Land	
Job creation potential	High	
Import value substituted US$		33,700,000
Reduction in primary resource extraction t/year	-164,000 (increase)	164,000 (decrease)
Investment costs	Medium	

To avoid increasing pressure on other forest land, methane from the digestion of organic residues might provide an alternative energy source.

Next steps

Next steps should build on existing initiatives to expand agroforestry in The Gambia. The FAO provides agroforestry extension services to communities and promotes the development and marketing of agroforestry products. To finance agroforestry incentives, carbon incentives can be coupled with agroforestry products to create additional value. Options that are already part of the forestry law include introducing levies on tourism and saw milling operations.168 Food forests can help optimize and diversify food production on small plots of land and could be implemented on smallholder farms and, perhaps, even in peri-urban settings.[169]

Impact

The annual sequestration impact[170] of multistrata agroforestry is 4.45 tCO_2e/hectare/year,[171] while tree planting in urban areas is likely to produce a smaller impact. The area of The Gambia that is suitable for agroforestry activities is at least as large as the UN Environment-targeted area of 13,000 hectares of forest land. Some sources report that The Gambia has lost 95,000 hectares of forestland since 2009;[172] perhaps this area could be restored.

The actual sequestration potential is likely to be closer to this value. However, when suitable agricultural lands are also included in the transition to agroforestry-based business models, the potential becomes significantly higher.

Based on the agroecological zones in The Gambia,[173] agroforestry yields are significantly higher than those from conventional agricultural practices, and help to avoid soil erosion and improve water retention. Crops yields double on average.[174]

With an average yield throughout The Gambia of approximately 1 t/ha, additional production could total 97,000 tonnes, avoiding upstream emissions from imported food products and substituting an import value of around $19 million.

72%

According to the FAO, agriculture in The Gambia is the main source of income for about 72 percent of the population

3.5 Improving agricultural resilience by implementing climate-smart agriculture

Strategy description

According to the FAO, agriculture in The Gambia is the main source of income for about 72 percent of the population. The sector is characterized by small-scale, subsistence, rain-fed crop production and challenged by poor infrastructure, soil fertility depletion, declining agriculture commodity prices and low private investment. At the same time, prices for production inputs are rising.[175] As a result, rice yields in The Gambia are declining, while in neighbouring Senegal, for example, they continue to increase. Research shows that significant yield increases are also possible in The Gambia.[176]

Climate-smart agriculture[177] offers a combination of measures that reduce GHG emissions, while also increasing the resilience of agricultural production to the impacts of climate change. This is achieved, typically, through a combination of measures involving soil and nutrient management, water harvesting and use, biodiversity management, pest and disease control, and the use of quality seeds and planting materials of well-adapted crops and varieties.

The benefits of climate-smart agriculture extend beyond reducing GHG emissions. They also include improving climate resilience, soil water retention and overall soil fertility and increasing yields.[178] Given the importance of the agricultural sector to a significant segment of the Gambian population, climate-smart agriculture also provides a basis for international development cooperation.

Agricultural production needs to diversify. Development of the horticulture and fruit and vegetable processing sectors can support such diversification. Closed-loop farming can also be practiced in these sectors, reducing the vulnerability of agricultural production to climate conditions.[179]

International examples

Over 180,000 farmers in Zambia have adopted minimum tillage practices and planted trees to provide for mulch and nutrients. These practices reduce labour input and allow farmers to plant closer to the rainy seasons, thereby increasing some crop yields by 60 percent,[180] while reducing the use of inorganic fertilizer and their associated nitrous oxide emissions.[181]

In Ethiopia, soil analysis identified the nutrient deficits that fertilizers should target for the nine major soil types. Developing five fertilizer blends that target these deficits increases fertilizer efficiency.

Last, the West Africa Agricultural Productivity Program helped develop 160 climate-resilient staple crops for Western African countries. This increased productivity by up to 150 percent – 3 million tonnes over 4 million hectares – thereby raising the income of seven million farmers by 34 percent.[182]

2	Domestic	International
GHG mitigation potential tCO_2e/year	205,000	51,000
Solid waste avoided t/year	0	0
IPCC sectors targeted	3B2a Cropland Remaining Cropland (AFOLU) 3C7 Rice Cultivations	
Job creation potential	Very high	Negative
Import value substituted US$		51,000,000
Reduction in primary resource extraction t/year	60,000	60,000
Investment costs	Medium	

Next steps

The measures proposed should be part of a strategy to improve climate resilience, reduce GHG emissions and increase yields. The proposed measures include:

1. Practice conservation agriculture with adequate crop rotation, minimum tillage and the use of cover crops for cereals production and composting, which concerns 30 percent of harvested area in The Gambia.
2. Implement integrated pest management and intercropping for groundnuts, which concerns 28 percent of harvested area in The Gambia.[183]
3. Explore whether intercropping with nitrogen fixing legumes can improve nutrient management.[184] In Zambia, this was identified as the most cost-effective option.[185]
4. Improve irrigation infrastructure, relying on both tidal irrigation[186] in rivers and groundwater wells.[187] Irrigating agricultural fields can extend farming seasons from the current six months and increase productivity.
5. Improve the efficiency of fertilizer application by conducting a soil analysis.[188]

The Gambian Commercial Agriculture and Value Chain Management project also seeks to improve irrigation, with rice yields increasing from two to four and, even, five tonnes per hectare with two cropping seasons per year. If improved irrigation were applied to all 67,000 hectares of Gambian rice fields[189] or 30,000 hectares of rehabilitated and newly developed irrigated land, yields and production would increase such that The Gambia would no longer need to import rice.[190]

When combined with the adoption of Nerica Upland Rice, as proposed in the current NDC, or other varieties suitable to The Gambia,[191] increased production thanks to improved irrigation could be combined with efforts to stabilize or reduce territorial GHG emissions.

Interventions typically start with extension services, including training farmers in climate-smart agriculture. When this is adopted, The Gambia will be able to rely less on imported chemicals to fertilize its soils and control pests. That could create an opportunity for organic certification to further increase the value of organic agricultural commodities.

Impact

Climate-smart agriculture can reduce the need for synthetic fertilizer inputs and improve soil organic carbon in cereals and groundnuts produced in The Gambia. In calculating the impact, the emissions reduction potential from applying climate-smart agriculture to rice fields was excluded because rice fields were covered in the first NDC.

By using domestically-produced organic alternatives of domestic origin in place of imported synthetic fertilizers, government subsidies on fertilizer imports could be reduced by up to $33,000 per year, while saving $3.4 million in import value and 5,500 tCO_2e per year in international GHG emissions.[192] Substituting imported rice would further improve the trade balance by an additional $48 million.

According to the World Bank, increasing the yields on 30,000 hectares of rice fields would produce an estimated additional 240,000 tonnes of rice, matching national consumption. Substituting all imported rice with domestic production would reduce international GHG emissions by approximately 45,000 tCO_2e per year.

The estimate of soil organic carbon sequestration across The Gambia is conservative and based on the estimated 0.8 tonne CO_2e/hectare sequestration impact of reduced tillage practices only.[193] This value has been applied to the latest data on areas where cereals and groundnuts are harvested.

The benefits of climate-smart agriculture extend beyond reducing GHG emissions. They also include improving climate resilience, soil water retention, overall soil fertility and increasing yields

3.6 Improving livestock productivity

Strategy description

Methane emissions from enteric fermentation and methane management make up 11 percent of The Gambia's national GHG emissions. The Third National Communication[194] does not refer to emissions from manure management, but other sources report that they represent around 3 percent of methane emissions from livestock.[195]

According to that communication, total livestock emissions are broken down as follows: 77 percent from cattle; 16 percent from sheep and goats; and 7 percent from chicken, pigs and game.[196] Beef production alone (separate from milk) accounts for 321,000 tCO_2e, or 70 percent of all livestock emissions.

Beef is the most resource-intensive of all protein sources[197] and has a relatively high GHG footprint, due to its associated methane emissions. However, livestock also play an important role in a circular food system,[198] for example, by converting residual flows or crops unsuitable for human consumption, consuming grass and herbs from pastures in areas unsuitable for growing food, and providing manure to enhance soil quality. The latter is particularly important in The Gambia because of the country's low soil fertility.[199]

Livestock are also an important source of income for smallholder farmers. According to the World Bank, livestock supports the livelihoods and food and nutrition security of almost 1.3 billion people globally, while contributing to the preservation of biodiversity and carbon sequestration in soils.[200]

Some of the mitigation options are already practiced in The Gambia, including free roam grazing and combined forestry and cattle grazing. Still, livestock produce 11 percent of national GHG emissions. Further productivity improvements offer mitigation potential. The World Bank[201] and FAO[202] have identified measures that may still prove relevant to the Gambian context, ranging from improved forage quality, grazing management and improved animal health.

International examples

In western Zambia, the livestock sector contributes around 39 percent of rural income, although foot and mouth disease poses an immediate threat to revenues from cattle breeding. The Livestock Development and Animal Health Project strengthens veterinary services, while the Ministry of Fisheries and Livestock has set up vaccination centres. An estimated 253,000 farmers benefited from reduced occurrence of diseases.[203]

3	Domestic	International
GHG mitigation potential tCO_2e/year	196,000	1,000
Solid waste avoided t/year	9,000	
IPCC sectors targeted	3A1 Enteric Fermentation 3A2 Manure Management	
Job creation potential	Very high	Neutral
Import value substituted US$		215,000
Reduction in primary resource extraction t/year	n/a	
Investment costs	Medium	

Another example is Kenya's climate-smart villages initiative, which has improved food security and resilience and strengthened livestock management through veterinary services, the introduction of more resilient livestock varieties, improved manure management and agroforestry.[204]

Next steps

Steps towards a more circular meat value chain could include:

1. Improving forage quality: processing crop residues and providing good quality green fodder from multipurpose leguminous plants improves digestibility. Urea treatment can further improve the digestibility and nutritional value of crop residues, such as straws.
2. Improving animal health, husbandry and breeding improvements: preventive health measures such as vaccination, improved veterinary services, the provision of shade and water (perhaps through agroforestry, circular mitigation option 7), and breeding strategies contribute to reduce mortality and increase fertility.
3. Improving grazing management to optimize soil carbon sequestration: the impact of increased mobility and a better balance between grazing and resting can have a positive impact on productivity and the accumulation of soil carbon.[205]

Achieving this will likely require training smallholder farmers to support productivity increases[206] through, for example, enhanced feeding,[207] improved animal health and welfare through disease prevention and veterinary services,[208] and improved pasture management and rotational grazing.

Impact

According to the FAO, the carbon intensity of small ruminant meat production in West Africa is an estimated 55 percent above the global average. The emissions reduction potential for The Gambia has been determined based on an average emission reduction potential of between 27 and 41 percent extrapolated to the entire livestock sector.[209]

The international mitigation potential is based on substituting 1,343 tonnes of imported feedstock for domestic animal feedstock.

27–41%

The emissions reduction potential for The Gambia has been determined based on an average emission reduction potential of between 27 and 41 percent

3.7 Nature-based solutions: reducing firewood extraction with improved cookstoves

Strategy description

This strategy builds on nature-based approaches to reducing forest degradation. These solutions are actions that protect, sustainably manage and/or restore ecosystems, while simultaneously contributing to achieving multiple sustainable development goals. Nature-based solutions identified for The Gambia that do not overlap with existing NDC commitments or other circular economy strategies include:

- Firewood harvest avoided: 180,000 tCO_2e/year;
- Avoided peat impacts and peatland restoration: 70,000 tCO_2e per year; and,
- Reforestation: 650,000 tCO_2e per year.[210]

Reforestation and peatland restoration will contribute significantly to restoring ecosystems and the services they provide, but do not rely on circular economy solutions. Therefore, they are mentioned separately in the mitigation potential overview in this report as potential that extends beyond the current NDC and beyond the circular mitigation opportunities proposed.

Interventions to reduce firewood extraction rely on the use of efficient cookstoves. These can be deployed in addition to the biogas solutions proposed in intervention 5 on organic waste recovery.

International examples

The Tanzania Traditional Energy Development Organization (TaTEDO) aims to improve access to modern energy technologies in Tanzania.[211] According to TaTEDO, firewood use in Tanzania places a high burden on women, who often bear the responsibility for collecting it. Burning it creates indoor air pollution and GHG emissions during cooking, while driving both deforestation and soil erosion.[212]

TaTEDO's cookstove programme increased the use of improved cookstoves in Dar Es Salaam to 60 percent. Trained artisans produce and provide the stoves.[213] The project was reported to reduce firewood consumption, reduce women's workload and reduce indoor air pollution while improving the incomes of stove users and artisans.[214]

The Belarus Wetlands project provides an example of ecosystem restoration. It is restoring 12,000 hectares of disturbed and inefficiently drained peatlands as a trial for restoring country's 260,000 hectares of disturbed peatlands. These peatlands and peatland forests produce between 5 to 15 tCO_2e per hectare per year,[215] while restoration converts them from a net source of GHG emissions into a net sink.

Next steps

The success of improved cookstove programmes depends on whether the stoves' technical parameters meet social expectations, are consistent with local needs and culture, and are affordable. An improved cookstove programme should thus adopt a 'bottom-up' strategy that involves users and local artisans, who participate in establishing a self-sustaining industry.[216]

4	Domestic	International
GHG mitigation potential tCO_2e/year	153,000	0
Solid waste avoided t/year	0	0
IPCC sectors targeted	3B1 Forest Land	
Job creation potential	Medium	
Import value substituted US$		0
Reduction in primary resource extraction t/year	147,000	
Investment costs	Medium	

Further steps, which extend beyond the circular economy to implementation of nature-based solutions that seek to restore ecosystems, include:

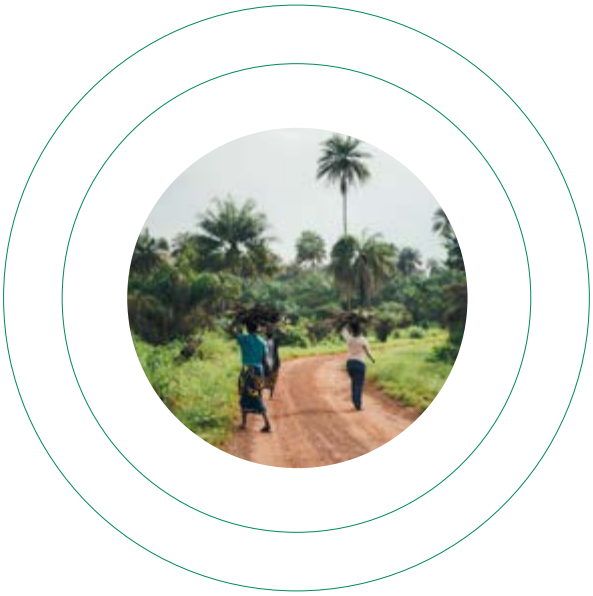
1. Initiate a reforestation programme.
2. Improve forest management and avoid converting forests into agricultural or residential land. This also requires improved urban planning to avoid unregulated urban sprawl.
3. Restore degraded peatland ecosystems around the Gambia River and its tributaries through rewetting by increasing the water levels.

Impact

The mitigation potential of the UNDP's proposed nature-based solutions totals 1.1 million tCO_2e.[217] However, part of this potential overlaps with existing NDC commitments or other circular economy interventions in this report. Efficient cookstoves offer the remaining circular mitigation potential. With the agroforestry intervention already providing reductions of 27,000 tCO_2e, improved cookstoves can provide additional reductions of 153,000 tCO_2e.

The GHG mitigation of the other nature-based solutions, which go beyond the NDC and the circular economy solutions proposed in this metabolic analysis, can add another 393,000 tCO_2e of mitigation potential. These measures are:

- Reforestation in addition to the agroforestry circular mitigation opportunities proposed and the afforestation already included in the NDC, totalling 323,000 tCO_2e per year;
- Avoided peat impacts and peatland restoration avoided, totalling 70,000 tCO_2e per year; and,
- Biochar application on grasslands, totalling 70,000 tCO_2e per year.



1,100,000tCO_2e

The mitigation potential of the UNDP's proposed nature-based solutions totals 1.1 million tCO_2e

Uneaten food contributes 9 percent to global greenhouse emissions. Avoiding food waste and loss is thus the single mitigation opportunity with the greatest potential impact

3.8 Taking a value chain approach to reducing food losses and waste

Strategy description

For purposes of this report, food loss is defined as post-harvest losses occurring in the food value chain and food waste refers to waste by retailers and consumers.[218]

Estimates suggest that uneaten food contributes 9 percent to global greenhouse emissions.[219] Avoiding food waste and loss is thus the single mitigation opportunity with the greatest potential impact.[220]

The Gambia is no exception. In sub-Saharan Africa, roughly 37 percent of all food produced is lost or wasted.[221] Organic waste makes up 53 percent of municipal solid waste in The Gambia.[222] However, per capita food waste in the region is between 120 and 170 kg per year. This is significantly lower than the 280 to 300 kg per year of food losses in Europe and North America.[223]

In African countries, the most significant food losses occur upstream in the value chain, not at the retail or consumer stage. For example, in South Africa,[224] an estimated 50 percent of food losses and waste occur at the farm, 25 percent during processing and packaging, 20 percent during distribution and retail, and only 5 percent at the consumer level.[225]

Post-harvest losses along the full value chains in The Gambia are estimated at 30 percent for vegetables, 50 percent for irrigated rice and 20 to 30 percent for fish.[226] The underlying causes for these high losses are lack of access to adequate machinery to harvest on time, combined with inadequate harvesting practices and timing, poor storage capacity and inadequate processing methods. Other causes include disruptions in the cold chain along the value chain, for example, during transportation, and the expiry of unsold food remaining on retail shelves.[227]

Food losses in the cereals value chains are estimated to cost sub-Saharan Africa about $4 billion per year.[228] In addition, 46 percent of global food production should be refrigerated after harvest, but only just under half of that amount is actually refrigerated. Lack of refrigeration alone is responsible for a loss of 13 percent of global food production, with losses particularly high in low-income countries.[229]

International examples

Losses in The Gambia's fruit and vegetables value chains are also quite high. The country could look to Bangladesh, which implemented a successful intervention in the fruit value chain for mangoes, using a modified harvesting tool to reduce mechanical damage and latex staining and removing latex from the fruit with a hot water bath.

This reduced losses from 38 percent to 18 percent along the full value chain, for a reduction of

5	Domestic	International
GHG mitigation potential tCO_2e/year	90,000	9,000
Solid waste avoided t/year	59,000	
IPCC sectors targeted	3A Livestock 3B2 Cropland 3C Aggregate Sources and Non-CO_2 Emissions Sources on Land 4A Solid Waste Disposal	
Job creation potential	Medium	Negative
Import value substituted US$		3,500,000
Reduction in primary resource extraction t/year	45,000	14,500
Investment costs	High	

66 percent. Other case studies in South Asian countries show that some have reduced food loss by discarding damaged harvest that is prone to rot and contaminate other harvest. Other successful strategies have included using optimal closed, yet breathable, transport and storage containment to minimize external contamination and keep pests out. [230]

Next steps

Interventions that can help reduce food losses include:

1. Adopting improved harvesting techniques;
2. Providing adequate storage to limit exposure to moisture, heat and pest infestation with hermetic bags or metal silos;
3. Using mobile processing units, solar dryers, graters and pressers, where applicable;
4. Setting up contractual and aggregation points to help bring products to market and warehouse receipts systems to reduce losses during storage; and,
5. Improving transport conditions and cold storage capacity.[231]

Impact

This impact analysis aims to provide an order-of-magnitude indication of the impact of reducing food waste. Reduction of between 50 percent and 75 percent by 2050 is realistic.[232]

In The Gambia, where undernourishment is a problem and the country relies heavily on food imports, reducing food waste is a high priority. For this estimate, a 40 percent reduction is assumed, which is below the 50 to 75 percent range for 2050 noted earlier and below the 66 percent from the Bangladeshi mango case study. Such a reduction would save nearly 60,000 tonnes per year, 25 percent of which is imported.

In terms of emission reductions, import-related food waste in The Gambia can be reduced only at the retail and consumer stages. Both national and foreign greenhouse gas emissions can be reduced there. When the entire value chain is in The Gambia, only territorial GHG emissions can be reduced. Finally, reducing food waste in The Gambia also reduces landfill methane gas in territorial GHG emissions. An estimated 31 percent of all organic waste disposed in landfills and dumpsites is food waste. The volume of food waste will be reduced by 40 percent. However, the first-order decay model that provided the basis for the estimate of 116,000 tCO_2e of landfill gas in the Third National Communication was not available. Therefore, a reduction in landfill gas emissions of 10 percent has been assumed for calculation of the mitigation potential. This is lower than the 40 percent over 31 percent estimate, considering the legacy emissions from past disposal of organic material.

37%

In sub-Saharan Africa, roughly 37 percent of all food produced is lost or wasted

3.9 Organic waste recovery

Strategy description

An estimated 53 percent of municipal solid waste in The Gambia is organic waste. Most of the country's solid waste is dumped in informal dumpsites or burned. Only an estimated 3 percent is composted.[233]

This strategy aims to reduce the volume of organic waste that is dumped or burned, while producing soil enhancer. Agricultural soils in The Gambia have relatively low fertility. In addition, new processing capacity, such as the fishmeal factory, increase the flow of industrial organic waste. However, before aiming to optimize the use of compost, food loss in the food value chains should be minimized (circular mitigation option 5 on reducing food losses). The proposed strategy includes:

- Collecting household organic waste from food preparation and, perhaps, garden waste for composting; and,
- Installing biogas digesters where demand exists for biogas and, perhaps, manure is available.

International examples

A composting project developed by Earthcare Nigeria, Ltd. processes 1,500 tonnes of solid waste per day to produce composted material in Lagos.

The Nigeria Earthcare Solid Waste Composting Project aims to reduce GHG emissions by diverting solid waste that would typically be sent to Lagos' landfills to a state-of-the-art composting facility. This reduces the amount of waste disposed in those landfills by 10 to 20 percent. The project is estimated to reduce GHG emissions by 253,800 tCO_2e per year over 10 years.[234]

With a population of 1,362, residents of the small village of Essom, Senegal make their living primarily from traditional cow breeding and agriculture. The use of charcoal for cooking has led to forest degradation, so the community, working with Greening Africa Together, developed a biogas plant. The 14 m3 underground digestor will be fuelled daily by 120 kg of cow manure and will produce 17 m3 of methane daily. As a subproduct, the plant will generate fertilizer that local residents will sell, providing another source of income.[235]

Next steps

The Government of The Gambia, in collaboration with international funding agencies, could investigate and implement the following:

URBAN AREAS – collect household organic waste and waste from food processing for composting or anaerobic digestion. The digestate can also be composted. The compost would be used to green urban centres by planting trees for shade and for

6	Domestic	International
GHG mitigation potential tCO_2e/year	77,000	0
Solid waste avoided t/year	64,000	0
IPCC sectors targeted	4A Solid Waste Disposal	
Job creation potential	Medium	Neutral
Import value substituted US$		0
Reduction in primary resource extraction t/year	n/a	0
Investment costs	Low	0

food forests under circular mitigation option 6 on agroforestry.

RURAL AREAS – collect manure and agricultural waste for composting or anaerobic digestion. Anaerobic digesters can supply biogas for cooking and sludge from the digester can be used as organic fertilizer for agriculture.

TRAINING – several organizations offer agricultural training in The Gambia. Their training modules could focus on improving soil quality and organic residue management via composting and digestion.[236] The trainings could also include modules on new business models based on organic waste, such as mushroom production on coffee grounds.

Impact

The impact of the organic waste recovery strategy could not be quantified because the first-order decay model that provided the basis for the estimate of 116,000 tCO_2e of landfill gas in the Third National Communication was not available. In addition, no information is available on the amount of manure collected in The Gambia. However, the potential likely exceeds the value of 3,000 tCO_2e per year from recycling and composting, as estimated in the first NDC.[237] Diverting 20 percent of organic waste would reduce landfill gas emissions by 23,000 tCO_2e per year. Organic waste recovery can also generate revenue. According to the Africa Waste Management Outlook, organic waste has a market value of $16 per tonne in Africa.[238]

53%

53 percent of municipal solid waste in The Gambia is organic. Only 3 percent is composted

Construction

7–11

In a circular construction sector, regenerative and secondary resources receive priority over imported construction materials with a high carbon footprint. The Gambia would seek to develop wood-based and earth-based construction, while adjusting building design to minimize energy use during the use phase. Circular public procurement by the Gambian government, development partners and investment banks can drive the transition to a circular construction sector.

3.10 Sourcing firewood and timber from agroforestry operations

Strategy description

The 95,000 hectares under community-based multistrata agroforestry in intervention 1 can produce around 151,000 tonnes of wood per year, assuming an agroforestry yield of 2.8 tonne/ha per year. [239] In the short run, it can replace firewood from non-renewable sources. In the long run, when biogas and improved cookstoves further reduce firewood demand, the wood from agroforestry operations could be used for timber and as a substitute for carbon-intensive construction materials. Considering the health impacts of firewood use, prioritizing the use of improved cookstoves and biogas is recommended.

International examples

In Peru, smallholder farmers produce timber through their agroforestry farm systems, supplying local and national markets with construction materials for low-cost housing. These systems encourage production over the extraction of construction wood from forests.[240] Combined timber and cocoa production in Venezuela also show positive results, with the shade from the timber species increasing cocoa yields.[241]

Experience from Guatemala shows that agroforestry systems can reduce firewood extraction from forests, supporting both increased firewood production and crop yields. Families that relied on the conventional cropping system extracted 81 percent of their firewood from forests, while those that adopted agroforestry systems extracted only 32 percent of their firewood from forests.[242]

Next steps

Next steps should build on existing initiatives in The Gambia, as described in circular mitigation option 6 on agroforestry. The following steps could also be taken:

1. Extend agroforestry extension services to support the local use of timber products and their marketing on national timber markets.
2. Develop sawmill capacity in rural areas with large agroforestry timber potential so that the timber is available on local markets at low cost.
3. In line with the prioritization of local construction materials in circular economy intervention 9, encourage architects to use domestic resources in their building designs. Showcase building projects with modern designs that use local timber resources to help popularize domestic timber.

Impact

Under circular mitigation option 1, an estimated 95,000 hectares was available for agroforestry operations. The sequestration impact of these agroforestry operations was quantified in that proposed intervention. However, sequestration potential can be increased by periodically harvesting timber and storing it in the built environment. Given that timber can substitute for imported construction materials, the mitigation potential is even greater.

Those 95,000 hectares could produce 266,000 tonnes of timber per year, which could easily substitute for the imported 33,000 tonnes per year

7	Domestic	International
GHG mitigation potential tCO_2e/year	27,000	28,000
Solid waste avoided t/year	0	0
IPCC sectors targeted	3B1 Forest Land 3D1 Harvested Wood Products	
Job creation potential	High	Negative
Import value substituted US$		8,600,000
Investment costs	Low	

of wood construction materials. That would reduce international GHG emissions by 28,000 tCO_2e per year. This is a conservative estimate as it does not take into account the sequestration potential of wood-based construction materials and their ability to substitute for carbon-intensive construction materials.[243]

The remainder of the wood can be used as firewood. In The Gambia, an average of 58,000 tonnes of forest stock are lost annually,[244] compared to 766,000 tonnes of firewood used per year. This means that 6 percent of firewood and timber used is non-renewable. According to the UNFCCC, 91 percent of firewood extracted is non-renewable,[245] indicating that firewood extraction is a major driver of deforestation in The Gambia. If that figure is used to calculate the GHG mitigation potential of avoided firewood extraction, it would total 388,000 tCO_2e per year.

151,000 t/year

The 95,000 ha under community-based multistrata agroforestry can produce around 266,000 tonnes of wood per year

3.11 Circular procurement in infrastructure projects

Strategy description

Circular procurement involves integrating circular economy requirements into the procurement of goods and services. It aims to offer a competitive advantage to more sustainable products and service providers in procurement processes.[246] Examples of these requirements include minimizing greenhouse emissions during throughout the investments' lifecycle, requiring a certain amount of recycled or regenerative content in products, or requiring that certain packaging is compostable.

The Gambia's state budget is approximately $490 million. The government allocated $80 million to the Ministry of Works and Infrastructure for 2020.[247] This ministry provided an overview of investments planned in 2019 to 2021, which amounted to around $70.3 million annually to build and maintain roads, sewage systems and public buildings. Such public investments in infrastructure create emissions during construction and production of construction materials of around 96,000 tCO_2e while requiring the extraction of 240,000 tonnes of raw materials.[248]

If the government connects circular requirements to the issuance of licences, investments in infrastructure and issuance of land and concessions, government expenditure and international donor funding can become a driver for circular design, investments and innovation. Also in partnership with development partners, the government could emphasize the importance of further reducing the environmental impact of large infrastructural investments.

International examples

A national institute in the Netherlands supports circular procurement in the country, providing trainings and collecting and sharing experiences with this process.[249] The Dutch have committed to taking the lead in the transition to a circular economy simply by creating demand for circular products and services.[250] Through a green deal, several banks and large companies agreed to a joint commitment on circular procurement.[251] (In 2015, UNEP identified the potential of product-service systems to reduce the environmental impact of public procurement.[252])

Next steps

Circular procurement in The Gambia could begin with a pilot project to gain experience. The circularity goals could range from:

1. using minerals from demolition waste as road filler, rather than using primary gravel and sand, which is downcycling; and,
2. recycling secondary concrete into gravel sand and cement, which is recycling or, even, upcycling.[253]

As part of the procurement process, applicants could be challenged to quantify the environmental impact of their project proposals, to be scored using a pre-defined framework.2[54]

8	Domestic	International
GHG mitigation potential tCO_2e/year	10,000	10,000
Solid waste avoided t/year	n/a	n/a
IPCC sectors targeted	2A Mineral Industry	
Job creation potential	Medium	Negative
Investment costs	Medium	

Impact

The estimates below are based on the 2020 infrastructure investment of $70 million. This amount of investment typically produces an estimated 96,000 tCO_2e through the production of materials and during construction.

Estimating the potential of circular procurement requires a detailed analysis of the kind of investments planned. As an indication, circular procurement could target a 20 percent emission reduction related to government and donor expenditures, half of which in imports and the other half domestic. The total amount of waste avoided depends on the availability of suitable secondary material flows.

$70.3 million

The Ministry of Works and Infrastructure plans around $70.3 million annually to build and maintain roads, sewage systems and public buildings

3.12 Sourcing low-carbon, local construction materials

Strategy description

This circular mitigation option aims to prioritize the use of low-carbon construction materials other than wood (option 7 on sourcing firewood and timber addresses wood as a construction material.) Fifty-one percent of buildings in The Gambia are built of mud, stone and compressed earth, while 47 percent have a concrete or brick enclosure.[255] Mud, stone, thatch and compressed earth require very little energy and do not generate GHG emissions when produced, but they also have limitations. They require stabilizers to make them water resistant; cement, lime, bitumen, natural and synthetic fibres are often used.[256]

Eighty-five percent of all minerals extracted globally are sand.[257] Global cement production accounts for 4 percent of global fossil fuel use and 1.5 $GtCO_2e$ of GHG emissions.[258] The Gambia imports cement, which has a negative impact on the trade balance. In addition, extracting sand to produce concrete threatens forest stock, including forests that are managed and protected by local communities.[259]

International examples

Soil is one of the world's oldest construction materials and some buildings made of earth last hundreds of years. Compressed earth bricks or blocks can use clay as a stabilizer instead of cement, with vegetable fibres adding further stability. However, building with soil has lost its appeal.

Worifila, a design collective in Senegal,[260] is working to mainstream building with earth, while ElemenTerre[261] is a Senegalese construction company specializing in that approach. By combining modern design with the use of these materials, the firms are contributing to the renewed popularity of earth-based construction and are developing an architectural identity unique to the region. The Collège Universitaire d'Architecture de Dakar supports modern earth-based construction.[262]

Next steps

The Government of The Gambia could stimulate the development of skills and knowledge in modern building design with optimized use of locally available construction materials and the application of passive design principles (option 11).

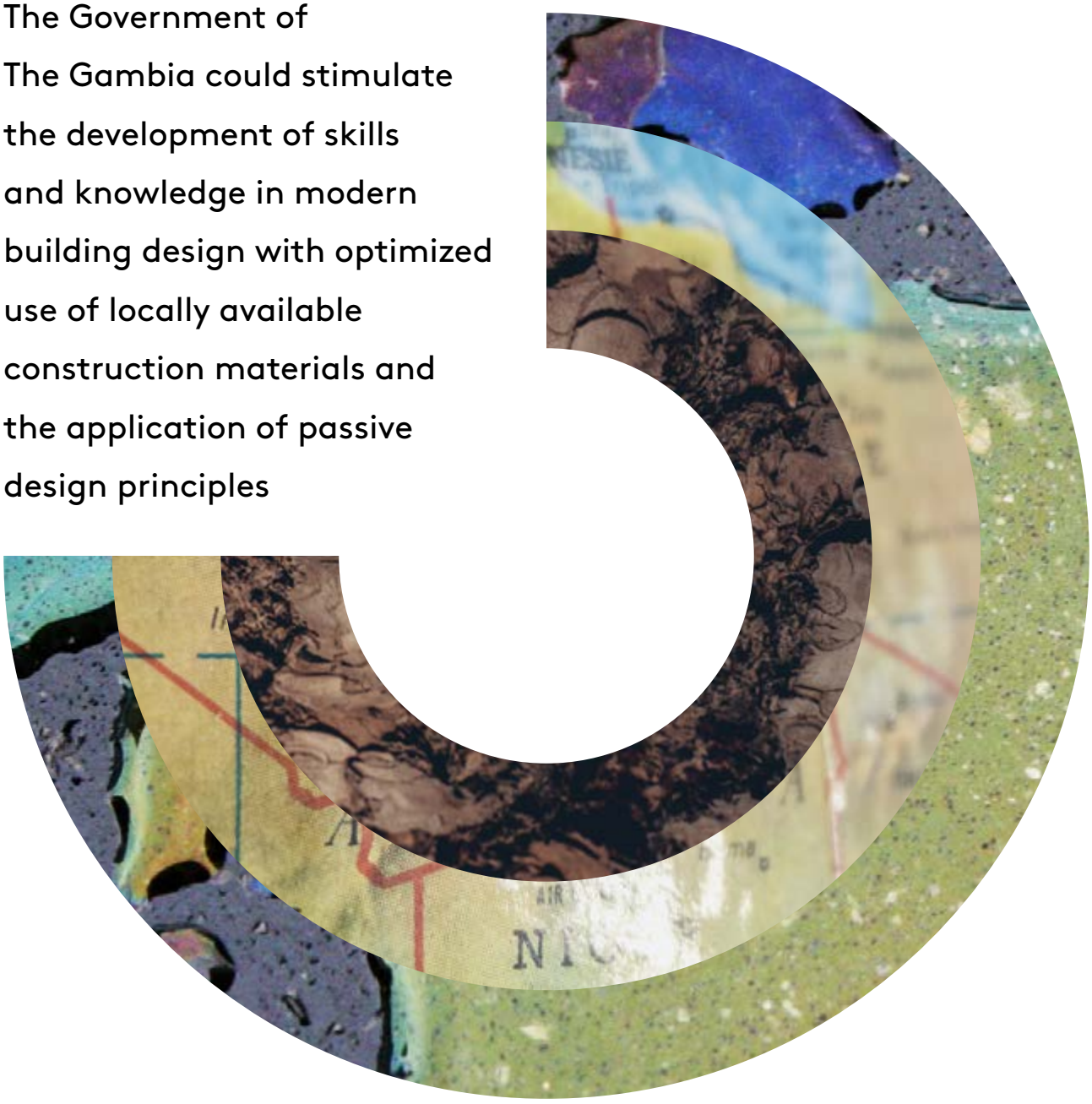
In the long run, prefab construction can support housing stock development in urban areas. Offsite construction moves construction activities to an industrial location, with only the prefabricated elements assembled onsite. This can significantly reduce costs, reduce the amount of waste produced during construction and help move construction and housing from the informal sector to the formal.[263]

Impact

Substituting construction materials, which are largely imported, with locally available materials can significantly reduce international GHG emissions. The potential reduction has been estimated based on an assumption about the reduced import of construction materials. Reducing those imports by just 10 percent would reduce foreign GHG emissions by 63,500 tCO_2e per year. (Our analysis does not include the sequestration impact of the use of wood-based construction materials.)

9	Domestic	International
GHG mitigation potential tCO_2e/year		110,000
Solid waste avoided t/year	0	0
IPCC sectors targeted		2A Mineral Industry
Job creation potential	High	Negative
Investment costs	Low	

The Government of
The Gambia could stimulate
the development of skills
and knowledge in modern
building design with optimized
use of locally available
construction materials and
the application of passive
design principles



3.13 Making the renewable energy transition circular

Strategy description

The Gambia plans to reduce its GHG emissions by 197,000 tCO_2e by investing in renewable energy capacity, reducing power transmission losses and adopting the use of solar water heaters. When that effort is complete, the newly installed equipment will avoid GHG emissions throughout its lifetime. However, when it reaches end of life, it could join a growing pile of e-waste. This strategy aims to extend the life of this equipment to the extent possible, while optimizing its end-of-life value by designing it to allow for disassembly and the reuse of most of the materials and components.

International examples

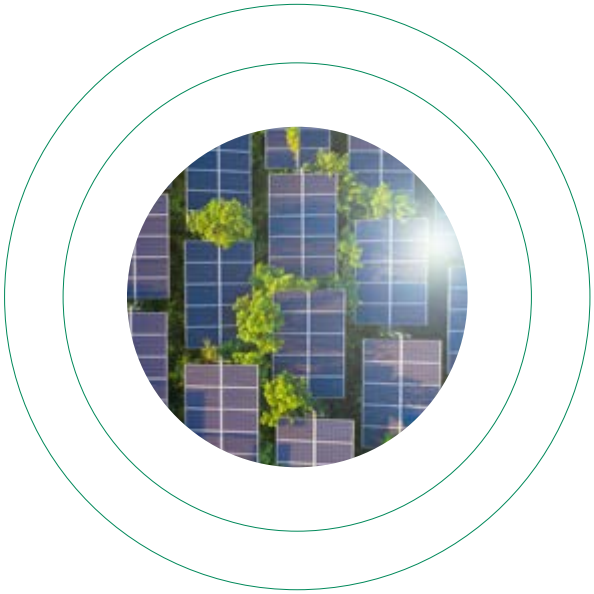
Alliander develops and maintains the energy infrastructure in the Netherlands. It found that when underground cables were replaced, most of the old cable was sent to landfill, as the components – such as the metal core and the protective layers surrounding it – were glued together. By connecting cable manufacturers and waste management companies, Alliander inspired a redesign of the cables, allowing them to be disassembled. When new cables reach end of life, approximately 90 percent of their components can be reused.[264]

When IRENA conducted an initial assessment of the growth of e-waste from solar panels, the agency concluded that lightweight solar panels could save around 30 percent of the energy used to produce the panels, specifically by using less silicon. It recommended developing testing capacity to determine the power output remaining in used panels. In addition to such flash tests, a wet leakage test can help determine whether a panel can be repaired safely and reused. If reuse is not feasible, 65 to 70 percent of the raw materials, by mass, can be treated and recycled today. Most of it is glass, aluminium, copper, silicon and silver.[265] As West Africa's volumes of e-waste from renewables increase, The Gambia could consider developing its own recycling capacity to serve the wider region and take advantage of its logistics infrastructure.

Next steps

IRENA recommends adopting specific e-waste regulations to require collection and recycling. This could be part of an extended producer responsibility scheme, as described in circular mitigation strategy 13. In line with Alliander, IRENA also recommends that equipment producers and waste management companies jointly develop solutions.[266] This strategy can also be applied to electricity distribution networks, wind and hydropower generation capacity. The European Investment Bank's solar project could serve as a pilot effort, where equipment producers and their recyclers work together to help mitigate end-of-life waste. Circular procurement approaches as described in circular mitigation strategy 8 can incentivize suppliers in that project to apply circular design. The Bank's project involves installing 20 MW solar capacity and 400 kilometres of distribution lines.[267] Such an approach would support the Bank's

10	Domestic	International
GHG mitigation potential tCO_2e/year		6,000
Solid waste avoided t/year		1,000
IPCC sectors targeted		2 Industrial Processes and Product Use
Job creation potential	Low	Positive
Import value substituted US$	0	0
Reduction in primary resource extraction t/year	0	650
Investment costs	High	



197,000 tCO_2e

The Gambia plans to reduce its GHG emissions by 197,000 tCO_2e by investing in renewable energy capacity

goal to make all its projects circular.[268] The UNDP's 10.5 MW solar power investment offers another potential pilot project.

Impact

Together, the 20 MW installed capacity planned by the Bank and the 10.5 MW planned by UNDP require installing around 46,000 tonnes of solar power generation capacity, at just below 150 tonnes per MW installed.[269] When recycled properly, recovering 70 percent of the materials would save close to 31,000 tCO_2e of emissions from raw material extraction and processing in these two projects alone.[270] Since such investments are not made every year, the impact has been distributed over five years.

The impacts of altering the design of renewable energy infrastructure and generation capacity to facilitate repairability, lifetime extension, disassembly and recycling are experienced only in the long run. Solar panels, for example, have a lifetime of around 30 years.[271] Only when the redesigned and newly installed equipment reaches the end of its lifetime can its materials and components be harvested and reused in new products.

When giving priority to the use of recycled materials in new projects, some of the mitigation potential might be realized earlier, during the construction of new capacity.

3.14 Passive building design

Strategy description

Around 76,000 tCO_2e of GHG emissions stem from industries, including power production. Some of that electricity is used in the residential and services sectors. Many houses in The Gambia depend on electric lighting and mechanical ventilation, which cannot be relied upon during load shedding or power disruptions.[272] Direct fuel use in the residential and services sectors is a source of 15,000 tCO_2e.

Almost all residential buildings in The Gambia rely on artificial lighting and ventilation and require large amounts of energy to improve the indoor environment. These issues can largely be solved by adopting appropriate design, reducing electricity consumption and avoiding the associated GHG emissions.[273]

The design of a building, its orientation to the sun and the prevailing wind direction, as well as its positioning in the existing surroundings and shade, can improve the indoor environment. Combined with proper insulation, energy efficient design can drastically reduce building energy use.[274] Starting at the design phase, passive design principles consider a building's lifetime energy use.

Passive design uses a building's layout, fabric and form to reduce or eliminate mechanical cooling, heating, ventilation and lighting demand. As such, it involves architecture as well as spatial planning to ensure that a building is oriented correctly to the sun. Designing the building to facilitate natural ventilation strategies and making effective use of thermal mass all help to regulate internal temperatures.[275]

The Gambia included building efficiency in its NDC as an activity that should receive international funding.[276] The mitigation activities specified refer only to solar water heating, which leaves potential for building efficiency, in particular to reduce energy consumption for cooling.

International examples

The Habitat Research and Development Centre in Namibia gave priority to recycled materials in its construction. In addition, the building provides shade and is oriented towards the dominant wind for ventilation. Captured rainwater provides water that can be sprayed into the air to provide additional cooling.[277]

Passive design is often associated with modern, detached villas, but its principles can be applied equally to multi-storey buildings, such as Cornell Tech in New York City.[278]

Next steps

To encourage the application of passive design principles, the Government of the Gambia could:

- require passive design when procuring construction services. This could be achieved by applying stringent building energy efficiency targets in the bidding process for allocating areas for real estate development; and,
- enforce sustainable and energy efficient building design through the building code.

Although this may increase the cost of new buildings, it will reduce expenses during the usage phase, which will lower users' energy bills for decades to come.

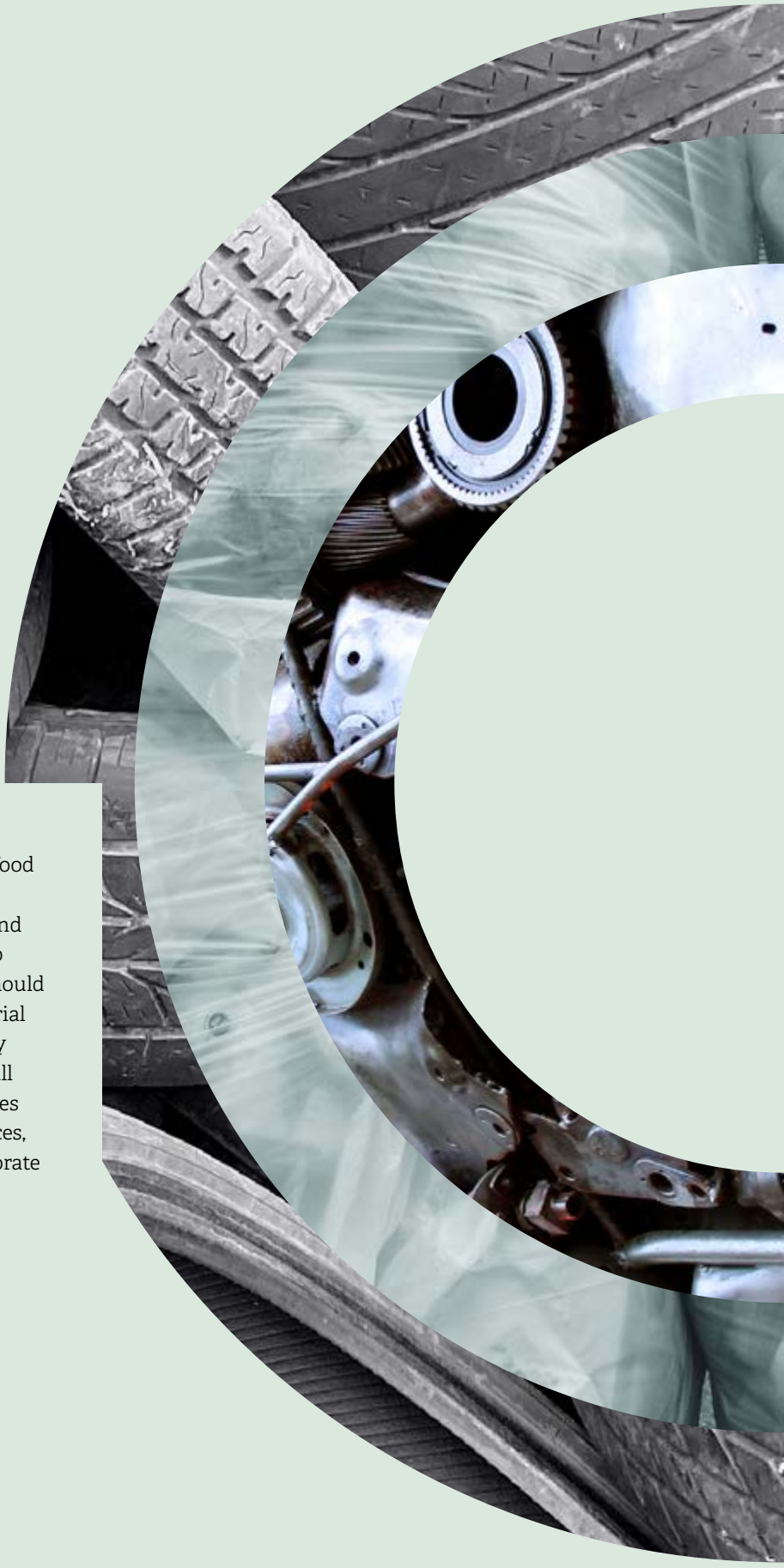
Impact

Efficiency targets for new buildings can be far more ambitious than for the existing building stock. A passively designed building can consume 60 to 80 percent less energy than one built using conventional methods. Case studies from New York show that passive design can reduce energy use in high-rise buildings by 73 percent.[279] However, clear data for the African context is lacking. Passive design can also be used to retrofit existing buildings, but emission reductions could not be quantified due to a lack of data.

11	Domestic	International
Job creation potential	Low	
Investment costs	Low	
IPCC sectors targeted	1A1 Energy Industries	

Industry

12–15



Most industrial activities in The Gambia are in food and wood processing, furniture production and the assembly and production of metal, plastic and concrete construction materials. An ambition to make industries in The Gambia more circular should recognize the decentralized character of industrial activities in the country. This requires the ability to inspire the informal sector and its micro, small and medium-sized enterprises with opportunities and incentives to prioritize regenerative resources, recycle, extend the lifetimes of products, collaborate with partners in the product value chain and perhaps move to circular business models.

3.15 Substituting hydrofluorocarbons (HFCs)

Strategy description

The latest available data on HFC emissions from The Gambia date from 2010. In that year, HFC emissions totalled 705,000 tCO_2e, or 17 percent of national GHG emissions.

HFCs were introduced into The Gambia as a substitute for chlorofluorocarbons, which are ozone-depleting substances regulated under the Montreal Protocol. HFCs are used in refrigeration, air conditioning (311,000 tCO_2e), aerosols (308,000 tCO_2e) and fire retardants (8,000 tCO_2e). It is important to consider HFCs, as intervention 4 on food losses includes expanding cold storage and cold transport capacity, which could lead to increased HFC emissions.

Since HFCs are potent GHGs, their increased use as a refrigerant can increase in GHG emissions beyond the emission reductions achieved from reducing food losses and food waste. For example, the Kigali Amendment to the Montreal Protocol seeks to cut the production and consumption of HFCs by 80 to 85 percent by 2040, which would reduce global warming by 0.4 degrees by 2100.[280]

The UNIDO is supporting The Gambia in reducing HFC emissions.[281] Its activities aim at recovering HFCs and substituting them with hydrocarbons by:

- redesigning products to phase out both ozone-depleting substances and GHGs;
- extending the lifespan of existing appliances and training technicians to handle these substances and repair products that use them;
- supporting companies to convert to service-oriented business models, where value is retained, products and resources are reused, and supplies are circular; and,
- supporting governments to monitor the import and consumption of ozone-depleting substances and GHGs and provide policy advice.[282]

International examples

The Maldives committed to phase out HFCs completely by 2025.[283] In 2011, the island nation held a high-level workshop on these issues[284] and secured $1.1 million to support the required investments.[285] In addition to controlling and monitoring products with HFCs, project activities include the recovery and recycling of HCFCs when equipment is serviced or disposed of and offering an equipment retrofit or replacement option to end users.[286]

Australia provides an example of monitoring HFC use. It established a national refrigerant bank, which aims to track all of the country's 41,100 tonnes of refrigerants in 37 million appliances and to reduce HFC emissions through user trainings and equipment standards.[287]

Next steps

The Gambia could fully explore the synergies between reducing HFC emissions and reducing food waste under circular mitigation option 4 by:

1. investing in a programme to improve cold storage capacity and accelerate the phase-out of HFC use in The Gambia. Since a phase-out offers limited

12	Domestic	International
GHG mitigation potential tCO_2e/year	705,000	
Solid waste avoided t/year	n/a	
IPCC sectors targeted	2F Product Uses as Substitutes for Ozone-Depleting Substances	
Job creation potential	Low	Neutral
Reduction in primary resource extraction t/year		n/a
Investment costs	High	

co-benefits to users, linking the it to improving and expanding cold storage capacity might gain greater public and political support;

2. phasing out the use of HFCs as aerosols and allowing only alternatives with a low Global Warming Potential, such as hydrocarbons and oxygenated organic compounds, to be imported;[288]
3. updating the quantification of The Gambia's HFC emissions, which represented 17 percent of national GHG emissions in 2010. If they are still anywhere close to that value or have increased, their mitigation should be an international priority;
4. targeting trainings at both service technicians and end users, while also improving overall awareness of the adverse impacts of HFC use; and,
5. promoting HFC recovery, recycling and reclamation.[289]

Impact

A complete phase-out of HFCs by 2030 would reduce GHG emissions in The Gambia by 705,000 tCO_2e.

17%

In 2010, HFC emissions totalled 705,000 tCO_2e, or 17 percent of national GHG emissions

3.16 Preserving value of secondary materials with extended producer responsibility

Strategy description

Extended producer responsibility (EPR) places the responsibility for the environmental impact of products on their producers. It aims to incentivize them to use design to minimize the environmental impact of their products, while accepting the legal, physical or socio-economic responsibility for environmental impacts that cannot be eliminated by design.[290] Examples of ways in which producers can minimize the environmental impacts of their products include a deposit scheme to collect used packaging, a take-back scheme whereby the user is paid for returning the product at the end of its lifetime, or switching the economic model to 'pay per use,' rather than selling the product itself, thus promoting 'access over ownership.'

The results of mapping out material flows in Part 2 showed that much of imported minerals and metals end up as waste in landfills. A significant part of this is packaging waste. Introducing an EPR scheme for packaging waste can support the recovery of packaging materials, divert them from landfills and make them available as secondary resources.[291] Where this waste would otherwise be burned, GHG emissions from incineration sites are avoided. If the materials are also made available as a secondary resource, further international emissions are avoided from the extraction and processing of primary materials.[292]

A functional EPR system creates incentives to recover secondary products and resources for take-back and reuse or recycling. This means that The Gambia can develop a domestic collection and recycling industry and create jobs. Studies claim that for every 10,000 tonnes of waste products and materials, one job would be created if the materials were incinerated, six if sent to a landfill, 36 if the products are recycled, and between 300 and 800 if the products are refurbished and reused.[293]

However, this concept is not new to The Gambia. The country already has a deposit system for glass beer bottles and most glass bottles are returned[294] to their point of sale for reuse by the beverage industry. There is no deposit on PET bottles and aluminium and steel cans, but they are routinely removed from the waste stream because of their intrinsic value. A Gambian pipe manufacturer collects and recycles HDPE.

Unfortunately, deposit return systems for other types of packaging can be very costly and logistically complicated for producers. As a result, they are rarely introduced on a voluntary base and, therefore, exist in The Gambia only for glass bottles. Several international examples do provide alternatives to a traditional deposit system.

International examples

Packa-Ching, a packaging return system targeting low-income areas has been introduced successfully in South Africa.[295] This social enterprise supports small businesses to collect recyclables from designated areas with their own Packa-Ching branded vehicle. Packa-Ching also visits schools and educates communities on recycling and the value of recycled materials. Its affiliated businesses organize

13	Domestic	International
GHG mitigation potential tCO_2e/year	0	18,500
Solid waste avoided t/year	18,000	
Job creation potential	Low	Negative
Reduction in primary resource extraction t/year		26,000
Investment costs	High	

EPR

A functional EPR system creates incentives to recover secondary products and resources for take-back and reuse or recycling

collection days for community members to deliver their materials and receive payment per kilogram through a cashless eWallet payment system.

South Africa's experience with different kinds of plastic bottles – one with and one without a deposit scheme – shows that deposits work.[296] Encouraged by consumer support in response to a recent pilot project, the beverage company extended the deposit to other types of PET bottles.[297]

Refill stations, like the ones developed by Unilever for cosmetics,[298] provide access to products without any packaging required. By avoiding waste, they avoid the need to extract more primary resources and for reverse logistics.

Next steps

The Gambia could introduce mandatory EPR systems for the most environmentally problematic packaging items such as those defined in the single use plastics[299] category. Producers[300] of packaging products will then have to take full responsibility for the environmental impact of their products and provide financing to manage takeback and recycling.

Many products imported into The Gambia are produced by companies outside the country. Therefore, the EPR should also require those that import products whose packaging contributes to domestic solid waste to pay a levy. Even if the levy is passed on to consumers, it might reduce product demand and, thus, the amount of waste associated the product.

South Africa[301] is preparing to implement EPR legislation by 2021 after a stakeholder engagement process that took more than six years, due to policy planning mistakes that could have been avoided. The Gambia may also want to develop its own EPR schemes in close consultation with domestic stakeholder and policymakers in other countries. For example, Namibia is seeking advice from South Africa regarding its planned e-waste policy development.

To create the economies of scale that make investments in processing waste flows feasible, The Gambia could pursue cooperation with other countries in the region, specifically Senegal.

Impact

Recycling plastics reduces the need to extract primary materials and avoids GHG emissions associated with the production of primary plastics. The estimated impact is based on recycling or avoiding the use of 50 percent of plastic waste in The Gambia. Other packaging materials, such as paper and metals, are not considered. Plastics recycling would thus avoid an estimated 18,000 tonnes of waste, reduce international GHG emissions by around 18,500 tCO_2e and avoid the extraction of 15,000 tonnes of finite raw materials to produce plastics.

Continued untreated discharge poses a serious threat to the livelihood of many artisan fishers, food security, marine ecosystems and tourism. Avoiding pollution from fish meal factories may not create many jobs, but it could help preserve them

3.17 Avoiding pollution from fish meal factories

Strategy description

The Gambia has attracted fish meal factories; three operate along the country's coastline. Most of the fish meal is exported to China. These factories deserve attention not because of their GHG emissions but because of the significant co-benefits that could be realized if their operations can be made sustainable.

An estimated 200,000 people in The Gambia rely on fishing for their daily nutrition. However, the factories are controversial and there are calls to phase them out. Environmental NGOs and local communities believe that the factories' disposal of phosphate-rich effluent and organic solid waste causes algae blooms in the ocean, with a detrimental impact on the coastal environment and fish stocks. [302]

In addition to the impact on fish stocks, polluted beaches and waters also have an adverse effect on the tourist appeal of coastal regions, exacerbated by the odour that fish meal factories produce.[303] Debate is ongoing over whether the factories benefit local communities by providing employment and creating market demand for fish, or whether they deprive communities of access to low-cost fish protein and a healthy marine ecosystem.[304]

It is also difficult to integrate fish meal factories into a circular economy. A report by Wageningen University recommends that rather than using fish meal, which is harvested from the sea, we should feed farmed animals with waste-fed insects or plants, which humans cannot eat.[305]

Little information is available regarding the factories' processing capacity. One source has stated that the Golden Lead factory processes around 500 tonnes of fish per day.[306] If true, that factory alone could process over 180,000 tonnes per year. With three factories running in The Gambia, total processing capacity could exceed the annual fish extraction volumes reported for The Gambia. The Gambia's fishing grounds are reported to have sustainable production capacity of 70,000 tonnes per year,[307] which is far below the potential capacity of the three fish meal factories.

Before examining the opportunities to make fish meal factories more sustainable, the volumes they process should be made public and verified. This is important to ensure that the volumes processed do not exceed those that can be extracted sustainably from Gambian and, perhaps, even international waters.

A balance should be struck between nutrients from land that reach the seas though river flows and those brought ashore as fish, crustaceans and seaweed. This could also involve selecting the fish with the least negative impact on the marine ecosystem.[308]

However, if the factories are to remain, fish meal production can be made more sustainable by avoiding the disposal of organic waste. This could be achieved by using wastewater to produce liquid fertilizers[309] or installing an anaerobic digestor that can produce biogas by digesting organic material from the wastewater.[310]

14	Domestic	International
GHG mitigation potential tCO_2e/year	n/a	n/a
IPCC sectors targeted	4D Wastewater Treatment and Discharge	
Job creation potential	Low in terms of job creation, high in terms of safeguarding existing jobs	
Investment costs	Medium	

International examples

Owino is a Kenyan entrepreneur who produces leather accessories from fish waste. He employs 300 women and 17 factory staff, while procuring agricultural products from some 80 farmers in the region to soften and dye products.[311]

The Canadian company, SabrTech, developed a technology to turn fish waste into nitrogen fertilizer or fish meal.[312] A UK company is upcycling fish skins into fashion accessories.[313]

Next steps

The question is whether fish meal factories are compatible with maintaining the sustainable artisan fishing practices of coastal communities, preserving the tourism sector on the coast and maintaining the quality of coastal ecosystems. If the factories remain operational, they should comply with:

1. reporting requirements regarding volumes processed and their source to determine the validity of claims of overfishing;[314] and,
2. clear requirements on the quality of effluent water. To comply with discharge criteria, the factories may have to invest in wastewater treatment.

Impact

The impact on GHG emissions of removing or cleaning the effluent from fish meal operations is hard to estimate. The Gambia's national GHG inventory does not report on such emissions from unregulated wastewater discharge. However, continued untreated discharge poses a serious threat to the livelihood of many artisan fishers, food security, marine ecosystems and tourism. Avoiding pollution from fish meal factories may not create many jobs, but it could help preserve them.

200,000

An estimated 200,000 people in The Gambia rely on fishing to provide their daily nutrition

3.18 Strengthening informal sector manufacturing with circular economy strategies

Strategy description

Small and medium-sized enterprises are the backbone of the Gambian economy. An estimated 97 percent of private sector companies have five or fewer employees.[315] That offers a certain versatility, as the more inspiring and radical innovations often come from small enterprises. [316] This strategy aims to strengthen informal sector manufacturing by extending the use of secondary resources or offering products as a service.

Micro-scale entrepreneurs operating in the informal sector represent most of the country's manufacturing capacity. These small manufacturers, traders and retailers jointly operate as a network, providing decentralized infrastructure to produce and distribute products. Together, these informal entrepreneurs account for 62.8 percent of the entire labour force[317] in The Gambia. Their estimated contribution to the country's GDP may be as high as 44 percent.[318] Employing 95 percent of the informal sector workforce, micro, small and medium-sized enterprises are truly the foundation of the Gambian economy, even though 71 percent of them operate in the informal economy.

Training and financial support can help the informal sector further expand its economic activities. This would require both the government and the formal business sector to view all of The Gambia's people, including its large informal sector, as 'sources of innovation, not just labour.[319] Such a radically different viewpoint is particularly important in the context of finding workable solutions to address current unemployment rates, particularly affecting youth, and identifying alternative income opportunities outside urban hubs.[320]

Most artisans in the informal sector routinely take on apprentices, while passing on their knowledge and skills systematically over a period of years until the apprentice is deemed qualified to start his/her own business. The trainers or master artisans who transmit their skills to the next generation or to entrepreneurs should receive training on sustainable business innovation and the circular economy. Examples of circular economy strategies that offer significant potential for the informal sectors are using regenerative resources, sourcing secondary resources and offering products as a service.

Informal entrepreneurs who offer a specific product or service tend to cluster in physical locations. This attracts supporting services, such as food and materials suppliers, hardware shops, and, even, financial services like micro-credit companies.

International examples

In Kenya, informal artisans (known as jua kalis) are typically active in metalwork, carpentry, textiles, and/or ceramics manufacturing. In Kenya, the jua kali sector continues to generate more than 90 percent of new jobs annually and employs an estimated 80 percent of the labour force.[321] Twenty-five percent of all non-agricultural GDP generated in Kenya is linked to these types of micro or small business entrepreneurs.[322] Most of the required manufacturing inputs are actually sourced as secondary materials, either directly as production waste from formal businesses or from scrap yards, building demolition sites and, even, dumpsites located close to affluent suburbs. Kenyan artisanal metal and wood workers have successfully designed the blueprint for a multimachine that can combine machining processes such as drilling, milling, and

15	Domestic	International
IPCC sectors targeted		2 Industrial Processes and Product Use Job potentialJob creation potential
Job creation potential	Very high	
Investment costs	Low	

turning in one piece of equipment. It can be built affordably, including by semi-skilled workers, with scrap materials.[323]

The Kisumu Innovation Centre Kenya, or KICK,[324] is a social enterprise that works predominantly with youth, women and young men artisans. KICK provides financial incentives for new designs based on environmentally sustainable, innovative reuse and recycling concepts and made of both technical and biological materials. It also trains qualified artisans in-house on manufacturing such products and basic business skills, including how to bring products to market successfully, locally and for export.

Matilda Payne, a Ghanaian woman, founded MH Couture, which develops new products from waste. The company employs 75 people and has received business development support from the Switch Asia Green project.[325]

Next steps

To grow the small, medium and microenterprise-based informal manufacturing sector, the government must first acknowledge its existence. Next, it must expand the understanding of what constitutes 'decent work' and the role that integration of the informal sector may play in future national (youth) employment strategies and policies,[326] based on the value it already contributes to the economy.Government policies must provide an enabling environment for manufacturing artisans to thrive, perhaps lowering entry-level barriers for new artisanal entrants by providing them access to secondary resources.

The Gambian government can also play a major role in stakeholder integration and networking by initiating programmes and building meeting platforms that can create linkages among all players, including governments, NGOs, formal enterprises, academic institutions and end-use markets.

The government can further provide both physical and educational support to the informal sector's activities by helping artisans gain access to required tools (including training on how to use them safely) and free/low-cost co-working space. Ideally, such a 'makerspace' would closely collaborate with or even be based in a tertiary educational facility.[327] It would thus be the interface between academic training and practical skills development, benefiting both conventional learners and artisan-learners.[328] This way, other value-adding departments (for example, information technology and economics departments) and university-based assets (including CAD design software and 3D printers) could be made accessible to artisan workers to promote new local product design and manufacturing innovation initiatives.

Finally, reducing financial innovation/investment risks for informal artisans, providing access to financial transaction tools and providing basic workplace insurance coverage are crucial if this sector is to thrive. Therefore, financial and insurance institutions must be committed to developing tailor-made products and services that will serve the vast majority of Gambians who, as part of the informal sector, cannot otherwise obtain these services and protections.

Impact

Data is lacking on the availability of useful secondary resources, demolition waste and their substitution potential. Therefore, an estimated mitigation potential could not be provided for this intervention.

62.8%

Informal entrepreneurs account for 62.8 percent of the entire labour force in The Gambia

Public, commercial and financial services

16–20

A transition to a more circular economy defines new roles for the food industry and the manufacturing and construction sectors. Other sectors, such as government, financial and commercial services and, even, education and transport, also have a clear role in this process. This section explores their potential new roles.

3.19 Biogas from wastewater treatment and landfills

Strategy description

The latest inventory for The Gambia (2010) reports no GHG emissions from wastewater treatment.[329] According to the 2000 inventory, methane emissions from landfills and wastewater treatment totalled 206,700 tCO_2e. Landfills and wastewater discharge threaten public health as they can pollute drinking water sources. It is important to minimize pollution in The Gambia's marine environment,[330] which provides livelihoods and food for an estimated 200,000 people living on the coast.[331]

The greater Banjul area has a sewage system, but it cannot handle the increasing volumes of wastewater, which leads to untreated discharges into rivers and the sea.[332] In general, wastewater treatment facilities in Africa are characterized by uncontrolled input, power cuts and increasing wastewater volumes, combined with poor operation and maintenance. As a result, they deliver insufficient quality, threatening access to safe drinking water.[333]

This strategy calls for improving the sewage system, equipping it with wastewater treatment facilities that capture and use biogas. Existing landfills are covered and the landfill gas (methane) is captured. These activities also aim to avoid polluting ground and surface waters and contribute to securing existing rural water supply and the sanitation initiatives in The Gambia.[334] In addition, if the sludge from the wastewater facility is clean, it can be used as an organic fertilizer, thereby replacing the use of synthetic fertilizers.

International examples

The African Development Bank supports implementation of wastewater treatment facilities across Africa. A wastewater plant in Burkina Faso treats 400 tonnes of faecal sludge per day. With the 1.08 million cubic metres of biogas produced per year, the plant produces 2.16 million kWh of electricity and 2 500 tonnes of organic fertilizer.[335]

The Clean Development Mechanisms of the UNFCCC has supported landfill gas projects across Africa through the certification and sale of GHG emissions reductions as carbon credits. For example, the Nkolfoulou Landfill Gas Recovery Project in Cameroon has reduced emissions by approximately 12,000 tCO_2e per year by capturing and flaring landfill gas at flaring stations.[336]

SNV, a development NGO, has developed a low-cost biogas concept for households and small farms that has been implemented successfully across Africa and Asia.[337]

Next steps

The next steps are to:

1. fully exploit opportunities to reduce the disposal of organic materials in wastewater and landfills, including through interventions 6 (organic waste recovery), and 14 (waste reduction from fish meal factories);
2. invest in pollution prevention by recycling resources from industrial wastewater;[338]

16	Domestic	International
GHG mitigation potential tCO_2e/year	50,000	0
Solid waste avoided t/year	0	0
IPCC sectors targeted	4D Wastewater Treatment and Discharge 4 Waste	
Job creation potential	Medium	Neutral
Investment costs	High	

3. invest in the sewage system so that it can collect wastewater and make it available for treatment before it is discharged and in solid waste collection and sanitary landfills where polluted water or leachate cannot leak into groundwater sources;[339] and,
4. equip wastewater treatment sand landfills with facilities that can capture and use biogas. If the sludge is clean, it can be used as a fertilizer. In rural areas, organic waste/manure and human faeces can be collected in decentralized biogas systems to produce both biogas and fertile sludge.[340] Composting organic waste and faeces offers a low-cost alternative for rural areas.

Impact

GHG emissions from wastewater treatment and discharge from The Gambia were estimated to total 44,000 tCO_2e per year in 2000. Methane emissions from landfills are estimated at around 160,000 tCO_2e per year.[341] The emission estimates from 2000 probably underestimate current emission levels, as the population and GDP have grown significantly since then. However, the 2010 estimate did not break down emissions from landfill gas and waste water treatment.

The mitigation potential of this intervention may be lower when other measures, such as diverting organic waste for composting (intervention 6), are implemented successfully. Considering these uncertainties, this mitigation estimate is indicative.

Based on the assumption that 30 percent of landfill gas emissions can be avoided through organic waste diversion under intervention 6, that still leaves 180,000 tCO_2e of emissions from landfills and 70,000 tCO_2e from wastewater treatment. As an indication of the additional impact of landfill gas capture and flaring, measures addressing only 20 percent of the remaining emissions from wastewater treatment and landfill gas would avoid more than 50,000 tCO_2e per year.

206,700 tCO_2e

Methane emissions from landfills and wastewater treatment totalled 206,700 tCO_2e in 2010. Landfills and wastewater discharge are a threat to public health as they can pollute drinking water sources

3.20 Aligning the tax regime with sustainable development ambitions

Strategy description

The Gambia has a progressive income tax, with rates rising from zero percent for annual incomes up to $350 and 30 percent for annual incomes above $1,126.[342]

A recent study in Bangladesh shows that prioritizing environmental levies, rather than income tax, as a source of government revenue can help keep countries on track to achieve the Sustainable Development Goals.[343] UN Secretary-General António Guterres summarized this approach, saying, 'We should tax pollution, not people.'[344] A carbon tax is the leading first candidate for a pollution tax. A World Bank study found that a carbon tax of $30 per tonne of CO_2e would provide enough revenue to double the current levels of social assistance in 60 countries.[345] Similarly, a study by the African Development Bank notes that a levy of $0.12 per litre on diesel and petrol could close historic gaps in budget and investment requirements for adequate road maintenance.[346]

In a country with an unemployment rate reaching 35 percent[347] and with concerns over youth unemployment, taxing labour may conflict with the goal of reducing unemployment rates. To ensure that reducing the tax on labour is revenue-neutral, the government could tax pollution, including carbon-intensive products such as cement, steel, synthetic fertilizers or plastics. Since these materials are mostly imported, this could be done through import levies. Import restrictions are controversial as they disrupt the free flow of goods and competition. On the other hand, The Gambia has been a member of the WTO since 1996[348] and WTO rules allow countries to take measures to pursue environmental policy goals.[349]

If the public is to accept subsequent price increases for certain carbon-intensive goods, government communications must link the reduced income tax to higher taxes on certain products.[350]

Revenues from carbon taxes or import levies on carbon-intensive products can also be used to support domestically-produced products and encourage sustainable and renewable means of production, including renewable energy.

International examples

Ex'tax is a Dutch foundation that promotes tax reform. In a study for Bangladesh, it estimated that a tax reform that would invest revenues from a $30/tonne carbon tax in infrastructure or social spending could reduce GHG emissions throughout the economy by about 4 percent. Reduced coal use by industry was responsible for most of the mitigation impact. Ex'tax launched similar studies for the EU, Finland and the Netherlands.[351] Several countries have adopted environmental tax reforms, including Sweden, which reduced VAT on repair services.[352]

17	Domestic	International
GHG mitigation potential tCO_2e/year	9,000	11,000
Solid waste avoided t/year	0	0
IPCC sectors targeted	1 Energy	1 Energy
Job creation potential	Very high	
Import value substituted US$	11,000,000	
Reduction in primary resource extraction t/year		3,000
Investment costs	Low	

The Government of Senegal is exploring options to introduce carbon taxation, while avoiding undesirable impacts on the more vulnerable parts of the population. Participants in the study consultations noted their preference for a hybrid system, through which the carbon revenues are divided between those most affected and the State.[353]

In another example, the World Bank examined the introduction of carbon pricing in Ethiopia. As in The Gambia, livestock produce a substantial share of Ethiopia's GHG emissions. The World Bank concluded that the GHG mitigation impact of a carbon tax on fuels, which would increase gradually to $30/tonne by 2030, could be enhanced further if the revenues are used to reduce the income tax.[354]

Next steps

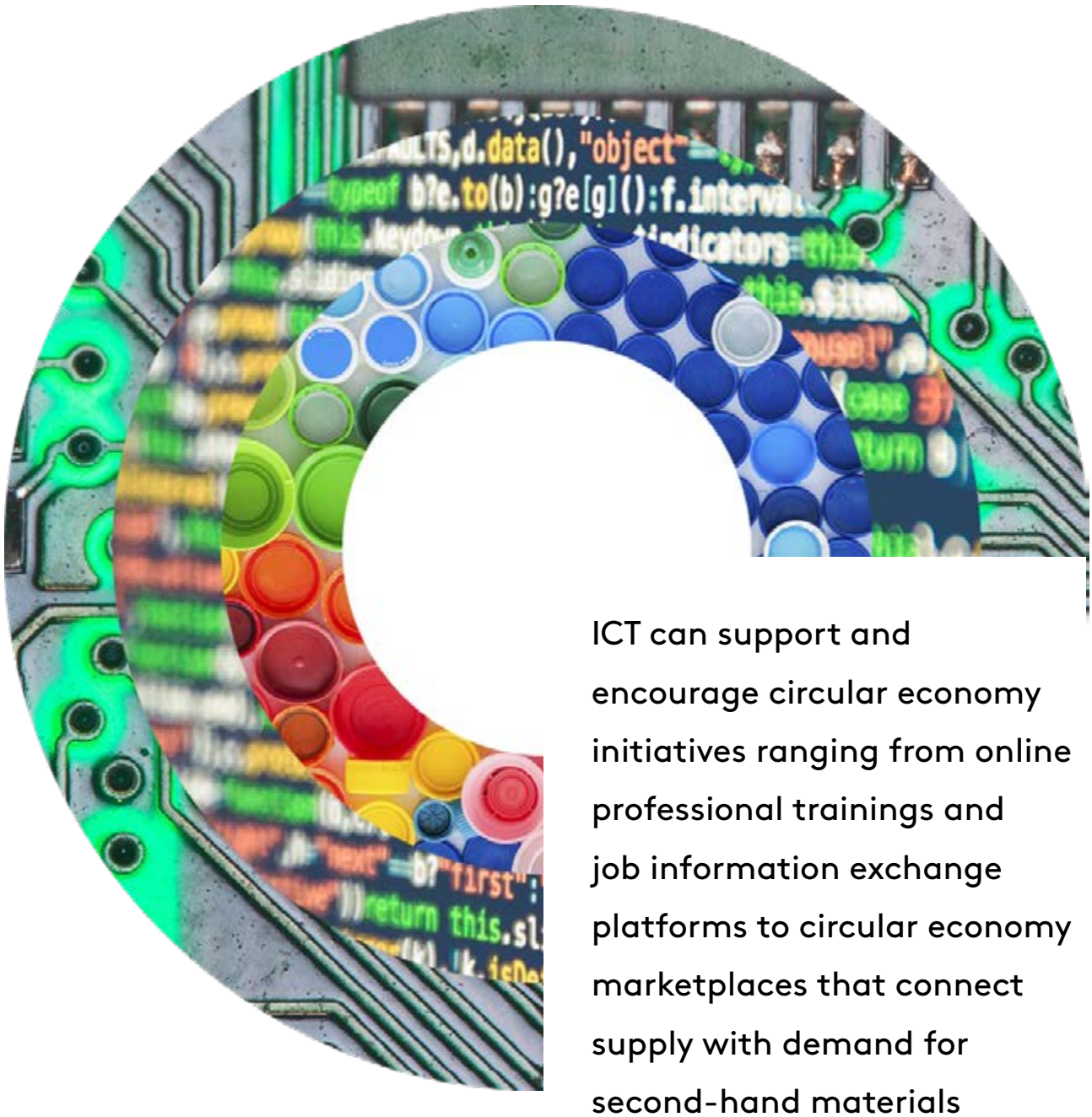
As a first step, the Government of The Gambia could commission an economy-wide study to understand which tax reforms are most effective in supporting economic development while safeguarding natural assets. This study should also help identify how more vulnerable members of the labour force, who often lack the means to adapt to changing economic incentives, can be supported. Tax reforms can be introduced gradually to allow the private sector and the population to adapt. Communication on the change to the tax regime must convey that it is not intended to raise more taxes, but to ensure sustainable development. It can even be designed to be budget neutral or, even, budget positive for the country's lower-income brackets, thereby helping to alleviate poverty.

Impacts

In The Gambia, a 4 percent reduction in fuel-related GHG emissions would total 9,000 tCO_2e/year. That would save $11 million in fuel imports and avoid the extraction of 7,000 tonnes of primary materials, notably fossil fuels.

$30

A carbon tax is the leading first candidate for a pollution tax. A World Bank study found that a carbon tax of $30 per tonne of CO_2e would provide enough revenue to double the current levels of social assistance in 60 countries



ICT can support and encourage circular economy initiatives ranging from online professional trainings and job information exchange platforms to circular economy marketplaces that connect supply with demand for second-hand materials and products

3.21 Promoting access to services over ownership in information and communications technology

Strategy description

An estimated 20 percent of The Gambia's population uses the internet.[355] The proposed solution would increase computer access by providing decentralized access to ICT via mobile units. These units provide access to a service, in addition to reducing the need for private ownership of hardware, thereby increasing both the use intensity and physical accessibility of the hardware. Where people would typically aspire to buy their own ICT, shared and second-hand products could provide a low-cost alternative to purchasing new hardware.

As discussed in Part 1, The Gambia wants to invest in its younger generation by supporting the uptake of ICT.[356] Offering ICT access at low cost provides additional benefits by avoiding e-waste to the extent possible and limiting the extraction and processing associated with the production of new products. This would save GHG emissions from the extraction of raw materials and the processing and manufacture of new hardware.

In addition, by offering ICT as a service, trained technicians can operate these mobile units while also servicing and maintaining any personally-owned hardware. This extends the lifetime of equipment in circulation even further.

Where functionality cannot be restored, the operators of the mobile units can offer a reverse logistics service that transfers rural e-waste to areas in The Gambia where it can be disposed of responsibly.

Finally, dedicated software can further support and encourage circular economy initiatives. This could range from online professional trainings and job information exchange platforms to circular economy marketplaces that connect supply with demand for second-hand materials and products. Another software service could involve applications for farmers that offer access to virtual marketplaces, enabling optimized, real-time trade of local agricultural products and offering farm equipment as a service through an asset-sharing platform. This can support other initiatives directed at avoiding food waste and losses along the food value chain, while optimizing the use of agricultural machinery. It can also provide rural farmers with access to services that aim to increase crop yield and optimize soil carbon sequestration,[357] as described further in circular economy strategy 2 on climate smart agriculture.

Finally, these software solutions can provide access to crowdfunding platforms. Examples include Farmcrowdy and EZ Farming, which are used by farmers across Nigeria, Ghana and Sierra Leone.[358]

International examples

In South Africa, NGOs such as Big Box Containers have repurposed redundant shipping containers into portable standalone computer centres.[359] The

18	Domestic	International
GHG mitigation potential tCO_2e/year	0	10,500
Solid waste avoided t/year	0	0
IPCC sectors targeted		2 Industrial Processes and Product Use
Job creation potential	Medium	Negative
Import value substituted US$		7,600,000
Reduction in primary resource extraction t/year		9,000
Investment costs	High	

converted containers are loaded on a truck and dispatched to serve different communities.

Mobile ICT units have also been introduced in Tanzania. These 40-foot containers are equipped with solar panels, laptops, routers, printers and other hardware. They serve up to 18 learners or community members at a time.[360]

WeCare,[361] an initiative of Sims Lifecycle Services,[362] a global recycler of e-waste, offers another example. It provides users with basic training, for example, in drafting a curriculum vitae. Their ICT containers provide jobs for three technicians per unit. In addition to providing access to ICT, WeCare also supports schools and communities with repair and refurbishment services and by accepting e-waste at its units.

Next steps

Mobile ICT stations could be introduced, funded through the private sector, including members of the Information Technology Association of The Gambia (ITAG). Similar to the WeCare business model, these modular units would be owned and managed by young technicians, who would receive special training, possibly facilitated through the Gambia Telecommunication and Multimedia Institute (GTMI). The solar-powered mobile ICT stations would offer off-grid access to all required network technologies and software applications that can help improve rural connectivity, including added value services such as public internet access.

The Ministry of Trade, Industry, Regional Integration and Employment and the Ministry of Youth and Sports could initiate a mobile ICT station pilot project. It could be part of efforts under the Youth and Trade Roadmap of The Gambia 2018-2022, with financial support and technical assistance from the EU-funded Youth Empowerment Project and existing members of the ICT roadmap core team.

If the pilot project succeeds, the ministries could map out potential sites where the stations could be located and determine the minimum number of stations needed to cover 80 percent of rural areas. Ideally, the shipping containers sourced could be converted locally or by specialists such as BigBox,[363] or from solar outreach specialists, such as Stiftung Solarenergie.[364]

Impact

The environmental impact of ICT as a service is based on reducing private ownership. The strategy provides a low-carbon, resource-efficient way to develop ICT infrastructure. While creating this infrastructure would generate GHG emissions, the ICT-as-a-service option requires fewer resources than an ICT model based on private ownership. According to BigBox, a single unit can serve 2,500 community members.

The environmental impacts are estimates based on providing 20 percent of the workforce in The Gambia with access to a computer through modular ICT stations, compared to privately-owned computers, which may serve four users.[365]

2,500

A single mobile ICT station can serve 2,500 community members

3.22 The educational impact of decentralized recycling initiatives

Strategy description

The Gambia has taken measures to clear plastics from its coastlines by organizing coastal clean-ups[366] and plastic-free days during which residents are challenged not to use any plastics over the course of a day. These campaigns help create awareness and can be made permanent – and become relevant to businesses – by establishing artisan plastic recycling workshops. The secondary plastics collected could cater to the tourism industry with creative souvenirs. The materials could also be used to build circular technologies, such as modular anaerobic digesters for schools, farms or communities.

In many regions, the export of recyclable materials has stalled due to falling prices for secondary materials.[367] However, plastics do have value in The Gambia, as a national pipe manufacturer incorporates 20 percent recyclable materials in its products and PET bottles are typically reused. Creating decentralized demand may also create demand for recyclable secondary plastics in rural areas.

International examples

Dave Hakkens is a designer who promotes open source, do-it-yourself initiatives to recycle plastics and make consumer products or artwork out of secondary plastics. Instructions for a mobile plastics recycling facility with a shredder, extruder, injector and press are available online. The cost is less than 3,000 EUR. The community has developed many more machines that can be built without sophisticated tools in small workshops,[368] and may create opportunities for informal entrepreneurs.[369]

This kind of facility can be combined with crowdsourced waste to produce valuable products for the community. The city of Eindhoven used crowdsourced plastics waste for the façade of a new building; the community was mobilized to collect and sort the plastics by colour.[370]

Whale offers another example.[371] This social enterprise builds high-end products, such as furniture and boats, from plastics recovered from marine environments.[372]

Impact

The estimate below is based on one facility, which can process one tonne of plastics per month.

19	Domestic	International
GHG mitigation potential tCO_2e/year		26
Solid waste avoided t/year	12	
Job creation potential	Low	
IPCC sectors targeted		2A Mineral Industry
Investment costs	Low	

3.23 Ecotourism supported by local communities

Strategy description

Gambia has been exposed to both the adverse impacts of pollution and the impact of COVID-19 on tourism. Sustainable tourism could be linked to preserving those natural assets that provide the country its international appeal.[373] In addition, a sustainable tourism sector could build on indigenous knowledge of the environment[374] and the government's ambition to develop eco-agricultural tourism, with trails into natural and agricultural areas.[375]

International examples

Costa Rica markets itself as an ecotourism destination, offering ecolodges and eco-adventure holidays, backed with a voluntary certification programme. The Dominican Republic's efforts show how community-backed tourism development can help engage local companies[376] and Bali's initiatives highlight actions to reduce tourism-generated plastic waste.[377]

Next steps

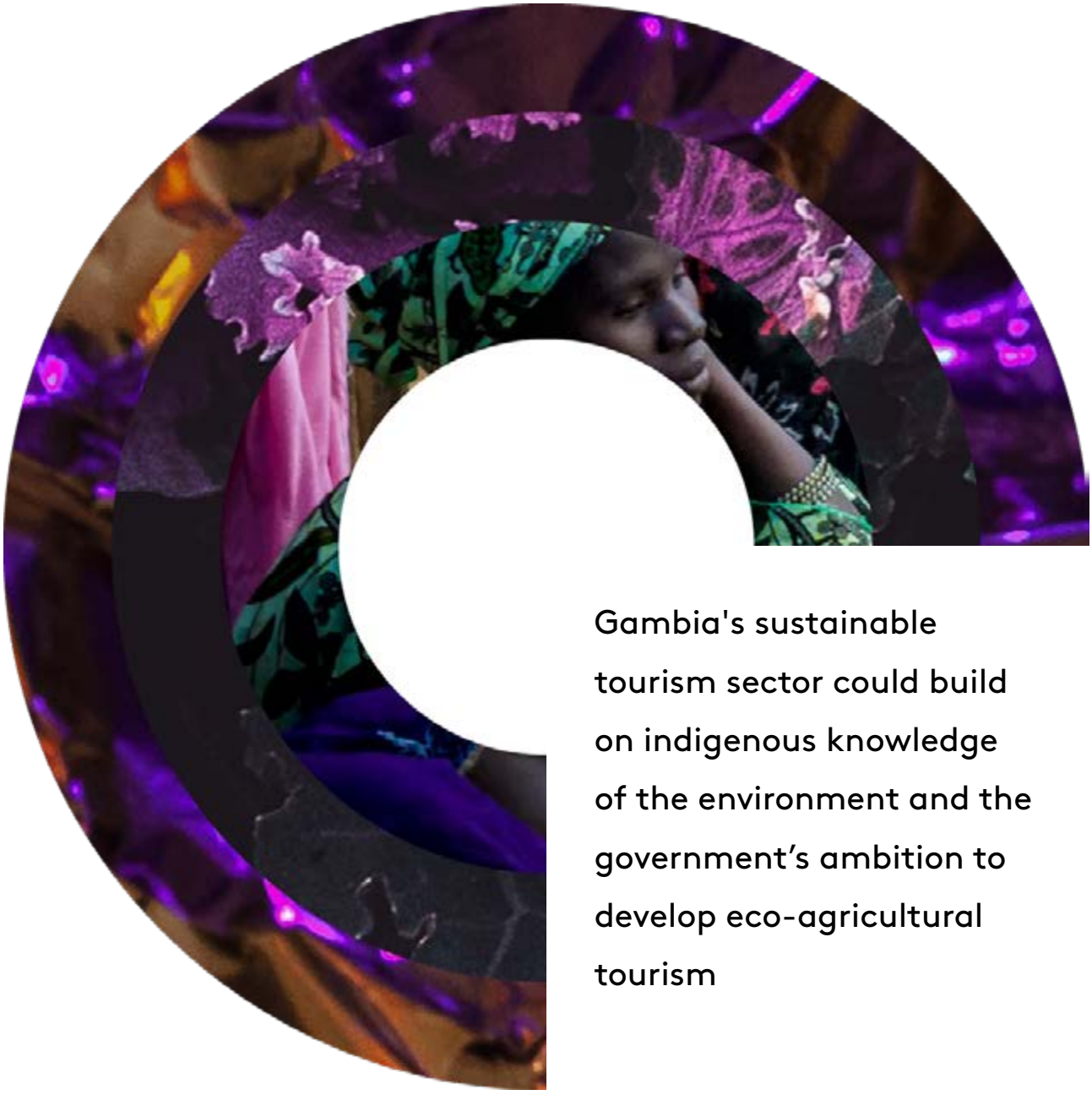
Actions to encourage ecotourism include:

1. Establish collaboration between farms and the tourism sector to increase the use of food products from The Gambia.
2. Adopt minimum standards for tourism operations, perhaps following guidance from the Sustainable Tourism Stewardship Council (STSC). This could be incorporated into the licensing process for tourist operations or as part of an ecotourism certificate scheme.
3. Implement a green tax on tourism, which allows tour operators to pay for the ecosystem services that attract tourists. This tax could be levied on hotel rooms.[378]
4. Encourage tourism companies to adopt green building standards that rely on domestic construction materials and construction traditions. This action could also be included in an ecotourism certificate scheme.
5. Prioritize the use of local products to help reduce plastic waste generated by tourism, as plastics are a primary concern, given their impact on natural assets and the negative impact of marine litter on the country's tourism appeal.

Impact

Estimating the impact of prioritizing the use of local products in the tourism sectors requires more information on the volume and type of imported products that can be substituted, and the impact of enforcing green building standards for hotels and resorts.

20	Domestic	International
IPCC sectors targeted	3 Agriculture, Forestry and Other Land Use	3 Agriculture, Forestry and Other Land Use
Job creation potential	High	Negative
Investment costs	Low	



Gambia's sustainable tourism sector could build on indigenous knowledge of the environment and the government’s ambition to develop eco-agricultural tourism

3.24 Conclusion – Part 3

Most of the circular GHG mitigation potential lies in the agriculture and forestry sectors, with the exception of the reduction of HFC emissions from industry. Interventions in the construction sectors will reduce primarily upstream emissions in international value chains that supply construction materials to The Gambia.

The majority of interventions related to agriculture, forest management and sourcing local construction materials have high job potential. Some interventions, such as avoiding pollution from fish meal factories, offer significant potential to preserve existing jobs because they avoid pollution of coastal ecosystems. This pollution has a negative impact both on the tourism sector and the fishing grounds on which many artisan fishers rely.

The total impact of the circular GHG mitigation measures selected is 1.94 million tonnes of CO_2e in territorial GHG emissions and 329,000 tonnes of CO_2e in the carbon footprint of imported goods and materials. These figures represent 36 percent and 38 percent, respectively, of the GHG emissions within the scope of this metabolic analysis.

In addition, the interventions would reduce import volumes by 7 percent, thereby improving The Gambia's trade balance. Solid waste volumes would be reduced by 37 percent and raw material extraction by 694,000 tonnes per year. This does not take into account that, according to some sources, the measures proposed could transform The Gambia from a net food importer to a net food exporter. Finally, 10 of the 20 opportunities have high or very high job creation potential.

Reducing food losses offers considerable potential to reduce The Gambia's reliance on imports, while diversifying production via agroforestry or food forests on a commercial basis and/or enhancing subsistence agricultural activities can increase national food security. The Gambia's soils are of poor quality, and climate-smart agriculture and agroecological approaches to agriculture can improve both that quality and the climate resilience of the agricultural sector.

Design is key to circular strategies in the construction sector. The very basic principle of considering energy and resource use in a building's design phase can reduce energy use by 70 percent and convert the building from a source of GHG emissions into a net carbon sink. This entails passive design, adjusting the design to incorporate secondary remanufactured construction elements and using construction materials of renewable, rather than carbon-intensive, origin. Initiatives in nearby Senegal show that modern design and soil-based construction material work very well together.

The Gambia has very little industry, but the informal sector hosts a wealth of small industrial workshops. An estimated 97 percent of firms in the private sector have five or fewer employees and many of them operate in the informal sector, making it an important part of the country's economy. Specific interventions have been proposed to include it in the transition to a circular economy.

Circular procurement and tax reform can give circular business models a decisive competitive advantage. In addition, local governments have an important role in providing space for local production and small-scale industries or design workshops that harvest and create value out of locally available resources and products. This is where and how the circular economy can improve the profitability of the informal sector and drive innovation.

Education also plays an important role in engaging the next generation in the importance of sustainability. Some small and larger initiatives already train farmers to apply regenerative agricultural practices. The government could help integrate more circular economy concepts into the curriculum by including topics such as recycling, the value of organic waste as a resource and circular business models.

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