ignored unless they are deforested, in which case there would be emissions to account for. In other words these 'non-Kyoto forests' could represent a liability to the owners if they choose to change their land use. Forest management is another activity that could be included under the Protocol, but it is far from clear that this would help the NZ carbon balance (or individual owners). Furthermore it is highly uncertain what future obligations might be placed on this land if it is included in the first commitment period.

New Zealand is expected to have an abundance of carbon credits from forest sinks for the entire first commitment period (2008-2012) and for most or all of the second commitment period (2013-2017). In other words, NZ would be able to 'offset' most if not all of the emissions growth until 2017 or beyond. The numbers quoted by government in the Consultation Paper were that emissions in energy and industrial sectors would exceed the allowable level by approximately 50 million tonnes of CO_2-equivalent ($MtCO_2$-e) during the first commitment period. If measures suggested in the national energy efficiency and conservation strategy are successfully implemented the excess might be reduced to 40 $MtCO_2$-e. Plantation forests established since 1990 would sequester 110 $MtCO_2$-e during the same period.

It is clear in the above analysis that New Zealand is in a position to meet its obligations and sell the surplus removals. The question is who stands to gain from this sale? As mentioned above, if Kyoto-forest owners are given the credits, they are likely to be accompanied by a list of rules and obligations. Non-Kyoto-forest owners would receive nothing but would be penalised if they change land use.

If all the credits are given to forest owners, the implication is that emitters would have to reduce their emissions, obtain emission permits elsewhere, buy sink credits from forest owners or pay a penalty. This would inevitably impact on the forest processing sector (amongst others) that is trying to expand to deal with the "wall of wood".

Denis Hocking said recently "carbon sequestration is just a hobby and I'd like to be able to continue my business of growing wood fibre unhindered". Can this be achieved? We think it could if a government-appointed agency is left to deal with the international politics and trade in emissions.

If we remove 110 and emit 50 $MtCO_2$-e, New Zealand can offset all our emissions growth and still have 60 $MtCO_2$-e to sell. Even at \$10/tCO_2-e this equates to \$600 million over the 5 year commitment period. This money could be used as a generic incentive to encourage sustainable land use and energy practices. For example to facilitate appropriate afforestation, or to enable forest processing plants to improve energy efficiency and to adopt renewable energy, particularly bioenergy. A healthy forest processing sector and additional use of bioenergy would both improve returns to forest growers, which would itself lead to further afforestation. More afforestation and more bioenergy will both increase the credits receivable and reduce the emissions. Pressure on energy-intensive wood substitutes must enhance the attractiveness of wood.

To summarise, we don't think the New Zealand forest sector need necessarily be afraid of the Kyoto Protocol - at least in the first commitment period - provided that New Zealand adopts an appropriate domestic policy.

What will happen next? By the time this appears in print, we expect government to have outlined its preferred policy approach. This is generally predicted to include Kyoto ratification and government retention of all or most credits. This bill is scheduled for enactment in late August. The second bill, due later in the year, should be far more interesting and important. As they say, the devil is in the detail.

Samoan interlude - 36 years ago

Peter McKelvey[1]

The Asau Development Block, originally known as the Cornwall Estate, was an irregularly shaped rectangle, approximately 13 km long and 1.6 to 3.2 km wide, straddling the western extremity of Savaii, the largest Samoan island. It ascended from the northern coast of Savaii to the watershed ridge at about 900 metres and then dropped down more steeply to the south-western coast on the other side. The area was nearly 2500 ha.

The intention of the Samoan Government in the 1960s was to develop suitable parts of the Block as food plantations and settle more people there. The Government asked for New Zealand technical assistance in making a timber inventory of the extant indigenous forest, for the timber would have to be harvested and sold before the food plantations could be established. Accordingly two New Zealand Forest Service officers, Noel Berryman and the author, travelled to Savaii in September 1965, over 36 years ago, for this purpose.

Our field procedure entailed systematic line/plot sampling across the contours with one acre (0.405 ha) temporary plots. In all 93 of these were measured. The job was really a mini-National Forest Survey. Fortunately, access to recent aerial photographs made it possible to plan the field work in advance. An assessment of the timber resource was completed, and made confidential to the Samoan Government at the time with advice on logging and timber sale procedure.

The composition of the mixed tropical hardwood forests - there are no indigenous softwood species on Savaii - on the Asau Block is influenced principally by altitude. There is little site variation around the contour because there is no run-off, due to the porosity of the volcanic basaltic rock, and consequently no land dissection, despite an annual rainfall of at least 2500 mm. The precipitation emerges at the coast as springs. The only distinctive site changes occur where the even slopes of the basalt sheets have been interrupted by several small volcanic cones and a few small scarps, the latter putatively the lower edges of those younger, extruded sheets which did not reach the sea. By far the

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Buttresses on kava tree (Author's photo).

Tangle of roots on massive aoa tree (Author's photo).

most important forest changes occur along the altitudinal gradient and as we climbed up the long slopes it was clear that the stockings of some species decreased and others increased.

The more frequently occurring species were asi-vao and asi-toa (*Syzygium spp.*), kava (or tava) (*Pometia pinnata*), lopa (*Adenanthera pavonina*), mamala (*Dysoxylum samoense*), mamalava (*Planchonella samoensis*) and solato (*Laportea spp.*). A further 25 less frequently occurring timber species were recorded. At lower altitudes the stands reached up to heights of about 30 metres. Above about 600 metres altitude the height of stands dropped significantly and ferns and minor scrubby species became more prominent.

In fact, the absence of streams and hence the lack of water made field work more difficult as water had to be carried in. This absence of water made fly-camping impossible and the two New Zealanders and their 12 Samoan assistants had to walk into the forests every day. This took progressively more time as the locations of the plots became more remote. Consequently there was time to do only a few plots in a day as the main watershed ridge was approached.

There were some other striking features. Many of the species had massive buttress roots. These were frequently plate-like and sometimes corrugated. Also observations made of many fallen trees showed that the trees rooted mainly on, rather than in, the bouldery basalt and that there was very little root penetration. Indeed the noise of falling trees was occasionally heard during winds that could be described only as light. There were some massive aoa (*Ficus graeffi*) of epiphytic origin with multiple stems and gigantic crowns (one measured about 70 metres in diameter). And the presence of snakes, thankfully non-poisonous and imported years ago to control the rats, which had been a nuisance in the copra plantations, was a novelty for the New Zealanders. Finally, the forest floor was composed of small lava blocks (technically termed "aa" lava) that were hard on feet and boots.

Another aspect of the job was the insistence of the women's' committee in Asau village, where our assistants were billeted, that they take weekly medication which made some of them ill as prophylactic against the bites of the filarial mosquito, a vector of the disease elephantiasis.

At the start the New Zealanders had problems with the identification of the Samoan species. In the 1960s it was difficult to find comprehensive floras to work from so, before travelling to Samoa, a preliminary flora had been compiled eclectically using the work of Christophersen (Bulletins 128 and 154, Bishop Museum), the field notes of a New Zealander who had worked in Samoa in the past (B.E.V. Pareham) and a most valuable timber handbook developed during World War 2 by the American Navy for use by their engineers (Kraemer, 1944). Thankfully, once we got there we received invaluable tuition in species identification from our Samoan assistants who knew the common names of all the species. It then became a matter of checking these for consistency and selecting key criteria - usually associated with bark - for each tree species.

This preliminary inventory was the start of a long New Zealand involvement at Asau Bay. Logging and sawmilling were initiated by an American firm but later these operations were taken over by the Samoan Government. Then New Zealand foresters provided a lot of technical assistance here and also in reforestation after logging with mahogany, eucalypts and other exotic species. They helped too in the suppression of the extensive fire that devastated much virgin and planted forest in 1983. Some years later there was much windthrow and stem and branch breakage in planted forest, wrought by a hurricane that hit the north-facing slopes. (I am grateful to Ian Armitage, who was the last Chief Technical Adviser from New Zealand, for this information about what happened at Asau after we left).