

**IS COMMERCIAL FORESTRY SUSTAINABLE IN SOUTH AFRICA?: THE
CHANGING INSTITUTIONAL AND POLICY NEEDS**

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D. D. TEWARI*

***Professor, Division of Economics, School of Economics and Management, University of Natal (Durban), King George V Avenue, Durban 4001, South Africa. The financial assistance received from Research Office, University of Natal, Durban; and research assistance from Tania Kotsos, and Alan Isemonger, Charles Gasana is duly acknowledged.**

ABSTRACT

Commercial forestry is an important industry in South Africa, generating considerable employment and foreign exchange. The industry has grown rapidly after the World War II with active government support. However, since the beginning of the transition to democracy in 1991, there have been increasingly vociferous attacks on the industry regarding its urban and big business bias and its role in damaging the environment. The transition to democracy has brought a change in the structure or make-up of its stakeholders which have diverse expectations from the industry. At the same time, the sustainability of the industry is a major concern for policymakers and has to be dealt with in conjunction with concerns from its stakeholders and society at large. This study points out a need for new institutional or policy reforms and suggests a set of policy guidelines that might defuse the tension in the industry and set it on a sustainable path.

Key words: Commercial forestry, Institutions, Sustainability, Stakeholders, Environment.

IS COMMERCIAL FORESTRY SUSTAINABLE IN SOUTH AFRICA?: THE CHANGING INSTITUTIONAL AND POLICY NEEDS

INTRODUCTION

Commercial forestry is an economic force in the South African economy. For example, in 1996, the industry was a net exporter to the value of R1.7 billion which was roughly 7.8 percent to the overall exports of manufactured products (Burger, 1998, 69). The total turnover in 1996 was around R13.1 billion, and 35 percent of it was destined for exports (Burger, 1998, 68). The industry employed some 250 thousand people directly and some one million people indirectly (Ministry of Water Affairs and Forestry, 1996, 5). The economic significance of commercial forestry is expected to increase in the future which can be attributed to a constellation of factors. Firstly, the long-term growth prospects of the industry are assessed to be excellent. It is believed that annual wood demand facing the forestry industry will almost double from the current consumption of 19 million cubic meters by 2005 AD (Schargetter, 1987, 256-257). The Strategic Forestry Development Plan envisages a doubling of the afforested area over the next 25 years (Van der Zel, 1989). Secondly, there are strong income incentives for downstream wood processing industries to integrate backwards so as to plant more to earn more. Thirdly, being a world leader in the pulp and paper technology, South Africa has a strategic competitive advantage which she can harness to her benefit¹ (Kaplan et al., 1995).

However, since the beginning of the transition to democracy in 1991, there have been increasingly vociferous attacks on the industry; in particular regarding its urban and big business bias as well as the damage it causes to the environment. Also, after the transition to democracy, various other new groups have joined to the ranks of stakeholders of commercial forestry. Thus, the old image of industry—its urban and big business bias and white dominated management—is now being questioned as the transformation in South African society proceeds. Major concerns have been raised against the

environmental damage that it is causing to the society. The environmental damage is of diverse nature which includes: the loss of water, biodiversity, and aesthetic value of environment; soil and water pollution, soil compaction and erosion, and so on. Environmentalists and other interest groups believe that the success of commercial forestry, in particular the pulp and paper sector, has come at the expense of environment (Natal Mercury, 23/12/96). The twin factors—rising environmental concerns and changing structure of its stakeholders—have contributed to the rising concerns about the sustainability of the commercial forestry as such. Indeed, the commercial forestry in South Africa is now in a state of flux as it now seeks a socially, economically, and environmentally sustainable growth path.

Ensuring sustainability of the commercial forestry industry has thus become a major concern to policymakers and to those inside the industry, which can no longer ignore public concerns, unlike during the past apartheid regime. Also, the changing structure of stakeholders demands a re-structuring of priorities of the industry and the industry cannot simply follow a path of profit maximizing without being responsible to people and environment. The new environmental law, which adopts polluter pays principle, makes the industry responsible for the externalities that it generates (The Department of Environmental Affairs and Tourism, 1996). This requires an understanding of various issues; namely, the issue of environmental damage, the issue of stakeholder ship, and finally the issue of institutional and policy vacuum that has been generated through these changes.

This study makes a modest attempt to understand and analyze these issues with reference to the sustainability of the commercial forestry. A review of the historical factors which led to the development of commercial forestry down an environment-destroying path, is done in section one. The types and the extent of environmental damage caused by the industry are discussed in section two. An analysis of stakeholders, their interests, possible incentives, is done in section three. Various institutional and policy changes that should ensure sustainable growth of the industry are discussed in the last section.

COMMERCIAL FORESTRY AND DETERIORATING ENVIRONMENT

South Africa is not a naturally forest rich country and most of its natural forests are concentrated on the eastern coast in the provinces of the Mpumalanga and Kwazulu-Natal. It is believed that originally a very small area (0.1% of the total geographical area) was covered by indigenous natural forests. These included principally stinkwood and yellowwood tree vegetation. With the onset of European settlers in the seventeenth century, the indigenous forests were slowly cleared (Bethlehem, 1994, 46). Several efforts, dating as far back as 1882, were made to control the cutting of natural forests. These efforts met with little success. Finally the government banned the cutting of natural forests by law in 1939 (Bethlehem, 1994, 46).². However, the continuous rising demand for timber forced government to resort to the plantation forestry. The first plantation forest dates back to 1890 (Bethlehem, 1994, 46; King, 1938; Grut, 1965). In the beginning of 20th century, the government gave a big boost to the plantation forestry as an initiative to provide income and employment to poor whites and returned soldiers from the First World War (Van der Zel, 1989).

“The timber famine occurring during the (first world) war years, was a strong motivation after the war for the Republic of South Africa government to establish saw timber plantations with the object of attaining self sufficiency within 50 years. The economic depressions in the post-war period, and the unemployment coupled there with, provided the incentive for the RSA government to embark upon large afforestation schemes to provide a living to poor whites and returned soldiers (Van der Zel 1989)”.

During the following years of First World War, the timber prices rose significantly due to an international timber shortage. This gave further impetus to the investment in the forestry sector and attracted the private sector to participate in the afforestation (Grut, 1965; Lack, 1957). Up until 1960s, the bulk of afforestation was done by the South African government; and, after that private afforestation proceeded rapidly. The species planted were all exotic, mostly obtained from Australia and California. Between 1920 and 1990,

over one million hectares of commercial forests were planted (Bethlehem, 1994, 47). Currently commercial forestry covers some 1.37 million hectares, 1.1% of the total land area of the country³. Some 62.5% of the area is owned by private forestry companies such as Mondi, Sappi, and HL & H. Another 11.3% of the total cover is owned by individuals and partners under the umbrella of South African Timber Grower Association (SATGA). The rest 26.2% area is owned by the government and now being managed by the South African Forests Company Limited (SAFCOL) under the privatization program (Table 1). This effectively transformed South Africa from a net importer into a net exporter of timber products in the international market and the industry earns some R3.5 to 4 billion per annum in foreign exchange (Burger, 1998, 69). And, some 72% of this foreign exchange are attributed to the exports of pulp and paper related products (www.southafrica.net/economy/forest-agri/manage.html).

(Insert Table 1 here)

The pulp and paper sector of the industry is hence of utmost importance to the economy. The pulp, paper and board sector of South Africa is small but has a significant place in the international export market, traditionally dominated by North America and the Scandinavian countries. South Africa supplies less than 2% of international demand, though physical volumes have grown substantially over the last decade (Bethlehem, 1994, iii). The South African commercial forestry is dominated by two internationally acclaimed companies, Sappi and Mondi. Sappi is ranked 35th in terms of gross sales amongst the world's top 150 firms. From a profit perspective, Sappi was the 20th most profitable pulp and paper company in the world for the same year. Both companies are expanding internationally. Although South Africa is in a position is not among the dominant producers, consumers or exporters in the world pulp, paper and board industry, South African companies have evidently established themselves as significant players in the international market.

It is obvious by now that commercial forestry had become an economic force in the 1990s and beyond. This has happened due to both government protection and support and the economic opportunities that the industry has enjoyed over the years. Environmentalists and other interest groups believe

that the success of commercial forestry has come at the expense of the environment. This is a public unaccounted cost which needs to be made private.

ENVIRONMENTAL DAMAGE BY COMMERCIAL FORESTRY

It is important to mention that environmental concerns about commercial forestry are not new. From the early days, when plantations of Eucalyptus, Pines, or Wattles began, the South African government was aware of their long-term environmental consequences. The controversy about the effects of afforestation on water supplies began in the 1920s, and still continues today. This led to the development of Afforestation Permit System (AFS) since 1972. The major objective of permit system was to allow plantations in areas where environmental damage is within required limits. By 1994, nearly 1 million hectares had been permitted for afforestation but only 40% of this were planted. The commercial forestry consumed about 1.2 billion cubic meters of water that otherwise would have been available to downstream users (Ministry of Water Affairs and Forestry, 1996).

Two important social forces have elevated awareness off environmental costs imposed by the industry on the South African public. Firstly, global awareness about the environment has been rising since 1970s. This reached its zenith in 1991 when the countries of the world gathered at Rio Summit. The growing body of environmental knowledge and its dispersion made people increasingly aware of the intangible costs that commercial forestry imposed on the society but did not pay for. The environmental activist and non-governmental organizations played significant role in making these concerns heard at the national and international levels. Secondly, during the early 1990s, the democratic transition in South Africa took place and a new constitution provided safeguards for the protection of rights of people and the environmental resources of the nation; the polluter pays principle is accepted by the South African parliament⁴. The empowerment of people had made them to question the status that the industry had enjoyed in the past. As a result, the old image of industry is now being questioned.

Although commercial forestry generates sizeable amount of foreign exchange and employment, it also creates many intangible damages to the environmental capital of the country. These damages become especially important if we view their impact on the sustainability of the industry in the long run context. If this damage were allowed to continue unabated, the cost to the society would be enormous and perhaps irreversible too. The environmental damage occurs in various forms such as: loss of water yield, soil pollution, increasing soil compaction, loss of biodiversity, deterioration of scenic beauty and habitat, and so forth (Figure 1).

(Insert Figure 1 around here)

Loss of Water Yield

Water has been implicated as being the most important contributory factor restricting the growth and development of forestry in South Africa (Wood South Africa, 1992, 10). To ensure profitability, commercial companies plant water hungry alien species (principally Pine and Eucalyptus). It is the substantial dependence of the alien species on both ground water and surface run-off or rain, which affords them with their rapid maturity rate. Commercial forestry has thereby had to depend on one of South Africa's most scarce resources, water. Surface run-off currently accounts for more than 80% of South Africa's water supply. Owing to the average rainfall of 493 mm received per annum, compared to the average annual global rainfall of 860 mm, and together with long droughts and high rates of evaporation, South Africa is considered to be a semi-arid country (Environmental Monitoring Group (EMG), 1992, 64). In essence, water is the main contributing factor to the limitations of tree growth in South Africa (Boden, 1991, 49) and the availability of soil water has been recognized as the main factor influencing the growth of commercial plantations in South Africa. Declining yields may result as successive rotations of water-demanding species such as Eucalyptus and Pines deplete the reserves of soil water (Boden, 1991, 49).

Commercial timber planting uses larger quantities of water than shorter vegetation types, such as scrub, herbs and grass (Le Roux, 1990). Van der Zel (1985) indicated that for the Umvoti catchment, Pine trees would use

1080 mm of water compared to 850 mm for grassland, while Whitmore (1983) conducting a study in the Eshowe area indicated that afforestation tended to deplete substantially both the annual total water yield and the base flow in the dry season. Some estimates suggest that an establishment of 6 hectares of timber in South Africa would reduce the run-off by an equivalent amount of water required for one hectare of irrigated wheat (Le Roux, 1990). Pine plantations consume more water than indigenous trees as their evaporation rate is higher, resulting in a reduced streamflow (Forsyth, 1997). Pine afforestation (*P. Patula*) in the Drakensberg area decreased streamflow by 52% from 750mm to 360mm per annum (Le Roux, 1990; Forsyth, 1997).

If trees are planted in catchment areas on a large scale, there is a major impact on downstream users of water. Unfortunately owing to their high water-dependence, most plantations have been established in the escarpment areas of the country, which are also the water catchments of major rivers, particularly in the Eastern Cape, KwaZulu Natal and Mpumalanga provinces. Besides, the exotic trees are able to reduce water table reserves, which they reduce by the magnitude of 150 meters per annum (Forsyth, 1997). Consequently plantations seriously affect both water users downstream and the continued functioning of the river ecosystems. Plantation trees in catchment areas permit maximum infiltration of water and thus reduces supply of water for downstream users. This is clearly profitable to the owners of the respective commercial forests, but may be devastating to downstream users (Armstrong and Hensbergen, 1996).

Within catchment areas, the excessive use of water may affect not only the water table but the water availability to other crops as well. In KwaZulu - Natal, for instance, communities are experiencing severe water shortages as a result of such practices and rain-dependent agriculture has been further marginalized as the water table has dropped. Furthermore, these plantations are not conducive to the growth of undercover at ground level, resulting in a loss of natural habitats, more rapid soil erosion, as well as in enormous silt loads on rivers, especially where steeply sloped land is ploughed to boost production. Given the fact that South Africa's high-lying, high rainfall regions are very limited and they play a vital role in the generation of high-quality water, not only for irrigation and conservation but for human consumption as

well, the opportunity cost of water used by the commercial forestry is very high.

Increasing Land Degradation

Commercial forestry contributes to the process of land degradation in two major ways: first, the use of pesticides causes soil pollution; and, second, use of heavy machinery leads to soil compaction and to subsequent soil erosion problems (Figure 1). Commercial forests necessitate the heavy use of pesticides. There are environmental dangers associated with these chemicals drifting into the air or dissolving in rainwater which can in turn seriously affect downstream communities. The phenomenal growth rate of the Eucalyptus species can only be achieved through repeated fertilization with nitrogen and the extensive use of pesticides and herbicides but that the resultant economic and environmental costs may make the Eucalyptus species socially non-economical. Over and above the monetary expense of repeated fertilization, it bears a biological risk in that nitrogen and phosphorous in fertilizers attract harmful insects (Mueller-Dombois, 1992, 58). Such insect herbivore on Eucalyptus has resulted in high death rate of species, this being particularly evident in Australia. The success stories pertaining to Eucalyptus outside Australia can be attributed to the absence of insect pest; however, continued absence is by no means guaranteed. Furthermore, insect control will ultimately exacerbate the costs of maintaining Eucalyptus plantations (Mueller-Dombois, 1992, 58).

The other aspect of land degradation is soil compaction and erosion (Brink, 1990, 62; Armstrong and Hensbergen, 1996) and increased mechanization in the industry increases the seriousness of these two issues. Brink (1990, 59) accurately depicts the ensuing danger when he argues that "improper harvesting techniques is a catalyst destroying the environment, and should be avoided at all costs". The topic of soil compaction as a direct result of commercial forestry is one of complexity and concern. In essence, compaction involves a rearrangement of the soil particles such that they are closer together thereby increasing bulk densities. Bulk density itself is often used as a measure of compaction. Compaction has been associated with the weight of the machinery used in the industry, but it has been shown, however, rather a combination of the "pressure on the soil from the tyres or track of the vehicle and the axle load" (Whittal, 1991, 6). Other important influencing factors include the type of machinery employed, the number of passes, vibration levels, the frequency of harvesting and the stationary time (Brink, 1990, 63). Furthermore, the level of compaction at which negative effects commence differs between soil types. It is medium-to-fine textured soils, having a high silt and very fine sand content, on which compaction is most severe (Brink, 1990, 63). The degree of compaction itself is largely dependent on the soil moisture content, the susceptibility of the soil to compaction increases with the moisture present in the soil (Brink, 1990, 59; 63).

Research conducted by the Institute for Commercial Forestry Research (ICFR), has indicated that soil compaction on sensitive sites has several damaging consequences. The negative effects of compaction include: the inhibition of root development thereby reducing the volume of soil penetrated by roots for the uptake of nutrients and water; poor root pattern development; inadequate water infiltration and permeability, which in turn limits the availability of water to the plant, and increases soil erosion through higher runoff; compaction in run-off water adversely affects the off-site water balance; poor aeration resulting in a reduction in oxygen diffusion; a reduction in the availability of soil moisture; higher root penetration resistance; erosion of valuable top soil (Whittal, 1991, 6).

The overall impact of the above-mentioned effects are two-fold. In the first instance, there is an inevitable loss in timber yield, and, secondly, there are obvious environmental implications. For instance, Burger and Grey (1985) found that, in the Southern Cape, soil compaction still existed eight years after harvesting (Brink, 1990, 63). A consequence of soil compaction is soil erosion, particularly on the steeper sites (Brink, 1990, 63). In South Africa, donga and rill erosion alone have rendered three million hectares of land as unusable. This is equivalent to the permanent freezing of assets valued at R1.5 billion in 1990 prices (Brink, 1990, 63). The seriousness of such a figure is exacerbated when one considers the fact that it takes several thousands of years for one single centimeter of soil to form, thereby making soil, unlike trees themselves, a non-renewable resource. A 15% increase in soil density owing to compaction has been recorded to produce a 93% reduction in soil permeability, resulting in an increased water run-off. Arguably, one of the most significant on-site impacts associated with surface soil erosion is that of the loss of nutrient-rich top-soil, which in turn decrease site productivity. An off-site impact of particular concern is that of the transportation of sediment into stream systems thereby causing siltation (Brink, 1990, 65). The current forces causing compaction are likely to increase significantly in the near future (Whittal, 1991, 6).

Commercial forestry also adds to acidification of soils. Most commercial forests in South Africa were established in grassland ecosystem on naturally

acid soils which are prone to loss of mineral nutrients. About one-sixth of the plantations in South Africa are on soils with a high risk of acidification due to their shallowness and low buffer capacity. The acidity levels in South Africa have been found to be comparable to areas affected by acid rain in the western Europe (Ministry of Water Affairs and Forestry, 1996).

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Loss of Biodiversity

The preservation of biodiversity and the sustainable use of resources are considered as being two of the primary objectives of environmental conservation. In the first instance, it is essential to preserve biodiversity so as to prevent the loss of species and ecological processes vital to the operation of any ecosystem. Second, it is necessary that resources be used in a sustainable manner in order to ensure that development occurs in such a way that long-term benefits are derived from the resource base. The significance of biodiversity in the South African situation arises for two reasons: one, it forms part of South Africa's natural and cultural heritage; and two, biodiversity provides services essential for the continuation of life, such as clean air, fresh water and wildlife. Unfortunately the most suitable areas for commercial afforestation purposes in South Africa are also those regions in which biodiversity is most concentrated (Heydenrych, 1995, 20). Biodiversity is at risk in South Africa, particularly due to large scale plantations of Eucalyptus and Pines (Armstrong and Hensbergen, 1996). It has been found that the commercial plantations of Pines invade adjoining nature habitats, finally leading to loss of indigenous plant and fauna species. Porter (1990) estimated that some 43 animal species and 83 plant species are threatened by the commercial afforestation of Natal.

Afforestation replaces natural vegetation such as grassland or woodland, ancient communities rich in species--engendering a fundamental habitat change which impacts upon the biodiversity. Of these, the grasslands are the most affected; about 11% of the grasslands of the mountains and higher lying parts of South Africa are afforested; and, about 25% of the grasslands typical of the escarpment of Mpumlanga are afforested (Ministry of Water Affairs and Forestry, 1996, 14-15). Similarly, afforestation has replaced the sugar plantations and other agricultural crops in the eastern coastal forest zone. Even, afforestation has taken place in some environmentally threatened areas such as in the Eastern Shores of St Lucia and in the districts along the Drakensberg (Ministry of Water Affairs and Forestry, 1996. 15).

Deterioration of Scenic Beauty and Loss of Habitat

A landscape that is diverse in terms of natural, agricultural, and afforested areas has greater appeal to humans than a continuous monoculture (Porter, 1990). Pulp mills are associated with offensive odours, ash fallout, and an increased incidence of respiratory ailments. These have negative implications for the tourism industry (Porter, 1990).

The impact of commercial forestry on wetlands has been adverse and life-forms dependent upon these aquatic systems have also been threatened. Cooper (1990) reports that commercial afforestation in the Natal Midlands has been responsible for the loss of several wattled crane nesting sites, a bird whose existence is at stake. The wattled crane requires large wetlands for nesting and substantial areas of adjoining grasslands for rearing its young. Cooper (1990) also points out that commercial afforestation reduces the natural habitat for many endangered species such as the blue swallow, bustard, and the Oribi antelope. The breeding sites of the blue swallow in particular coincide with prime afforestation sites.

In addition to the above, the commercial forestry also competes with other forms of land use. The expansion of plantations has displaced local communities and agricultural farms, thereby placing excessive pressure on already marginal land. Moreover, commercial forests are aimed at meeting the demands of the pulp and paper industry, rather than the basic needs of local communities for fuel and building materials. This has, in turn, aggravated deforestation of adjacent homelands where people have been forced to over-exploit their limited timber resources.

At the current rate of extraction, South Africa's natural timber resources will be totally depleted within the next 30 years (Wood South Africa and Timber Times, 1993, 14). Population growth, together with extant poverty, is leading to increased pressure on South Africa's natural forest resources (Wood South Africa, 1992, 10). With an estimate of over 30% of the population being dependent on fuelwood as a primary source of energy, a potential energy

crisis awaits South Africa in the not too distant future. Furthermore, it has been estimated that some 8 to 10 million tons of fuelwood will be utilized annually by the year 2000 (Wood South Africa and Timber Times, 1993, 14). Estimates indicate that if the present consumption level of 8-10 million tons of fuelwood per annum continues then South Africa's natural woodlands will be almost entirely denuded by the year 2020 (EMG, 1992, 28). Such deforestation, in turn, contributes to soil erosion as well as to the loss of natural species and the elimination of habitats

Yet another serious consequence of deforestation is desertification, an environmental dilemma currently facing South Africa. The area worst affected by desertification is that of the Karoo in the North Western Cape, where the desert is advancing in an eastward direction at an alarming rate of 2.6 km per annum (Wilson, 1991, 30). An interesting point to note is that commercial forests have earned themselves the title of "green deserts" in that, unlike natural forests, they do not encourage biodiversity.

Other Environmental Damage

The practice of burning, necessary for plantation protection (Sappi, 1992, 15), is directly associated with negative environmental impacts such as the destruction of the top soil, increased erosion and with the loss of soil structure and nutrients. (Grey, 1989, 59). A study of soil fauna under Pines has indicated that it has changed within one rotation. Furthermore, there have been indications of the alteration of the nature of organic matter into compounds highly resilient to biological breakdown (Grey, 1989, 59). The primary cause of sediment reaching surrounding streams has been attributed to the inferior design of forest roads (Grey, 1989, 59). The marketplace shows little, if any, appreciation for factors such as soil quality and the intangible values accruing to landscape diversity, let alone to cultural values associated with archaeological sites, or aestheticism (Grey, 1989, 59).

As is evidently clear from discussion of commercial forestry in South Africa, its environmental implications are severe. The vast majority of these consequences represent negative externalities and the costs thereof are not borne by the industry itself but rather by society at large. The foregoing discussion reveals the types of damage that commercial forestry inflicts on the environment. We see there exist a trade-off between the benefits in terms of income and employment generation and costs that are incurred by the society in

terms of environmental damage. To resolve the issue of whether benefits to society exceed costs, we can resort to the social benefit- cost analysis (Table 2). However, this answers the questions of social efficiency, it does not examine the equity issues. The equity considerations need some other value criterion to regulate the commercial forestry so as to meet the aspirations of its stakeholders. A distressing yet true fact is that the vast majority of the key decision-makers in the field of commercial forestry are in fact lacking in the knowledge and background necessary to acquire a balanced appreciation of the environment (Grey, 1989, 60).

(insert Table 2 around here)

STAKEHOLDERS OF COMMERCIAL FORESTRY

There are various stakeholders in commercial forestry with disparate interest and, since the transition to democracy, the structure of stakeholders has undergone a drastic change. A better understanding of the objectives and interests of various stakeholders is needed for better planning so as to run the industry on a sustainable basis. The forestry White Paper sketches a preliminary list of the industry stakeholders which is reproduced below and is a useful starting point (Ministry of Water Affairs and Forestry, 1996)

- affected communities and their community-based organizations
- relevant firms from industrial forestry
- organized labor
- employees of the firms and agencies in the forest sector
- industry associations
- relevant government departments and agencies, including conservation agencies
- relevant parastatals and statutory councils
- agricultural organizations
- the tertiary education sector
- environmental organizations
- research bodies
- non-governmental organizations

- where appropriate, representatives of Southern African Developing Community states and the international community.

Various categories of stakeholders operate at different levels in the macro to micro continuum. The environmental interests of stakeholders depend upon where they operate upon the continuum. For example, at the micro level, land and forestry product issues dominate, while at the global and international level, the issues such as biodiversity conservation and climate regulation become of central importance (Table 3).

(Insert Table 3)

Within the commercial forestry itself there are two main stakeholders, namely management and forestry workers. The relationship between management and forestry workers is generally a mix of conflict and consensus. There is a consensus over the need to run an efficient company and conflict over the distribution of resources between management and workers. Attached to both of these interest groups are their respective dependants (though the workers, often coming from poorer rural backgrounds, have higher dependency ratios than management). The other historically important stakeholders in commercial forestry are the government and environmentalists. The roles of the environmentalists and the commercial organizations (management and workers) are almost directly opposed. As a rule, the environmentalists wish to see less and more careful commercial forestry, whilst the commercial organizations are intent upon profit maximization within certain constraints. In this scenario, government has a dual and a very responsible role. It has a vested interest in the revenue and employment-generating activities of the industry, whilst it has to act as final arbiter in matters such as the distribution of power between industry and environmentalists, as well as the distribution of resources between current and future generations.

Among the other major players are a number of smaller stakeholders. These include downstream commercial farmers (interested in water rights and runoff), the adjacent and downstream rural communities (water and fuelwood), urban communities (water and recreation), and, of course the future generations. A schematic diagram, showing the structure of stakeholders and their interrelationships, is shown in Figure 2.

(Insert Figure 2 around here)

What is evident is that there has been a structural shift in the distribution of power between the industry stakeholders. Before the 1994 elections, the distribution of power was concentrated in the hands of white management and commercial farmers, who were then, and are still now, almost completely white. The disenfranchised black workers, who until 1979 were not even allowed to organize trade unions, were almost completely disempowered. The concerns of the largely black communities adjacent and downstream from forests was as unimportant. In addition, the emphasis was more specifically on crude economic growth rather than sustainable development. In the new South Africa, the influence of commercial farmers is definitely on the decline (most noticeable are the issues of land restitution, the disbanding of the agricultural marketing boards, the probable imposition of a land tax, and the appropriation of water rights by government). The commercial forest companies have experienced a gradual weakening of their power and influence, although no single grouping has emerged to gather in that power. Rather the power that the companies have lost has been appropriated by government and also dispersed to the rural communities and the workers in particular. The proximity of the latter two to government and their voting power has empowered them.

Nowhere is this shift more obvious than in the speeches of Kadar Asmal, the former Minister of Land and Water Affairs. In a speech to the forestry industry on the 28th of May 1994, he extended the responsibilities of the forestry industry beyond the issues surrounding indigenous forests and conservation

(Wood South Africa and Timber Times, 1994, 6). He stated that his greatest concern lay with the wider community, ranging from the private forest owners to the thousands of workers, relying on the forestry industry for their livelihood. According to Asmal

"our responsibilities in the new South Africa are far wider than the environment, conservation, ecology or profit, however important these may be".

Some of these issues include: the adequate housing of all workers, together with their families; the rectification of the wastage occurring in timber plantation in such a manner so as to alleviate the pressure exerted upon natural fuelwood by rural communities; the provision of opportunities for local communities to make use of waste timber rather than natural fuelwood; and the creation of jobs as opposed to the drive for mechanization in the name of lower costs. The importance of community forestry is underlined by the government's white paper (Ministry of Water Affairs and Forestry, 1996, 3) which identifies this as one of the three central types of forestry, the other two being commercial and environmental forestry. If the forestry industry is to continue on its growth path of recent years, it is imperative that it becomes socially responsible and environmentally sustainable. Thus, a need for a new set of institutional and policy framework which would take into account the issues of efficiency as well as equity and build a sustainable path for the industry, has arisen. This is discussed in the next section.

CHANGING INSTITUTIONAL AND POLICY NEEDS

The foregoing discussion reveals a rapidly changing face of commercial forestry in South Africa in the post-apartheid era. As the various new entities and groups have joined the ranks of stakeholders of the industry, the pressure is mounting on to bring about the institutional and policy changes in the industry. The industry now needs to take cognizance of this change and realize that it cannot function any more without being answerable to people of South Africa.

A comprehensive social benefit-cost analysis of commercial forestry industry would help to clarify an increasingly acrimonious debate; however, it will not solve the problem of environmental damage per se. In sum, the environmental concerns emanating from the commercial forestry sector have now become real ones in the psyche of South African public and cannot be simply ignored. It is interesting to note that, contrary to most countries where forests are seen as producing net benefits to society, forests in South Africa appear to impose a net social cost. The possible changes that are asked of the industry should meet the aspirations of its stakeholders as well as the concerns raised about the sustainability of the industry as such. In order to make the commercial forestry an environmentally and socially responsible industry; five broad policy principles are suggested. (1) water pricing principle, (2) biodiversity protection principle, (3) multiple-use forestry management principle, (4) small-holder-promotion principle, (5) value-addition principle (Figure 3).

(Insert Figure 3)

Water Pricing Principle

In the past, water was used as a free resource, resulting into wasteful usage and less or no regard to its value. Commercial forestry is seen as a big user of water. This is reflected in terms of reduced run-off or streamflow, causing reduced water supplies to downstream users⁵. The stream reduction flow depends upon various factors including rotation, site, slope or topography, and species. The streamflow reduction from commercial forests in South Africa is estimated to be to the tune of 1.4 billion cubic meters per annum from an area of 1.44 million hectares of plantation; that is, 972.2 cubic meters per hectare per annum. The government has realized that water is a critical and scarce resource hence should be used efficiently. In order to materialize this, the new water bill provisions for charging for water. Forestry sector is not an exception to this.

Two types of charges are suggested: catchment management charge, and streamflow reduction charge. The forestry industry concurs with the first but challenges the second. The debate is not resolved yet and it is not clear whether a streamflow reduction charge would promote water conservation or not as the industry has no control on rainfall as such⁶. Whether a water charge on streamflow reduction would induce the forest industry to reduce forest plantations and release more water downstream users, is another issue. The

bottom line is that the industry will now have to meet, at least in part, the cost of scarce water resource. How will this materialize will depend upon the willingness of the industry and public at large, and the enforcement cost of the law. Pricing water is a step in right direction in the eyes of economists and is expected to induce efficient use of water in the economy, including the commercial forestry sector.

Biodiversity Protection Principle

Commercial forestry is blamed for its monoculture cropping and consequent adverse impacts upon the biodiversity. Unchecked and not properly coordinated forestry will eventually reduce the genetic variability in plants and in animals. The long-run opportunity costs of commercial forestry could be very high. It is hence essential to devise ways to ensure a coordinated growth of the industry without jeopardizing the biodiversity of the nation.

To circumvent the difficulty, two possible solutions are suggested: one, to impose a biodiversity tax on the industry and the proceeds from this could be invested in the maintenance or creation of biodiversity; two, to introduce the zoning concept in the forestry so as to meet local, regional, and global demands on the forestry sector. A flat tax on the commercial forestry to generate biodiversity protection is probably politically infeasible. Zoning could be a more politically accepted method of deflecting the negative biodiversity impacts of commercial forestry. Under this approach, the entire country can be divided into four zones. Zone one would include natural forest areas which are to be undisturbed and kept for ecological reasons. Some areas of Kruger National Park and sanctuaries would fall in this category. Zone two would cover areas which can be partially harvested periodically but without disturbing the forest stand. Zone three would include commercial forestry with major objective of earning market revenue and zone four would include community and farm forestry to meet the local needs in terms of fuelwood, fodder, and other non-timber forest products.

Value Addition Principle

This principle recognizes that raw material exports from a region or country could be beneficial and thus value can be added to them locally. The benefits from this value addition would arise in terms of income and employment generation in the domestic economy. This argument is grounded in what is normally termed as the beneficiation of natural resources strategy (Kaplan et al., 1995). The beneficiation philosophy is based on the fact that the value per unit of weight of processed resources is far more than that of the raw or unprocessed materials. Despite her natural advantage in low cost of timber fiber and very low energy costs and eventual success in production of pulp/rayon, South Africa still exports quality raw timber, wood chips and unsawn log to foreign markets, particularly to

Japan. The argument here is that value could be added to these raw materials using the potential in the paper industry and in furniture manufacture.

Multiple Use Management Principle

With the increasing variety and numbers of stakeholders of commercial forestry, the most critical task is to accommodate the interests of divergent groups of stakeholders having different objectives or goals. This requires a switch from single objective profit maximizing to multiple objectives or goals such as a combination of maximizing profit, employment, income of poor workers, and community development in rural areas. To this end, the practice of multiple use management of forest resources is recommended.

The multiple use management concept entails promotion of forestry practices which increases both productivity of forest and the diversity of forest products. These practices would include a combination of commercial forestry, community and agro-forestry, natural and indigenous forest management, and the development of non-timber forest products. This means that commercial forestry sector should promote alternative models of forest management so as to meet the multiple goals of its stakeholders. The community forestry and agro-forestry could fulfil this goal partially. The natural forest regeneration option can be adopted for promotion and protection of indigenous forests. This method does not require heavy doses of fertilizers and pesticides and can hence be suited to various community management systems.

Moreover, the diversity of forest species permits the production of multitudes of products, including timber and non-timber forest products, besides environmental benefits. The non-timber forest products are an important part of multiple use management as they generate income and employment for villagers and at the same time promoting ecological future of forest.

Small holder Promotion Principle

Promotion of small holder tree growers is necessitated to meet the aspirations of many stakeholders to have fair share of cake. Smallholder cultivation is expected to: (1) produce fuelwood for meeting energy needs of the rural people; (2) alleviate poverty by generating income and employment;

and (3) conserve fragile ecosystem; and (4) to halt the process of deforestation. In South Africa, wood is primary source of fuel for 12 million rural and urban dwellers; and, more than 10 million cubic meters of firewood is chopped annually in South Africa, amounting to 75 thousand man-hours spent every year on the gathering of wood (www.southafrica.net). Most small growers enter into contracts with timber companies. Sappi and Mondi--the two main companies--have small grower schemes. Mondi's small grower scheme is considered to be unattractive as it demands a considerable amount of capital, forcing farmers to sell their land to the company. Sappi's small-grower scheme "Project Grow" which was aimed at the small-scale growers in Kwa-Zulu Natal, has been successful. All land and labor inputs are provided by the farmer whilst Sappi provides tree saplings, silvicultural training and planting supervision, and interest free capital which is offset against the value of crop. These individuals own area between 2 and 7 ha of tribal land. The scheme started in 1983 with three growers on 5 ha of land and since then the membership has grown more than 2000 growers on more than 4000 ha of land. Interestingly enough, many of these small growers happen to be women.

The economic impacts of small-scale timber growing are manifold. One survey showed that net profits from timber comes about R2124 per hectare for the first rotation which translates to R340/ha/annum (Cairns, 1993). Economic spin-offs also occur in terms of development of micro-enterprises in contracting and haulage, and employment of local people in building the roads in rural areas. Small timber growing can empower women if they had the land. However, conflicts between the afforestation permit system and the small timber growers can also emerge when small timber growers, if not regulated, can add up to a large forestry development with a major collective impact on run-off. In many areas, such as in Transkei, forestry is considered as not part of tribal culture and afforestation attempts have largely failed.

SUMMARY AND CONCLUSIONS

Commercial forestry industry in South Africa is a success so long as only its profit, foreign exchange, and employment generating potentials are considered. However, over the years, the industry has caused a large damage to environment primarily in terms of land-degradation, loss of water yield and biodiversity and deterioration of scenic beauty and loss of habitat for many animals and birds. Although quantifying these cost is an uphill task, it is believed among experts that these damages are of sizeable nature and had been borne by the society at large. Rising public awareness about the environment in the post-apartheid South Africa has engendered concerns in the minds of people, environmentalists, activists, and the policymakers. Furthermore, since the transition of South Africa to democracy, various new groups and entities have joined to the ranks of stakeholders of the industry. Most of the stakeholders come from poor black and formerly disadvantaged position and question the urban and big business bias and white dominated management of the industry. The question of sustainability is thus the uppermost and cannot be ignored without taking into account the sociocultural context. This has created a need for a new set of institutional and policy changes. Five broad policy principles are suggested to make this happen: water pricing principle, biodiversity protection principle, value addition principle, multiple-use forestry management principle, small-holder promotion principle.

REFERENCES

- Armstrong, A. J. and Van Hensbergen H. J. (1996) 'Impacts of Afforestation with Pines on Assemblages of Native Biota in South Africa'. **South African Forestry Journal**. No.175: 35-41, March
- Anonymous, "Water Pricing in South Africa", **Commonwealth Forestry Review** , September, 1998.
- Bethlehem, L., **An Industrial Strategy for the Pulp and Paper Sector**; Rondebosch: UCT Press, 1994.
- Boden, D. I., (1991), "The Relationship between Soil Water Status, Rainfall and the Growth of Eucalyptus Grandis", **South African Forestry Journal**, No. 156, March.
- Bosch, J. M. and Gadow von K. 1990. 'Regulating Afforestation for Water Conservation in South Africa'. **South African Forestry Journal**. No.153: 41-54, June
- Brink, M. P. (1990), "The Environmental Impacts of Harvesting as Related to Soil Compaction and Erosion", **Wood Southern Africa**, February.
- Burger, D. (ed) **South Africa Yearbook 1998**, Government Communication and Information System, Pretoria, 1998.
- Byford-Jones, C. (1989), "Timber Now More Profitable than Beef and Sheep" **Farmer's Weekly**, December.
- Byford-Jones, S. C. (1989), "No Danger from Eucalyptus", **Farmer's Weekly**, November 24.

Cairns, R. I. **Small Grower commercial Timber Schemes in KwaZulu, Center for Social and Development Studies**, University of Natal, Durban, 1993.

Cellier, G. A. (1993), "The Changing Landscape: Is there Room for Forestry in the New South Africa?", **South African Forestry Journal**, No. 167, December.

Coetzeer, H. and Cooper, D. (1991), "Wasting Water: Safeguarding a Precious Resource", **Going Green**, Cape Town: Oxford University Press.

Cooper, R. H. (1990), "Commercial Forestry Impact on Wetlands, Grasslands, and Indigenous Forests" cited in Erskine (1990).

Department of Environmental Affairs and Tourism, **Towards a New Environmental Policy for South Africa**, Discussion Document, 1996.

Edwards M. (1990), "The Economic Significance of the Forestry and Forest Products Industry to the Natal-KwaZulu Region", In: Erskine J. (ed) "The Physical, Social and Economic Impacts of Large Scale Afforestation In Natal/KwaZulu", **Proceedings of the Forestry Impacts Workshop**, 8th May, Institute of Natural Resources, South Africa.

Environmental Monitoring Group (1992), **Toward Sustainable Development in South Africa**; Cape Town: EMG, Western Cape, 34.

Erskine, J. (1990) ed. **The Physical, Social, and Economic Impacts of Large-Scale Afforestation in Natal/Kwazulu**, Proceedings of the Forestry Impacts Workshop 8 May, Institute of Natural Resources, Pietermaritzburg, 1990.

Forest Industries Association (1995), "Commercial Forestry Stands United on Policy Issues"; **Wood Southern Africa and Timber Times**, April.

Forest Owners Association (1996), **Abstract of the South African Forestry Facts for the Year 1994/5**, Leaflet.

Forestek, (1992); 'Forestek and the Environment'; **Wood Southern Africa**; May

Forsyth G. G., Versfeld D. B., Chapman R. A., and Fowles B. K. 1997. **The Hydrological Implications of Afforestation in the North-Eastern Cape. 'A Survey of Resources and Assessment of the Impact of Land-use Change'**. WRC Report N0. 511/1/97.

Gandar, M. (1991), "The Imbalance of Power"; **Going Green**; Cape Town: Oxford University Press

Grimble, R.J. J. Aglionby, and J. Quan. **Tree Resources and Environmental Policy: A Stakeholder Approach**, NRI, ODA, 1994.

Forest Owners Association (1996), **Forestry and Forest Products Industry Facts and Figures (1996)**, September.

Forest Owners Association (FOA). 1998. **Abstract of South African Forestry Facts**.

Forest policy Discussion Paper (1995),
(<http://www.polity.org.za/gnu/dwaf/discussion.htm>)

Forestry White Paper (1996), (<http://www.polity.org.za/gnu/dwaf/whitepaper.htm>)

- Frederick, K.D. (1993), "Balancing Water Demands with Supplies: The Role of Management in a World of Increasing Scarcity." **World Bank** Technical Paper, No. 189.
- Gibbons, D.C. (1986), "The Economic Value of Water", **Resources for the Future**, Washington, DC.
- Grey, D.C.(1989), "Conservation Research Requirements and Commercial Forest Management", **South African Forestry Journal**, No. 149, June.
- Grut Mikael. 1965. **Forestry and Forestry Industry in South Africa**. Cape Town.
- Hacker, F. (1995), "Environmental Auditing in South African Forests", **Wood Southern Africa and Timber Times**, July.
- Hanke, S.H. and Davis, R. (1973), "Potential for Marginal Cost Pricing Water Resources Management", **Water Resources Research**, 9(4):
- Heydenrych, B. (1995), "Forestry Plantations vs Biodiversity", **Veld & Flora**, March.
- Kaplan, D., Lewis, D., Kaplinsky, R., and Joeff, A. (1995). (1995), Section 1 of Improving Performance in South Africa: Report of the Industrial Strategy Project. Cape Town, University of Cape Town Press.
- King, N. L. 1938. 'Historical Sketch of the Development of Forestry in South Africa'. **South African Forestry Journal**. No.1: 4-16, October
- Lack, C. E. 1957. **Forestry Development in Natal**. The South African Forestry Association. **No. 29: 19-30, May**

- Le Roux, S. D. (1990), "The Impact of Afforestation on the Agricultural Resources of Natal," Forestry Impacts Workshop, 8 May 1990. Cited in Erskine (1990).
- Louw, J. (1994), "Scientific Models for Plantation Management", **Wood Southern Africa and Timber Times**, September.
- MacLennon, L. (1993), "The ICFR's award Winning Coulter Ripper-a Tool for Effective Slash Management", **Wood Southern Africa and Timber Times**, July.
- Marais, G. (1995), "SAFCOL: Milestones in the Forestry Environment", **Wood Southern Africa and Timber Times**, June 35
- Martin, W.E., Ingram, H.M. Laney N.K. and Griffin, A.H. 1984) "Saving Water in a Desert City." Resources for the Future, Washington, DC..
- Ministry of Water affairs and Forestry, Sustainable Forest Development in South Africa, White Paper, March, 1996.
- Mueller-Dombois, D., (1992), "Sustainable Forestry: The Role of Eucalypts and Lessons from Traditional and Artificial Monoculture Systems", **South African Forestry Journal**; No. 162, September
- Porter, R.N (1990) Future afforestation and the potential impacts on Nature Conservation in Natal cited in Erskine, 1990.
- Rezende, A evaluating Forestry Projects, Ph.D. Thesis, Faculty of Forests, University of Toronto, Canada, 1978.

- Saville, A. (1994) **The Forestry Sector in KwaZulu/Natal**, unpublished paper, department of Economics University of Natal, Durban.
- Schargetter, H. (1987) "Timber Resources and Needs in Southern Africa" in **South African Journal of Science** 83 (5): 256-7.
- South African Forestry Institute, (1995); "South African Forestry Industry Environmental Statement"; **Arbor**; March.
- Sappi, (1992); "Responsible Plantation Management", **Wood Southern Africa**; October.
- Scotcher, J., (1995), "The Integration of Environmental Management into Sappi Forests", **Wood Southern Africa and Timber Times** June.
- Small Grower Development Trust (1996) Annual Review 1995-1996, unpublished.
- van der Zel, D.W., (1995); "Forestry Companies Take Lead In Environmental Well-Being", **Arbor**; June.
- van der Zel, D.W. (1985) **A Decision Making Modeling Approach to Mountain Catchments Management in Southern Africa**. PhD Thesis, Cited in Erskine, (1990).
- van der Zel, D.W. (1989) **Strategic Forestry Development Plan for South Africa**, Pretoria: Directorate of National Forestry Planning, Department of Environmental Affairs, RSA.
- Whitmore, J.S. (1983) Effects of Forests on the Water Yield of Catchments and on the Flow Characteristics of Streams. **Report** prepared for the Eshowe Soil Conservation Committee, July Cited in Erskine (1990).

Whittal, B., 1991; "The Latests News on Compaction" **Wood Southern Africa**; February.

Wilson, F., 1991; "A Land Out of Balance"; **Restoring the Land**; London; Panos.

Wood SA, (1992), "Wood preservation essential to reduce stress on resources" **Wood Southern Africa**, August.

Wood S A/Timber Times', (1994); "The new Minister of Water Affairs and Forestry speaks", **Wood Southern Africa and Timber Times**; June 36

Wood SA/Timber Times, (1993); "Focus on Rural Forestry: Trees for the People"; **Wood Southern Africa and Timber Times**; August

Wood SA/Timber Times, (1993); "Save time and costs with low water volumes in forestry weed control spray programmes", **Wood Southern Africa and Timber Times**, August.

Press Clippings

Business Report (19/10/96) "EU calls for realistic water price".

Business Report (27/11/96) "Safcol privatisation probe on hold".

Cape Times (23/11/96) "Govt. to scrap water ownership rights".

Financial Mail (01/09/95) "Kader Asmal's difficult choices".

Natal Mercury (23/12/96) "Asmal steps in to defuse conflict between timbermen and environmentalists".

SaturdayStar (02/08/96) "We pay too little for Water".

The Star (09/07/96) "Action needed to keep rivers flowing Asmal".

The Star (13/11/96) "18m people lack sufficient water supply".

The Star (26/11/96) "Cabinet approves radical water - law changes".

Table 1: Distribution of Commercial Forestry Acreage, South Africa, 1990

Particulars	% Area Owned	Afforested Area (m. ha)
Private Companies		
Mondi	25.7	0.35
Sappi	22.1	0.30
HI& H	14.7	0.20
Sub-total	62.5	0.85
Individuals and Partners		
	11.3	0.16
State (Safcol)	26.2	0.36
Total	100.0	1.37

Source: Constructed from data obtained from Bethlehem (1994, 47).

Table 2: Benefits and Costs of Commercial Forestry, South Africa

Benefits	Costs
Foreign exchange	Water loss
Income generation	Pollution costs
Employment generation	Soil compaction
Natural air filter	Soil erosion
Windbreaker	Loss of soil fertility
Reduced pressure on indigenous forests	Loss of habitat
Supply of fuelwood	Deforestation
New wildlife habitat	Competing land use for agriculture and livestock
Use of marginal lands	

Source: Based on discussion with experts in the forestry sector

Table 3: A Typology of Commercial Forestry Stakeholders on a Macro to Micro Continuum

Continuum level	Example stakeholders	Environmental interest
Global and international level	International agencies, Foreign governments Environmental lobbies, Future generations	Bio-diversity conservation climatic regulation
National level development,	National governments, Macro planners, Urban pressure groups NGOs	Timber extraction, tourism resource and catchment protection
Regional level	Forest departments, Regional authorities, Downstream communities	forest productivity, water supply protection, soil depletion
Local off-site supply,	Downstream communities, Logging companies and sawmills, local officials	protected water supply, access to timber conflict avoidance
Local on-site	Forest dwellers, Forest-fringe farmers, Livestock keepers, Cottage industry	Land for cultivation, timber and non-timber forest products, cultural sites

Source: Adapted from Grimble et al (1994).

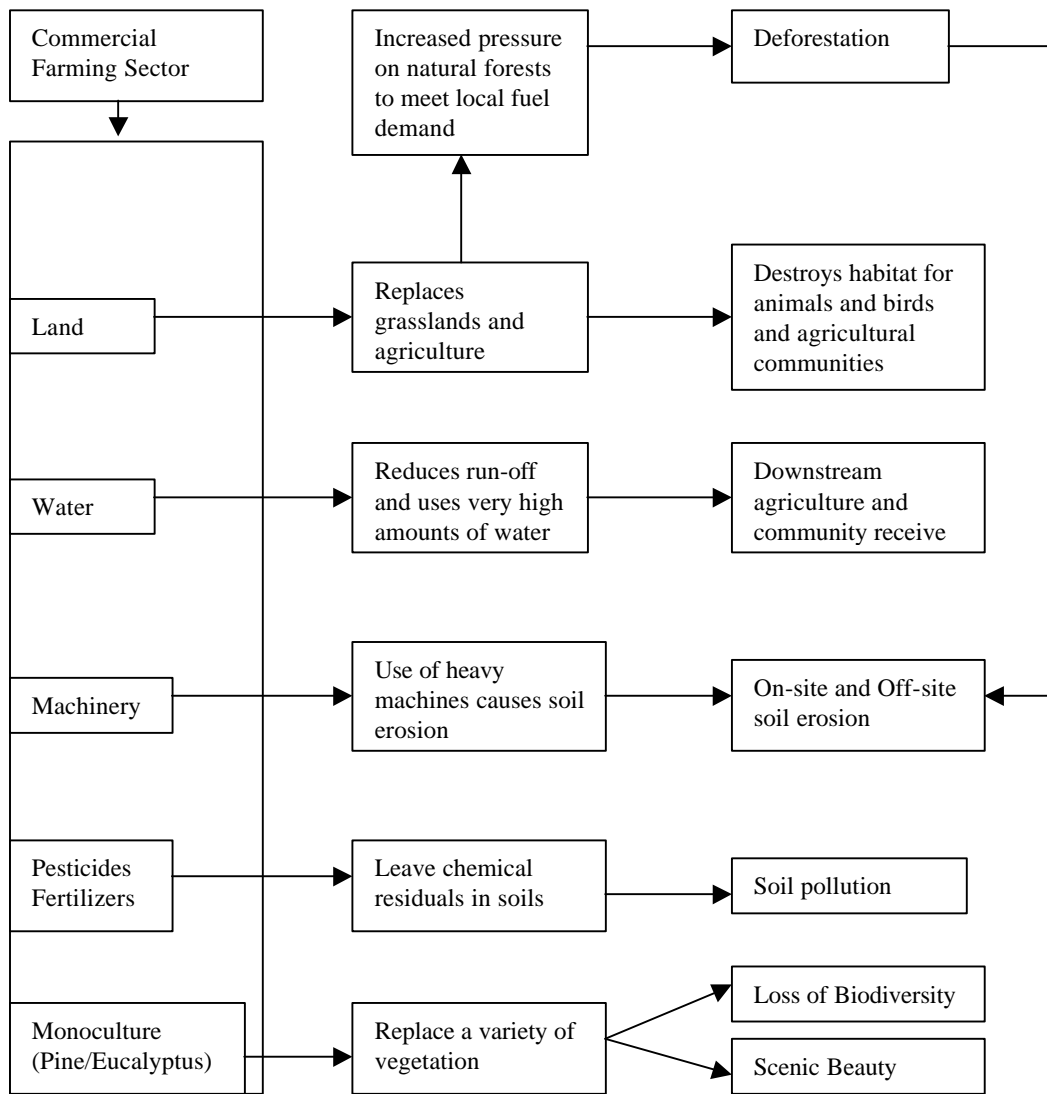


Figure 1: A Schematic Diagram Showing Environmental Impacts of Commercial Forestry, South Africa

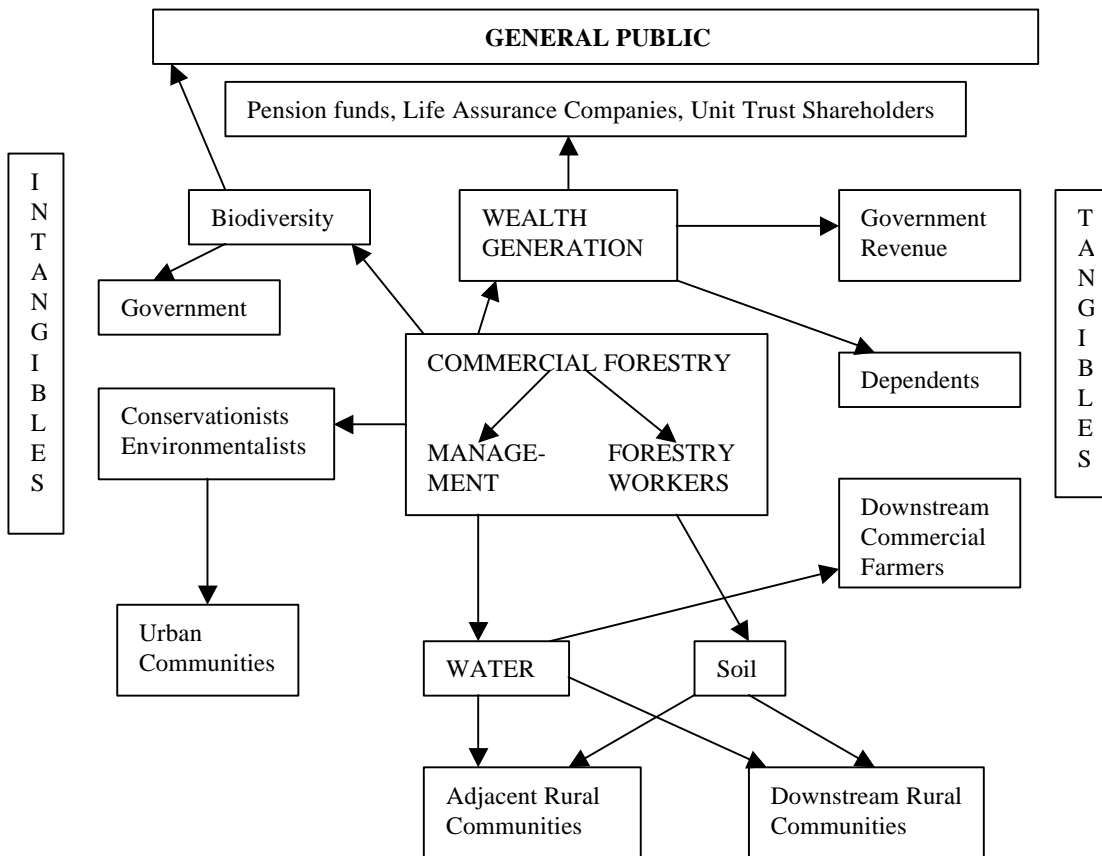


Figure 2: A Schematic Map of Stakeholders of Commercial Forestry in South Africa

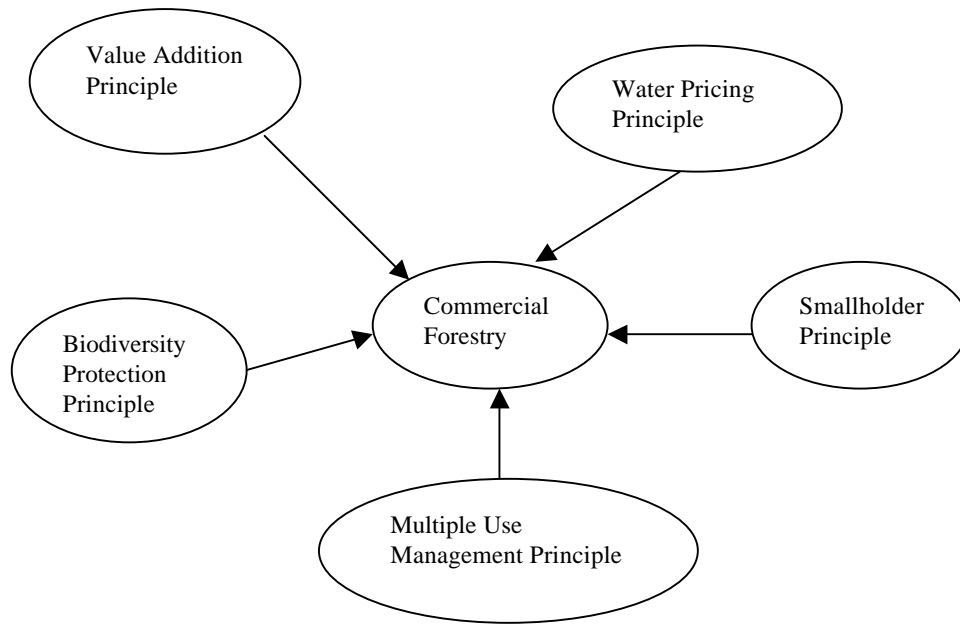


Figure 3: A Framework for Sustainable Commercial Forestry in South Africa

ENDNOTES

¹ South Africa has developed many technique locally and globally under license (www.southafrica.net/economy/forest-agri/mange.html).

² Currently only about 200 thousand hectares of natural forest remain in South Africa. These are protected areas and are not harvested.

³ According to Forest Owners Association (1998), the total area is near 1.5 million ha (1.3 % of the total land area).

⁴ The Section 24 of the Bill of Rights guarantees that every one has the right: (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development (Department of Environmental Affairs and Tourism, 1997). The environmental policy of South Africa is built upon the following principles: (a) accountability which requires the government to be responsible for policy formulation, monitoring, and enforcement; (b) capacity building which requires that all people be given opportunity to develop the understanding, skills and capacity for effective participation in achieving sustainable development and sustainable resource use; (c) coordination which calls for the integration of environment into the work of all government institutions; (d) cradle to grave management , i.e., managing the environment throughout the life cycle of a product or process or any other activity; (e) full cost pricing which requires that the full cost or social costs of environment is to assessed in making decisions; (f) equitable access to environment; (g) due process applied to all environmental management decisions; and , (h) global and international cooperation and responsibilities requiring the governments to recognize the shared responsibility for global and regional environmental issues (Department of Environmental Affairs and Management, 1997).

⁵ Streamflow reduction is more rapid under Eucalyptus than under Pines; the mature plantation of both can cause mean flow reduction of 5000 cubic meters per annum per planted hectare (Anonymous, 1998, 7).

⁶ However, some studies in the Western countries have shown that the forests can increase the local precipitation up to 5% of the rainfall in a region (Rezende, 1978, 71).