TRADE & INDUSTRIAL POLICY STRATEGIES

SOUTH AFRICA'S FORESTRY VALUE CHAIN AND THE TRANSITION TO CLIMATE COMPATIBILITY

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Trade & Industrial Policy Strategies (TIPS) is a research organisation that facilitates policy development and dialogue across three focus areas: trade and industrial policy, inequality and economic inclusion, and sustainable growth

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ABBREVIATIONS

AOX	Absorbable Organic Halogens
CEPI	Confederation of European Paper Industries
CHP	Combined Heat and Power
CoC	Chain of Custody
COD	Chemical Oxygen Demand
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DWP	Dissolving Wood Pulp
FES	Forest Ecosystem Services
FSA	Forestry South Africa
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HCV	High Conservation Values
IAP	Invasive Alien Plant
IEA	International Energy Agency
ITAC	International Trade Administration Commission
PAMSA	Paper Manufacturers Association of South Africa
PEFC	Programme for Endorsement of Forest Certification
SAFAS	South African Forestry Assurance Scheme
SAFCOL	South African Forestry Company Limited
SAFI	South African Furniture Initiative
SEV	Specific Effluent Volume
SWI	Specific Water Intake

“The increased pressures on forests implied by climate policies make it even more important that these same policies incorporate the protection and sustainable management of forests”
(Forest Stewardship Council, 2016)

1 INTRODUCTION

South Africa has a long history of plantation forestry, with early plantations established to supply wood for local use(Scott and Gush 2017). Many socioeconomic benefits are derived from forestry and its associated products. Wood is an important raw material for many industries, such as mining; construction of houses and commercial buildings; poles for electricity distribution and telecommunications; furniture manufacture; pulp and paper manufacture; and energy production (DAFF 2020). The value-added products are diverse, ranging from traditional products such as timber, pulp, paper, wood-based energy to liquid biofuels, biochemicals and biomaterials, to advanced products derived through techniques like nanotechnology applied on wood fibre/cellulose for products needed for automobiles, aerospace, defence and medical science (PAMSA 2016). In addition to a wide range of wood and non-wood products, forestry also provide social and environmental services that include the conservation of soil, water and biological diversity (DAFF 2016). Most importantly, forestry plays an important role in multi-dimensional poverty alleviation (Mtengu and Green 2016).

The forestry value chain faces many challenges. These include rising costs for transportation, labour, raw material inputs, energy and imported raw materials, exacerbated by poor road infrastructure that contributes to high maintenance costs and inefficiencies (Who Owns Whom 2018a). Increasingly, climate change is an additional stressor that demands transitioning from business-as-usual practices. There is a close link between climate change and the forestry value chain. On the one hand, forests are affected by climate change physically through higher mean annual temperatures, changing precipitation patterns and more frequent and extreme weather events, and also economically through climate change related policy measures. On the other hand, forests help to mitigate climate change through sequestrating carbon if the forests are sustainably managed, but with land-use conversion and forest degradation, can contribute to climate change through more carbon emissions (WBCSD and WRI 2011).

Climate change impacts affect the vulnerability of plantation forests in many ways, including droughts, fire events and intensity, and the susceptibility of trees to existing and new pests and pathogens (SA Forestry Online 2013). Climate change can contribute to altering the fire regime. For instance, the 2017 fire season was abnormally long, due to the drought over most of the country (FSA 2017a). Depending on how the climate change impacts play out in altering the fire regime, a reduction in fire intensity may promote tree production, while an increase in intensity is likely to favour grass production (Naidooet al. 2013). Already, forestry plantations are vulnerable to many factors (Table 1). In the 2016/2017 period, a total of 25 682 hectares of forestry plantation area in the country was destroyed by various causes that included fires, weather, diseases, insects, and animals and rodents. Fire was the biggest challenge with 2 793 fires damaging 16 145 hectares of forestry plantation area.

Table 1: Damage by fire and other causes on forestry plantations in 2016/2017

	FIRES		WEATHER	DISEASES	INSECTS	ANIMALS AND RODENTS	TOTAL AREA DAMAGED
	Number	ha	ha	ha	ha	ha	ha
Softwood	829	9 986	488	127	43	1065	11 709
Hardwood	1 964	6 159	1 636	267	5 407	503	13 973
Total	2 793	16 145	2 124	394	5 450	1568	25 682

Source: DAFF (2018: 54)

Not only are forests vulnerable to climate change, but there are other external stressors such as desertification and erosion, which might interact with the climate change impacts, to worsen vulnerability (Naidoo et al. 2013). As such, the sector needs to contribute to climate change mitigation, while at the same time adapting to climate change and taking action to reduce its overall vulnerability.

As in other parts of the world, climate change impacts are becoming more evident in South Africa. Projections indicate that these are set to worsen in the future. Climate change is already acknowledged as impacting the forestry value chain. The South African forestry industry is sensitive to climate change, as only 1.5% of the country is suitable for tree crops under the current climate. The effects of climate change may reduce the land surface area suitable for plantation forestry (Robertson 2018). Moreover, tree plantations are also vulnerable to environmental change as there is a long period between planting and harvesting (Scott and Gush 2017). The state-owned South African Forestry Company Limited (SAFCOL) (2017) has stressed that climate change and natural disasters are two of the biggest risks to the forestry industry. For example, in 2016, the Belfast plantation was affected by a tornado, while cyclone Dineo caused flood damage throughout many plantations. Sappi (2018) acknowledges that climate change is already impacting some of its plantations and has the potential to significantly impact its woodfibre base, hence the need for concerted action to mitigate the risk.

As a consequence, the increased vulnerability of forest ecosystems to climate change has serious negative implications for the people, communities and economies that depend on them (Naidoo et al. 2013). Unfortunately, the industry has generally been focusing more on the management of carbon, with less focus on reducing vulnerability to climate change, which demands that all future planning incorporate both mitigation and adaptation measures (PAMSA 2016; 2020).

These actions are not only necessary for the sector to be able to produce raw materials and other products but also have implications on the economic viability and sustainability of the sector. Increasingly, it is imperative for economic and manufacturing activities to seek sustainability as well as combat climate change. Taking a lead in ensuring that the forestry value chain is climate compatible is a necessary step in safeguarding market access and guaranteeing future sustainability. Just like the influence of phytosanitary trade barriers,[1] climate change response measures are strongly gaining traction, which makes it imperative for the South African forestry value chain to be climate compatible. More and more concerned consumers, retailers, investors, communities,

[1] For the first time in the history of forestry in South Africa, one member of Forestry South Africa(FSA) experienced the imposition of trade barriers due to a pathogen (Guava Rust), even though there was no record of it having spread to eucalyptus trees, three years after it was first detected on an indigenous tree. It took the intervention of FSA's Pests and Diseases Committee, National Plant Protection Organisation (NPPO), the Department of Agriculture, Forestry and Fisheries (DAFF) and the International Trade Administration Commission (ITAC) to get the barrier lifted (FSA 2017a).

governments, and other stakeholders want products that make positive social and environmental contributions (WBCSD and WRI 2011).

Climate change represents both a challenge and an opportunity. As such, a proactive approach is required to harness the profitability associated with embracing sustainability (SA Forestry Online 2013). Thus, adapting to and mitigating climate change makes socioeconomic sense for the forestry value chain. Climate compatibility is a necessary condition for sustainability, i.e. being climate compatible will contribute to current and future sustainability of the value chain. There are, however, challenges that relate to climate compatibility such as high water usage, high energy footprint, and use of fossil fuels and the associated emissions.

While climate change impacts have been assessed for various ecosystems across the world, the risk to industrial forestry plantations in South Africa is not yet well understood (ICFR 2014). This is still the case, and a dearth of information on the subject persists.

Against this background, the objectives of this report are:

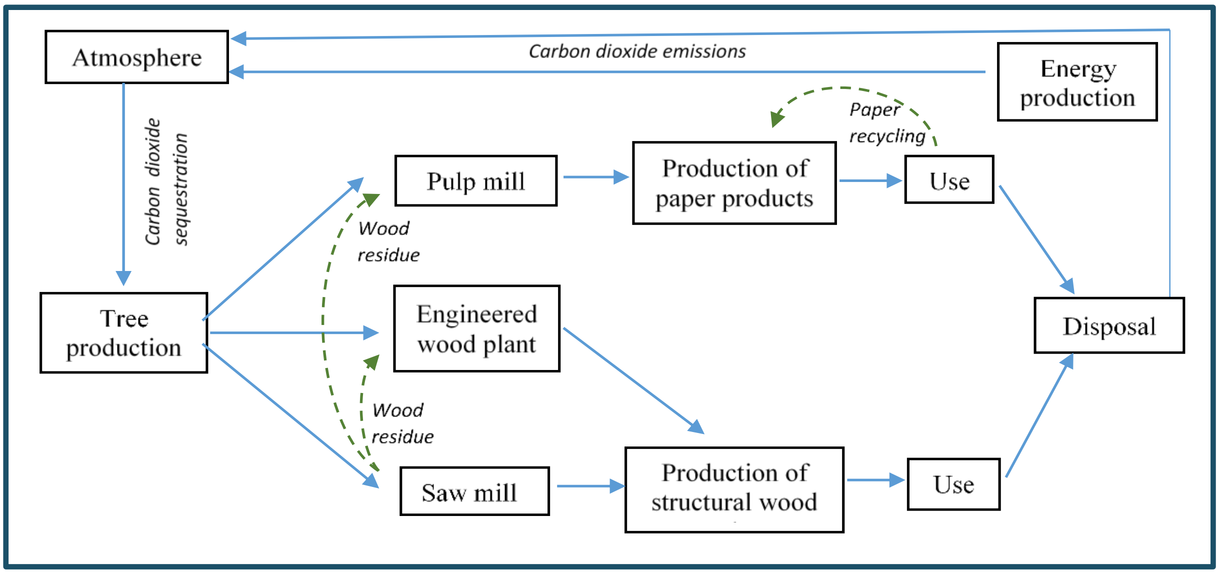
- To identify and explore the climate-compatibility in South Africa's forestry value chain; and
- To suggest solutions to address the climate-compatibility problems in South Africa's forestry value chain.

The report is organised as follows. After this introduction, the main components of the value chain, which are the focus of this paper, are discussed. Then, the importance of the value chain to South Africa and the world is highlighted. This is followed by identifying the problem for the value chain from a climate-compatibility perspective, after which potential solutions are suggested. Last, the conclusion and recommendations are presented.

2 THE VALUE CHAIN

There is no single standard value chain for wood and paper-based products; however, there are common elements useful in showing connections among various manufacturing points, the product flows, and the associated environmental and social issues (WBCSD and WRI 2011). Figure 1 shows the forestry value chain, highlighting the major activities along the chain. Based on key components in the forestry value chain in relation to the South African economy, this study explores three related components, namely forestry and timber; pulp and paper; and furniture and other wood products.

Figure 1: Generic forestry value chain and related environmental and social issues

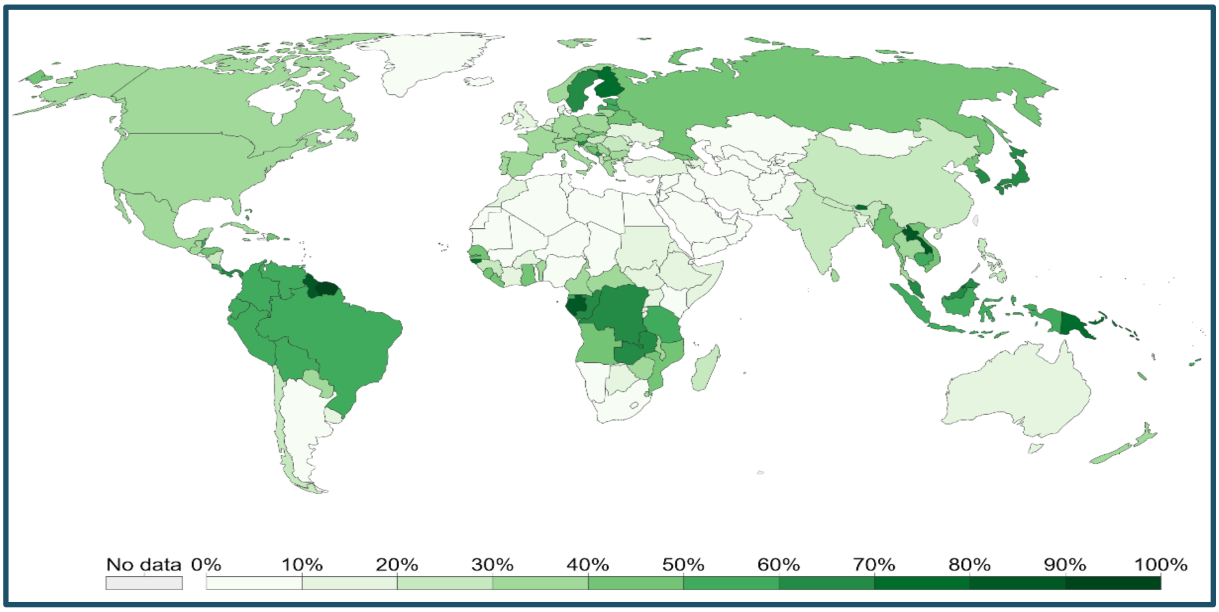


Source: Adapted from WBCSD and WRI (2011: 2.9)

2.1 Forestry and timber

The first component is plantation forestry, whereby trees are grown to produce raw materials. Forestry is important to South Africa as it is to the rest of the world. In 2015, the proportion of forest area to total land area in South Africa was 7.6%, which is lower than that of Southern Africa at 10.4%, Africa at 20.7%, and the world at 30% (Figure 2 and Figure 16 in the Appendix).

Figure 2: Forest area as share of land area, 2015



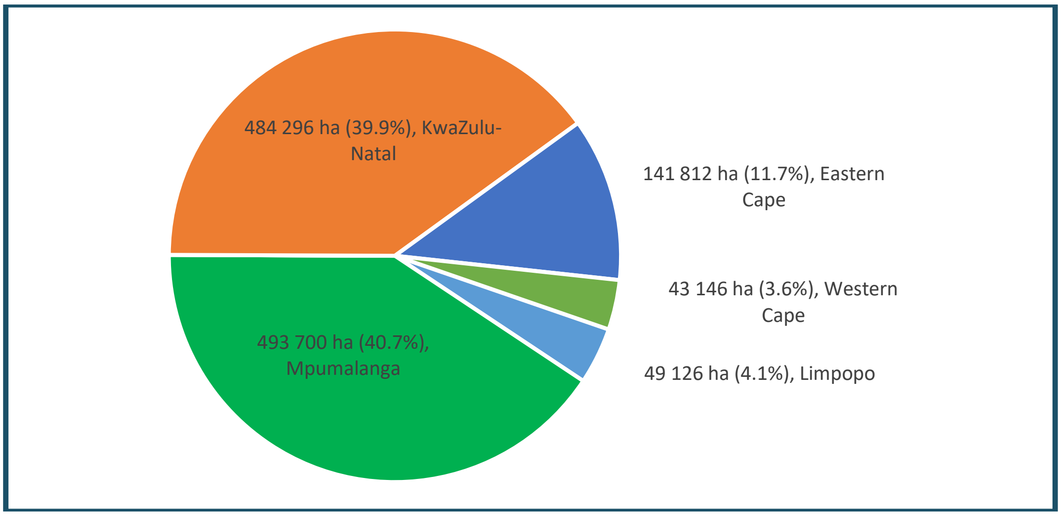
Source: Roser (2010); University of Oxford and Global Change Data Lab (2020) based on FAO (2015)

Plantation forest covers about 1.3 million hectares in South Africa (FSC 2017; Ledger 2017; Scott and Gush 2017), amounting to about 1% of the total South African land area of 122.4 million hectares (DAFF 2016; Who Owns Whom 2018a). Timber is grown on plantations, indigenous forests and woodlands. The plantation tree species are mostly exotic trees that include softwoods, of which pine makes up about 50.6% of the total plantings; hardwoods are eucalyptus making up about 41.8%; wattle makes up about 7.0%; and other is 0.4% (DAFF 2016). Timber plantations were mostly established in non-forest ecosystems, replacing grasslands and fynbos (FSC 2017). Indigenous forests cover just about 0.5 million hectares. These are legally protected, i.e. limited harvesting can take place under strict licensing conditions (SAFAS 2018).

DAFF (2018) noted that, in 2017, the reported plantation area in the country was 1 212 383 hectares in 2017, down by 8 343 hectares, from 1 220 726 hectares reported in 2016. The distribution of the plantation area by province in 2017 is shown in Figure 3. Mpumalanga had the largest area under forestry plantations (40.7%), followed by KwaZulu-Natal (39.9%), and Eastern Cape (11.7%).

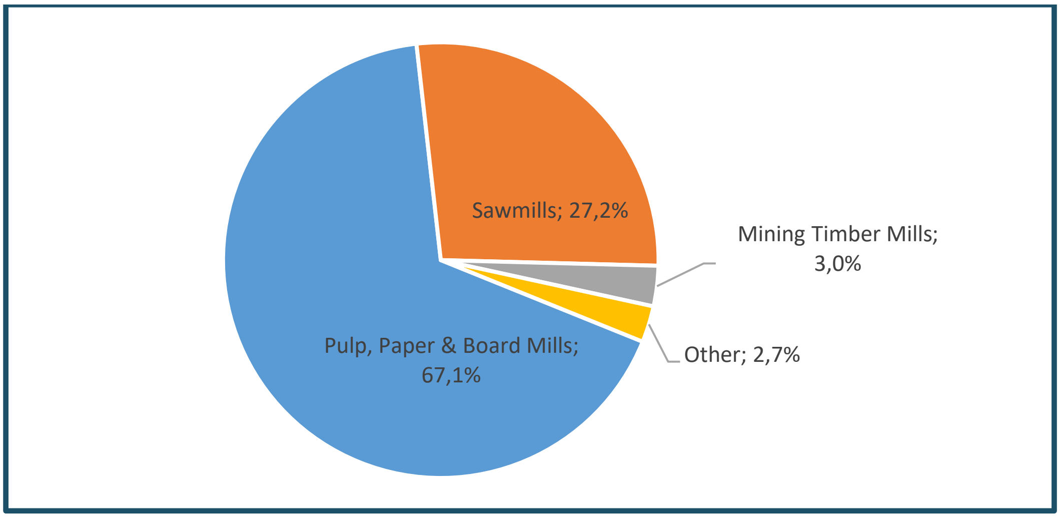
A total of 17.65 million m^3 of roundwood went into processing plants in 2018. The largest amount of roundwood (67.1%) was processed by pulp, paper, and board mills, followed by sawmills that processed 27.2%, while mining timber mills processed 3.0% (Figure 4).

Figure 3: Afforested area in South Africa by province in 2017



Source: DAFF (2018: viii)

Figure 4: Roundwood intake into processing plants in 2018



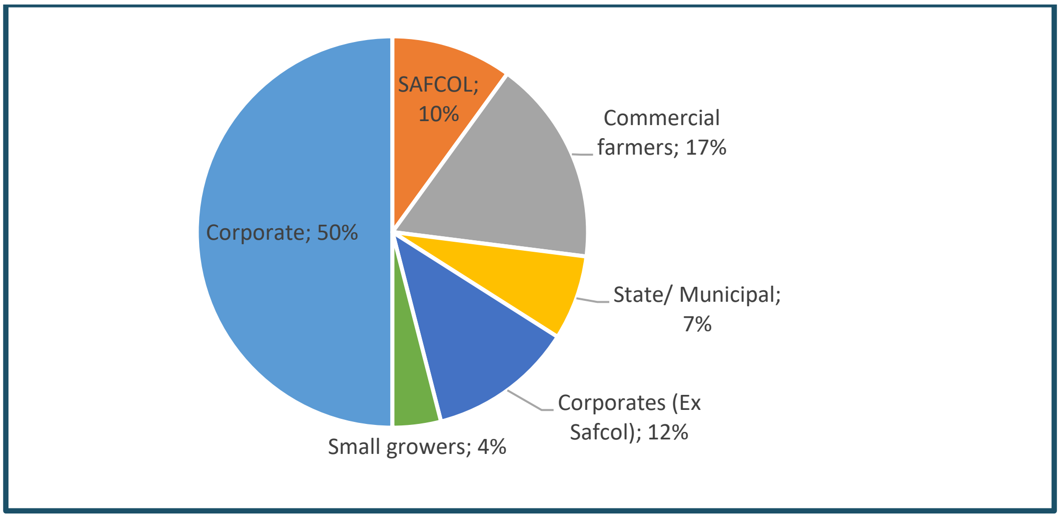
Source: FSA (2020)

Wood is the key raw material in the production of timber, which is needed in the construction industry. The estimated market value of the timber roofing industry is around R1.5 billion per annum, and the estimated total number of timber frame builders in the country is about 265 (Macaskill 2019). Pole production is a small subsector of the forest industry, using just over 2% of total roundwood input to processors (Clarke 2018). A variety of products are manufactured, such as treated poles, with large poles for transmission and telephone poles, and smaller poles for building, fencing and agricultural uses. Untreated poles are also produced for various applications including smaller diameter poles meant for droppers and laths.

In the context of social equity, it is important to understand the ownership structure of the plantations. Industry players include private timber companies, small growers on land held by traditional authorities, community forestry co-operatives and state-owned plantations (Who Owns Whom 2018a). Indigenous forests are managed by provincial conservation authorities and South African National Parks (SANParks). There are co-operatives, such as the NCT Forestry Co-operative Limited (NCT), which facilitate market access and transport brokering for about 2 000 small growers.

There is a strong bias in the ownership of plantations toward large private corporate companies (Ledger 2017). Fifty percent of forestry plantations are owned by corporate, followed by commercial farmers at 17%, corporates (ex-SAFCOL) at 12%, SAFCOL at 10%, the state at 7%, while small growers at 4% (see Figure 5).

Figure 5: Plantation by ownership in 2015



Source:DAFF (2016: 5)

2.2 Pulp and paper products

Pulp and paper is an important component of the forestry value chain. The country's pulp and paper sector contributed about R7.3 billion to the country's balance of trade in 2018, of which R4.9 billion worth of papers were imported while pulp worth R12.2 billion was exported (PAMSA 2018). There are variations in the production and consumption of several products in the pulp and paper sector. A total of 2.34 million tonnes of paper, paper packaging and tissue was consumed in South Africa in 2018 (Table 2). To put this into perspective, in 2017, the average per capita consumption for South Africa was 41 kg per person per year; the global average was 54 kg per person per year, the average for Africa was 6 kg (amounting about 7.8 million tonnes per year), while North American consumption was very high at 207 kg. China was at 78 kg and Europe was at 123 kg (FAO 2019).

In general, the volume of printing and writing grades decreased because of the growth of electronic media; however, packaging and tissue grades showed some resilience (PAMSA 2018).

Growth in the packaging sector is being driven by the growth of electronic commerce shipment, population growth, increased agro-processing and pressure to reduce fossil fuel-based packaging (Who Owns Whom 2018a). The increase of packaging-focused regulation, which targets single-use plastics, and the growing demand for more renewable and recyclable packaging has given impetus for sustainable wood fibre, pulp, paper and packaging (Who Owns Whom 2018a; Crane 2019; PAMSA 2018). In South Africa, improved living standards have also contributed to increased consumption of packaging and tissue paper (Van der Merwe-Botha et al. 2017).

Table 2: Production and consumption of various types of paper in South Africa

	PAPER PRODUCTION (TONNES)	PAPER IMPORTS (TONNES)	PAPER EXPORTS (TONNES)	PAPER CONSUMPTION (TONNES)
Newsprint	113 912	53 479	63 094	104 297
Printing/writing	361 238	500 654	147 793	714 098
Corrugating materials/ containerboard	1 325 518	144 720	310 034	1 160 204
Tissue	11 151			11 151
Other paper	239 209	29 607	37 084	231 732
Board	135 162	57 259	106 252	86 168
Total	2 223 213	785 719	664 257	2 344 675

Source: PAMSA (2018: 1)

The downward trend in printing and writing grades in the country mirrors global trends, with digitisation taking centre stage (PAMSA 2018; Roth et al. 2016). Different pulp grades have been performing differently, with some facing a decline but others witnessing some growth. Though local pulp production has generally remained static, it has tended to shift towards competitive grades. Although the rise of digitisation has cast a glim picture, with demand for graphic paper declining, the paper and forest-products industry as a whole is not disappearing but rather it is changing and morphing. Niche industry making bio-products, which range from applications for nanofibers to composite materials and lignin-based carbon fiber, are being developed and growing (McKinsey & Company 2019). The bio-economy through food packaging and pulp-based fabric hold the prospects for the pulp and paper sector (Roth et al. 2016).

There are various types of processing plants along the forestry value chain. They produce a range of wood products, from poles, furniture, paper and packaging to wood-derived chemicals, needed for a variety of goods such as viscose fibre for clothing and wood-derived chemicals, including for hygiene products and computer screens (Who Owns Whom 2018a).

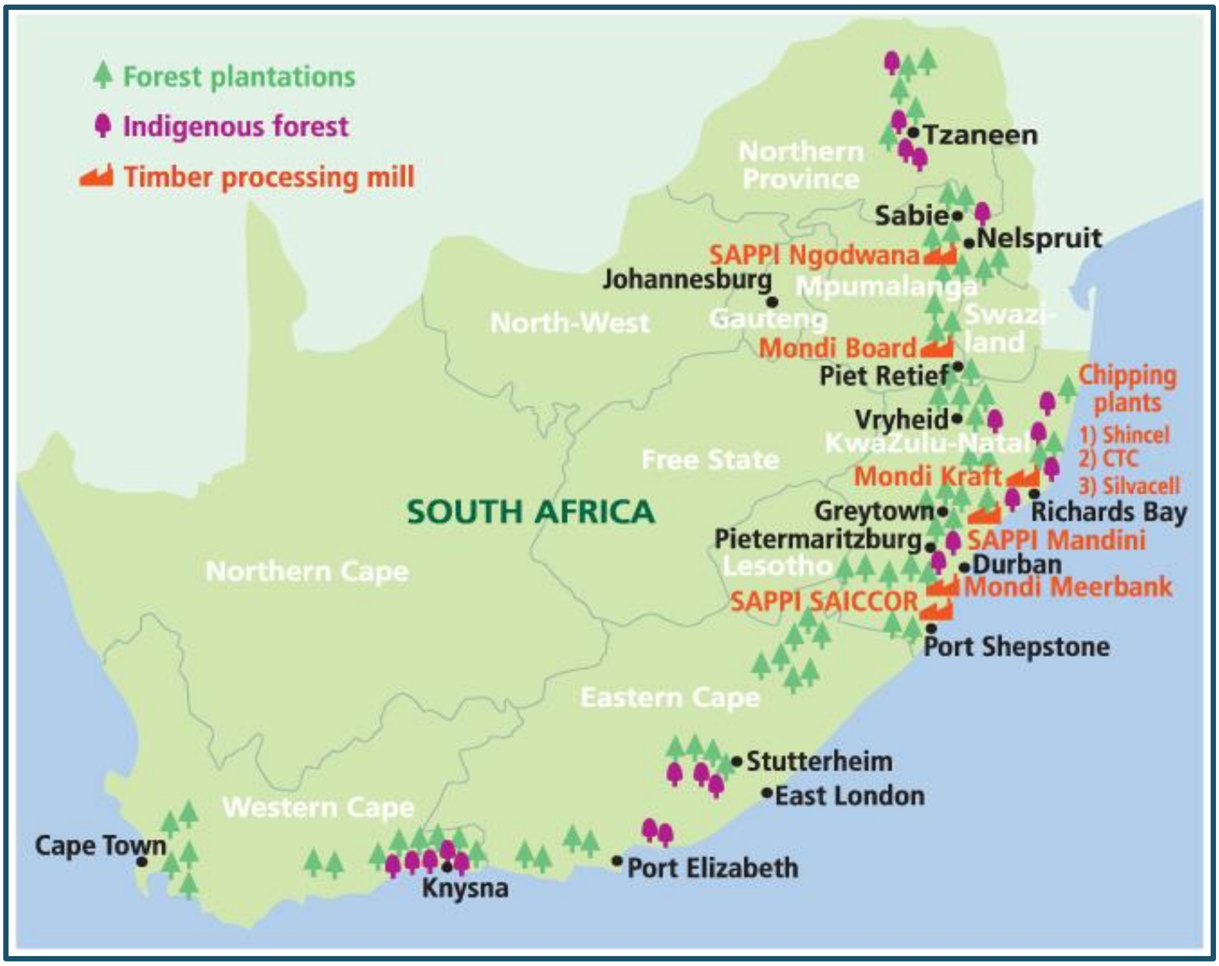
According to Department of Agriculture, Land Reform and Rural Development (DALRRD) (previously DAFF), there were approximately 300 primary processing plants operating as saw, pulp and board mills; their operational intakes range from small-scale mills with an annual intake of less than 5 000 m^3 to those in excess of 200 000 m^3 per annum (Who Owns Whom 2018a). However, according to Forestry South Africa (FSA) (2019), in 2018, there were a total of 139 processing plants comprising 73 sawmills, 29 pole treating plants, 16 pulp, paper and board mills, 15 mining timber plants, four charcoal plants, one veneer mill, and one match factory. The location of some of these processing plants is shown in Figure 6.

Table 3: Number of processing plants by type of plant and intake in 2018

	ANNUAL ROUNDWOOD INTAKE (IN M³)					
	0-20 000	20 000-50 000	50 000-100 000	100 000-200 000	200 000 +	Total
Type of plant	Number of plants					
Sawmills	32	13	11	12	5	73
Veneer Mills	1	0	0	0	0	1
Pulp, Paper and Board Mills	5	0	2	4	5	16
Mining Timber Mills	7	5	3	0	0	15
Pole Treating Plants	23	5	1	0	0	29
Match Factories	0	1	0	0	0	1
Charcoal Plants	2	2	0	0	0	4
Total	70	26	17	16	10	139

Source: FSA (2019)

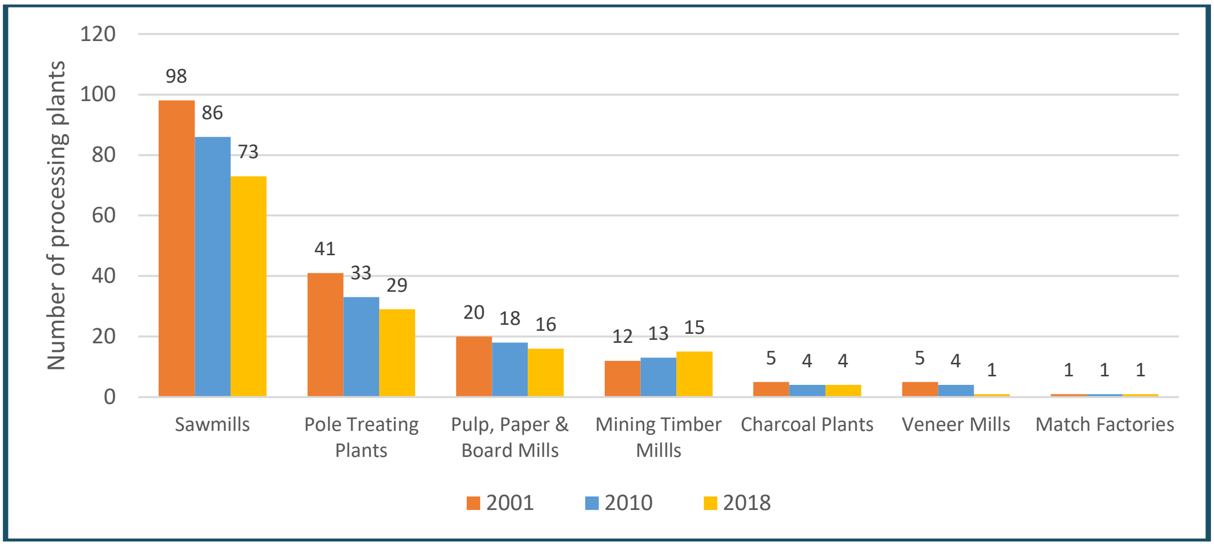
Figure 6: Geographic location of plantations, indigenous forests and large timber mills



Source: Who Owns Whom (2018a: 5); SAFIRI (n.d.)

The number of processing plants has declined. In 2001, there were 182 processing plants, which went down to 159 plants in 2010, and then down to 139 plants in 2018. The number of almost all types of processing plants went down from 2001 to 2018, with the exception of mining timber mills which increased from 12 in 2001 to 13 in 2010, then 15 in 2018 (Figure 7). There has been one match factory since 2001 and this had not changed in 2018. It is noteworthy to point out that this picture of declining processing plants in South Africa mirrors the global trend. In the European Union, there has been a steady decrease in the number of companies; since 2000, the number of pulp mills has been reduced by 32%, while the paper and paperboard mills have fallen by 30% (Roth et al. 2016).

Figure 7: Number of processing plants by type of plant in 2001, 2010 and 2018



Source: FSA (2020; 2013; 2002)

Besides the big companies, there are various smaller logging and sawmilling enterprises; a few large packaging companies; a number of small tissue factories supplying the major retail chains; and a number of relatively small, specialised companies producing moulded egg cartons, wooden window and door frames, and laminated board. Who Owns Whom (2018a) noted that South Africa has four small-scale manufacturers which produce biotech fuel pellets from biomass, mostly meant for the export market, such as Europe.

Tapping into niche products is very important in the pulp and paper sector. In this regard, Sappi is the world's largest manufacturer of dissolving wood pulp (DWP), with a total global DWP capacity of over 1.3 million tonnes per annum from its three mills, one in the United States (Cloquet Mill), and two in South Africa (Saiccor Mill and Ngodwana Mill) (Clarke 2018; Sappi 2017). DWP is a highly purified form of cellulose extracted from wood through specialised cellulose chemistry; it is a primary input into the manufacture of viscose staple fibre, which is a natural substitute for cotton and polyester in the textile industry (Sappi 2017). DWP is used to produce diverse products, with applications in food and beverages, health and hygiene, wrapping and packaging, and pharmaceuticals. Hence, it is regarded as a green alternative to petrochemicals in the manufacture of various products (Clarke 2018). The demand for DWP has been growing as a sustainable raw material.

In addition, Sappi has been putting efforts into expanding its product range. For instance, in 2016, a new business unit, Sappi Biotech, was established, with the aim to produce more renewable products with a low-carbon footprint. Such products include nanocellulose, a new material platform for sustainable production of a wide range of high-performance products. The global market for nanocellulose is expected to exceed more than US$700 million by 2023 (Sappi 2017). Related to this, Mondi has a green range of uncoated fine paper products, produced from wood derived from sustainably managed forests certified by the Forest Stewardship Council (FSC) or Programme for Endorsement of Forest Certification (PEFC), or derived from 100% recycled paper, or are produced totally chlorine free (Mondi 2018). Mondi has also been promoting the transition towards more sustainable packaging solutions, particularly in the fast-moving consumer goods sector through its EcoSolutions, centred on using paper when possible, and plastic only when useful.

2.3 Furniture and other wood products

The furniture industry plays an important role in the South African economy. In 2017, South Africa was Africa's second-largest furniture exporter, after Egypt (Who Owns Whom 2018b). The furniture manufacturing industry has about 2200 registered companies (Who Owns Whom 2018a; SAFI 2018). They produce a variety of furniture, which include office furniture, household furniture, beds and mattresses, hospitality furniture, cinema seating, outdoor furniture, and case goods (e.g. coffee tables and entertainment centres) (Who Owns Whom 2018b).

The sector contributes positively to employment because it is labour-intensive and has active participation of small and medium enterprises. The industry collectively employs about 26 400 factory workers; it contributes about 1.1% to manufacturing employment; and about 1% to the manufacturing gross domestic product (GDP) (Who Owns Whom 2018a). Furniture manufacturers are mostly located in the Gauteng, Western Cape and KwaZulu-Natal provinces; each region's furniture manufacturing industry is shaped by the resources and infrastructure found in the area, for instance most hardwood furniture manufacturers are close to the hardwood forests of the Southern Cape region (Who Owns Whom 2018b).

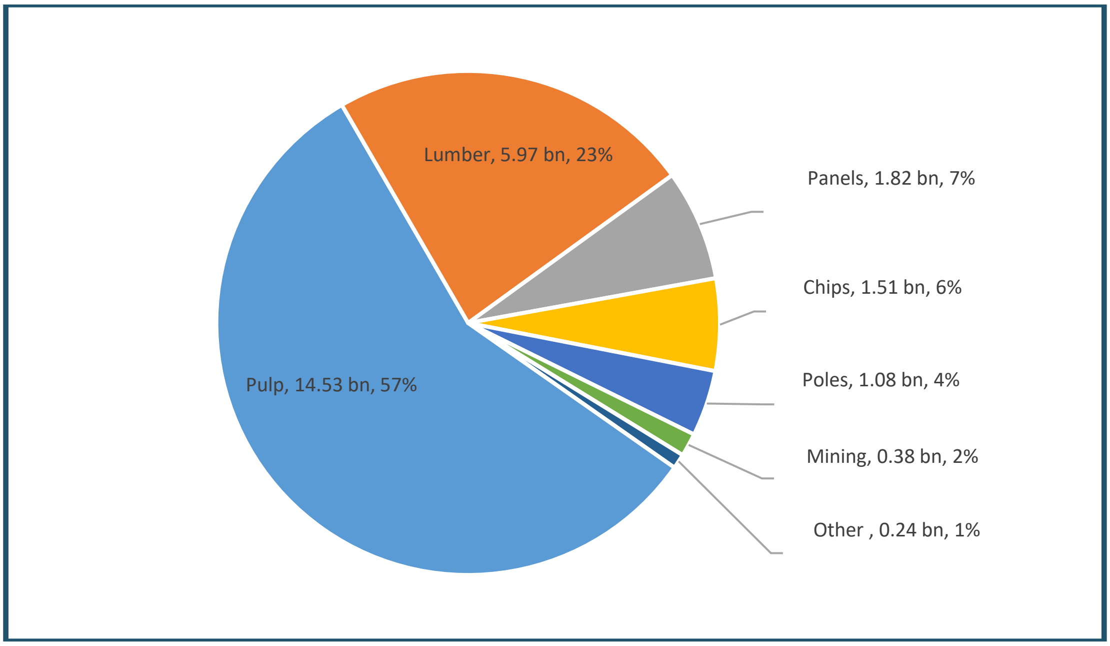
The furniture industry is the largest user of timber boards. Production in the sector tends to be cyclical, higher production occurs in the second half of the year, and it reaches a peak in the last quarter of the year (Macaskill 2019). However, local furniture manufacturing has been negatively affected by a shortage of higher-skilled workers, rising production costs, and poor domestic demand (Who Owns Whom 2018b; SAFI 2018). Increasingly, the local furniture manufacturing sector has been facing stiff competition from imports. Imported furniture, especially from Asia, is often cheaper than locally manufactured, thus many retailers prefer to import (Who Owns Whom 2018b). Local manufacturers are losing their cost competitive advantage, leading to a general contraction of the local furniture retail market; the formal retail market is being replaced by informal traders (SAFI 2019).

Wood is also used in a number of downstream industries. It is notably an important material in the construction of buildings. This is especially so with the rise in demand for green buildings and the need for a lower-carbon and energy footprint, which is driving the demand for wood construction and the production of engineered wood, structural wood products, wood boards and panels, and timber framing (Who Owns Whom 2018a; Macaskill 2019). However, the main constraint to wider adoption of timber construction in the country are negative perceptions driven by misinformation (Clarke 2018).

2.4 Contribution to manufacturing and trade

The forestry value chain provides significant economic benefits in the country. While the total forestry sector contributes between 1% and 2% to the total GDP of the country, it contributes between 10% and 12% to manufacturing GDP (Ledger 2017). In 2016, the combined forestry and forestry products sector (excluding paper and packaging) was valued at approximately R34.5 billion (Who Owns Whom 2018a). On the one hand, the sales value of roundwood production was R9 billion, broken down as pulpwood (R6.47 billion), sawlogs (R2.03 billion), poles (R0.23 billion), mining timber (R0.20 billion) and other (R0.06 billion). On the other hand, the sales value of products from primary processing plants amounted to R25.5 billion, broken down as shown in Figure 8. The biggest amount was in pulp (R14.53 billion), followed by lumber (R5.97 billion).

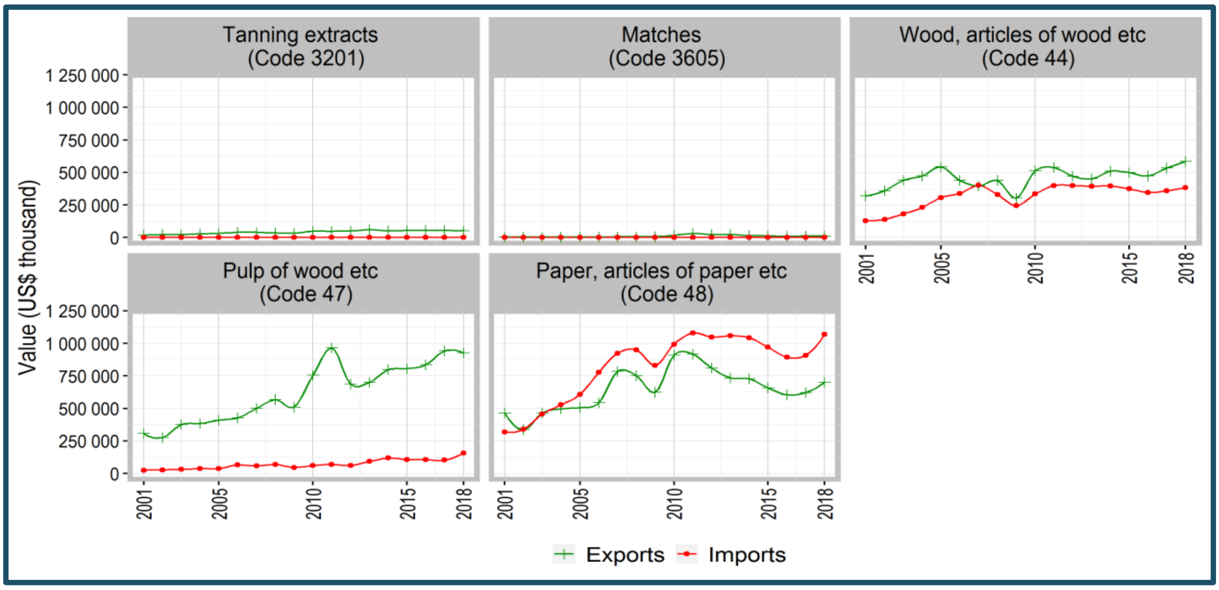
Figure 8: The breakdown value of sales of products from primary processing plants in 2016



Source: Who Owns Whom (2018a: 8)

The imports and exports of various products in the value chain are presented in Figure 9. Over the years, there has been clear positive balance of trade for wood, and pulp, while paper has a negative balance of trade. Overall, the entire forestry sector has a positive balance of trade. Most exports are to other parts of Africa (TIPS 2017a; DAFF 2016). The share of value added by printing and publishing in manufacturing as a whole was generally stable at around 3% over the past 20 years (TIPS 2017a).

Figure 9: Trends in imports and exports for products in the forestry value chain



Source: Author based on ITC (2019)

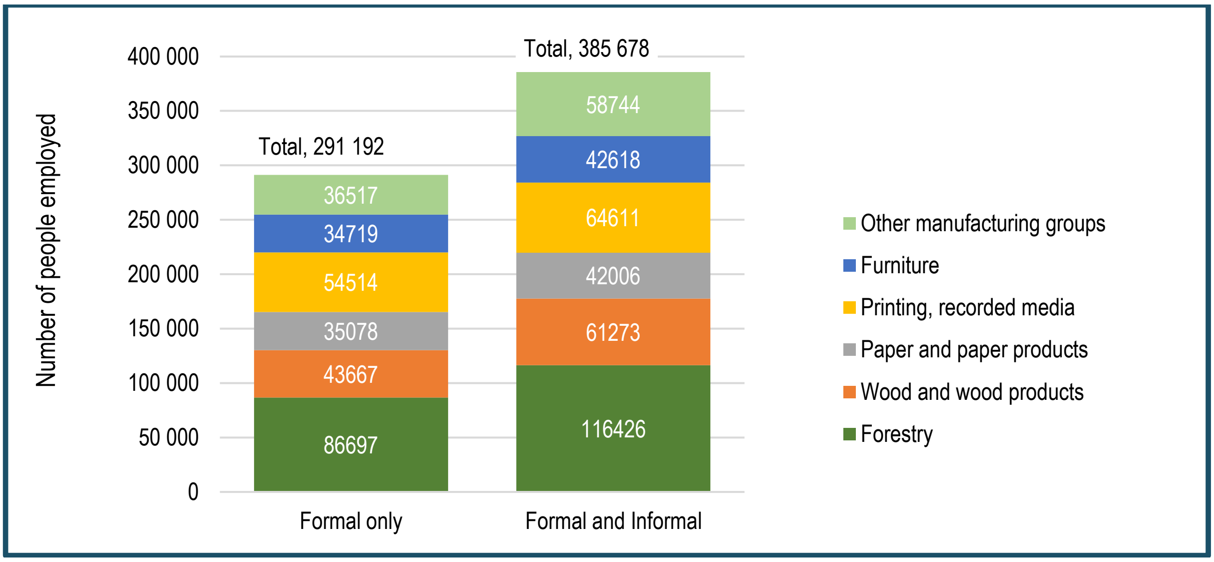
In general, South Africa tends to export relatively unbeneficiated products, while importing more value-added ones (TIPS 2017b). South African products, whether for export or local consumption, tend to be less competitive, against foreign imports, particularly from competitors which benefit from direct and indirect subsidies (Who Owns Whom 2018a).

2.5 Contribution through employment

The forestry value chain is an important driver in boosting local economies, particularly through providing employment opportunities (FP&M SETA 2014; Ledger 2017; DAFF 2016). The forestry resource base tends to be concentrated in some of the poorest areas in the country, thus it plays an important role in reducing poverty through job creation, economic growth, supply of basic needs and acting as a safety net (DAFF 2012). Even though important, the plantation forestry industry in the country has not sufficiently transformed; and the work it provides tends to be unskilled and semi-skilled (Robertson 2018).

Figure 10 shows that in terms of formal employment, the value chain had 291 192 employees in 2018 which is about 1.8% of total employment in the country. When considering both formal and informal employment, the contribution is much more, it contributes 382 678 employees which is about 2.4% of total employment.

Figure 10: Employment in the forestry value chain in 2018

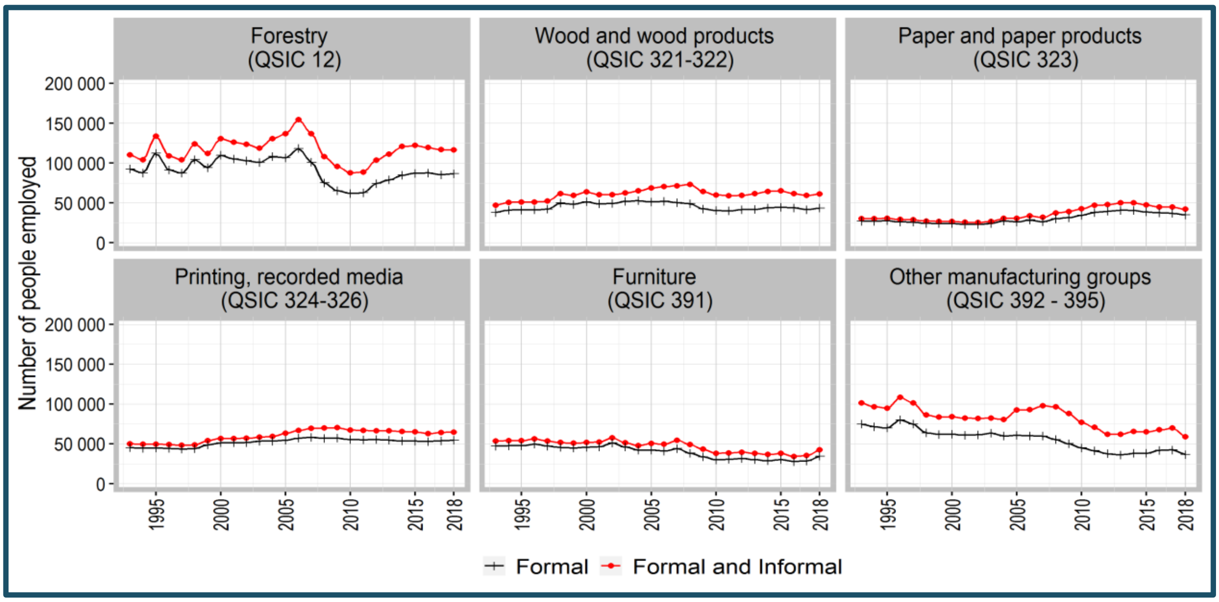


Source: Author based on Quantec (2019)

Employment trends in the forestry value chain (Figure 9) show that, besides some fluctuations over the years, the contribution to employment has generally remained important to the country. However, with corporates owning the majority of plantation land, the majority of them are in the process of mechanising forestry operations and outsourcing labour, which is leading to a substantial reduction in jobs (Clarke 2018).

At a provincial level, more than 90% of employment in printing and publishing is in Gauteng, the Western Cape and KwaZulu-Natal (TIPS 2017a). This is also the case with wood and paper manufacturing, whereby three quarters of employees, like the rest of manufacturing, are in Gauteng, KwaZulu-Natal and Western Cape (TIPS 2017b). However, for forestry and logging, 40% of employees are in KwaZulu-Natal, while 35% are in Limpopo and Mpumalanga.

Figure 9: Trends in formal and informal employment in the forestry value chain



Source: Author based on Quantec (2019)

Some of the largest employers in the sector are shown in Table 4 (many other key players are presented in Table 24 in the Appendix). The industry has two dominant, vertically integrated paper producing companies, namely Sappi and Mondi (Who Owns Whom 2018a; TIPS 2017b).

Another key player is SAFCOL, which is a state-owned forestry company that operates through its main subsidiary, Komatiland Forests, in Mpumalanga, Limpopo and KwaZulu-Natal, and has a Mozambican subsidiary IFLOMA (Who Owns Whom 2018a). The tendency towards full integration has implications for competition and pricing mechanisms in the industry.

Table 4: Largest employers in the forestry sector

PRODUCER	CORE BUSINESS	PLANTATION LOCATION(S)
Sappi Forests	Sappi Forests supplies more than 70% of the wood requirements of Sappi Southern Africa, from its own and managed commercial timber plantations of 561 000 hectares. This equates to more than 35 million tons of standing timber. All Sappi plantations are certified by the FSC.	KwaZulu-Natal, Mpumalanga
Mondi South Africa	Owns and manages more than 307 000 hectares of forestry plantations. The company employs more than 1 600 people; and has a contractor base of around 15 000 people, most of whom are employed in the forestry sector. All Mondi South Africa plantations are certified by the FSC.	KwaZulu-Natal
Komatiland Forests	Komatiland Forests is a subsidiary of SAFCOL, whose sole shareholder is the government, represented by the Department of Public Enterprises. It operates 18 commercial plantations comprising a total surface area of 187 320 hectares. Its main business includes forestry, timber harvesting, timber processing and related activities.	Limpopo, Mpumalanga, KwaZulu-Natal

Source: Extracted from FP&M SETA (2014: 3)

2.6 Legislation and policies

The forestry industry is highly regulated, especially around the environmental impact of forestry activities (FP&M SETA 2014). Key legislation governing the sector are the National Forests Act No. 84 of 1998; National Forest and Fire Laws Amendment Act No. 12 of 2001; National Environmental Management Act No. 107 or 1998; and National Water Act No. 36 of 1998. Some of the licences and authorisations required for operation in the sector are presented in Box 1.

Box 1: Licences and authorisations required for activities along the forestry value chain

A number of licences and authorisations are required for various activities along the forestry value chain particularly paper and pulp production (Centre for Environmental Rights, 2019). These include the National Forests Act licence that is required for activities such as the establishment and management of a plantation; the felling of trees and removal of timber; the cutting, disturbance, damage or destruction of any other forest produce; and the removal or receipt of any other forest produce.

The Atmospheric Emission Licence is applicable for activities that result in atmospheric emissions which have, or may have, a significant detrimental effect on the environment. This applies to pulp and paper manufacturing activities such as the recovery of lime from the causticizing process; the recovery of chemicals from the thermal treatment of spent liquor using furnaces as well as using Copeland reactors; the production and use of chlorine dioxide for paper production; the burning or drying of wood by an external source of heat; and the manufacture of laminated and compressed wood products. The Atmospheric Emission Licence also applies to solid biomass fuel combustion installations used primarily for steam raising or electricity generation.

The Water Use Licence based on the National Water Act applies to a number of activities such as drawing water from a water resource; storing water; impeding or diverting the flow of water in a watercourse; engaging in a stream flow reduction activity; altering the bed, banks, course or characteristics of a watercourse; discharging waste or water containing waste into a water resource; and disposing waste in a way that may detrimentally impact on a water resource.

Environmental authorisation is required for a number of activities depending on the extent of operations. The activities include the development of facilities or infrastructure for the generation of electricity from renewable and non-renewable resources; and the development and related operation of infrastructure for the bulk transportation of water, storm water, sewage, effluent, process water, wastewater, return water, industrial discharge or slimes. This applies to the development of facilities or infrastructure for the off-stream storage of water, or storage and handling, of a dangerous good. It also to the physical alteration of virgin soil or clearance of indigenous vegetation for the purposes of commercial tree, timber or wood production.

A Waste Management Licence may be required for the sorting, shredding, grinding, crushing, screening or bailing, recycling, recovery, refining, utilisation, or co-processing of waste at a facility. Other activities may also require heritage approval from the heritage resources authority in the applicable area.

Source: Centre for Environmental Rights (2019)

3 IDENTIFYING THE PROBLEMS FROM A CLIMATE-COMPATIBILITY PERSPECTIVE

Identifying the problems and framing the solutions for climate compatibility requires an in-depth assessment of how the various stages of the value chain impact or are impacted by climate change. A step-by-step guide on implementing a value chain approach in enhancing climate compatibility is presented in the Appendix (Box 3, based on WEF (2016, 14-15)). However, this paper concentrates more on the first step and focuses on identifying the challenges and exploring ways to address the challenges

The main mechanisms through which climate change manifests are changes in temperature and rainfall. Most importantly in relation to forestry, the interaction between the two affects water availability, whose extremes include droughts, floods and storms. With climate change, the frequency and occurrence of such extremes intensifies. Therefore, looking from a climate-compatibility perspective, the discussion focuses mostly, on the one hand, on how the forestry value chain contributes to climate change through greenhouse gas (GHG) emissions. On the other hand, the discussion explores the relationship between the forestry value chain and how it impacts/contributes/worsens challenges associated with climate change, particularly with a focus on water. The discussion further expands on the vulnerability of the sector to the impacts of climate change, and the need to adapt.

3.1 High water consumption

Water usage and demand in the forestry value chain has been a topical issue for some time. For South Africa, this is extremely important as the country is water scarce, while timber plantations are water thirsty (Robertson 2018). Availability of surface water has two main important effects on the sector. First, surface water in the soil is required to sustain forestry operations. This surface water needs sufficient rainfall in excess of 500 mm per annum. Second, pulp and paper mills require sufficient water to operate (Macdonald 2004). As such, the three key areas in the forestry value chain that require significant amounts of water are plantation forests, pulp and papermaking, and paper recycling (PAMSA 2016).

The water that is consumed at the early stage of the value chain, particularly plantation forests, is quite significant. Forest plantations significantly affect water resources in the country (Scott and Gush 2017). As noted, the industry relies mostly on exotic species, which consume a lot of water. Unfortunately, plantation forestry in the country is witnessing a general shift from longer rotation pine to shorter rotation eucalyptus. While the advantage is that eucalyptus grows about twice as fast and produces double the yield per hectare than pine, the negative side is that eucalyptus is more water thirsty, is hostile to other plant species, and provides a less suitable form of substitute habitat than pine (Robertson 2018).

The water challenge in the sector is further worsened by the fact that, over the years, some of these exotic trees have dispersed to other areas where they are now established as invasive alien plants (IAP). The IAPs quickly spread along wetlands and water courses, which alters and compromises freshwater ecosystems (FSA 2017b).

While water usage in the forestry value chain is contentious, those active in the value chain argue that the amount of water consumed is not very high compared to other uses. PAMSA (2016) notes that forestry is one of the most efficient and beneficial water users in the country, in terms of the costs versus the social, and economic and environmental returns it delivers. It consumes 3% of available water in the country. This amounts to 5% of the water used by agriculture, which consumes 62% of the available water in the country. Sappi (2020) adds that the water use in forestry compares favourably with other forms of land use, particularly when considering that forestry uses land that has few other economic options for use. Sappi (2017) asserts that its forestry plantations are not irrigated. Table 5 shows that, compared to other agricultural plant species, a forestry tree species (SA Eucalyptus) absorbs more carbon dioxide (CO_2) per unit of water consumed.

Table 5: Comparison of water consumption and the CO_2 sequestrated between forestry species and other agricultural crops

SPECIES: RAIN/IRRIGATION FED	TONNES OF WATER REQUIRED FORGROWTH PER TONNE OF CO_2 ABSORBED	TONNES OF CO_2 ABSORBED PER HA PER ANNUM
SA Eucalyptus fibre	274	26.9
Cotton fibre	4 866	2.5
Wheat grains	4 776	5.1
Sugar cane molasses	3 152	2.2

Source: PAMSA (2016: 18)

Water legislation has been amended to take cognisance of the negative effect of forestry plantations on water resources. In the National Water Act No. 36 of 1998, forestry is classified as a "streamflow reduction activity", due to its estimated effects on streamflow, which necessitates that it be licensed (Scott and Gush 2017). In addition, forestry is deemed as a water diversion land use activity, and as such permits are required to utilise water as well as expand the area under plantation (FP&M SETA 2014).

The process of obtaining a water permit is, however, onerous, time-consuming and an administrative burden, which has the unintended consequence of excluding small and medium enterprises. One consequence is that the water availability limitations and the cumbersome process to get licences are serious constraints to plantation expansion (Ledger 2017; Naidoo et al. 2013; Robertson 2018). With projections that climate change will further strain limited water supplies and freshwater ecosystems (FSA 2017b), the water challenges in the sector are set to worsen.

As mentioned, water is also a key input in pulp and paper production processes. These operations are highly dependent on the availability and responsible management of water resources (Sappi 2020; Macdonald 2004). Water is needed for all major process stages, such as raw materials preparation, pulp cooking, washing and screening, pulp slurry dilution, process cooling, materials transport, equipment cleaning, general facilities operations, and steam generation (Sappi 2020). Water consumption is highly dependent on the type of operations that are undertaken. For example, pulp production has a higher specific water requirement than paper production. To illustrate, Sappi (2020) highlighted that water use in its mills in Europe is lower than that of mills in North America and South Africa, as the mills in Europe have a lower share of pulp production compared to those in North America and South Africa.

Historically, the pulp and paper industry had a very high specific water intake (SWI) (ton water/ton product), but this has been improving over the years (Table 6). To illustrate, water usage as high as 156 m^3/t was reported in 1975 in Canada (Macdonald 2004; Van der Merwe-Botha et al. 2017).

Table 6: Change in water use of a recycled fibre mill in Canada

YEAR	PAPER PRODUCTION (T/D)	WATER USE (M^3/D)	SPECIFIC WATER USE (M^3/T)
1950s	100	10 000	100
1960s	150	7 500	50
1970s	400	10 000	25
1980s	500	2 500	5
1990s	1 000	3 000	3
2003	1 200	2 400	2

Source: Macdonald (2004: 1) citing Webb (2003)

The NATSURV survey (Van der Merwe-Botha et al. 2017) assessed water and wastewater management in the pulp and paper industry in South Africa in 2015. The study found that the SWI for the pulp and paper mills varied between 11.9 and 76.1 m^3/t, while for paper mills varied between 3.5 and 38.8 m^3/t (Table 7). Over the years, there has been a marked improvement in water efficiency. Comparing the 1990 versus the 2015 NATSURV survey, shows that average SWI decreased from 40.0 m^3/t to 25.2 m^3/t, with the maximum SWI having decreased from 136 m^3/t to 76.1.

Table 7: Comparison of water and effluent management practises in 1990 and 2015based on NATSURV survey results

	1990 SURVEY RESULTS			2015 SURVEY RESULTS		
Parameter	N	Range	Average of N Companies	N	Range	Average of N Companies
Specific Water Intake (m^3/t)	11	0.8-136	40.0	21	3.5-76.1	25.2
Pulp and paper SWI (m^3/t)				8	11.9-76.1	40.8
Paper SWI (m^3/t)				13	3.5-38.8	15.6
Specific effluent volume (m^3/t)	11	0.3-103	28.6	21	0.08-84.5	22.8
Pulp and paper SEV (m^3/t)				8	10.5-84.5	37.4
Paper SEV (m^3/t)				13	0.08-38.2	12.2

Source: Van der Merwe-Botha et al. (2017: iv). Note: N = Number of companies contributing data.

3.2 GHG emissions along the value chain

The forestry value chain is very important in the GHG emissions debate. The value chain's carbon profile comprises of emissions, sequestration and avoided emissions. Plantations are regarded as high impact carbon sinks (PAMSA 2016). The Paris Agreement (UN 2015) recognises the importance of forests in responding to climate change, encouraging all countries to conserve and enhance reservoirs and sinks of carbon in forests.

About 20% of global GHG emissions result from deforestation and forest degradation (Naidoo et al.2013). Table 8 presents the processes and examples of GHG emissions that occur during dimensional lumber manufacturing and paper manufacturing.

Table 8: Processes and emissions in dimensional lumber manufacturing and paper manufacturing

	PROCESS	DESCRIPTION	EMISSIONS
Dimensional lumber manufacturing	Sawing	Log storage and breakdown of raw logs into rough green lumber.	Dust, Volatile Organic Compounds (VOC), Acetaldehyde, Formaldehyde and methanol can be emitted into the air. Solid emissions (e.g. sawdust, bark, chips, and rough green lumber) can be burned for energy production or other industrial processes.
	Drying	The removal of water and moist content.	Common emissions include organic lubricants, solid particles, dust, and VOCs. Emissions of inorganic compounds are not considered highly toxic or hazardous due to their volume.
	Planning	The removal of excess wood to produce lumber of pre-determined dimensions.	Coarse dust, VOCs, wood shavings and chips.
Paper manufacturing	Fibre production	Separates fibres from other compounds through mechanical and chemical processes.	Mostly water-borne emissions including sulphur compounds, Biochemical Oxygen Demand (BOD), suspended solids, Chemical Oxygen Demand (COD), Absorbable Organic Halogens (AOX), and VOCs. Most input chemicals (e.g. sulphur and sodium compounds) can be recovered for reuse.
	Bleaching	Eliminates remaining compounds from the pulp, increases brightness and increases absorbency.	Potential pollutants released to the air and water include chlorinated organic and inorganic compounds, AOX, and VOCs.
	Papermaking	Produces a continuous and uniform thread of paper.	Chemicals are used to create special properties (gloss, colour, water resistance). Emissions include particulate waste, organic and inorganic compounds, COD, and acetone.
	Recycling	Involves two major steps: re-pulping and de-inking.	Mostly water-based, including printing inks, adhesive components, fats, resins and AOX.

Source: Extracted from WBCSD and WRI (2011: 2.71-2.72)

Emissions of GHGs in the pulp and paper industry come mostly from the combustion of on-site fuels and non-energy related emission sources (e.g. by-product emissions from the lime kiln chemical reactions and emissions from wastewater treatment), while off-site generation of steam and electricity contribute to the indirect emissions of the pulp and paper sector (Roth et al. 2016). Based on the available data at the global level[2] (Table 8), the GHG emissions associated with the value chain are mainly offset by the sequestration in forests and forest products (Miner and Perez-Garcia 2007).

Table 8: Estimates of the greenhouse gas and carbon profile of the global forest products industry

TYPE OF EMISSIONS	ACTIVITY/ SOURCE	MILLIONS TONNES CO_2 EQUIVALENTS PER YEAR
Direct emissions	Fuel consumption at pulp and paper mills	205
	Fuel consumption at wood products facilities	25
	Management of mill wastes	20
	Secondary manufacturing operations (i.e. converting primary products into final products)	12
	Total direct emissions	*262*
Indirect emissions	Electricity purchases by pulp and paper mills	140
	Electricity purchases by wood products facilities	40
	Electricity purchases by secondary manufacturing operations (i.e. converting primary products into final products)	13
	Harvest and transport emissions from the pulp and paper value chain	40
	Harvest and transport from the wood products value chain	30
	Methane emissions from forest products decomposition in anaerobic municipal solid waste landfills	250
	Total indirect emissions	*513*
Sequestration	Sequestration in sustainably managed forests	-60
	Sequestration resulting from establishment of new managed forests	0
	Sequestration in products in use	-200
	Sequestration in products in landfills	-340
	Total sequestration	*-600*
Avoided emissions	Avoided direct emissions associated with the use of biomass fuels	-175
	Avoided indirect emissions related to the use of combined heat and power systems	-95
	Avoided indirect emissions associated with recycling paper	-150

Source: Miner and Perez-Garcia (2007: 87)

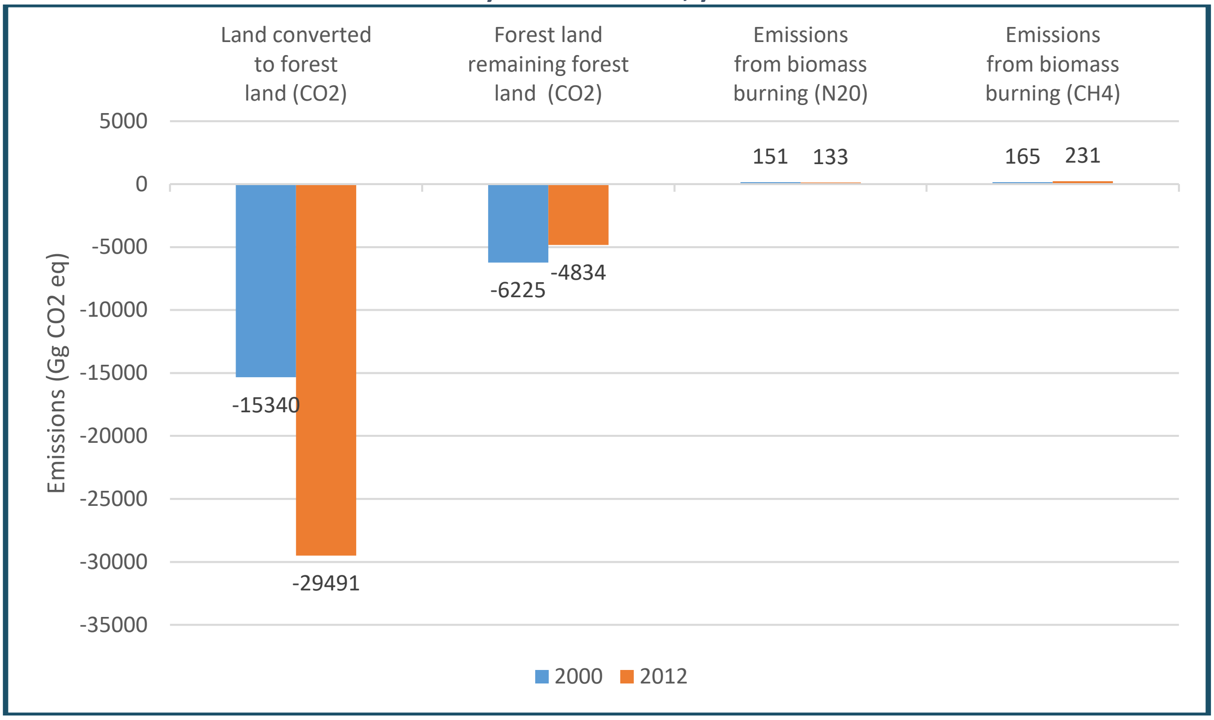
For South Africa, the disaggregated data on emissions along the forestry value chain is not easily available. However, the GHG National Inventory Report for South Africa (DEA 2017) shows some emissions data for some components of the value chain (Figure 10). In 2000, the carbon sequestrated by land converted to forest land was 15 million tonnes[3] (CO_2 eq), while, in 2012, it was about 29.5 million tonnes (CO_2 eq). The carbon sequestrated by forest land remaining forest land was six million tonnes (CO_2 eq) in 2000, while, in 2012, it was about 4.8 million tonnes (CO_2 eq).

Because of data limitations, the net GHG emissions could not be established in this report. However, PAMSA (2015) noted that the country's 1.3 million hectares of commercial timber plantations

[2] The author could not get disaggregated data on GHG emissions along the forestry value chain for South Africa.
[3] 1 gigagram (Gg) is equivalent to 1 000 kilotonnes or one million tonnes

sequester about 20 million tonnes of CO_2 and GHGs annually, making a considerable positive impact on country's net carbon emissions profile.

Figure 10: Comparison of GHG emissions from land use and biomass burning related to forestry in South Africa, years 2000 and 2012



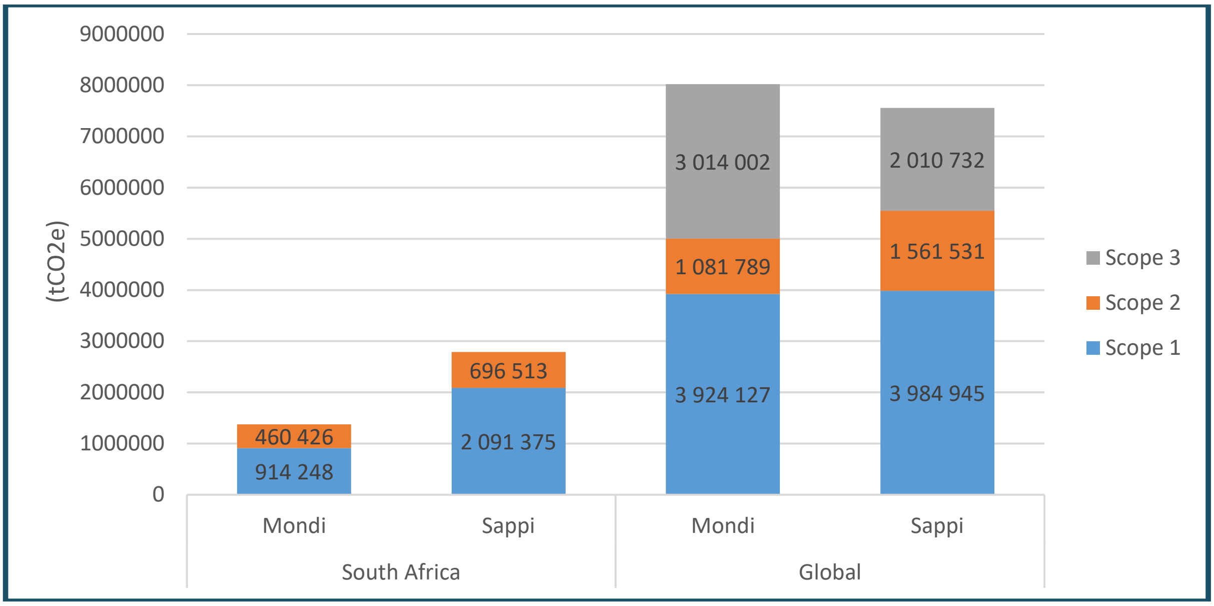
Source: Author based on data extracted from DEA (2017: 294-298)

GHG emissions[4] data (Figure 13) shows that in 2018, Mondi had Scope 1 emissions in South Africa that amounted to 914 246 tCO2e, while Scope 2 were 460 426 tCO2e, giving a total of 1 374 674 tCO2e. Sappi had Scope 1 emissions in South Africa that amounted to 2 091 375 tCO2e, while Scope 2 were 696 513 tCO2e, giving a total of 2 787 888 tCO2e.

Sappi's emissions in the country were double that of Mondi, however at the global level, Mondi had higher total emissions at 8 019 918 tCO2e, while Sappi had a total of 7 557 208 tCO2e.

[4] Scope 1 emissions – direct emissions from the industry's own activities.
Scope 2 emissions – indirect emissions resulting from the purchase of electricity, heat or steam by the industry.
Scope 3 emissions – other indirect emissions resulting from activities across the industry's associated upstream and downstream activities (WEF 2016: 8).

Figure 11: GHG emissions for Mondi and Sappi in 2018



Source: CDP (2019: 7)

The Paper Manufacturers Association of South Africa (PAMSA) is already working on responding to climate change. In its Industry Progress Report (PAMSA 2016), it outlines some priority actions for climate change for the South African pulp and paper industry. This includes driving bio-energy leadership as well as engaging government on the carbon positives of plantation forests, so as to help decision-makers understand that protecting and expanding plantation forestry has benefits, particularly where the expansion does not threaten food security. PAMSA regards the inclusion of carbon sequestration and afforestation as an offset in the Carbon Tax Act No. 15 of 2019 to be an important step towards recognising the important role that forests play in mitigating climate change (PAMSA 2016; 2020). The recognition can enable the industry to get a rebate on carbon tax liability (Who Owns Whom 2018a).

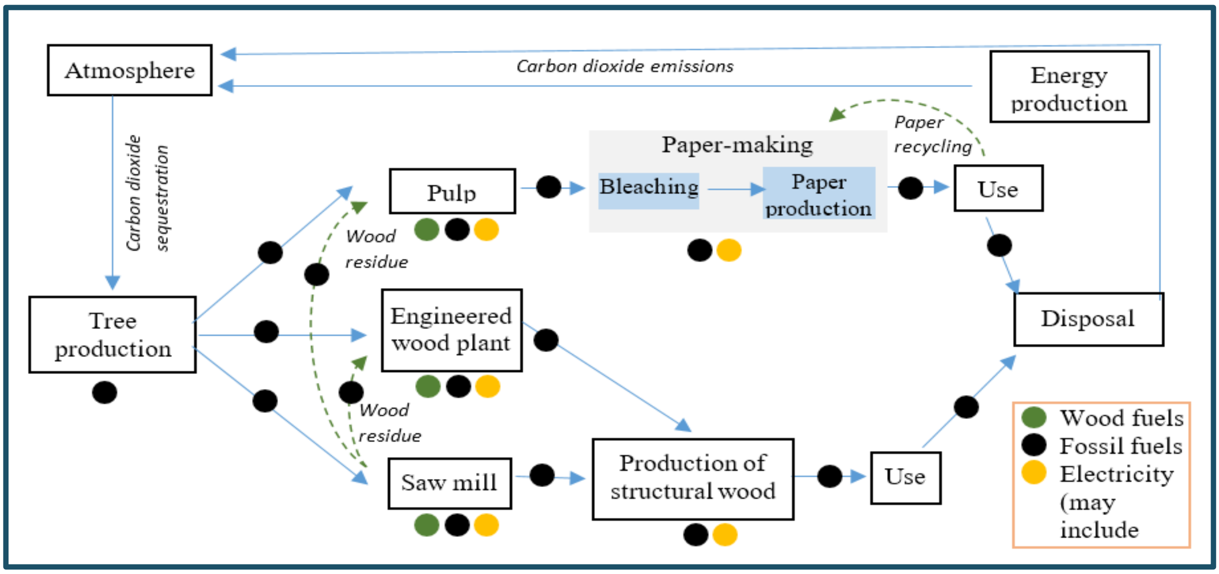
There has been notable improvements and efforts to reduce the GHG emissions in the sector. However, with the transformation and evolution of the sector, there has been some unintended consequences for GHG emissions and sequestration. For instance, Robertson (2018) observed that general transition towards shorter rotation plantation trees implies that less carbon is being captured. Furthermore, the extensive use of fossil fuels, or electricity generated from unsustainable sources, at the primary stages of the value chain tends to counter the positive environmental benefit of carbon sequestration provided by forests (Robertson 2018).

3.3 High energy demand and fossil fuel usage

Energy use along the forestry value chain varies across different stages. Non-renewable energy such as fossil fuels (petrol, diesel, gas, oil and coal), electricity, and renewable fuels are being used to power processes along the value chain (PAMSA 2016), as shown in Figure 12.

At the primary stages of the value chain, such as timber growing, harvesting and transportation, there is notable use of fossil fuels. With movement along the chain, a combination of fuels is used, including renewable biomass-derived fuel. Towards the end of the chain, mostly electricity and fossil fuels are used for transporting goods.

Figure 12: Examples of emissions and energy used in manufacturing processes along the forestry value chain



Source: Adapted from WBCSD and WRI (2011: 2.71). Note: Dots representing energy indicate type and do not quantify amount or proportion of energy inputs.

Due to data limitations, it is difficult to gain a more detailed and disaggregated understanding of how the forestry value chain has performed in the country over the years. Only aggregate figures are available. In 2015, energy use in the pulp and paper industry was split between 51% electricity and 49% gas, amounting to 10 174 terajoules in total,[5] reflecting the industry's shift from complete reliance on electricity for production (DoE 2018).

3.4 High waste disposal

One of the biggest challenges across all value chains is that of waste. If the waste is not properly managed, it can result in various forms of pollution. For example, there is a lot of waste at the early stages of the value chain. Timber recovery rates in the sector in the country are below 50%, whereas the international benchmark standard is 60% (Ledger 2017; Robertson 2018). There are a lot of inefficiencies in downstream processing at the sawmilling stage, where old and inefficient sawmilling equipment is still being used (Robertson 2018). The relatively low timber recovery rates imply that there is need to enhance efficiency in the processing of timber.

For the pulp and paper sector, there is notable amount of wastewater that needs to be managed properly to prevent extensive pollution. To put it into context, the specific effluent volume (SEV) generated by pulp and paper mills in 2015 varied between 10.5 and 84.5 m^3/t, while for paper mills it was between 0.08 and 38.2 m^3/t (see Table 7). Comparing the 1990 and 2015 NATSURV surveys shows that the average SEV decreased from 28.6 m^3/t to 22.8 m^3/t, with the maximum SEV having decreased from 103 m3/t to 84.5 m3/t (Van der Merwe-Botha et al. 2017). This shows that over the years there has been improvements in managing this waste.

A lot of waste is generated through the consumption and disposal of paper. As shown Table 2, a lot of paper is consumed in South Africa. This makes it imperative to consider ways to reduce the waste associated with improper disposal of wastepaper.

[5] This energy demand total excludes own generation from biomass, which is currently not reported.

4 ADDRESSING THE CHALLENGES – SOLUTIONS

Having identified the challenges, it is imperative to suggest potential solutions. Some of the suggested solutions are general because of the lack of detailed data on key variables, specific information and solutions could not be formulated. Some of the suggested solutions apply to the whole value chain while other are specific to certain components.

4.1 Mainstreaming climate change adaptation and mitigation in the forestry value chain

Opportunities for mainstreaming climate change adaptation and mitigation should be considered at all stages of the value chain, particularly early design stages and the in-use and end-of-life stages, as these are where decisions are made that define the emission pathways and footprints (WEF 2016). In terms of climate compatibility, the forestry value chain has benefits that include the absorption of carbon dioxide (CO_2) in trees, the storage of CO_2 in products, the substitution benefits of wood-based products compared to other fossil-based products, and the substitution benefits of renewable energy compared to climate-unfriendly energy sources (ICFPA 2013).

It is also important to consider the interlinkages and relationships between sectors. What happens in one sector can have feedback and consequences in another. For instance, adaptation actions taken outside the sectors relying on the forestry value chain, may have negative consequences, or generate disincentives to the value chain (Naidoo et al. 2013). Hence, the need for a holistic approach in framing strategies for the value chain.

With the demand for forest-derived products set to grow, sustainability and climate compatibility in particular will depend on the balance between the harvesting of forest resources and their regeneration. If more forests resources are cut faster than their regenerative capacity, this will contribute to climate change. In addition, this also negatively affects the balance of ecosystem services supplied by the forests (WBCSD and WRI 2011). PAMSA (2016) asserts that only 9% of the total plantation area in South Africa is harvested each year, which ensures that the carbon sequestration cycle is kept in balance. In this context, Robertson (2018) suggests that there should be ways to reward longer rotation over shorter rotation forestry plantations.

Mobilising for action and scaling up is an important step in ensuring climate compatibility. This implies that different stakeholders need to take action and implement strategies that will ensure ramped-up efforts towards climate compatibility. In this regard, there is some traction towards greening the different components of the value chain; however, this is still being done mostly by the big companies. For instance, Sappi (2017) noted a reduction of 5.4% in its GHG emissions intensity over five years, with Scope 1 (direct) emissions having reduced by 4.6%, while Scope 2 (indirect) emissions fell by 7.42%. Mondi (2018) also highlighted a reduction is its Scope 2 emissions from 0.69 million tonnes CO_2e in 2017 to 0.58 in 2018. Notable milestones are being reached in transitioning towards renewable energy (see Section 4.2).

In addition, these companies are also active in some international efforts to increase global momentum for climate compatibility. For instance, Mondi and Sappi are part of the 4evergreen alliance, an initiative of the Confederation of European Paper Industries (CEPI), that seeks to boost the use of fibre-based packaging to minimise climate and environmental impacts (Crane 2019). Mondi is also signatory to the New Plastics Economy Global Commitment – committing to 100% of plastic-based packaging being reusable, recyclable or compostable; and 25% being from recycled content (Mondi 2018). While these efforts are commendable, for wider transformation of the value chain even small players need to embrace and be part of these efforts towards ensuring climate compatibility in the sector.

Technological options to enhance mitigation fall into three categories, namely improving the carbon efficiency of the current machinery stock; production process changes; and adopting new low-carbon machinery (Roth et al. 2016). Some of the technological solutions are shown in Table 9.

Table 9: Available technologies for pulp and paper production processes

PROCESS	MITIGATION OPTIONS	REDUCTION POTENTIAL
Boiler	Burner replacement, Boiler process control, Reduction of excess air, Blow down steam recovery	12.5% Emissions
Chemical Recovery Furnaces	Black liquor solids concentration, Quaternary air injection, Improved composite tubes for recovery furnaces	30% Energy 20% Fuel
Turbines	Boiler/steam turbine combined heat and power (CHP), Combined cycle CHP, Steam injected gas turbines	14% Electricity
Natural-Gas Fired Dryers and Thermal Oxidizers	Selection of technologies requiring less fuel consumption, Proper design and attention to monitoring and maintenance	
Kraft and Soda Lime Kilns	Piping of stack gas to adjacent PCC plant, Lime kiln oxygen enrichment	7-12% Fuel
Makeup Chemicals	Practices to ensure good chemical recovery rates in the pulping and chemical recovery processes	40% Energy
Flue Gas Desulfurization Systems	Use of sorbents other than carbonates, Use of lower-emitting FGD systems	
Wastewater Treatment	Use of mechanical clarifiers or aerobic biological treatment systems (instead of anaerobic treatment systems), Minimization of potential for formation of anaerobic zones in wastewater treatment systems	
On-site Landfills	Dewatering and burning of wastewater treatment plant residuals in on-site boiler, Capture and control of landfill gas by burning it in onsite combustion device (e.g., boilers) for energy recovery and solid waste management	

Source: Roth et al. (2016: 21) based on CEPI (2011) and Ernest Orlando Lawrence Berkeley National Laboratory (2009)

Table 10: Socio-economic implications of mainstreaming climate change adaptation and mitigation in the forestry value chain

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Inclusion of climate risk into business planning and operations Adoption of climate-friendly (green) best available technologies and practices	Reduces vulnerability to climate change and ensures business resilience Reduces climate risks hence potential losses due to climate impacts Improves business competitiveness	The business might lack resources and technical knowhow of implementing climate change adaptation and mitigation measures Implementing anticipatory measures might be difficult to justify especially when there are competing needs
Government	Formulate and implement legislation that incentivise climate change adaptation and mitigation Roll-out awareness and capacity building programmes Support the associated research, development, and innovation programmes	Enhanced climate change adaptation contributes to overall resilience of the economy Proactive measures reduce the vulnerability of the value chain and preserves jobs and productivity Mitigation contributes to lower CO_2 emissions, which ultimately decreases the carbon footprint and enhance competitiveness of products	It is costly to implement support measures Businesses might not prioritise climate action
Workers	Understanding of the importance of climate change adaptation and mitigation	Job preservation due to business resilience	The benefits might not trickle down directly to the workers Some of the benefits accrue over a long time horizon, thus difficult to justify in the short-term
Households/ Communities	Cooperation and willingness to support climate change adaptation and mitigation programmes	The adaptation and mitigation measures might have spill-over benefits in the local community Contributes to overall resilience of the communities	The spill-over benefits might not materialise

Source: Author

4.2 Energy efficiency and renewable energy

The International Energy Agency (2019) observed that, between 2000 and 2017, energy use in the global paper and paperboard industry rose by less than 5% while its output increased by over 25%, which shows there has been some decoupling of energy use from production. Globally, the pulp and paper industry is energy intensive and it is the fourth largest industrial energy consumer; however, its reported carbon intensity is low because over half of the energy used (55%) comes from biomass and most of the rest from natural gas (38%) (Roth et al. 2016).

Van der Merwe-Botha et al. (2017) reported that total specific energy consumption for the South African pulp and paper industry ranged from 3.7 to 11.3 GJ/ADt[6] (this includes Eskom electricity, steam, renewable/recoverable energy, coal to steam and gas). They further note that the industry is performing at par or exceeding international standards.

Industry players in South Africa are pursuing electricity generation opportunities, for own consumption as well as for the main grid. The energy plants being implemented vary with power ratings that range from 500kW to 15MW, and use a variety of energy sources, such as wood, gas or combined heat and power (CHP) (Who Owns Whom 2018a). CHP plants are more energy efficient than conventional power plants, as they generate electricity as well as heat, which is used for drying the paper (Sappi 2018). According to PAMSA (2016), the pulp and paper industry generates at least 45% (up to 70% in some cases) of its own electricity and steam using bioenergy resources. Co-generation[7] is the industry's main method of generating electricity (PAMSA 2016; WBCSD and WRI 2011). Its advantages are that there is better utilisation of the input energy as well as lower electricity generation related GHG emissions and water consumption.

Renewable biomass energy is an important component of the energy mix along the value chain. Indeed, biomass[8] is gradually replacing fossil fuels along the value chain (FSC 2016). In this regard, the usage of black liquor[9] is increasing. Black liquor contains more than half of the energy content of the digested wood (Sappi 2017). The energy generated by burning the black liquor is used to generate steam for heating as well as for power generation (Van der Merwe-Botha et al. 2017). Sappi and Mondi are the largest producers of renewable biomass energy in the country (Van der Merwe-Botha et al. 2017), contributing to avoiding 3.66 million tonnes of fossil fuel-derived CO_2 (Who Owns Whom 2018a). Figure 13 shows that renewable energy plays an important role in Sappi's operations across the world. In Southern Africa, the proportion of its renewable energy usage has increased steadily from 38.4% in 2014 to 42.7% in 2018. Globally, renewable energy usage for Sappi largely revolved around 47% from 2014 to 2018. In the same vein, Mondi (2018) reports that its renewable energy consumption at its mills (globally) increased from 59% in 2014 to 64% in 2018; in addition, the electricity self-sufficiency of its mills increased from 96% in 2017 to 100% in 2018.

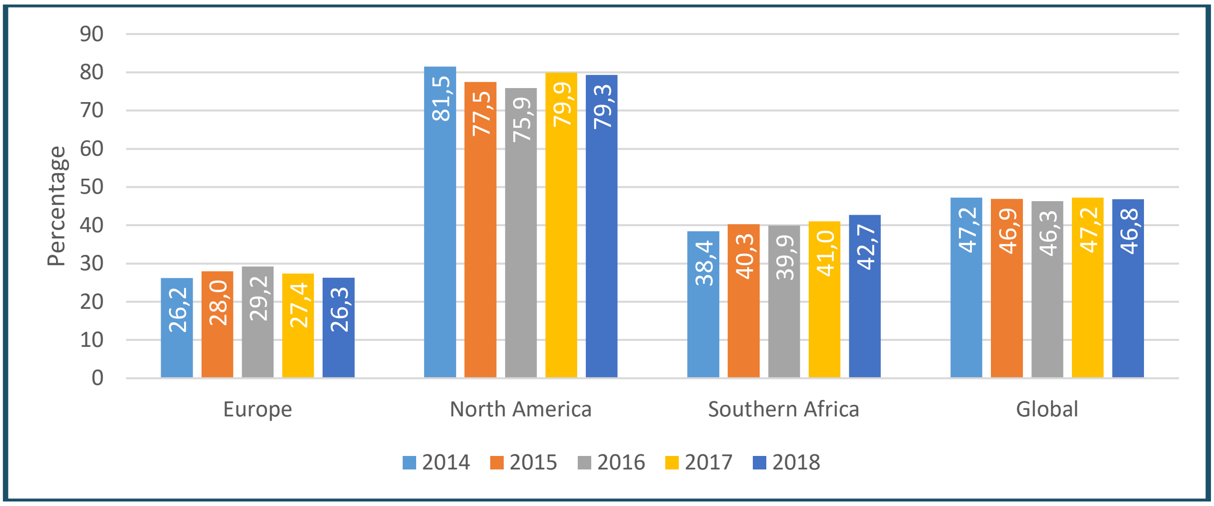
[6] Gigajoules of energy per air dried ton of paper produced.

[7] Co-generation refers to the generation of electricity from steam created as a by-product of the papermaking process (PAMSA 2016).

[8] Renewable wood-based fuels are considered carbon neutral.

[9] Black liquor is a by-product derived from digesting pulpwood chips in the chemical pulping process to give a mixture of spent cooking chemicals and dissolved wood solids, which is concentrated during the chemical recovery process to yield an organic rich fuel that can used to produce energy (PAMSA 2016). It can be upgraded through gasification to create syngas (IEA 2019).

Figure 13: Renewable energy usage (%) in Sappi's operations



Source: Sappi (2018: 54)

Some of the large companies are registered independent power producers (Robertson 2018). In previous years, the contribution of these companies to the national electricity grid has been affected by institutional red tape and delays in approval by the government (Who Owns Whom 2018a; PAMSA 2016). However, this is changing as Sappi (2018) has acknowledged that it is already contributing to the national grid by selling surplus energy from its Ngodwana Mill to the state power utility, Eskom.

While various parts of the value chain are already using renewable biomass energy, this is not yet enough, as fossil fuels are still a significant component of the energy mix. There is need for increased utilisation of the bioenergy resources as well as improving energy efficiency. Hugo (2016) noted that while bioenergy is feasible in South Africa, this is at a relatively small scale. A number of constraints limit the development of biomass energy in the country. These include: the high cost of collection and transportation of in-field residue versus the price of woody biomass on local markets; the high cost of transporting pellets to overseas markets relative to other producers; lack of a domestic market for pellets; an unfavourable environment for independent power production; and lack of investment in improved cook stove technology and promotion in rural areas (Clarke 2018).

The need to maximise the generation of energy from biomass should be balanced with other sustainability objectives. Van der Merwe-Botha et al. (2017) point out that though up to 50% of sawmill waste can be used as biomass for bio-energy; some foresters prefer a portion of this biomass to be retained in the fields for enriching the soil. This means that, as biomass is extracted for energy, this needs to be balanced with the need to ensure the rejuvenation and maintenance of the health of the soil.

As the reliance of the country's pulp and paper industry on the national grid is still significant (PAMSA 2016), there is need to ramp up efforts towards increasing efficiency in the generation and utilisation of bioenergy derived electricity. Enhancing fuel switching and energy efficiency through implementing energy management systems is an important strategy to decarbonise the sector (IEA 2019). In drawing recommendations, it is necessary to consider the context. For instance, electricity production using co-generation uses less water, and as South Africa is water scarce, this option can be a more appropriate option for the country's pulp and paper industry (PAMSA 2016). Hence, there is need for the wider adoption of such options.

It is important for the industry to explore technological innovations. The IEA (2019) notes that some technologies, such as deep eutectic solvents,[10] alternative drying and forming processes, lignin extraction, and black liquor gasification, though they might require further development, have great potential to improve energy efficiency in the sector and are thus worth pursuing. The country's forestry value chain already uses black liquor in energy production. However, more needs to be done to harness such energy sources to displace fossil fuels. Energy policies have an effect on stimulating shifts towards using biomass as a renewable and sustainable source of materials and energy. While such efforts are commendable, they need to be complemented by strong action to ensure there is sustainable forest management. This will help to avoid risks of increased deforestation, forest degradation, and failure to reduce carbon emissions from energy production (FSC 2016).

Table 11: Socio-economic implications of energy efficiency and renewable energy

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Investment in energy efficient technologies Adoption of renewable energy Upgrading and retrofitting production systems Behavioural change to reduce energy consumption	Reduced consumption reduces load on the national grid Renewable energy diversifies options and guarantees future supply Lowers carbon footprint of products	Legislations might hamper progress in the utilisation and supply of excess renewable energy High upfront cost to adopt the necessary technologies
Government	Formulate and implement legislation that incentivises energy efficiency and use of renewable energy, while also discouraging usage of non-renewable energy	Lower CO_2 emissions Enhanced energy security Reduced load on the national grid	The policy might not create enough impetus to drive industry-wide transformation Appropriate support to implement the policies might be lacking or inadequate
Workers	Behavioural change towards embracing energy efficiency and renewable energy	Job preservation due to energy security	Expected behaviour change might not materialise
Households/ Communities	None in most cases Might provide a market for products like wood pellets	Improved energy security at the household and community level	Households might fail to adopt cleaner biomass based cooking fuels The renewable energy and energy savings might not benefit local communities

Source: Author

[10] Deep eutectic solvents work by dissolving wood into lignin, hemicellulose and cellulose. It is low-carbon alternative to traditional chemical pulping (IEA 2019).

4.3 Reducing water consumption and improving water efficiency

There have been concerted efforts to improve water efficiency and reduce the water footprint of products along the value chain.

At the plantation level, one option going forward is striking a balance between the forestry plantation areas under exotic tree species and indigenous tree species. Even though biomass production is relatively low for indigenous tree species, they tend to use much less water than introduced exotic species. This provides a good basis for reforestation and expanding indigenous tree production systems in the country, while minimising resource impacts (water-use) (Scott and Gush 2017). Robertson (2018) calls for the conversion of wattle jungles to forest tree species that tend to use less water resources and have less risk of invasion into unplanted lands.

At pulp and paper production level, the big companies are showing evidence of improving water use efficiency in their operations. For instance, Sappi (2017) noted that, globally, 93% of the water that they use in the mills is returned to the environment after treatment and cleaning; of the 7% balance, about 4% exits the mills in the form of production, and 3% is lost to the environment. In South Africa, Sappi acknowledges water scarcity and has been implementing various measures to secure its water supply. In 2016, Sappi mitigated the impact of low flows on the Umkomazi River on water supply to the Saiccor Mil by raising the Comrie Dam wall (Sappi 2017). Moreover, Sappi also implemented more efficient use of water at the Ngodwana, Tugela and Stanger Mills. Mondi has also been implementing various measures to enhance water efficiency in its operations. Mondi (2018) highlights that it observed a 2.2% decrease in its water withdrawal in water-stressed regions in 2018. Mondi has been promoting water stewardship across water catchments in which it operates.

Van der Merwe-Botha, et al. (2017) attribute the reduction in SWI and SEV in pulp and paper mills to actions that included improvement in effluent treatment technologies and equipment, and use of water footprinting and risk management. Significant water recycling is employed in these processes. Water is recycled and reused up to 10 times throughout the mill and requires different levels of treatment depending on its use (Sappi 2020). Van der Merwe-Botha et al. (2017) observed that various mills in South Africa's pulp and paper industry were adopting practices that were in line with international best environmental practices in the industry. Some of the practices included:

- Better overall management that focused on integrated water management planning including continuous monitoring of flows and quality, combined with continuous improvement initiatives.
- Design-stage procedures that incorporated consideration of water savings during the initial design phase of a mill or a modification at a mill.
- Low-cost improvements that included awareness of water savings during the execution of daily production activities.
- Process modifications that entailed minor optimisation modifications.
- Process redesign that involved more capital-intensive options in treatment and recycling processes. Some of the technologies employed are activated sludge, clarification, dissolved air flotation and filter belt presses.

Along the forestry value chain, various measures can therefore be implemented to reduce water consumption and improve water efficiency. There is need for wider adoption of the measures and continued improvement in the processes in line with international best practices.

Table 12: Socio-economic implications of reducing water consumption and improving water efficiency

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Investment in water efficient technologies Upgrading and retrofitting production systems Behavioural change to reduce water consumption	Reduced consumption enables water availability for other uses Guarantees future water supply Lowers water footprint of products	Upfront cost to adopt the necessary technologies
Government	Formulate and implement legislation that incentivises the water efficiency and demand management, while also discouraging inefficient usage of water	Reduced water gaps between supply and demand Enhanced water security Reduced competition and conflicts between users	The policy might not create enough impetus to drive industry-wide transformation Appropriate support to implement and enforce the policies and might be lacking or inadequate
Workers	Behavioural change towards embracing water efficiency and saving	Job preservation due to water security	Expected behaviour change might not materialise
Households/ Communities	Co-operation in implementing programmes such as water stewardship in the catchment areas	Improved water security at the household and community level which can enable other socio-economic activities	Households and local communities might fail to directly benefit from the water savings

Source: Author

4.4 Promoting more resource recovery and recycling

Embracing the circular economy approach is key for sustainability along the forestry value chain. Recovery and recycling are central tenets of the approach. Besides diverting waste from landfill and the recovery of raw material for reuse, the spin-off of recycling is business development and job creation (PAMSA 2016). Opportunities to enhance this are possible at various stages of the value chain. There is need to improve efficiencies in downstream processing operations through upgrading of capital equipment, improved milling practices, and expanding use of by-products such a bark and wood shavings in other applications (Robertson 2018).

There are efforts in this regard. For example, Mondi has been promoting recycling, reuse and the substitution of resources to reduce waste with an 80% reduction of total waste to landfill at its Merebank Mill (PAMSA 2016). Sappi (2017) noted that it was assessing the wastewater biorefinery concept at its Technology Centre in Pretoria (South Africa), to explore the recovery of valuable products (such as sugars, lignin or biogas) from waste streams.

Improving efficiency and recovery in the production and consumption of paper can contribute to significant environmental benefits. One tonne of recovered paper saves three m^3 of landfill space

(PAMSA 2016). Pulp production from recycled fibres is less carbon and energy intensive than pulp production from virgin wood (EPN 2018; Roth et al. 2016). In this regard, recycling paper products are beneficial in reducing emissions, and there are additional benefits to the environment, as shown in Table 13.

Table 13: Environmental benefits of recycled paper compared to virgin paper

	1 METRIC TONNE OF 100% RECYCLED PAPER INSTEAD OF VIRGIN PAPER SAVES	1 METRIC TONNE OF 100% RECYCLED NEWSPRINT INSTEAD OF VIRGIN PAPER SAVES
Fresh wood and equivalent trees	4.4 metric tonnes of wood, equivalent to 26 trees	2.3 metric tonnes of wood, equivalent to 14 trees
Total energy	39%	23%
Greenhouse gases	58%	64%
Water usage	9%	25%
Ocean acidification	56%	74%
Hazardous air pollutants (hap)	13%	46%
Mercury emissions	20%	38%
Dioxin emissions	26%	93%

Source: EPN (2018: 19)

Notable recycling of paper is happening across the world (Table 14). In 2013, the rate of recycling paper in South Africa was 61%, which was above the global average of 57.9%.

Table 14: Selected recycling rates for 2013 (calculated by comparing collection to utilisation)

REGION/ COUNTRY	PAPER RECYCLING RATE
Worldwide	57.9%
Australia	85%
Japan	80.4%
Europe	72%
Canada	70%
United States	64%
South Africa	61%
Brazil	48%
China	44.7%

Source: EPN (2018: 21)

Over the years, recovery rates in the recycling of paper have improved (Table 16). In 2018, 71.7% of recoverable paper was diverted from South Africa's landfills, which equates to 1.285 million tonnes of the 1.793 million tonnes available for recovery (PAMSA 2018). This growth in recycling has seen the sector employing close to 160 000 people.

Table 15: Paper recovery rates in South Africa

PAPER RECOVERY RATES	2015	2016	2017	2018
Recyclable paper recovered as % of paper consumption	49.5%	58.7%	56.9%	54.8%
Recovered paper as % of recoverable paper	66.7%	68.4%	70.7%	71.7%

Source: PAMSA (2018: 2). Note: Recoverable paper excludes paper which is unrecoverable or unsuitable for recycling (e.g. toilet tissue and sanitary products, and cigarette paper)

Besides the general success in the recovery of paper, it is necessary to improve wastepaper collection from households, schools and businesses. Only 5% of households in the country recycle their paper (PAMSA 2016). Thus, there is scope to promote and strengthen the recovery of paper at these levels. Recycling efforts need to be supported by legislation as well as incentives. There is need to promote the separation and collection of waste and enhance recycling in the country (Robertson 2018). Initiatives that encourage stakeholders to do more recycling can be introduced. For instance, the government can implement landfill and waste collection fees that promote more recycling of household and commercial paper waste (IEA 2019). There is need to improve recycling channels to make it easier to collect paper for recycling. Minimising the use of landfills for disposing of easily degradable forest products can help to minimise releases of methane (Miner and Perez-Garcia 2007).

Table 16: Socio-economic implications of promoting more resource recovery and recycling

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Adoption of the circular economy approach along the value chain Investment in green technologies Upgrading and retrofitting production systems Behavioural change towards embracing resource recovery and recycling	Increased value and benefits derived from a given amount of resources Ensures business sustainability and cost-savings Improves the image of the business and its products	Upfront cost to adopt the necessary technologies Might not translate directly to monetary benefits The co-operation and collaboration needed from different stakeholders along the value chain might fail to materialise which makes it difficult to exchange material resources
Government	Formulate and implement legislation that incentivise the growth of circular economy, while also discouraging wastage of resources	Ensures environmental sustainability Improves the international competitiveness of the country's products Resource decoupling contributes to more output from less inputs	The policy might not create enough impetus to drive industry-wide transformation Appropriate support to implement and enforce the policies and might be lacking or inadequate
Workers	Behavioural change towards embracing the circular economy approach	Job preservation due to improved business sustainability More job opportunities might be created	Expected behaviour change might not materialise
Households/ Communities	Co-operation in implementing programmes such as wastepaper sorting, collection and recycling	Improved environment due to reduced waste and pollution Job opportunities associated with the resource recovery and recycling	The needed behaviour change at the household and community level (e.g. wastepaper sorting and collection for recycling), might fail to materialise

Source: Author

4.5 Prioritising the inclusion of small-scale growers and marginalised groups

A discussion on sustainability and climate compatibility would be incomplete without a strong emphasis on the need to ensure inclusion of different stakeholders. The participation of the often marginalised groups, such as small-scale growers, local communities and women, needs to be prioritised.

One key challenge in the forestry sector is the limited ownership and participation of small growers and local communities. Indufor and CAP (2017) evaluated the relative cost and development impact of 22 different plantation forestry projects in 10 African countries. They found that the smallholder option was the most cost effective on a per hectare basis because smallholder plantations can be established cost effectively, have high positive developmental and climate impacts, and can be scaled up more easily. While smallholder growers are often not given the necessary recognition, these findings highlight that empowering smallholders can be a cost-effective way to achieve developmental objectives and at the same time target climate objectives.

For many rural communities, there are overlapping rights to forest resources and informal rights associated with traditional systems of governance that tend not to be given formal recognition, which limits the participation of local people (Grieg-Gran et al. 2015). Indeed, land access is a contentious issue for the forestry sector in the country, with the issue of land claims having been topical for some time. The Mondi Group in its 2018 Integrated Report highlighted that it is subject to land claims and could face an adverse land claim ruling (Mondi 2018). This means that the land issue needs to be resolved so as to bring certainty to the sector (Robertson 2018). Already, the industry has limited available land for new afforestation (Who Owns Whom 2018a). Improving access to land by local communities and enabling them to meaningfully participate in various activities along the forestry value chain can help to guarantee long-term sustainability.

Overall, small-scale forestry growers need more support – financial, technical and market support. In particular, development of their plantations should be in close proximity to larger commercial plantations. This will assist them to access support with harvesting, transport, value-adding processing equipment, technical know-how and channels into the market (Indufor and CAP 2017). While many of the climate-related initiatives are being done by the big players in the industry, this needs to trickle down to small-scale players as well. Hence, the need for holistic support that enables small-scale players to achieve sustainability in general and climate compatibility in particular.

It is also imperative to mainstream gender issues along the value chain. This is particularly relevant in the context of a just transition. Women who are active in the protection and management of forest resources maybe disproportionately affected by the impacts of climate change on the value chain (Naidoo et al. 2013). Thus, for the sector to be sustainable, response strategies to incorporate the needs of women and other marginalised groups, including rural communities, are needed. Intervention in the forestry value, such as availing improved cooking stoves, have notable benefits for low-income families, women and girls, due to reduced pollution-related health effects and time savings in woodfuel collection and cooking (Grieg-Gran et al. 2015). Enabling households to switch from dirty cooking fuel to wood pellets, for example, has the potential to improve health and reduce fire damage costs at the household level (Jenkin and Mudombi 2018).

Table 17: Socio-economic implications of the inclusion of small-scale growers and marginalised groups

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Dedicated programmes that target the inclusion and participation of small-scale growers and marginalised groups Providing the necessary resources needed for meaningful participation by those groups Efforts should go beyond the normal corporate social responsibility	Business sustainability due to reduce conflicts Guarantees a social licence to operate and strengthens business resilience Empowering local communities and marginalised groups can create mutual benefits	Might be costly to avail the necessary resources needed for meaningful transformation Expectations by various stakeholders might go beyond what the businesses can afford Might create dependency rather than real empowerment
Government	Formulate and implement legislation that incentivise the inclusion of small-scale growers and marginalised groups Might include facilitating secure land tenure or access to finance	Having improved livelihoods of people reduces poverty and their dependency on the government This can boost local economic development	The intended beneficiaries might not share the same vision People who actual need the support might end up not receiving the support
Workers	They need to embrace and value the marginalised groups	Peaceful co-existence in communities	Tension might arise around issues such as local versus outsider in benefiting from jobs and programmes
Households/ Communities	Co-operation and willingness to participate in programmes	Improved livelihoods and reduced poverty Empowerment and economic independency	The target beneficiaries might not end up benefiting as intended

Source: Author

4.6 Wider adoption of forest stewardship and certification

Forest certification programmes seek to influence the management and use of forestry derived resources and products (FSA 2017b). In South Africa, forest certification has a long history. The main forest certification in the country is the FSC. The FSC has three different types of certification:

- Forest management assures that forestry operations are socially beneficial, and satisfactory from an environmental and economic perspective;
- Chain of custody (CoC) assures all branded end-products are sourced from certified forests; and
- Controlled wood, meant to allow organisations to avoid the categories of wood considered unacceptable in FSC mix products (FSA, n.d.; 2017).

Globally, 200 738 995 hectares of forest had been certified as of December 2019 (FSC 2019). This equates to more than 1 668 FSC forest management certificates issued globally in 82 countries; the breakdown per region is: Africa (53), Asia (260), Europe (791), Latin America and Caribbean (267), North America (258), and Oceania (39). The certified area in Africa is 6 073 580 hectares, with the breakdown presented in Table 18. South Africa has 1 555 270 hectares of forest plantation area certified under 22 certificates. South Africa is a leader on the continent in the number of certificates. More than 80% of land reserved for plantation forestry in South Africa is certified by the FSC, which is the highest in the world (PAMSA 2015; Ledger 2017). The first FSC certificate was issued in 1996 to a state-owned timber company, SAFCOL's subsidiary Komatiland Forests (FSC 2017).

Table 18: FSC-certified area and number of certificates in Africa

	TOTAL AREA (HA)	NUMBER
Cameroon	341 708	1
Democratic Republic of Congo	1 251 050	3
eSwatini	125 083	4
Gabon	2 061 190	6
Ghana	21 430	2
Mozambique	50 753	2
Namibia	391 711	4
Rwanda	10 002	1
Sierra Leone	6 281	1
South Africa	1 555 270	22
Tanzania	216 317	3
Uganda	42 785	4
Total	6 073 580	53

Source: FSC (2019)

The CoC is another important dimension of certification in the forestry sector. Globally, 40 331 CoC certificates have been awarded in 127 countries. The breakdown per region is: Africa (244), Asia (15 111), Europe (19 850), Latin America and Caribbean (1 562), North America (3 148), and Oceania (416) (as of December 2019) (FSC 2019). The distribution of the CoC certificates is shown in Table 19. From a total of 244 certificates on the African continent, South Africa has the most with 133.

Table 19: Chain of Custody certificates in Africa

COUNTRY	NUMBER
Algeria	1
Cameroon	6
Democratic Republic of Congo	2
Egypt	38
Eswatini	3
Gabon	12
Ghana	6
Kenya	5
Mauritius	3
Morocco	12
Mozambique	1
Namibia	11
Seychelles	3
South Africa	133
Tanzania	2
Tunisia	6
Total	244

Source: FSC (2019)

Forest certification is a marketing tool that helps to access international customers by providing credible independent verification of good management practices (FSA, n.d.). The demand for sustainably-produced wood and paper-based goods contributes to improved forest management (WBCSD and WRI 2011). Thus, forest certification assures that wood and wood-based products reaching the marketplace have been sourced from sustainably managed forests (Crane 2019). Most of the FSC-certified timber from South Africa is exported. The key driver of certification is the European market, though in recent years, there has been a marked increase from Japan and China. China is now the country with the most CoC certificates, with more than 3 500 certificates (Germishuizen 2014).

However, the certification process has been criticised. Germishuizen (2014) asserts that the certification is clearly not working for developing countries where impacts on forests are highest and where the richest and most threatened biodiversity resides. In addition, the complexity and costs of managing plantations under the FSC system precludes many smaller operations from achieving certification (Crane 2019).

Germishuizen (2014) observed that, in South Africa, over 76% of the plantation estate is owned and managed by large-scale growers, and over 95% of this area is FSC certified. But less than 4% of the forestry land is managed by small-scale timber growers comprising of rural communities and land reform beneficiaries, and none of this have been certified.

The exclusion of small-scale growers is because the certification process is prohibitively expensive (FSA 2017). Mtengu and Green (2016) identified a number of challenges that make it difficult for small-scale timber growers in South Africa to get FSC certification. These are the onerous water use licensing process; lack of access to financial and non-financial support and services; uncoordinated support; lack of extension support; lack of communication and access to information; poor infrastructure; lack of resources to protect their forests from pests, diseases and fires; and challenges with land ownership.

The realisation that the FSC was not adequately servicing the certification needs of small-scale timber growers led to the formulation of an alternative forest management certification system by the South African Forestry Assurance Scheme (SAFAS) (FSA 2017a; SAFAS 2018).

This certification system is endorsed by PEFC, and is specifically designed to accommodate smaller-scale forestry (smallholders) (SAFAS 2018: 3). This certification programme is extremely relevant for South Africa. With land reform, there could be an increase in the proportion of the plantation area being managed by smaller-scale timber growers, hence the need for a certification that is more aligned to their needs and circumstances (Who Owns Whom 2018a).

Table 20: Socio-economic implications of wider adoption of forest stewardship and certification

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Truly embracing forest stewardship principles Availing the necessary resources needed Promoting forest stewardship along the value chain	Business sustainability Guarantees a social licence to operate and strengthens business resilience Promotes environmental sustainability Can help secure the market	Might be costly to fully implement the forest stewardship and certification requirements
Government	Policy support to ensure wider adoption of forest stewardship	Nurture environmental sustainability Wider adoption can help to secure the market and strengthen international competitiveness	Businesses might not have the necessary resources needed to meet the requirements
Workers	They need to adhere to the principles of forest stewardship	Job preservation due to business sustainability	The benefits of forest stewardship might not trickle down to the workers if the forest stewardship is implemented half-heartedly (just to tick the boxes)
Households/ Communities	Cooperation and willingness to ensure the success of forest stewardship initiatives	Improved livelihoods and reduced poverty Inclusion of local communities	The benefits of forest stewardship might not trickle down to the local communities if the forest stewardship is implemented half-heartedly (just to tick the boxes)

Source: Author

4.7 Embracing the valuation of ecosystem services and environmental sustainability

At the industry level, there have been efforts to promote and enhance the recognition of ecosystem services and environmental sustainability in the forestry value chain. Ecosystem services are the benefits people derive from ecosystems, including food, forest products and water; regulating services such as regulation of floods, drought, land degradation, air quality, climate and disease; supporting services such as soil formation and nutrient cycling; and cultural services and cultural values such as recreational, spiritual, religious and other nonmaterial benefits (FSC 2017). Between nine and 12 million people in the country use fuelwood, wild fruit and wooden utensils obtained from forests and woodlands (DAFF 2012).

Sustainable forest management can help maintain, restore or enhance the carbon sequestration function of a forest (FSC 2016). It is possible to develop sustainable business models by incorporating certification of ecosystems services, in addition to carbon sequestration (UN Environment Evaluation Mission 2017).

About 25% of forestry land in the country is not under plantation but conserved for biodiversity through grasslands, wetlands, indigenous forests and savannah (PAMSA 2015). Over the past 15 years, the area under plantation forestry has been reduced, especially in riverine and ecologically sensitive areas or from commercially unviable areas, by 80 000 hectares (PAMSA 2016; 2015; FSC 2017). Moreover, there are efforts to incorporate diverse agricultural activities within plantations to enhance food security for their employees and surrounding rural communities. Industry players are exploring options to introduce agroforestry projects, such as cultivating berries and tree nuts, beekeeping, and livestock production within plantations (Who Owns Whom 2018a).

However, besides these commendable efforts, Robertson (2018) points out that the general shift in the country's forestry sector from longer rotation pine to shorter rotation eucalyptus has negative implications on biodiversity as this is negatively affected during harvesting, which becomes more frequent with shorter rotation cycles.

There is need to improve the generation and management of information on forest assets, so as to recognise the contribution made by forest ecosystem services to different sectors (Grieg-Gran et al. 2015). The role of forests in providing ecosystem services needs to be recognised. For example, Savilaakso and Guariguata (2017) allude to the certification of forest ecosystem services (FES), which is a market-based mechanism that includes activities meant to guarantee that a given forest stand is explicitly managed in a way that maintains or enhances the provision of a specified ecosystem service. However, they concede that developing a national standard for FES certification is complex, as it would be both a political and technical process, with a wide range of beneficiaries with varying needs and influence.

Much progress has been made in seeking to achieve sustainable forestry management in South Africa. With a significant amount of land having been FSC certified, a notable milestone was the development of the FSC National Forest Stewardship Standard of the Republic of South Africa (FSC 2017). The Standard focuses on plantation forestry of all species present in the country; however, it does not cover indigenous forests. The Standard incorporates a number of indicators and means of verification focused on ecosystem services (see Box 2).

Box 2: Recognition of ecosystem services in the FSC National Forest Stewardship Standard of the Republic of South Africa

Forestry activities that impact on water quality have been identified in the generic risk assessment. These are use of fertilisers, use of chemicals, uncontrolled fires, soil erosion and sedimentation originating from the road network, hydrocarbon spillage, harvesting and extraction, management of plantation residues, waste disposal, and soil erosion and sedimentation as a result of cultivation and the use of machinery.

The organisation (i.e. the person or entity holding or applying for certification and therefore responsible for demonstrating compliance) shall maintain and/or enhance the High Conservation Values (HCV) in the Management Unit through applying the precautionary approach. HCV 4 focuses on Critical Ecosystem Services. The biggest impact of afforestation on ecosystem services is by reducing the amount of water available to downstream users. This is protected through the requirement for a water use licence, which is only granted once it has been determined that there is sufficient water available in the catchment. An environmental impact assessment also considers the impact on water quality, soil erosion, availability of grazing and other resources, covering all potential HCV 4 in the South African context.

Furthermore, the systematic conservation plans incorporate Ecological Support Areas. Ecological Support Areas are not essential for meeting biodiversity targets, but play an important role in supporting the ecological functioning of Critical Biodiversity Areas and/or in delivering ecosystem services. The following basic ecosystem services are associated with plantation forestry relevant to HCV 4: water quantity, water quality and soil retention.

Criterion 10.1 stipulates that after harvest, or in accordance with the management plan, the organisation shall, by natural or artificial regeneration methods, regenerate vegetation cover in a timely fashion to pre-harvesting or more natural conditions.

Criterion 10.2 stipulates that the organisation shall use species for regeneration/re-establishment that are ecologically well adapted to the site and to the management objectives. The organisation shall use native species and local genotypes for regeneration, unless there is clear and convincing justification for using others.

Criterion 10.3 stipulates that the organisation shall only use alien species when knowledge and/or experience have shown that any invasive impacts can be controlled and effective mitigation measures are in place.

Species choice is governed by site, fire risk, market and risk of disease. The invasiveness of the species also needs to be considered.

Consideration for climate change and its impacts on site, such as increasing risk of drought and disease.

Source: Extracted from FSC (2017)

Table 21: Socio-economic implications of valuation of ecosystem services and environmental sustainability

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Incorporating the valuation of nature and ecosystem services into business planning and operations	Can guarantee future supply of nature and ecosystem-based inputs Business sustainability Promotes environmental sustainability Can help secure the market	Some of the ecosystem services might not accrue directly to business, hence might be difficult to justify (the benefits go beyond the factory fence) Few people understand the benefits of ecosystem services
Government	Policy support to promote the valuation of nature and ecosystem services	Nurture environmental sustainability Wider adoption can ultimately reduce the vulnerability to physical risks associated with climate change Wider adoption can help secure the market and strengthen international competitiveness	Businesses might not have the necessary resources needed To realise benefits, this needs to be implemented on a large scale, which requires collective action between different stakeholders; however, it might be difficult for the collective action to materialise
Workers	They need to understand the value of nature and ecosystem services	Job preservation due to business sustainability Some ecosystem services can enhance livelihoods of workers	The benefits of ecosystem service might not trickle down directly to the workers
Households/ Communities	Co-operation and willingness to protect nature as well as the valuation and the sustainable utilisation of ecosystem services	Improved livelihoods and reduced poverty Inclusion of local communities Environmental sustainability and ecosystem services helps to reduce vulnerability of local communities	The benefits of forest ecosystem services might not trickle down directly to the local communities

Source: Author

4.8 Information, monitoring and evaluation, learning and sharing best practises

To improve understanding that would help in framing appropriate and more specific recommendations, there is need for improved data collection and availability. An understanding of the GHG emissions and the sequestration associated with the entire life cycle of forest products is required for the development of optimal GHG control policies (Miner and Perez-Garcia 2007).

In this report, it was difficult to get comprehensive disaggregated industry data on variables such as CO_2 emissions and water usage along the value chain. The challenges with data availability are significant. This is acknowledged in the GHG National Inventory Report (DEA 2017: 28): “In the 1990, 1994 and 2000 GHG inventories for South Africa … supporting data and methodological details were not recorded, which made updating the inventory a very difficult and lengthy process. In the 2000 – 2010 GHG inventory … still very little supporting data and method details were kept.”

Dovey (2014) observed that a robust methodology to assess carbon stocks in commercial forest plantations in South Africa does not exist, hence the need for a country-specific carbon accounting/ estimation method that is compatible with the existing local and regional forest plantation inventory and management systems. There is need to make sure the data is available in formats that are easier to perform analysis, thus enabling research, regulatory and monitoring efforts.

Climate change worsens the uncertainty over the degree of abiotic and biotic risks that must be considered over rotation timeframes, thus a better understanding of likely future climate scenarios can be factored into the various risk management decisions involved in plantation management (ICFR 2014). In this context, there is need to map areas that are suitable for forestry and the potential spatial shifts in optimum growing regions (DEA 2013).

Sharing of best practices is needed for meaningful transition towards climate compatibility. In this regard, there is need to continually evolve, as yesterday's best practice may no longer be considered best practice today (Van der Merwe-Botha et al. 2017). This motivates the need for industry-wide sharing of information and learning, so as to realise meaningful transformation across the various components of the value chain.

Table 22: Socio-economic implications of enhancing information, monitoring and evaluation, learning and sharing best practises

STAKEHOLDERS	IMPLEMENTATION REQUIREMENTS	EXPECTED BENEFITS	EXPECTED RISKS
Businesses (along the forestry value chain)	Data collection on various sustainability indicators Monitoring and evaluation of operations and impacts Information sharing	Better decision-making informed by data Improvement in operations as remedial action is implemented timeously Learning from peers	Availability of information and data does not mean it will be used
Government	Encouraging voluntary and compulsory reporting on key environmental related variables by business Monitoring and verification mechanism	Can get up-to-date information on industry trends to avail necessary support as needed Better decision-making informed by data	It is costly to undertake proper monitoring and verification Without proper monitoring and verification, there is the possibility of incorrect data being reported
Workers	Co-operation in the collection and dissemination of correct information	Job preservation due to improved business performance Improved worker productivity with the learning and sharing of best practices	The benefits might not trickle down directly to the workers
Households/ Communities	Co-operation and willingness to participate in data collection and surveys.	Better performance by businesses might have positive spill-over benefits to the local communities	The spill over benefits might not materialise

Source: Author

5 CONCLUSION

Climate compatibility is a central aspect of sustainability. Increasingly, the consideration of carbon and water footprints, and resource efficiency of products, is taking centre-stage in the market and among consumers. Some of the key challenges along the forestry value chain that demand climate compatibility are high water consumption, GHG emissions, high energy demand and fossil fuel usage, and high waste disposal. Addressing these and taking a lead in ensuring that the forestry value chain is climate compatible is a necessary step in safeguarding market access and guaranteeing future sustainability.

Climate compatibility entails a combination of climate change adaptation as well as mitigation measures, which include improving energy efficiency, use of renewable energy sources, reducing water consumption and improving water-use efficiency, and adopting more recovery and recycling. Complementary to these measures is the need to prioritise the inclusion of small-scale growers and marginalised groups, embracing forest stewardship, embedding the value of ecosystem services in forest management practises, and promoting learning and sharing best practises along the value chain.

The transition towards sustainability in general and climate compatibility in particular requires relevant engineering and technical skills, which are currently lacking (FP&M SETA 2014). In addition, a supportive policy and regulatory environment is needed to trigger and drive the transition. Policies and regulations should incentivise players along the value chain to transition, particularly in developing and adopting climate-friendly technologies and best practises.

Already, there is goodwill among key players in the forestry value chain to transition towards climate compatibility. PAMSA (2020) asserted that its members recognised the opportunity to maximise their positive role in responding to climate change.

On some of the sustainability metrics along the value chain, South African firms perform much better or are in line with global benchmarks, and are also employing international best practices. This is highly commendable; however, most of this is isolated and being undertaken by a few large firms. For meaningful impact, an industry-wide transition towards climate compatibility is required.

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7 APPENDIX

Box 3: Step-by-step guide to implementing a value chain approach to enhance climate compatibility

1. Analyse the value chain

- Understand the industrial value chain (material flows, players, and roles).
- Understand the associated carbon intensity through a life-cycle analysis approach (carbon emissions sources, climate actions, current trends, existing and emerging regulation (e.g. carbon pricing or trading, energy efficiency), potential for innovation (technical, process, business model), and stakeholder interest (consumer, non-governmental organisations, media).
- identify opportunities for collaborative action in the value chain (technological, financial, regulatory). Prioritise these based on criteria, such as carbon impact and ease of implementation.

2. Mobilise for action

- Convene upstream and downstream players (identify key value chain players on climate action – big emitters and action champions, identify shared value, engage in dialogue, review existing efforts and lessons learned).
- Identify champions to drive collaboration and business opportunities.
- Define shared goal and narrative.

3. Deliver and scale up

- Engage partners and define roles (identify required capabilities and match to best organisation).
- Agree scope and timelines.
- Mobilise investment.
- Create pilot.
- Scale up and roll out (communicate on intermediate results, refine key success factors and enablers, educate and engage other value chain players, and extend scope).

Source: Extracted from WEF (2016: 14-15)

Table 23: Key data on commercial plantations in South Africa, 1995 – 2011

PERIOD	EXTENT PUBLIC HA	EXTENT PRIVATE HA	TOTAL HA	SUSTAINABLE FORESTRY CERTIFICATION	NUMBER OF PEOPLE DIRECTLY EMPLOYED IN PLANTATION SECTOR
2010-2011	216 078	1 057 279	1 273 357	1 511 739	129 244
2009-2010	216 114	1 055 177	1 271 286	1 572 568	129 244
2008-2009	215 961	1 058 908	1 274 869	1 572 568	66 500
2007-2008	215 839	1 041 502	1 257 341	1 572 568	129 244
2006-2007	214 972	1 051 222	1 266 194	1 622 196	129 244
2005-2006	303 219	978 299	1 281 519	1 443 416	129 244
2003-2004	305 962	1 033 320	1 339 282	1 088 071	67 469
2002-2003	305 286	1 066 339	1 371 625	1 088 071	67 469
2001-2002	322 525	1 028 877	1 351 402	1 006 500	164 800
2000-2001	380 663	971 097	1 351 760	1 006 500	164 800
1995	421 100	1 065 900	1 487 000	-	Figures not comparable

Source: DAFF (2020)

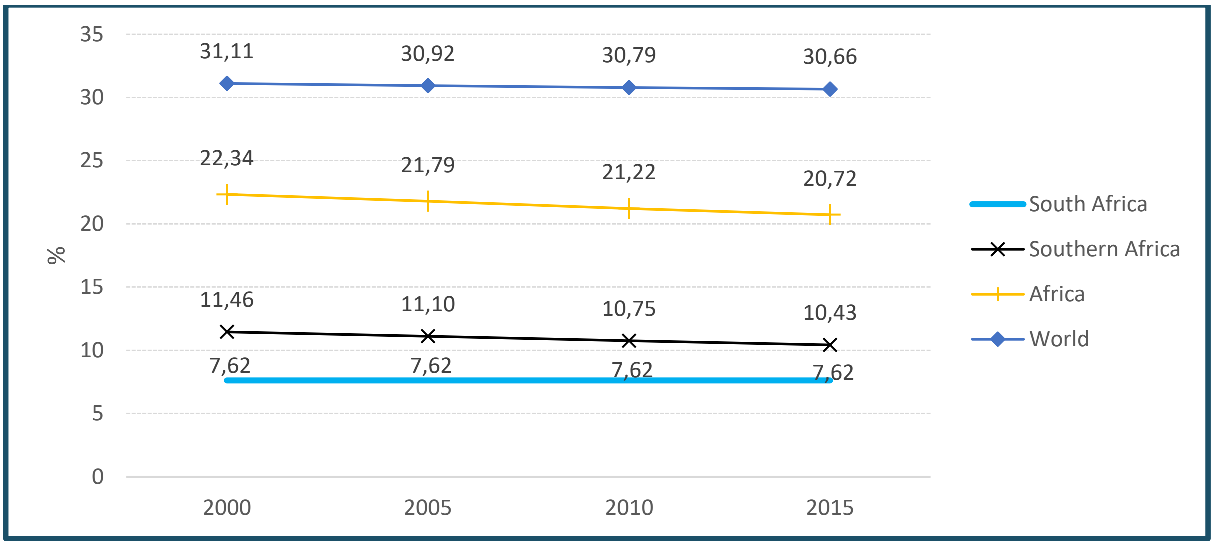
Table 24: Summary of key players in the forestry value chain by province

COMPANY	EMPLOYEES	REVENUE	ESTIMATED HECTARES OF LAND UNDER MANAGEMENT IN SOUTHERN AFRICA	NUMBER OF SAWMILLS	FORESTRY	SAWMILLS	TIMBER TREATMENT
Eastern Cape							
Amathole Forestry Company (Pty) Ltd	387		15 000		x		
C J Rance (Pty) Ltd t/a Rance Timber	820	R180.0 million (2017)		2		X	X
Gauteng							
Bedrock Mining Support (Pty) Ltd	446				3	x	x
KAP Diversified Industrial (Pty) Ltd	1 425	R6 385.0 million (2017)	44 088	1	x	x	x
Merensky Timber (Pty) Ltd t/a Northern Timbers	1 045		11 000	1	x	x	
Mondi Ltd	25 400 (Group) (1 700 South Africa)	R94 933.5 million (2016)	155 537		X		
Sappi Ltd	12 158 (4,701 - South Africa)	R68 477.28 million (2017) (R17 489.0 million – Southern Africa sales)	479 000	1	x	x	
South African Forestry Company (SOC) Ltd t/a SAFCOL	2 310 (1 783 – South Africa)	R903.3 million (2016)	187 320	1	x	x	
KwaZulu-Natal							
Bracken Timbers (Pty) Ltd	1 300		5 400	1	x	x	x
Masonite (Africa) Ltd t/a Evowood	819	R618.17 million (2015) (R129.9 million – Forestry)	16 414	1	x	x	
NCT Forestry Co-Operative Ltd	562	R2 800.0 million (2017)	17 150 (own) 300 000 (for members)			x	4 (wood Chipping)

R and B Timbers (Pty) Ltd t/a Harding Treated Timber	180						X
Singisi Forest Products (Pty) Ltd	1 400		58 000	3	x	x	
SiyaQhubeka Forests (Pty) Ltd	1 218 (estimate.)		21 720		x		
Treated Timber Products (Pty) Ltd t/a TTP	350	R356.0 million (2017)	63		x		x
U C L Company (Pty) Ltd	1 375	R133.25 million (2017)	6 500	1	x	x	x
Mpumalanga							
York Timber Holdings Ltd	5 253 (Group)	R1 832.81m (2017) (External sales: R1 245.7 million – Processing plants; R523.2m - Wholesale; R60.7m - Forestry)	93 988	4	x	x	x
Western Cape							
MTO Forestry (Pty) Ltd	1 400		118,476	2	x	x	x

Source: Who Owns Whom (2018a: 11-13)

Figure 16: Forest area as a proportion of total land area (%)



Source: University of Oxford and Global Change Data Lab (2020)