The impacts of rural industry on the native forests of Papua New Guinea

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As a leading member of the Coalition for Rainforest Nations, Papua New Guinea (PNG) has a vested interest in proving to the international community that it could reduce the volume of greenhouse gas emissions from the process of deforestation and forest degradation if suitable financial incentives were to be provided for such action. An assessment of the baseline or 'business-as-usual' scenario for emissions from this process is therefore crucial to current debate about the relationship between national forest policy and measures taken to mitigate the impacts of climate change. This paper shows that the PNG government's own attempts to construct a baseline scenario for the contribution made to this process by logging and agribusiness companies have ignored a number of significant supply-side constraints on their economic activities, both in the past and in the future. This can be understood as the result of a perverse incentive for the governments of 'rainforest nations' to exaggerate the past, present and future rates of deforestation or forest degradation in order to claim a reward for reducing greenhouse gas emissions from a fictitious or exaggerated baseline to a level which approximates the real trajectory.

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There is a longstanding scientific debate about the significance of different drivers of tropical deforestation. This debate has recently acquired greater political significance because of proposals to compensate 'rainforest nations' for the reduction of greenhouse gas emissions from deforestation and forest degradation (REDD). Papua New Guinea is not only a rainforest nation but also has a government that plays a leading role in the Coalition for Rainforest Nations, and is therefore a leading advocate for REDD payments. This article is not concerned with all of the direct and indirect drivers of deforestation and forest degradation in Papua New Guinea, but only with the question of how to assess the direct contribution made to this process by the activities of logging and agribusiness companies, which are here combined under the label of 'rural industry'. My more specific concern is to assess the validity of

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claims made about this contribution by the PNG government itself.

The PNG government's Development Strategic Plan (GPNG 2010b:90) targets very substantial growth in the production of Papua New Guinea's four major export crops over the next 20 years (Table 1). The plan does not set an equivalent target for the harvesting of logs from native forests or timber plantations, but it does predict that the share of processed-timber exports in the value of total forest product exports will increase to 80 per cent by 2030 (GPNG 2010b:94). It also says that Forest Clearing Authorities (FCAs) will be used to 'prevent felling of virgin forests unless the land is developed to provide sustainable jobs and income, whether through agriculture, plantation or other profitable land uses' (GPNG 2010b:95).

The PNG government's policy statement on climate-compatible development (hereafter called the climate change policy) constructs a 'business-as-usual scenario' in which the output of three major export crops (palm-oil, coffee and cocoa) is assumed to grow by 2 per cent a year over the same period, although the area planted to oil-palm is assumed to grow at the rate of 5–6 per cent a year (GPNG 2010a:11). In the climate change policy, the annual log harvest is projected to grow from 2.8 to 3.5 million cu m, with an 'upper-end scenario' in 2030 wherein one-tenth of the harvest will be derived from 'one-off timber extraction from land cleared for commercial plantations', while the rest is derived from 'commercial logging' (GPNG 2010a:12).

I argue that these projections fail to take account of significant supply-side constraints on the development of rural industries in Papua New Guinea, regardless of any change in demand for the commodities they produce or in the distribution of economic rewards between industry participants or other parties. Insofar as these industries are partly responsible for the process of deforestation and forest degradation in Papua New Guinea, their contribution is therefore likely to be diminished in years to come, whether or not the PNG government takes additional action to reduce the level of greenhouse gas emissions from this process.

Measuring impacts on native forests

The starting point for my assessment of recent changes in Papua New Guinea's forest cover is a data set known as the PNG Resource Information System (PNGRIS), which is derived from a variety of scientific field surveys that were carried out over 20 years (1953–72), complemented by the

Table 1 Planned increase in annual production of major export crops by 2030 (metric tonnes)

Crop	Baseline	Target	Percentage change
Palm-oil	556,000 (2007)	1,600,000	+187.8
Copra	110,000 (2007)	440,000	+300.0
Coffee	63,000 (2008)	500,000	+693.7
Cocoa	56,000 (2008)	310,000	+453.6

Source: Government of Papua New Guinea (GPNG), 2010b. *Papua New Guinea Development Strategic Plan 2010–2030*, Department of National Planning and Monitoring, Waigani.

analysis of two sets of aerial photographs with national coverage (Bellamy and McAlpine 1995). In most of the publications associated with this data set, 1975 is treated as the 'baseline year' for the analysis of changes in the national landscape, but the second set of aerial photographs largely dates from 1973, so that is treated as the baseline year in this article.

The PNGRIS data set divides Papua New Guinea's landmass into several thousand physical environments (known as resource mapping units), attributes one or more 'forest types' or other 'vegetation types' to each of these polygons, estimates the extent of 'disturbance' in each type of forest, and makes a separate estimate of the proportion of land in each polygon that is 'used' by human beings (Hammermaster and Saunders 1995). The information about vegetation communities has been condensed into two baseline maps of 'agricultural land use' and 'forest resources'. The first map (Saunders 1993a) assigns areas of 'cultivated land' to one of seven classes of 'land-use intensity', ranging from an 'extremely low' level, where less than 10 per cent of the vegetation is man made and less than 1 per cent is being cultivated (while the rest is in some form of fallow), to a 'very high' level, where more than 75 per cent of the vegetation is man made (but a distinction is drawn between land planted with tree crops and land dominated by subsistence crops). A broader distinction can also be drawn between areas of 'significant' land-use intensity, defined as those in which the proportion of man-made vegetation is more than 20 per cent of the total, with more than 1 per cent under cultivation at any one time, and areas of 'low' or 'light' land-use intensity, defined as those in which the proportion of man-made vegetation is less than 50 per cent of the total, with less than 1 per cent under cultivation at any one time. Most areas of low land-use intensity are described as 'forests' in the PNGRIS map of forest resources (Saunders 1993b), while most areas of significant land-use intensity are described as 'non-forested areas'. Interpretation of both maps, however, needs to recognise that part of the 'forested' area has been disturbed (to a greater or lesser extent) by the practice of shifting cultivation, so the whole of this area cannot exactly be described as 'primary forest', while the total area of 'significant land use' includes small areas of primary forest (with no sign of human disturbance) and quite large areas of man-made 'secondary forest' or forest fallows.

In 1993, some of the architects of the PNGRIS data set began work on the production of a second spatial data set, which is known as the Forest Inventory Mapping System (FIMS), and which has been used as the basis for Papua New Guinea's contribution to the Global Forest Resource Assessments published by the United Nation's Food and Agriculture Organization (FAO) (Ambia 2005; Ambia et al. 2010). As the main purpose of this data set is to assess the potential for sustainable commercial forestry operations, the authors removed certain types of forest from what they called the 'total gross forest area' because they would never be suitable targets for such operations. Further subtractions were then made from the 'adjusted gross forest area' (which is often simply called the 'gross forest area') where either there were major physical constraints to large-scale logging operations or the estimated timber resource fell below a certain minimum standard. The result was something described as the total area of 'potential production forest' (Table 2).

The authors of the FIMS data set used satellite imagery, supplemented by rapid ground and air surveys, to assess the extent of change in forest cover and land-use intensity over the period 1973–96

Table 2 **FIMS derivation of potential production forest from gross forest area, 1973**

	Area (sq km)	Land (%)
PNGRIS total land area	464,099	100.0
PNGRIS total gross forest area (including mangroves)	336,666	72.5
FIMS adjusted gross forest area	293,175	63.2
FIMS potential production forest area	137,114	29.5

Source: McAlpine, J. and Quigley, J., 1998. *Forest Resources of Papua New Guinea: summary statistics from the Forest Inventory Mapping (FIM) system*, Coffey MPW Proprietary Limited for the Australian Agency for International Development and the Papua New Guinea National Forest Service, Canberra.

Table 3 **FIMS assessment of changes in forest cover, 1973–96**

	Area (sq km)	1973 (%)
Adjusted gross forest area in 1973	293,175	100.0
Forest logged and left to regenerate by 1996	19,223	6.6
Forest logged then converted by 1996	3,476	1.2
Forest converted but not logged by 1996	9,397	3.2
Adjusted gross forest area remaining in 1996	280,302	95.6
Unlogged forest area remaining in 1996	261,079	89.1

Source: McAlpine, J. and Quigley, J., 1998. *Forest Resources of Papua New Guinea: summary statistics from the Forest Inventory Mapping (FIM) system*, Coffey MPW Proprietary Limited for the Australian Agency for International Development and the Papua New Guinea National Forest Service, Canberra:Table 4.

Table 4 **FIMS estimates of potential for logging in 1996**

	Area (sq km)	Area (%)
Unlogged forest area remaining in 1996	261,079	100.0
Potential production forest area remaining	116,833	44.8
Unlogged forest area in concessions	59,732	22.9
Potential production forest in concessions	33,997	13.0
Unlogged forest area unallocated	201,347	77.1
Potential production forest unallocated	82,837	31.7

Source: McAlpine, J. and Quigley, J., 1998. *Forest Resources of Papua New Guinea: summary statistics from the Forest Inventory Mapping (FIM) system*, Coffey MPW Proprietary Limited for the Australian Agency for International Development and the Papua New Guinea National Forest Service, Canberra:Tables 6 and 8.

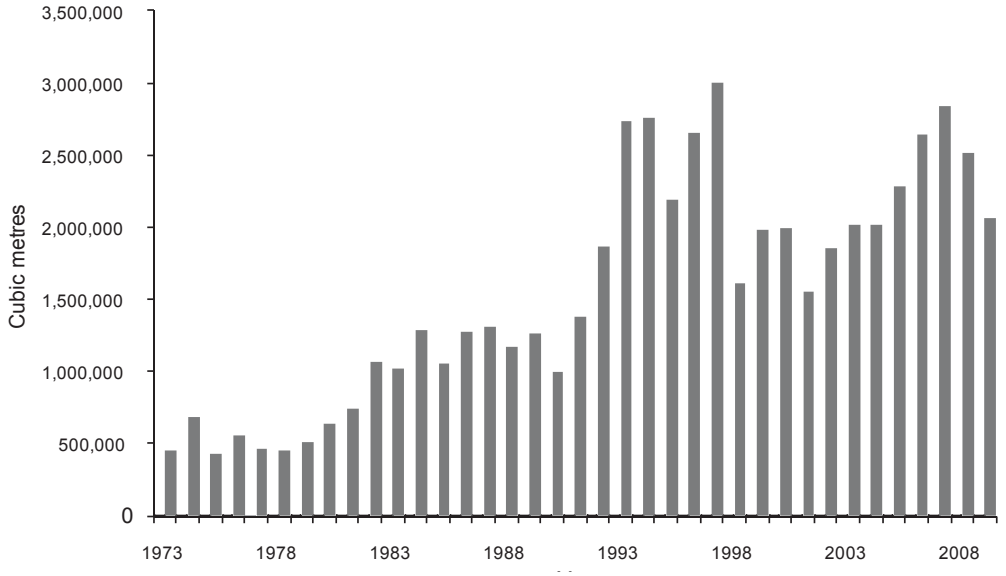
(McAlpine and Quigley 1998). For this purpose, a distinction was drawn between areas of forest that had been disturbed by selective-logging operations and then left to regenerate, areas that had been logged and then converted to other forms of land use, and areas that had been converted without having first been logged (Table 3). The assumption here was that forests that had been logged and left to regenerate were still part of the (adjusted) gross forest area, but were no longer part of the potential production forest area in 1996. The 12,873 sq km of forest that no longer counted as part of the (adjusted) gross forest area had mostly been converted to agricultural use with significant levels of land-use intensity.

Part of the area described in the FIMS data set as forest that had been logged and converted to other forms of land use between 1973 and 1996 had been completely cleared of native vegetation and planted with commercial tree crops—what the PNGRIS data set describes as very high levels of land-use intensity. Most of the new plantations consisted of oil-palm or commercial timber species, but they varied a good deal in size because some were established by local smallholders with assistance from private companies or aid agencies. The area occupied by oil-palm plantations grew from about 200 sq km to about 700 sq km over this period. This should be regarded as a fairly permanent form of land-use conversion, but it is hard to determine how much of the growth came at the expense of native forest clearance. The area occupied by timber plantations seems to have shrunk from 1,079 sq km in 1973 to 563 sq km in 1996 (Ambia 2005), but it is known that new plantations were being established over this period. Therefore, it seems likely that some timber plantations were converted to another form of intensive land use during this period.

Most of the forest area that was converted to significant levels of land-use intensity between 1973 and 1996—perhaps 12,000 sq km in all—would have been land used by local farmers at higher levels of intensity than had previously been the case. About 25 per cent of this land was logged before it was converted, but it is not clear that logging made much difference to this form of deforestation or forest degradation because most of the land in question was already being cultivated at low levels of land-use intensity before the logging took place. On the other hand, the authors of the FIMS data set found that more than 60 per cent of the area of forest that had been 'logged and left to regenerate' by 1996 had not yet begun to regenerate when the data set was completed (Filer 1998:410). The main reason for this is that Papua New Guinea had experienced a log export boom in the previous three years (Figure 1), so a large part of this area had been logged quite recently. It is possible that part of the area that had not begun to regenerate was subsequently converted to significant levels of land-use intensity. Most of this area, however, is likely to have been primary (or previously unused) forest. If it did not regenerate, this would constitute a form of deforestation that can be treated as a direct effect of selective-logging operations.

The FIMS data set made a further assessment of the potential production forest area remaining in 1996, part of which was already included in current logging concessions, while the remainder had yet to be allocated to logging companies (Table 4). It was recognised that some parts of this potential production forest area would still be unsuitable for commercial logging operations, either because they consisted of 'fragile forests' that would not recover their commercial timber volumes over a 40-year cutting cycle or because they had already been included in protected areas officially recognised by the government.

Figure 1 **Raw-log exports from Papua New Guinea, 1973–2009**



Sources: Bourke, R.M. and Harwood, T. (eds), 2009. *Food and Agriculture in Papua New Guinea*, ANU E Press, Canberra:Table 5.8.3 (1973–2007 data); SGS (2008 and 2009 data).

The FIMS data set does not assume that commercial-logging operations over the period 1973–96 were confined to areas described as 'potential production forest' in 1973. The publication of summary statistics from the data set (McAlpine and Quigley 1998) does not, however, include an estimate of the area that had been logged, despite the presence of major physical constraints to large-scale logging operations. Other evidence from the FIMS data set indicates that approximately one-third of the area that had been logged was outside the potential production forest area in 1973 (Filer 1998:411–12).

There has been no systematic effort to update the information contained in the PNGRIS and FIMS data sets since 1996. A recent assessment of satellite imagery from the early years of the current decade claims a much higher rate of deforestation and forest degradation than the rate indicated in the FIMS data set (Shearman et al. 2008), but this study contains a number of flawed assumptions and does not attempt to produce a comparable spatial data set (Filer et al. 2009). Therefore, an assessment of change in the spatial extent of different forest types in the 12 years from 1997 to 2008 has to rely on proxy measures derived from the data sets covering the earlier period of 1973–96. In particular, it is necessary to consider

- whether there has been a constant relationship between the total recorded volume of Papua New Guinea's log harvest from native forests and the spatial extent of the forests subject to selective-logging operations

- whether there has also been a constant relationship between additions to the total volume of selected cash-crop exports (especially palm-oil exports) and the area of primary or secondary forest cleared for the planting of new crops.

The volume of Papua New Guinea's raw-log exports since 1995 has been carefully monitored by an independent agency (the Swiss company SGS), so the discrepancy between actual and recorded log-export volumes has probably been lower than it was in the period before 1995. It is also possible to estimate with a reasonable degree of accuracy the volume of logs harvested and processed onshore by large-scale commercial operations. It could be argued that large-scale selective-logging operations have needed to log a progressively larger area of native forest in order to produce a specific volume of commercial timber because areas with the highest density of commercial timber species were the first areas to be logged, and the logging industry has since been moving into areas with progressively lower densities of commercial timber species. This argument sounds plausible on economic grounds and might be supported by resource inventories from forestry concessions if these inventories were accurate and accessible (which they are not). On the other hand, it could be argued that logging companies have learned to be more efficient in the extraction and marketing of commercial timber species from successive concessions, either because of the knowledge they have acquired about the physical environment in which they are operating or because of their efforts to comply with new regulations and codes of practice. In the absence of hard evidence to the contrary, this article assumes that the ratio of harvest volumes to harvested area has been constant.

In the case of cash crops, the volume of recorded exports is tied more closely to harvest volumes because there is minimal domestic consumption and (with the exception of copra and copra-oil) there is no distinction between processed and unprocessed commodities in the official export records. There are various ways in which the relevant industries could have secured higher levels of output from the same area of land, so the area under cultivation might not have increased in proportion to the size of the harvest. In the case of palm-oil, industry records do allow for an assessment of changes in the ratio of harvest volumes to planted area over the period 1997–2008. It is, however, much harder to determine what proportions of the newly planted areas were previously occupied by which types of forest or other vegetation.

Logging industry impacts

Official records indicate that 28,972,470 cu m of raw logs were exported from Papua New Guinea in the 24 years from 1973 to 1996 (Bourke and Harwood 2009). The FIMS data set indicates that 19,223 sq km of forest was logged and left to regenerate, while another 3,476 sq km was logged and converted to significant levels of land-use intensity over the same period (Table 3). In the 12 years from 1997 to 2008, the total volume of raw-log exports was 26,306,985 cu m. If the ratios of total raw-log exports to the total commercial-log harvest and to the area harvested have been constant since 1973, the prediction would be that the area harvested in this latest 12-year period would be 20,611 sq km. If the proportion of logged-over forest that has been left to regenerate has also been constant since 1973 then 17,458 sq km of forest should have been logged and left to regenerate, while 3,153 sq

km should have been logged and converted to significant levels of land-use intensity in this latest period. According to one recent estimate, log exports from a sample of 13 selective-logging operations averaged 13 cu m per hectare over the period 1993–2005 (Shearman et al. 2008:56). This estimate is consistent with the aggregate data for the longer period of 1973–96, which indicate an average of 12.76 cu m of raw-log exports per hectare of harvested area. These figures do not, however, take account of changes in the ratio between the volume of raw-log exports and the volume of the total commercial-log harvest.

As previously noted, the assumption of a constant relationship between these variables could be questioned on a number of counts. For example, it is possible that official records underestimated the volume of log exports in the years before SGS was engaged to monitor log shipments in 1995 (Filer 1998:231). Evidence from the Bank of Papua New Guinea shows that the proportion of raw-log exports in the value of Papua New Guinea's total forest-product exports fell from 98 per cent in 1994 to 90 per cent in 1998, reached a low point of 81 per cent in 2004, but had risen again to 92 per cent by 2009. Both examples suggest that the average log-harvest volume could have been higher than 13 cu m per hectare over some periods. It is, however, unlikely to have exceeded 20 cu m per hectare in any period and could now be declining as logging companies either have started moving into less accessible forest areas with lower merchantable timber volumes or have begun a second harvest from areas that were already logged in an earlier period. I assume an average timber yield of 15 cu m per hectare in the period 1997–2008. If raw-log exports accounted for 90 per cent of the total timber harvest during that period, it would imply that the area subjected to selective-logging operations in this period was 19,487 sq km.

Evidence assembled by the PNG Forest Research Institute (FRI) in the period since 1997 indicates that 15 per cent of the area subject to selective-logging operations is permanently deforested, while another 25 per cent is more or less permanently degraded. This would help to explain the observation made by the authors of the FIMS data set that more than 60 per cent of the area of forest that had been 'logged and left to regenerate' by 1996 had not yet begun to regenerate when the data set was completed (Filer 1998:410). If the FRI's figures are applied to the total area subjected to selective-logging operations from 1973

Table 5 **Reduction of logging potential, by forest altitude class, 1973–96**

Forest type	Adjusted GFA[a] 1973 (sq km)	Unlogged GFA[a] 1996 (sq km)	Unlogged PPF[b] 1996 (sq km)
Lowland plains (< 1,000 m)	32,608	26,304	20,954
Lowland hills (< 1,000 m)	179,468	157,487	82,371
Lower montane (> 1,000 m)	81,099	77,288	13,509
Total Papua New Guinea	293,175	261,079	116,833

[a] GFA = gross forest area
[b] PPF = potential production forest
Source: McAlpine, J. and Quigley, J., 1998. *Forest Resources of Papua New Guinea: summary statistics from the Forest Inventory Mapping (FIM) system*, Coffey MPW Proprietary Limited for the Australian Agency for International Development and the Papua New Guinea National Forest Service, Canberra:Tables 4 and 6.

to 2008, it suggests that 6,327 sq km of land has been deforested and another 10,546 sq km has been more or less permanently degraded by selective-logging operations.

The annual volume of Papua New Guinea's log exports rose steadily between 2001 and 2007. The rate of increase, however, was even higher in the period 1991–93 and that boom was followed by a slump in 1998. The total volume of log exports in the period 1997–2008 (26.3 million cu m) was 27 per cent greater than the total volume of exports in the preceding period, 1985–96 (20.7 million cu m). The slump that occurred at the beginning of the latest period resulted from the combination of a regional drought and a regional financial crisis. A downturn in the volume of log exports was recorded in 2008, and a further downturn was recorded in 2009 because of the combination of the global financial crisis and unusually high rainfall in the early months of the year (Figure 1). Another constraint on the maintenance of high log-export volumes during the period 2009–20 could well be, however, the steady shrinkage of loggable areas within forestry concessions.

In the period 1973–96, large-scale logging operations had only a marginal impact on those parts of the (adjusted) gross forest area located at altitudes above 1,000 m. Logging operations still have a very small impact on these mountain forests because of the cost of harvesting and exporting logs from such altitudes. There were, however, still very large swathes of lowland forest that had not been logged by 1996, and more than 100,000 sq km of this unlogged forest area is described as 'potential production forest' in the FIMS data set because of the absence of extreme or serious constraints on logging (Table 5). Even if more than 20,000 sq km of lowland forest was logged between 1997 and 2008, there should still be at least 80,000 sq km of potential production forest available for commercial exploitation in the period 2009–20.

The shrinkage of the area of potential production forest currently available to logging companies is due mainly to the fact that no new forestry concessions were granted in the first half of the period 1997–2008. In 1996, there were 59,732 sq km of unlogged forest within the boundaries of operational forestry concessions, and 33,997 sq km (57 per cent) of this unlogged area counted as potential production forest (Table 4). Log-exporting forest concessions (excluding timber plantations) covered a combined area of 60,198 sq km in 2008 (Table 6). Almost 80 per cent of this area (47,520 sq km) was, however, in concessions that were first allocated before 1997. Although these concessions still accounted for more than 90 per cent of log exports in 2008, most had already been subject to selective-logging

Table 6 **Log exports in 2008 from timber permits granted over native forests, by various periods**

Period	No.	Area (sq km)	Exports (cu m)
1973–84	3	8,806	277,885
1985–96	36	38,714	1,765,826
1997–2008	5	12,678	182,402
All periods	44	60,198	2,226,113

Sources: Government of Papua New Guinea (GPNG), 2009. *National Forestry Development Guidelines*, PNG Forest Authority, Hohola (permit dates and areas); SGS (2008 log exports).

operations (on and off) for 15 or 20 years. According to the Independent Forestry Review Team (in 2004), many of the timber permits granted over these concessions should have expired some time ago, so the continuation of log-export operations is something of a puzzle (Forest Trends 2006). Even so, the amount of merchantable timber or the extent of the potential production forest remaining in these concessions must have been substantially reduced. If 57 per cent of the area contained in these 'old concessions' (27,086 sq km) counted as potential production forest when the concessions were originally granted, and if the permit holders confined their operations to this smaller area, at least half of it (and possibly much more) is likely to have been logged by 2008, so it is unlikely that the old concessions now contain more than 10,000 sq km of potential production forest. As previously noted, the authors of the FIMS data set found that there had been extensive logging beyond the boundaries of what they defined as potential production forest in the period 1973–96, and that this type of activity might have persisted into the more recent period despite the introduction of government regulations designed to prevent it. This does not, however, make too much difference to the estimation of commercial timber resources still available for exploitation in concessions allocated before 1997.

By 2020, the total native forest area in forestry concessions could shrink to one-third of its present level unless current timber permits are continually renewed or additional concessions are allocated by the National Forest Board. The five new concessions shown in Table 6 have all been allocated since 2004; one other concession (1,489 sq km) was allocated in 2006 to a company that processes the whole of its log harvest. Over the past decade, the board has made attempts to allocate another four concessions—with a combined area of 13,958 sq km—but logging operations have not commenced in any of these areas because of legal wrangles about the allocation process. There are 10 other possible concessions—with roughly the same combined area—where the timber-harvesting rights have been acquired from local landowners under Forest Management Agreements, but there is no way to determine when these areas might be subject to selective-logging operations under timber permits. Even if we assume a short-term increase in total new concession areas to something in the order of 20,000 sq km, there would not be more than 12,000 sq km of potential production forest in these concessions that had not already been logged by the end of 2008. New concessions are covered by timber permits that allow for only one-fortieth of the loggable area to be logged in any one year. If this fraction is applied to 12,000 sq km of forest, and if average timber yields are estimated at 15 cu m per hectare, the annual timber harvest from these new concessions will be 450,000 cu m in the period 2009–20. Even if the projected harvest from the old concessions is added to the equation, the result could be a 'low growth scenario' in which the average annual volume of the commercial-log harvest over this period is about only 1 million cu m.

Another possibility is that logging companies will exceed their annual allowable cut by a substantial margin—with or without the approval of the government. For example, if the loggable area in each concession were to be logged at twice the rate currently allowed under the National Forest Policy, this would obviously double the total area 'degraded' by logging operations, as well as the total size of the log harvest, in any particular period. But even if logging companies comply with the 40-year cutting cycle prescribed by the National Forest Policy, they do not currently

have an economic incentive to minimise the amount of damage or degradation caused by the first round of logging because they are granted timber permits for only one round at a time.

A study undertaken immediately after the new *Forestry Act* came into effect found very high levels of residual damage as a result of selective-logging operations (Cameron and Vigus 1993), and these observations have since been confirmed in studies undertaken by the FRI. More recent studies also indicate that logging companies in Papua New Guinea are removing the commercial timber resource from existing concessions at an unsustainable rate because the Forest Authority has overestimated the size of the resource in its own inventories (Keenan, Ambia, Brack, Frakes, Gerrand, Golman, Holzknecht, Lavong, Sam, Vanclay and Yosi 2005). Furthermore, analysis of sample plots in areas that have already been logged suggests that timber yields in a second or third round of logging are likely to be much lower than the yields obtained in the first round—partly because of the damage caused in the first round. It is not clear if any significant areas of previously logged forest will be made available for a second round of logging in the period 2009–20, but current policy suggests that these ought to be areas that had already been logged by 1984. Areas that have not previously been logged are, however, likely to be far more attractive to the logging companies.

If a 'low growth scenario' for the logging industry has the log harvest from native forests running at an average of 1 million cu m per annum in the period 2009–20, a 'medium growth scenario' might involve an average of 2 million cu m, and a 'high growth scenario' an average of 3 million cu m. It is hard to estimate the plausibility of these alternatives because of a lack of detailed evidence about the current extent of potential production forest in specific areas or the basis on which decisions are currently being made about the allocation of resources to different forms of development. The medium and high growth scenarios could, however, both entail a fairly radical change in the way that current forest policies and guidelines are implemented. One such change, which involves the grant of multiple FCAs for so-called 'agro-forestry projects', is considered in the next section of the article.

Cash crops and 'agro-forestry projects'

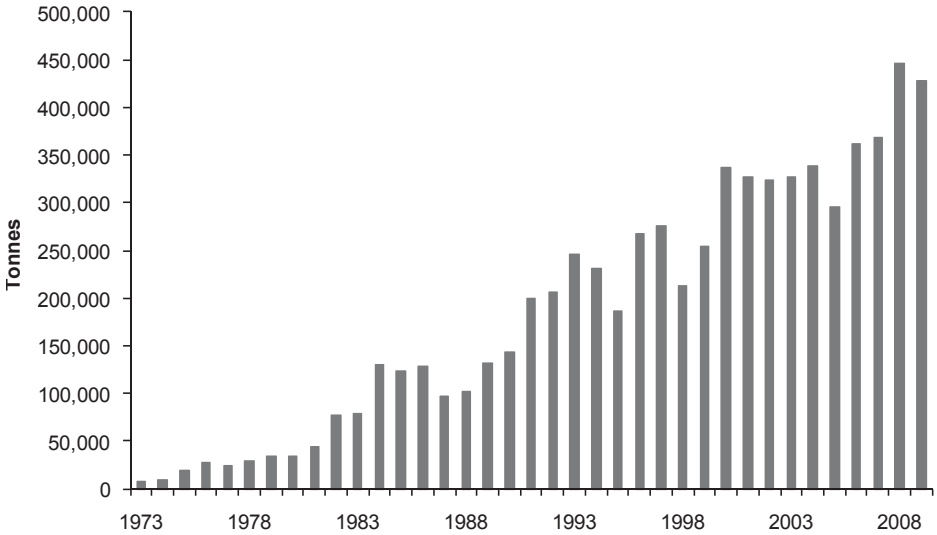
Oil-palm has accounted for the bulk of the increase in the export volumes of Papua New Guinea's major cash crops between the period 1985–96 and the period 1997–2008 (Table 7). If export volumes have a constant

Table 7 **Export volumes of major export crops, 1985–2008** (metric tonnes)

Crop	1985–96	1997–2008	Percentage change
Palm-oil	2,062,900	3,867,200	+87.5
Copra	851,166	449,100	–47.2
Coffee	696,142	789,835	+13.5
Cocoa	422,635	494,792	+17.1

Source: Bourke, R.M. and Harwood, T. (eds), 2009. *Food and Agriculture in Papua New Guinea*, ANU E Press, Canberra:Tables A5.4.1, A5.5.1, A5.6.1, A5.7.1.

Figure 2 **Palm-oil exports from Papua New Guinea, 1973–2009**



Sources: Bourke, R.M. and Harwood, T. (eds), 2009. *Food and Agriculture in Papua New Guinea*, ANU E Press, Canberra:Table 5.7.1 (1973–2007 data); Bank of Papua New Guinea (2008–09 data).

relationship to the areas of land from which the crops are harvested then oil-palm is the only major crop whose new plantings might have caused any significant reduction in the total area of forested land. Nearly all of the increase in the area planted to coffee and cocoa involved the conversion of land previously used at significant levels of intensity, and much of the increase in cocoa production came from ageing coconut plantations in coastal areas (Bourke and Harwood 2009).

We show changes in the annual volume of palm-oil exports over the period 1973–2009 (Figure 2). Comparison with the annual volume of raw-log exports over the same period (Figure 1) shows that the palm-oil industry has maintained a much steadier rate of growth than the logging industry, which could be cause for greater optimism about the industry's capacity to sustain this rate of growth in years to come.

We show the recent increase in the area planted to oil-palm in what are now the six major production sites in Papua New Guinea (Table 8). If the total area planted to oil-palm was about 700 sq km in 1996, this area had almost doubled by 2008, which means an average annual increase of about 50 sq km. Since the volume of palm-oil exports in 2008 was only 62 per cent higher than the 1996 export volume, it seems that output has grown more slowly than the land area in production. Most of the expansion in the area planted to oil-palm—including the new Ramu scheme on the borders of Madang and Morobe provinces—has taken the form of 'mini-estates' established under the so-called 'lease–leaseback' provisions of the *Land Act*. Under this arrangement, local villagers lease portions of their customary land to the government, which then issues them with a Special Agricultural and Business Lease (SABL) so they can issue

Table 8 **Areas planted to oil-palm by project, 2000–08**

Project	2000 (sq km)	2004 (sq km)	2008 (sq km)
Hoskins	400.7	536.8	600.1
Popondetta	207.9	235.2	232.7
Bialla	168.5	211.6	225.0
Alotau	83.3	138.3	134.7
Poliamba	72.9	80.5	82.2
Ramu			67.8
Total	933.2	1,202.3	1,342.4

Source: PNG Oil Palm Research Association.

a sub-lease to the nucleus estate operators (Oliver 2001). As this is a cumbersome process, it places a limit on the amount of additional land that can be brought into production each year.

It is not clear what proportion of the land newly planted to oil-palm since 1996 was previously covered by native forests or used by farmers at different degrees of land-use intensity. The Popondetta and Ramu oil-palm schemes have not involved any significant measure of deforestation since 1996; nearly all of their expansion has taken place in areas of grassland vegetation. On the other hand, a recent interpretation of satellite images from 1989 and 2000 found that 436 sq km of land on the island of New Britain (or 15 per cent of the whole island) had been converted to 'plantations' in the intervening period, of which 320 sq km (73 per cent) had been 'forested' in 1989 (Buchanan, Butchart, Dutson, Pilgrim, Steininger, Bishop and Mayaux 2008:60). The establishment of oil-palm plantations on the northern coastal plains of West New Britain (in the Hoskins and Bialla schemes) would account for most of this conversion. The authors of this study did not, however, try to distinguish the different types of forest affected by this process. Some of the areas newly planted to oil-palm since 1996 would previously have been used at significant levels of intensity, and some appear to have been previously occupied by timber plantations.

The two companies currently responsible for the whole of Papua New Guinea's palm-oil exports—New Britain Palm Oil Limited (NBPOL) and Hargy Oil Palms Limited (HOPL)—have both been certified for their compliance with the national version of the principles and criteria for sustainable palm-oil production established by the Roundtable on Sustainable Palm Oil. This means that '[n]ew plantings since November 2005… have not replaced primary forest or any area required to maintain or enhance one or more High Conservation Values' (RSPO 2006:40); further expansion should 'actively seek to utilise previously cleared and/or degraded land'; '[p]lantation development should not put indirect pressure on forests through the use of all available agricultural land in an area'; and 'independent smallholders must not establish plantings on lands containing one or more HCVs [High Conservation Values] or covered by primary forests' (RSPO 2008:45).

Even if 400–500 sq km of land has been deforested as a result of the spread of oil-palm since 1989—and there is still some risk of additional deforestation

from the expansion of existing oil-palm schemes between 2009 and 2020—there is a much larger risk of deforestation as a result of recent and current proposals to develop new agricultural projects under an alternative application of the lease–leaseback arrangement. SABLs covering a combined area of more than 19,000 sq km have recently been granted to private companies (rather than groups of customary landowners) for such purposes (Table 9). Most of these leases are for periods of 99 years, and, although their boundaries are not indicated precisely in the government's gazettal notices, most appear to contain significant areas of potential production forest. Agricultural development proposals for such areas are generally known in Papua New Guinea as 'agro-forestry projects' because they are likely to involve the commercial extraction of timber resources in a process that might or might not lead to the development of large-scale commercial agriculture. There is presently a lot of uncertainty about the legal status of the leasing arrangements and the compliance of individual project proposals with government regulations. There is no immediate prospect of 15,000 sq km, or even 5,000 sq km, of native forest being clear-felled to make way for a form of agricultural investment that might not materialise. But projects of this type could entail a substantial increase in the rate of deforestation that might otherwise be predicted under current arrangements for the formal allocation of timber permits to logging companies.

If the company holding an SABL intends to clear a large area of forest, the company or its contractor should apply to the PNG Forest Authority for an FCA under Section 90 of the *Forestry Act*. Forest Authority records show that a number of companies have applied for FCAs for what are typically described as 'integrated agriculture', 'integrated agro-forestry' or 'agro-forest development' projects. The total area covered by recent applications is more than 13,000 sq km, and FCAs have already been granted over a total area of more than 6,000 sq km (Table 10). In some cases, the applications are based on the previous grant of an SABL over part or all of the land for which an FCA is sought, but in others there is no evidence of an SABL being granted, either because the land in question is not customary land or because the State has already acquired forest-harvesting rights from the customary owners through a Forest Management Agreement. In 2008, total log exports from

Table 9 **Special Agricultural and Business Leases granted to private companies for agricultural development projects, July 2004 to June 2010**

Year	No.	Area (sq km)
2004–05	3	21.2
2005–06	2	883.3
2006–07	14	2,610.0
2007–08	9	3,177.6
2008–09	16	9,052.4
2009–10	10	3,476.5
Total	54	19,221.0

Source: PNG Government Gazette.

areas shown in Table 9 were 184,680 cu m, of which roughly half also appear in Table 6 because they came from an area over which a timber permit had been granted before an FCA was issued. The PNG government has recently established an Agriculture Sector Working Group to investigate the political and bureaucratic process by which leases and licences have been granted for all these 'agro-forestry projects', and the climate change policy proposes a moratorium on 'all agricultural leases' while these inquiries are being conducted (GPNG 2010a:29).[1]

Most 'agro-forestry projects' feature plans to replace native forests with new oil-palm schemes. One simple way to measure the expansion of areas planted to oil-palm is to count the number of seeds produced for the domestic market by NBPOL, which is the sole supplier. In 2009, NBPOL is thought to have distributed about one million seeds, of which it assumed that 80 per cent would germinate successfully. Dividing this number by 137 gives the number of hectares planted in 2009—a total of 5,839 ha. Most of the planting (90 per cent) took place in the Hoskins and Ramu schemes, while the balance apparently took place in two of the areas over which an FCA had recently been granted. NBPOL estimates that one in 20 of the palms growing in the Hoskins scheme has to be poisoned and replaced each year. This suggests that an area of 30 sq km was replanted, leaving a newly planted area of 28 sq km across the whole of Papua New Guinea—lower than the average annual increase in planted area over the period 1997–2008. This seems to reflect the stagnation or contraction of the three existing schemes (Alotau, Popondetta and Poliamba) since 2004 (Table 8). A projected rate of expansion of 50 sq km per annum over the period 2009–20 could therefore represent a 'medium growth scenario'. A 'low growth scenario', with a rate of expansion of 25 sq km per annum, is equally plausible, regardless of global market prices, because of institutional constraints on the acquisition of suitable land from customary owners. If the new generation of 'agro-forestry projects' accounted for less than 600 ha of the area planted to oil-palm in 2009, there is no particular reason to expect that these projects will make a significant contribution in the future. If, however, three or four of these projects do turn out to be genuine large-scale development schemes, it is possible to envisage a 'high growth scenario' in which the average rate of expansion reaches 75 sq km per annum.

Table 10 **Status of applications for Forest Clearing Authorities by proponents of agricultural development projects, 2007–10**

Status of application	No.	Area (sq km)
FCA granted after SABL granted	6	4,754.1
FCA granted before SABL granted	1	308.3
FCA granted without grant of SABL	6	1,417.7
Application pending after SABL granted	5	2,841.6
Application pending without grant of SABL	4	4,295.5
All applications	22	13,617.2

Source: Government of Papua New Guinea (GPNG), 2010c. PNG Forest Authority records, April, PNG Forest Authority, Hohola.

It is only under this high growth scenario that further expansion of the area planted to oil-palm would have significant impacts on native forests.

Conclusion

How do the projections made in the previous two sections match up against those in recent policy and planning statements made by the PNG government? The agricultural output projections made in the Development Strategic Plan can be discounted as a form of wishful thinking—not only in respect of their targets but also in respect of their baselines. For example, the production of palm-oil in 2007 was 368,000 t (Figure 2), not 556,000 t (as in Table 1). The failure of government planners to observe this discrepancy could be the result of overly optimistic projections previously made in the National Agriculture Development Plan, which forecast an increase of 380 sq km in the area planted to oil-palm over the period 2006–10 (GPNG 2007:72). As we have seen (Table 8), the increase between 2004 and 2008 was only 140 sq km, so an area of roughly 300 sq km would need to have been planted in the last two years of the planning period in order for the target to be met. There is no evidence that this has happened.

The output projections made in the climate change policy are more modest, since they are framed by a 'business-as-usual' scenario rather than by an aspirational target. Nevertheless, there is still a rather odd discrepancy between the forecast of annual growth in palm-oil output (2 per cent) and the forecast of annual growth in the area planted to oil-palm (5–6 per cent) over the next 20 years. If 2008 is taken as the baseline year (Table 8), and we assume that the forecast rate of growth in planted area is a fixed proportion of this baseline, a 5–6 per cent annual growth rate entails the addition of between 67 sq km and 81 sq km of land each year. This corresponds with what I described as a 'high growth scenario' (75 sq km per annum) in the previous section of this article. But why assume a much lower rate of growth in annual palm-oil output? One explanation would be that growth in the area planted to oil-palm proceeds at a much lower rate for the next 10 years, and is followed by the planting of much larger areas between 2020 and 2030 such that these areas would still be occupied by immature palms at the end of the planning period. A second explanation would be that units of output per hectare of planted area fall quite dramatically over the planning period because most of the expansion takes place on customary land, and so-called 'village oil-palm' has generally been less productive than oil-palm grown on nucleus estates (Koczberski, Curry and Gibson 2001). But the third—and perhaps most plausible—explanation is that more than half of the area planted to oil-palm will not produce any palm-oil at all because the planting is undertaken by the developers of 'agro-forestry projects' who are unwilling or unable to invest in the milling facilities required for commercial production. If that is the case, the opportunity costs of native forest conservation for many local landowners would be reduced, since they would stand to gain no benefit from the planting of oil-palm on their land.

This last version of the high growth scenario for oil-palm seems to be at odds, however, with the business-as-usual scenario that the climate change policy proposes for the forestry sector, since 'agro-forestry projects' here account for only 10 per cent of a projected log harvest of 3.5 million cu m in 2030 (GPNG 2010a:12). My own account of a 'high growth scenario' involving an annual log harvest of 3 million cu m in the period 2009–20 assumes that 'agro-forestry

projects' account for a larger proportion of the total harvest during this period. But even if this turns out to be the case, the plausibility of this high growth scenario is limited by physical, economic and institutional constraints on the capacity of the logging industry to maintain the current rate of timber extraction from native forests under timber permits rather than FCAs. These constraints are already reflected in the decline in raw-log export volumes from more than 2.8 million cu m in 2007 to about 2 million cu m in 2009 (Figure 1). This decline is now set to continue—not only because of legal and bureaucratic obstacles to the allocation of new timber permits over potential production forest but also because the new National Forestry Development Guidelines say that all timber permits granted from the start of 2010 will be for logging operations with '100% processing only' (GPNG 2009:15).[2] This is consistent with the forecast made in the Development Strategic Plan that the share of processed-timber exports in the value of total forest product exports will increase to 80 per cent by 2030 (GPNG 2010b:94). This forecast, however, represents a complete reversal of the situation that prevailed in the period 1997–2008, when processed-timber exports accounted for less than 20 per cent of the value of total forest-product exports. Government efforts to encourage downstream processing have been a persistent feature of the forest policy landscape for more than 20 years, but economic studies have persistently questioned the profitability of export-oriented processing operations in Papua New Guinea—whatever the restrictions placed on raw-log exports (FORTECH 1998). Banning the export of raw logs from new logging concessions is therefore unlikely to be consistent with a high growth scenario, or even a medium growth scenario, for the total commercial-log harvest from native forests.

There are many uncertainties in these projections and forecasts, and it is still hard to say how the prospect of compensation from the international community for measures taken to reduce the rate of deforestation and forest degradation will influence future land-use decisions in Papua New Guinea. This article highlights, however, a particular problem of moral hazard that besets the negotiation of such arrangements. There is a perverse incentive for the governments of 'rainforest nations' to exaggerate the past, present and future rates of deforestation and forest degradation in order to claim a reward for reducing greenhouse gas emissions from a fictitious or exaggerated baseline to a level that approximates the real trajectory (Filer et al. 2009). This makes particular sense for a government that cannot do much to alter the real trajectory, since the cost of solving a non-existent problem is much lower than the benefit that might be gained from persuading other stakeholders that it has 'in fact' been solved. The PNG government still has work to do to make its case.

Notes

1 It seems that the moratorium has not yet been implemented. Four SABLs with a combined area of 15,724 sq km were gazetted in September 2010.

2 The fact that raw-log exports are still allowed under Forest Clearing Authorities might help to explain the recent enthusiasm for 'agro-forestry projects', although this enthusiasm predates the publication of the new guidelines.

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