LAND DEGRADATION DESK STUDY
SOLOMON ISLANDS

Prepared by Owen Hughes, 1997, Integrated Land Resources Management Officer, FAO Sub-regional Officer for Pacific Islands

Background

The Pacific Islands sub-region includes as many independent developing nations as Southeast Asia, but its total population is only about 6.5 million. No single developing country in the sub-region has a population exceeding 4.2 million, whereas in mainland Asia hardly any nation has a smaller population. Less than two per cent of the sub-region's geographical area is land, and individual islands that form part of a nation may be several hundred kilometres apart. Pacific island nations have a wide range of landforms, resource endowments, land areas, populations and population densities.

For the Pacific Island communities, these scarce land resources and the closely linked coastal ecosystems support a wide variety of both subsistence lifestyles and commercial production. These are extensively documented, as are widespread concerns about the exploitation of natural resources. Also, they are not contemporary issues (see Box Two, for example). More significantly, But historical efforts at addressing resource management issues or to identify and fully understand barriers to the uptake of field solutions has, in general, been elusive both institutionally and to the two to three generations of development practitioners. There also appears to be institutional differences in understanding and responding to ..... forestry vs agriculture, the former some 10 years ahead.

Pacific agricultural systems are actively evolving in response to pressures of demographic change and socio-economic and cultural circumstances, are characterised by heterogeneity and high temporal variability through the exploitation of genotype-by-environment interactions, occur in a diverse range of environments, adapted to local micro-environmental conditions, and support humans and domestic animals at a wide range of population densities (Allen *et al*., 1995). Farmer's objectives and their resources are equally varied (Rogers, 1998).

In response to intensification processes, these dynamic systems are also evolving through farmer innovation spurred by enquiry and experimentation to maintain their resilience in the absence of agro-inputs. Moreover, traditional knowledge is too often promoted as a panacea for breaking the cycle of poverty. Strong relationships are also evident between traditional knowledge and traditional beliefs, especially in Melanesian countries. Alone, it is inadequate to deal with situations of population increases and the declining resource base. The issue remains on how to develop traditional knowledge to improve livelihoods, supported by scientific innovation to elevate livelihood standards. The dynamics of these systems should be better understood to enable generalisations across agro-ecological zones.

A crucial factor over which many of those working in issues of sustainable land management in the region have little influence, is the development of policies and institutional structures which promote better land management and land husbandry (IBSRAM, 1995). The present wide dispersal of land use planning responsibilities also constrains the sub-region's response to natural resource degradation, possibly because decision-makers and resource-users tend to assign a very low value to natural resources in weighing development decisions (Newell and Anson, 1993). National reports prepared for UNCED by the Pacific Islands generally express dismay at the poor prospects for more socially beneficial land allocation and land management (SPREP, 1992).

It is no surprise that the sub-regional concern for sustainability is manifested most strongly in natural resources, and environmental issues coupled with their use. Other than the regional report prepared for UNCED (1992), state of the environment reports (all FAO members except Vanuatu), national environmental management strategies (all FAO members except Papua New Guinea and Vanuatu), national conservation strategy (Vanuatu), national forest inventories (Fiji, Solomon Islands, Vanuatu), and land resource studies (all FAO members except Solomon Islands) have all been undertaken within the past 15 years under a prime directive for the sustainable use of natural resources.

Thistlethwaite and Davis (1996) argue there is major and escalating environmental abuse in Melanesia [and Polynesia], often accompanied by much breast-beating in public fora, but little real action to curtail or contain abuse, and little real commitment of government resources for environmental management and/or protection.

The need for a new approach to land resource management is being promoted (FAO and UNEP, 1996), using structural and institutional guidelines for land resources planning and management developed by FAO and UNEP (1997). The new approach emphasises the integration of physical, socio-economic and institutional aspects of land use. In particular, the approach stresses the need for an active participation of all stakeholders in decision-making, for access to information and for a commitment to the provision of incentives and an improved institutional and policy framework.

In the sub-region, financial, organisational and development gaps continue to expand, investment levels are not consistent with the magnitude of needs, and institutional action has not matched political commitment and rhetoric. To ignore the implications of this would be irresponsible and disastrous. Unless increased commitments and longer-term investment become available for tackling land degradation, it is likely that recurrent problems will become so conspicuous and acute that more expensive curative measures will be needed one generation from now.

Table Two: Natural Resource Issues in FAO Member Countries (SPREP, 1992)

Elements	CKI	FIJ	PNG	SAM	SOI	TON	VAN
Land							
Availability	X	O	O	X	X	X	O
Reclamation	X	X	O	X	X	X	O
Land-use controls	X	X	X	X	X	O	X
Degradation (rural)	X	X	O	X	O	X	O
Water							
Rainwater storage/water conservation	X	X	O	X	O	X	O
Groundwater pollution/contamination	X	X	O	X	O	X	X
Soil erosion	X	X	X	X	X	X	X
Agriculture							
Agricultural practices	X	X	X	X	X	X	X
Agricultural intensification (incl. chemicals)	X	X	X	X	X	X	X
Forestry							
Deforestation	O	O	X	X	X	X	X
Agrodeforestation	X	O	O	X	O	X	O
Legislation							
Loss of traditional controls on resource use	X	X	O	X	X	O	O
Crude Pop. Density 1992 km^2	75	41	9	56	12	130	13

X = considered a significant issue with current or threatened impacts
O = not indicated as an issue or not considered significant

The 24th FAO Regional Conference for Asia and Pacific (Myanmar, April 1998) requested FAO to give priority support to member countries in avoiding soil loss and degradation, reforesting degraded lands, developing agroforestry, managing forests sustainably, and protecting forests against damaging wildfires.

Direct Causes of Land Degradation

Overcutting of vegetation

Rural people cut natural forests, woodlands and shrublands to obtain timber, fuelwood and other forest products. Such cutting becomes unsustainable where it exceeds the rate of natural regrowth. This has happened widely in semi-arid environments, where fuelwood shortages are often severe. Impoverishment of the natural woody cover of trees and shrubs is a major factor in causing both water erosion and wind erosion (FAO, 1994).

Subsistence values compared with logging royalties in two tropical rainforest communities in the Solomon Islands.

Very little research has been undertaken in the Pacific to quantify the impact of tropical forest logging on rural village communities. Cassells (1992) researched and valued the subsistence use of tropical rainforest, in the villages of Nukiki and Kuku on the island off Choiseul. He concluded that villagers were heavily reliant on the subsistence use of the rainforest for their livelihood. Values for these uses in Nukiki were calculated at NZ$10,512 per annum for the average sized (7) household.

Using information derived from Nukiki and applying it to the village of Kuku, where logging operations had trespassed on village land, it was clear that the villagers had been severely disadvantaged when their forested land was logged. For example, one area of 41 hectares near Kuku village, was calculated to have yielded 2 018 m^3 in merchantable logs. The villagers were to be paid $9.00 per m^3 which would give them a once-only royalty payment of $18 162. Subsistence losses from the same area were reported to be four garden sites, six nari and sulu nut trees, 21 betel nut trees, 346 sago palms and about 25 percent of the villagers' other useful trees such as those used for house building, canoe making, medicine and food.

This loss in subsistence production would be sustained over many years and was calculated to have a present value of $176 613. The net loss suffered by the village as a whole was therefore $158 450, or a substantial $7 545 for each of the 21 households.

Source: Cassells, 1991 (cited in Pacific Islands Forests and Trees Newsletter, June 1997).

Lees (1990) reports that agricultural methods involving clearance of vegetation have altered the forest in many areas of the Solomon Islands. The Hancock and Henderson (1988) study of the flora cites about sixteen percent of total land area was either under secondary regrowth, or was being cultivated at that time. An earlier agricultural study (Eeley, 1978) estimated that nearly 70 percent of the forests cleared for gardening were recolonised with secondary regrowth species. Both these types were increasing at the expense of other ecosystems, particularly the lowland tropical rain forest. Disturbed forest is common around villages and serves as an indicator of the location of earlier gardens or village sites. For example, regenerating forest in the highlands of Malaita and Guadalcanal indicate large areas of abandoned garden sites. Weed problems at these sites are becoming more severe as suitable land for gardens becomes more difficult to find.

Located on the northern plains and foothills of Guadalcanal and the Florida Islands are also extensive areas of grasslands, accounting for between one-two percent of total land area, and believed to have been induced by fires (Hancock and Henderson, 1988). On Makira, villagers have noticed a decline in the quality of their garden produce after forest surrounding their villages was logged. A very high population growth rate (3.5 percent) is exerting greater pressure on gardening land around the villages and forcing cultivation onto marginal lands (steep slopes, poorer soils) that were previously forested, increasingly further away from villages.[1] Another report (SPREP, 1985) stated that 30 percent of the forest on Malaita will be cut down for gardens before it can be logged.

Shifting cultivation without adequate fallow periods

In the past, shifting cultivation was a sustainable form of land use, at a time when low population densities allowed forest fallow periods of sufficient length to restore soil properties by manures, fertilizers or alluvial deposition. Population increase and enforced shortening of fallow periods has led to it becoming non-sustainable (FAO, 1994). Shifting cultivation is practiced throughout the sub-region, where it is a cause of water erosion and soil fertility decline.

In general, smallholder farming systems in the Pacific, and especially in Melanesia, lie at upper end of a continuum between the two extremes of pure commercialisation and family sustenance. These are dynamic systems in which socio-cultural-technical considerations have conferred long-term advantages to farm households. In keeping with arguments used by FAO (1992) it can be argued that, in general, the sequential exploitation and restoration phases of these systems were in balance, and thus stable. The gradual reduction of the restoration phases through prolonging the exploitative phases of these agricultural systems in response to several external pressures, has contributed to the intensification of the exploitative phase and these systems are breaking down. The length of the fallow is generally dependent upon both the inherent richness of the soil and the availability of land.

Only about 12 percent of the **Solomon Islands'** land area is judged suitable for cultivation, and effective population densities are much higher than the overall figure of 11-12 km^2 reported by the World Bank (1986) and SPREP (1992). Food production has also slipped about 10 percent below levels achieved a decade ago, back to levels reported in the early 1970's. These are clear danger signals related to population growth in the Solomon Islands.

Solomon Islands is sometimes typified by 'subsistence affluence': the village-household sector is self-sufficient and there is generally plenty of food for everyone. However, population increase is affecting this level of self-sufficiency; partly a consequence of village food production systems remaining largely unchanged and partly because new technologies[2] are either inappropriate and have not been readily assimilated by smallholder farmers.

Satellite imagery provides evidence that the area under shifting cultivation has also doubled over the last 25 years, matching the increase in population. There is also considerable evidence that fallow periods are shortening in some regions as population densities increase and suitable agricultural land becomes more scarce.

John (1988) reports of extensive areas, particularly on Guadalcanal and Malaita that are degraded to the point of being non-productive. Some of these areas have been abandoned for agriculture and are now virtually unproductive grasslands, given the frequency of burning in these areas. Ten years ago, it was suggested that such areas were expanding. On Malaita declining fallow periods were causing severe soil degradation due to loss of topsoil nutrients, a similar situation on the coastal fringes where coconut and cocoa yields were declining through poor smallholder management. The degraded lands of the peri-urban fringe of Honiara also provide clear evidence of the irreversible damage to the land through

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[1] For example, women of Ura village on Malaita walk five hours a day, four days a week to their gardens.

[2] There is a long history of agricultural development and research in the Solomon Islands. It is interesting to note the contents of a *Bibliography of Agriculture and Forestry*, compiled in 1985 under UKODA assistance, containing some 1 700 entries dating from 1909. Much of this historical information is no longer accessible to the new generation of agricultural researchers as well as to the field extension workers.

inappropriate land use. In State forest areas, it was observed that smallholder cultivation was generally confined to the very steep land (30-75^0 slope), while gently sloping areas, although adjacent, remained closed.

This change has been accompanied by reduced crop yields and increased rates of soil erosion. Also due to the increased scarcity of land in areas of high population density, food cropping has moved on to less suitable land, particularly steep and forested areas which are both difficult to farm and extremely susceptible to erosion (see Box One). Because of population and economic pressures, shifting cultivation, which traditionally has a rotation in excess of 25 years, now has a rotation as short as three to four years in places. This will undoubtedly increase rates of soil erosion (Eyles, 1987).

In the Solomon Islands, Frazer (1973) reported that on north Malaita population pressure and the planting of cash crops have severely restricted the choice of garden sites so that the optimum conditions for new gardens cannot always be fulfilled. Of the gardens he studied 16 percent were in fallow for less than six years while only 5 percent were cleared from mature forest. Under the conditions of freely available land and low population pressures the optimum fallow period appeared to lie within the range 7-20 years. On northern Guadalcanal the length of fallow varies markedly within the range of 4-20 years and an average of 13.8 years (Lasaqa, 1972). In contrast, gardens on the Weather Coast of Guadalcanal were being cleared after less than five years fallow. In Malaita where Eutropept areas with exceptionally high nutrient levels for these islands, the fallow period was reputed to be seldom over five years and often as low as three, although there was no competition for the available land.

Lasaqa (1972) reported that on the alluvial soils of north Guadalcanal there was no substantial drop in yields of sweet potatoes as a result of successive crops. However, a study by Gollifer (1969) on the effect of successive cropping and the length of fallow period on the yield of sweet potatoes from the Weather Coast, indicate a reduction in yield of 45-65 percent (Table xx).

Table: Effect of land use on yield of sweet potatoes (Gollifer, 1969)

Previous land use	**Yield (t/ha)**
10 years fallow	8.0
5-9 years fallow	6.0
0-4 years fallow	4.8
Successive sweet potato crops	3.5

There is also considerable evidence that fallow periods are shortening in some provinces (Malaita, Guadalcanal) as population densities increase and suitable agricultural land becomes scarcer. In some areas of Solomon Islands, the cropping cycles have traditionally allowed more than 25 years of fallow, but these cycles now have a fallow period of only four years. This change has been accompanied by reduced crop yields and increased rates of soil erosion. In some cases traditional gardening techniques which were sustainable are at risk of being forgotten.[3]

There is little doubt that the major factor influencing the decision to abandon the garden is the decline in crop productivity, but the exact causes of this decline are not fully understood.

[3] For example, a Marovo Lagoon method of cultivating taro (a method known locally as *ruta*), allows almost continuous production from the land without addition of inorganic fertiliser. Few individuals can now recall this method of taro cultivation.

From the little evidence available from the Solomons, there appears to be a decline in yields from the second crop although the percentage decrease is much greater between the first and second crops than that between the second and subsequent crops. In many areas these reduced yields still provide a good return from a minimum labour input and may still be far higher than yields from newly cleared land elsewhere. It would seem, therefore, that a lower yield is not in itself sufficient reason for the abandonment of the garden. Another factor which must affect the farmer's decision to cultivate new areas is the possibility of the build-up of soil-borne plant diseases. Also, with the garden, there may be an increase in insect attack and insect-borne diseases which, in addition to reducing yields, could lead to the contamination of propagation material. Weeds rapidly encroach upon the gardens, where insufficient vegetative growth from crops do not shade out competition.

In many coastal areas, coconuts are being planted for the first or second food crops. This creates pressure on the remaining land available for food crops and progressively reduces the area available for subsistence crops and hence shortens the fallow period.

Overgrazing

Overgrazing is the grazing of natural pastures at stocking intensities above the livestock carrying capacity. It leads directly to decreases in the quantity and quality of the vegetative cover. This is a leading cause not only of wind erosion, but also of water erosion in dry lands. Both degradation of the vegetative cover and erosion lead to a decline in soil organic matter and physical properties, and hence in resistance to erosion (FAO, 1994).

Several authors, reviewed in Macfarlane (1993), argue that the degradation of the soil resource in terms of nutrient depletion, soil structural decline, soil acidification and biological decline is clear testimony to the non-sustainability of much of the Australian agricultural landscape. They cite that 13 percent of pastoral lands are seriously eroded with annual soil losses exceeding 20 t ha^{-1} yr^{-1}. The threat to sustainability through overgrazing is exemplified by the study of Bridge et al. (1983) on red earth soils near Katherine (Northern Territory) which showed that following two dry season burnings, followed by weekly pasture clipping to simulate grazing of wet season regrowth, there was increased surface sealing, reduced hydraulic conductivity and soil organic matter, and in some cases, complete scalding of patches. Such scald areas rarely regenerate due to seed removal during runoff, high soil temperatures, low water content in the sealed surface and high bulk densities mitigating against seedling emergence (Mott et al. 1979).

It is frequently stated by many that grazing leads to compaction which then alters landscape hydrology, commonly leading to increased run-off and enhanced potential for erosion.[4] Whilst grazing will compact soils to some extent there are no published Pacific data to suggest that grazing management directed at sustaining productivity leads to degradation, species shifts or soil fertility decline. On the contrary, data from **Vanuatu** and **Solomon Islands** (Macfarlane, 1993) indicate only a 10 percent increase in surface soil bulk density (after 20 years continuous grazing) and maintenance of important soil fertility indicators (over at least 10 years).

Farmers need to base stocking rate decisions on the state of their pastures, and not on the state of their animals. They should also be constantly looking for slight changes in weed populations which indicate excessive grazing pressure ultimately leading to degradation (Macfarlane, 1996).

[4] This can be shown for many soil types in Northern Australia with a high capacity for surface sealing.

Non-adoption of soil-conservation management practices

Improper crop rotations:

Unbalanced fertiliser use:

Overpumping of groundwater

The water resources of small islands and atolls are primarily in the form of groundwater. Surface water resources are not present on most islands; exceptions are 'Eua and a number of the volcanic islands including Niuafo'ou and Niuatoputapu. Groundwater is mainly found as freshwater lenses which form beneath the surface of the limestone islands and above seawater due to the density difference between freshwater and seawater. There is not a sharp interface between the freshwater and underlying seawater but rather a transition from one to the other. Freshwater lenses can only occur where there is sufficient recharge from rainfall and where the permeability of the island's geological formation is not too high as to cause rapid mixing of the recharge to the freshwater and underlying seawater.

Underlying causes of degradation

Land shortage

Agricultural activity throughout the Pacific is both intensifying and expanding into more marginal lands. Subsistence cropping pressure is being transferred to a shrinking pool of available arable land, forcing shorter fallow periods and encroachment into ecologically brittle areas. Under these conditions, Thistlethwaite and Davis (1996) consider that traditional practices are becoming inappropriate when applied in a more intensive situation, or where 'western' technology has reduced the labour component of traditional practices.

Solomon Islands is sometimes said to be typified by 'subsistence affluence': the village-household sector is self-sufficient and there is plenty of food for everyone. However, population increase is affecting this level of self-sufficiency.[5] This is partly a consequence of village food production systems and technology remaining largely unchanged despite the need to feed growing populations. As a result, there has been a steady demand for additional land on which to grow crops. Satellite imagery provides evidence that the area under shifting cultivation has doubled over the last 20 years, matching the increase in population. Food production has expanded in area, rather than intensified. The average cropland per capita was almost 0.45 hectare in 1995.

Also due to the increased scarcity of land in areas of high population density, food cropping has moved on to less suitable land, particularly steep and forested areas which are both difficult to farm and extremely susceptible to erosion. Only about 12 percent of Solomon Islands' land area is judged suitable for cultivation, and effective population densities are much higher than the overall figure of 11 per square kilometre reported by the World Bank.

Land tenure and open access to resources

Interests in land are held jointly and severally by a number of men, women and children who, being in kinship or social relationship with one another, form a group. In selecting a site for a food garden, a farmer has to consider both the 'legal' and 'technical' availability of the land.

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[5] Food production in the Solomon Islands has slipped about 10% below levels achieved a decade ago, back to levels of 20 years ago and significantly below the average for comparable lower-middle income countries in Asia. These are clear danger signals related to population growth in the Solomon Islands.

The former is governed by the farmer's right as a member of a line group or land-holding unit to exercise interests in the land, while people without primary rights must obtain permission to farm from those who have. Site selection is further dependent upon factors such as accessibility, drainage and, perhaps most important, the appearance of the vegetation at the site. Most Pacific Islanders also recognise the suitability of different soil types for particular crops, and, therefore, site selection will also depend upon the crop to be grown.

Box Three: Policies and Practices of Rural Tenure in the Solomon Islands

The author analysed the effects of Christianity and colonial administration on the customary land tenure system. Traditionally, gods, tribes, land and people were intimately related. Christianity replaced the gods, and the colonial government displaced the tribes as administrators of the land. People are now left 'isolated and exposed', and the way was open for poverty. By throwing away introduced legislation it was felt security could be restored. Introduced courts, particularly their procedures, brought injustice. It was suggested that the main answer to Solomon Islands' problems lay in national experience and knowledge, rather than in workshops or expertise from overseas.

Source: Leonard Maenu'u, Secretary, Ministry of Planning, 1984.

Smallholdings are frequently on customary land which is inherited patrilineally or matrilineally. They also occur on land which is formally or informally leased from, or granted short- or long-term user rights by traditional landowners. Customary land often passes from one generation to the next without dispute. However, the possibility of disputes over customary land use entitlements can deter agricultural development requiring long-term commitments (eg. forestry, coconuts, cocoa, coffee and cattle). Whether a smallholder or a plantation, the investment of time, capital and physical resources in non-subsistence livestock requires security of land tenure.

Agricultural activities are also affected by other issues relating to land; for example, where a household's land consists of disaggregated small pieces. This is common in the PNG Highlands. Some rural households attempt to increase their rights to land by fencing unused lands for enclosed cattle grazing or for the planting of coconuts. If a family can demonstrate it has consistently used a particular parcel of land, customary leaders will often allocate such lands to that family head who may then pass it on within the family.

Many government officials, investors and other observers tend to see land tenure as an obstacle to development and to more rational and sustainable land use. However, land tenure issues are often used as an excuse for government inaction. Box xx describes efforts by government and landowners in Vanuatu to introduce land use planning (see BTOR). While land use policies and pieces of legislation are plentiful around the islands, their implementation and enforcement on customary land cannot be undertaken without the consent of the farmer.

As land becomes scarce inter-cropping of subsistence or commercial crops is likely to expand into previously un-utilised or under-utilised coconut lands, or to displace grazed pastures on higher quality lands.[6]

The **Solomon Islands** experimented in the 1970s and 1980's with new ways of identifying customary land owners, but because the ideas were ill-considered, this has left behind a confused state of affairs (see Box Three). A Customary Land Records Bill (draft, 1990) still circulates in SIG circles. There is no clear policy on the sale of customary land and landowners fear its loss after registration. The primary purpose of the Bill was to enable the *recording* of customary land boundaries (cadastral mapping). It was estimated that this

[6] For example, pastures are better adapted to the shallow, lower fertility coastal coralline soils which frequently support coconuts than are traditional food crops.

exercise was likely to take 20-30 years to complete.

The agricultural census (1989) found the average household controlled 6.23 ha, but that one quarter of agricultural households controlled less than 2 ha of land; the latter considered a minimum size for a household which derives its total livelihood from agriculture.

Several groups (NGOs in particular) are working with local groups and organizations to develop alternative income generating opportunities in order to encourage landowners to protect their forests. A Provincial Government in the Solomon Islands (Isabel) passed recently three Conservation Ordinances. This legislation arose out of landowner concerns over their inability to control natural resource exploitation through traditional decision-making mechanisms.

There is a long experience of land registration in Melanesia, upon which predictions can be safely made about what cannot work, might work, will lead to problems, etc. There doesn't appear to be any clear evidence to suggest that development follows registration, or that registration is necessary for development (quote).

Population increase

At the regional level, there is a growing recognition of the critical interface between population, growth, sustainable development, and the environment.; as evidenced from a range of Communiqués and Resolutions at international and regional fora, in particular the 4th Pacific Islands Conference of Leaders on Sustainable Development and Population (1993).

Despite small populations, birth rates are high, and access to family planning services is low in many Pacific island countries. Population growth rates average 2.2 per cent across the region; while in **Solomon Islands**, a rate of 3.5 per cent makes it one of the highest in the world. Overall population growth rate projections for the Pacific region from 1980-2000 are second only to Africa and well above the world average. Such rapid population growth rates cannot be sustained in the long-term particularly given the region's slow economic growth and fragile resource base.

If unchecked, current rates of population growth will have serious implications for log-term economic growth and the achievement of sustainable development within the sub-region. The Pacific 2010 project estimates that even the lowest growth projections for **Papua New Guinea** yield a total population of 5.2 million by the year 2010. Projection scenarios for **Tonga, Solomon Islands, Fiji, Papua New Guinea,** and **Samoa** all show increasing numbers by the year 2010, and notwithstanding the different scale of population issues in the South Pacific, the overall rate of population growth is relatively high. The implications of demographic projections 20 years from now are particularly worrying for the Melanesian countries, reflecting declining mortality but very high fertility rates. In **Solomon Islands**, for example, population projections to the year 2011 by the Pacific 2010 project indicate that at constant rates of fertility and mortality the total population will double between 1991 and 2011.

For example, Gannicott (1993) projected changes in the economically active population from 1991 to 2011 in each Melanesian country. For Fiji and Papua New Guinea, the projections indicate 43 and 55 percent increases, respectively, over the 20 year period. These increases are substantial, but insignificant compared with the projected 95 and 102 percent increases, respectively, for Vanuatu and Solomon Islands.

The outcomes of a four year UNFPA funded project ($1,728,508) implemented by SPREP on *Integration of Population in Environmental Management in Pacific Island Countries* is uncertain (…………………..clarify).

There is a view amongst some government officials, and particularly amongst nongovernment organisations, that the development focus and investment have been too centralised and that significantly greater efforts are required to shift the focus to rural development and employment in the rural areas. The low 'average' population densities quoted for the Melanesian countries are estimated from total land area and therefore give rise to a false perception that, outside of the main urban centres, there is still a long lead time before the pressures from population growth will necessitate serious consideration about the allocation and utilisation of rural resources (Thistlethwaite and Davis, 1996). Large areas of land are not arable for many reasons, and are virtually uninhabited, so population densities are considerably higher than generally thought. Pockets of high rural population density already exist in most countries of the sub-region.

The adverse impacts of population growth on fisheries and marine resources are being felt most in near-shore areas. The pollution of lagoons (principally from sediment washed into the lagoons from logging and agricultural activity) and the cutting of mangroves are also listed as high priority issues. While such issues are recognised by the government, the budgetary allocation does not indicate any degree of urgency. As the population continues to expand, marine resources will come under greater pressure, and as local resources disappear, such concerns will then take on an impelling urgency; but the fear is that by the time appropriate recognition is accorded the problems, many areas near the main population centres will be degraded beyond the point of recovery. Needs once met through direct subsistence activity will then be satisfied only through commercial activities further afield and at significant cost, both in social and cash income terms.

Types of Land Degradation

Land degradation is the temporary or permanent lowering of the productive capacity of land (UNEP, 1992b). Degradation results primarily from incorrect land use and bad land management; that is, from land being used in a manner incompatible with its capability. It covers the various forms of soil degradation, adverse human impacts on water resources, deforestation and forest degradation, and lowering of the productive capacity of rangelands. The degradation of soil resources includes soil erosion by water and wind, deterioration in soil physical, chemical and biological properties, waterlogging, and build-up of toxicities, particularly salts, in the soil. Since soil productivity is intimately connected with water availability, lowering of the groundwater table is also considered. Deforestation is noted primarily as a cause of soil degradation, particularly erosion.

Box One: Common Regional Issues On Land Management and Inappropriate Land Use

1. a lack of effective land use policies and mechanisms to prevent the abuse of land and to foster the implementation of sustainable land management practices;
2. short-sighted agricultural policies which emphasise clearing and production while ignoring long-term productivity;
3. expansion of uncontrolled herbicide use in newly cleared steep areas;
4. lack of effective land management legislation;
5. increase in population leading to the intensification of land use, and to the use of marginal and sloping lands;
6. uncontrolled agro-deforestation on marginal and sloping lands, and the destruction of forests by logging activities accompanied by poor logging practices;
7. the depletion of soil nutrients in many farming systems, and the need to develop appropriate soil, water, and nutrient management technologies;
8. land tenure and land disputes, and the need to build on customary tenure systems and develop institutional frameworks for conflict resolution

Source: World Bank (1993); IBSRAM Highlights (1995)

Land degradation has both on-site and off-site effects. On-site effects are the lowering of the productive capacity of the land, causing either reduced outputs (crop yields, livestock yields) or the need for increased inputs. Off-site effects of water erosion occur through changes in the water regime, including decline in river water quality, and sedimentation of river beds and reservoirs. The main off-site effect of wind erosion is overblowing, or sand deposition (salt laden winds??).

Land degradation is stated to be a key long-term problem throughout the region, where deforestation, soil erosion, soil nutrient depletion, soil compaction, decreasing groundwater quality, flooding, dam siltation, reef degradation, and the decline of coastal fisheries can be traced to inappropriate watershed, agricultural, and coastal land use (SPREP 1992; World Bank, 1995). The resolution of these problems that threaten the sustainability of agricultural systems in the region must deal with communal land tenure systems, traditional land use practices and factors that influence farmer uptake of technologies (see Box Three), social and cultural values, and the integration of environment and development decision-making at the institutional level.

A shortage of suitable arable lowlands due to a combination of increased population, issues of land tenure and access rights, and the introduction of more commercialised forms of agricultural production are leading to the alienation of fertile lands, the encroachment and use of more marginal lands, and the intensification of existing land use on both sloping lands and lowlands, as well as atolls. Forests in the region are also in decline, in both quantity and quality. Recently completed national forest inventories in Fiji, Samoa, Solomon Islands, and Vanuatu, which define the extent and condition of their forest resources, support this finding (World Bank, 1995). The extensive clearing of forested land for farming (agro-deforestation) is also a major land management issue (Table Two).

However, very limited quantitative data exists on the types of land degradation in the sub-region; their extent, causes, and possible future consequences on traditional uses, agricultural productivity and farm output. Even where information is known, governments and communities often lack the collective authority or the will to prevent land mis-use or to encourage activities which are considered desirable.

Strategic decisions about the rate at which agroecosystem resources are used are taking on increasing importance in the sub-region. There is already evidence of declining productivity of some agricultural land in the sub-region, a consequence of the gradual breakdown of the traditional bush fallowing system. Pressures for land intensification are becoming greater in many rural villages as cash cropping assumes importance.

Why Pacific farmers do not adopt technologies

- technologies do not fulfil client's needs
- technologies do not work in farm locations
- technologies cannot be applied by farmers
- technologies are not known by farmers
- non-availability of technology inputs at farm level

Source: Stephen Rogers (pers. comm.)

Hardaker and Fleming (1994) regard it simplistic and misleading to place the blame for any negative effects of the pressures on land on cash cropping. Cash cropping need not be a cause of degradation of an agroecosystem. Hence, any strategy to solve a country's ecological problem by replacing cash cropping with food production is likely to be based on a false premise. Further, they consider the more difficult problem concerns the way in which cash crop expansion takes place. Cash cropping has often taken place on the best lands, relegating food production to less fertile lands. Consequently, ecological problems result from a lack of a suitable natural resource management programme and land tenure arrangements rather than the destination of the crop output. The authors suggest that the best long-term option is to establish a sound natural resource management programme which tackles the major causes of market failure causing degradation of the agroecosystem, and encompass a variety of measures, including among others tenure reform.

Evidence from problem identification phases of participatory approaches used in farming systems analysis have revealed seasonal drought and soil fertility decline (page 13 agroforestry, North Efate PRAP); declining soil fertility, soil erosion, deforestation; and problem ranking as soil organic matter rank 1), acidity (2) (Waibau, 1996); Causal diagrams for soil erosion available. For Samoa (districts?) thru problem ranking poor soil fertility (12), poor soil drainage (14); short season drought (15); Tongatapu: drought in taro (2), soil fertility in sweet potato and Colocasia (2), soil physical properties (3); causal analysis for drought in taro available; Vava'u: soil erosion, soil N and P deficiency, decline in soil physical properties, drought in yams and Colocasia; causal diagrams available for drought in Colocasia and decline in soil physical properties. Agroforestry trials with technical hypothesis the inclusion of woody perennials in food cropping systems in spatial arrangements and/or temporal sequences can improve the biological productivity, economic viability and sustainability of the systems. Gazelle Peninsula: Problem ranking: yield decline in old gardens (1); decline in soil fertility (6) with causal diagram; shortage of fuelwood (10) underway to include

In a regional survey to research and extension staff, problems were prioritised as follows:

Table xx: Land degradation elements scored from an FSRE problem ranking matrix at national level (aggregate ranking* out of 17 problems perceived by researchers)

Problems	FIJ	PNG (Gazelle)	SAM	SOI	TON Vava'u	TON T'tapu	VAN	Regional Ranking
Soil fertility decline	2=	3	8	6	4=	3	4=	**3**
Soil erosion	1	1=	10	10	6	11	7	**5=**
Poor soil drainage	5=	15	12=	13	9=	16	14	**13**
Drought	4=	12	14	12	3	2	5	**8**
Waterlogging	6	14	12=	15	10	15	15	**14**
Land pressure	2=	1=	6	5	4=	5	1	**2**

Source: PRAP Transition Review Logical Framework Workshop, August 1996, Suva, Fiji
* Criteria used: Distribution; Seriousness; Loss of exports; Loss of food security; Damage to environment; Ease to address

Types and causes of land degradation in the South Pacific reported from Problem Diagnoses undertaken at farm level (Grouped by FAO definition)

Country/Location	Land Degradation			
	Type[1]	Rank	Direct causes	Underlying causes
Cook Islands				
FAO, 1997 Manihiki, Penrhyn, Pukapuka	• Forest degradation	1	Land use intensification; cyclones	
FAO, 1996 Mauke	• Water erosion	3	Deforestation on marginal land;	
Fiji				
MAFF, 1996 Waibau	• Soil fertility decline (OM depletion)	1	Lower response to fertiliser by taro; reduced fallow periods	Insecure land tenure; restricted access to suitable land
	• Water erosion	2	Cultivation of marginal land without soil conservation; deforestation on marginal land	Insecure land tenure; restricted access to suitable land
PNG				
DAL, 1995 Gazelle	• Soil fertility decline	1	Soil nutrient imbalance in food gardens; reduced fallow periods; land use intensification; cultivation of marginal land without soil conservation	Land tenure; land shortage
	• Water erosion	3	Cultivation of marginal land without soil conservation	Land tenure; land shortage
FAO, 1996 Markham	• Soil fertility decline	3	Reduced fallow periods; land use intensification	Land disputes; land shortage

	• Water erosion	5	Excessive flooding	Watershed degradation
Samoa PRAP, 1996 Upolu	• Soil fertility decline (coastal areas) • Waterlogging	12 14	Reduced fallow periods; land use intensification High rainfall, no drainage	Shortage of suitable land
Tonga PRAP, 1996 Tongatapu	• Soil fertility decline (OM depletion)	1	Reduced fallow periods; agro-deforestation	Shortage of suitable land
	• Soil fertility decline (degradation of soil physical properties)	3	Excessive mechanical cultivation; reduced fallow periods; land use intensification	Shortage of suitable land
PRAP, 1996 Vava'u	• Water erosion	3	Deforestation	Land shortage
	• Soil fertility decline (degradation of soil physical properties)	4	Excessive mechanical cultivation; reduced fallow periods; land use intensification	Shortage of suitable land
PRAP, 1997 Tongatapu	• Soil fertility decline (OM depletion)	2		Shortage of certified land for organic farming
Vanuatu PRAP, 1996 North Efate	• Soil fertility decline	3	Deforestation; land use intensification; reduced fallow periods; inappropriate cultivation practices	Land disputes; land shortage

[1] Most causes have been defined around contributing factors to core problems and supported by causal diagrams following PRA exercises

There is little published data on soil erosion in the **Solomon Islands** (Eyles, 1987). Although recognized, its control is not considered by the government to have a high priority (internal FAO correspondence). The Ministry of Agriculture does not have an erosion control programme, but encourages soil conservation through good farming methods.

Wall et al. (1979) considered that surface wash is the most prevalent form of erosion. They also comment that gully erosion is common, occurring on almost all residual or sedimentary landscapes in all islands. In particular, Hansell and Wall (1970) reports that Guadalcanal has significant erosion in three of the seven Agricultural Opportunity Areas (AOA); the largely mountainous *Kaichui* and *Itiri* land regions are "subject to moderate to severe erosion" while the *Paru* land region has "landslide and gully" erosion.

Soil Fertility Decline (loss of nutrients and/or organic matter)

Managing soil nutrient status

The "non-depletion of soil nutrient status" is a complex issue, invariably linked with declining levels of plant available nitrogen and low rates of mineralisation of organic nitrogen, whilst total system levels of nitrogen are relatively constant (Myers and Robbins, 1991). Macfarlane and Whiteman (1983) reported that on oxisols in a 3 000mm rainfall environment on Kolombangara, Solomon Islands, a rainforest site logged in 1976 and established to *Eucalyptus deglupta* in 1977, experienced an increase in total soil N from 0.45% to a peak of 0.55% in year 4, and a decline to 0.42% in year 5. This decline was associated with a fall of legume dry matter on offer from 1 640kg to 1 130kg per hectare.

For much of the humid and semi-arid tropics and sub-tropics low plant available phosphorus (P) limits pasture and animal production. In environments of 4-10ppm plant available P, the use of adapted seca stylo oversown into native grasses and animal supplementation of 5-6gP/hd/day over a six month period is a sufficient and cost-effective strategy to sustain commercial production turning off a marketable steer at 3.5 years of age. The supplemental P equals product removal and thus satisfies the criterion of Williams and Chartres (1991).

The management strategy of fertilising tropical soils of high P fixation capacity to improve legume options by increasing plant available P levels is not cost-effective and therefore not sustainable. Typically these soils have 40-100kg extractable or available P/ha as part of a total pool of 2 000-4 000 kg P/ha. On oxisols on Kolombangara, Solomon Islands, MacFarlane and Whiteman (1983) showed that for soils with about 5 000 kg total P/ha (to one metre depth), the yield of centro and puero declined markedly once P levels fell below 12ppm and that 40 kgP/ha was necessary to restore a critical level of P in the soil solution to achieve near maximum growth.

Macfarlane (1993) reports that on Efate, Vanuatu, there are signal grass/native legume pastures which have had stable botanical composition and stable rates of steer turn-off to the abattoir for 18 years. Guinea/puero/centro/glycine pastures have been botanically stable for 15 years. Phosphorus is in adequate supply at about 50ppm bicarbonate extractable P and available nutrient status is adequate for maximum pasture production. Soil extractable nutrient levels have not declined over the last five years and it is reasonable to assume that these two particular systems will continue to operate at the current level of output with zero nutrient inputs for plant production for a considerable time.

Acidification

Soils in natural ecosystems can acidify especially in areas of high rainfall and where the parent material is low in basic minerals that buffer the soil pH. Organic matter accumulation and profile leaching of nitrate and with it basic cations such as calcium and magnesium are the principal processes which lead to acidification. In agro-ecosystems this process can be accelerated through product export, the addition of acidifying nitrogen fertilisers and increased nutrient leaching. To avoid decline in introduced grass/legume pasture productivity Robbins (1984) suggested a minimum fixation of 125 kgN/ha/yr. *Leucaena* pastures have fixed 560 kgN/ha/yr in Southern Queensland (Whiteman, 1980).

Naturally acidic soils derived from olivine basalt's with natural ecosystem pH's of 5-5.5 on Kolombangara, Solomon Islands, or on Erromango or North Tanna, Vanuatu, have a lower soil pH buffering capacity than soils derived primarily from calcareous sedimentary or recently uplifted coralline parent material which characterises much of the coastal and sometimes interior Pacific Island geology's.

Acidification is generally not being raised as a current issue in Pacific Island tropical pasture agro-ecosystems. Due to the high buffering capacity of average coralline derived soils, low levels of nitrogen fertiliser use and the absence of high legume pastures the problem is less acute than in Australia and regional agriculturists should seize the opportunity to identify areas of potential acidification now.

In a 3 000mm rainfall environment on Kolombangra, Solomon Islands, MacFarlane and Whiteman (1983) compared the nutrients immobilised in tree biomass and exported in beef associated with open pastures of puero and t-grass with *Eucalyptus deglupta* of 5-7 years of age. In the open pasture system exports of N, P, K, Ca and Mg were 11, 3.5, 0.8, 6.2 and 0.18 kg/ha/yr. In the silvo-pastoral system the annual export of animal growth and tree growth accounted for the removal/immobilisation of N (15.3), P (2.7), K (22.3), Ca (25.7) and Mg (7.4) kg/ha of nutrient. These differences were reflected in lower levels of exchangeable Ca and K in soils in treatments averaging 165 stems/ha or greater.

Bruce (1965) reported that 16 year old guinea/centro pastures sustained 3.8% organic carbon whereas virgin forest had 4.1% organic carbon. Similarly, MacFarlane and Whiteman (1983) reported 3.3% organic carbon and Hansell et al. (1975) reported 3.5% organic carbon on volcanic/coralline soils on the Russell Islands, Solomon Islands, supporting native pastures under 70 year old stands of coconuts.

Macfarlane (1993) emphasises the importance of appropriately detailed on-farm soil surveys for soil fertility monitoring. Sampling on a grid of one sample (composite of 10 sub-samples) per 50 hectares has shown that over a 600 hectare property, P_B levels range from 4-30 ppm.

> The complexity of what is involved in sustainable systems involves not only plants and pastures but animal performance, soil factors, the environment, and of course the man on the land. **For the Pacific, we often expect the most out of the system without even putting anything into it**.

Organic matter depletion; Negative soil nutrient balance; Imbalance in fertiliser application; Failure of increases in fertiliser use to be matched by increases in crop yield; Waterlogging; Lowering of the water table

Deforestation and forest degradation

Deforestation, often the result of repeated burning, has been endemic in the sub-region since first human contact and along with periodic cyclone damage is responsible for the development of secondary forests, savannah grasslands and a degraded fern and grassland (World Bank, 1995). In the Solomon Islands there are many forest areas dominated by single pioneer species, believed to have been degraded by cyclones and clearing for cultivation. In Fiji and Samoa, poor, degraded and non-commercial forest types dominate the landscape (World Bank, 1995). Recently completed national forest inventories in Fiji, Solomon Islands and Vanuatu, which define the extent and condition of their forest resources, support this finding.

The state of the World's Forests (FAO, 1997) estimated forest degradation of 756 000 hectares in Tropical Oceania[7] between 1990-95. This represented an annual rate of change of forest cover of -0.4 percent. Although deforestation (the destruction or removal of trees) is a major concern, agro-deforestation (declining tree planting and the elimination of trees from existing agricultural and urban landscapes) is also a serious problem, particularly in small island and atoll countries (Thaman and Whistler, 1996).

Table xx: Extent of forest cover and other statistics

FAO Members	Land Area ('000ha)	Forest tree cover ('000ha) [1]				Main causes of change in forest cover	Code of Logging Practice	Forest inventory
		Total area	% of land area	Production forests (area, %)	Change in forest cover (%/yr)			
Cook Islands	24	15.8 (E,96)	67	na	na	Cultivation, industry, cyclone	🗀	🗀
Fiji	1,835	993.3 (P,95)	54	253	- <1.0%	Logging, cultivation	1990	1996
Papua New Guinea	45,256	39,400	87	14,600 (37%)	na	Logging, cultivation	1996	🗀
Samoa	283	162.7? (1990)	40	16	- 3.5%	Cultivation, cyclones, logging	Being prepared	🗀
Solomon Islands	2,835	2,201	78	279	na	Cultivation, cyclones, logging	1994	1993
Tonga	74.7	4[2]	6	2[2]	na	Cultivation	🗀	🗀
Vanuatu	1,227	427[3]	35	116	na	Cattle ranching, cultivation, cyclones	1996	1995

[1] Source: Compiled from Country Reports presented at the Heads of Forestry Meeting, September 1996, Port Vila, Vanuatu. P=Provisional; E=Estimate
[2] An estimate of 3,779 ha is located on 'Eua (Larsen and Upcott, 1982), of which 1,747 is accessible. Reported in NEMS (1993)
[3] About 80% of forested land is open forest, mainly as a result of repeated cyclonic disturbance (SPREP, 1991)

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[7] Tropical Oceania includes: American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, New Caledonia, Niue, Pacific Islands (Trust Terr.), Papua New Guinea, Samoa, Solomon Islands, Tonga, and Vanuatu. Together, PNG and SOI accounted for 689,000 hectares (or 91 per cent) of forest cover loss.

However, deforestation rates alone do not provide an accurate indicator of the severity of forest loss. Forests are also being rapidly degraded (i.e. the number of trees, the diversity of species, the portion of crown cover, and soil quality, are declining), often due to poor logging practices which affect the capacity of the forests to regenerate naturally. The gradual loss of forests, forest lands and trees to timber production, agriculture, fuelwood and other land uses is a serious concern to all countries in the sub-region, over the impact on the *sustainability* of:

- the economically valuable forest and tree resources,
- available first-class land,
- agricultural productivity,
- water supplies and quality,
- habitable terrestrial environments,

On the atolls and low island nations where the coralline-based soil is inherently infertile coupled with very low water retention capacity and constant exposure to the prevailing salt-laden winds, the terrestrial ecosystems are relatively simple but very fragile. Limited forest and tree cover (including coconuts) have supplied vital shelter, soil protection, wood for canoes, fuel and other products to the local communities. As there is very little, if any, nutrient runoff to enrich the lagoons, atolls typically support relatively low total marine productivity compared to continental coastal areas or larger volcanic islands (Kearney 1980, in Liew 1990).

The use of the limited natural resources present has led to the depletion of valuable timber resources (Liew 1990; Solomona, 1997). Localised fuelwood shortages are occurring or imminent in many countries. Depletion of the biomass present will include more rapid soil erosion and the loss of the already very limited humus material, thus rendering regeneration of vegetation even more difficult. Growing disrespect for traditional socio-cultural values and controls (e.g. *raui* in the Cook Islands) also exist (Solomona, 1997).

Probably every economic report prepared on **Solomon Islands** in the past decade has highlighted problems related to commercial forestry, having identified commercial logging as the main environmental issue (Duncan, 1994). Solomon Islands has a natural forest area of around 2.2 million hectares, or between 78-80 percent of the total land area. However, less than 15 percent is thought to be commercially exploitable, containing an estimated 13.5 million m^3 of commercial round log reserves, the remainder being on very steep or inaccessible areas, or scattered over small islands. Also, about 2 560 km^2 (nine percent) of forests are reportedly degraded from shifting cultivation, logging activity and cyclonic disturbances. The AusAID funded national forest resources inventory

Application of land deterioration susceptibility classes to watershed conditions of the Salambara river catchment in New Georgia, Solomon Islands

The Salambara river (no. 320 by Hansell and Wall) and its two flanking catchments (nos. 319 and 321) flow into Kalena Bay, to the south-east of Roviana Lagoon. The upper catchment areas of these streams contain a significant proportion of the Hopuhopu land system, assessed as very susceptible to deterioration (class S3). Downstream, large areas of Viru, Serambuni and Kumotu land systems occur, which are also in class S3. In generating a susceptibility map of Western Province, it was predicted that uncontrolled logging in these catchments would result in extensive soil erosion and sediment deposition into Kalena Bay, which would damage coral and fishery resources.

In practice, these catchments have been extensively logged and considerable soil erosion has occurred. Large amounts of sediments that had entered Kalena Bay have completely destroyed the coastal lagoon systems and the coral reefs, with resultant depletion of fish stocks.

Source: Aldrick, 1993.

classified forest types at three levels of stratification. The range of mapping units included categories for degraded forests (human induced), logged forests, plantation areas, cyclone affected areas, etc., etc.. This information was incorporated into the Forest Resource Information System (SOLFRIS), making it possible to print 'land condition' maps for the country. It is worth repeating the utility of this type of application in assessing land areas for potential degradation, even if scale limitations of 1:150 000 are considered (refer Box xx).

It has been estimated that, at the 1994 rate of harvest (approximately 700 000 m^3 per annum), the Solomon Islands remaining commercial forests will be logged out by 2010 and 2015 or around 2003 if the harvest rate increases to 1 300 000 m^3 per annum. The sharp increase in the rate of timber harvesting since late 1994 indicates that this is the more likely scenario. In the Solomon Islands, areas which have been logged heavily are not regenerating. Estimates of Annual Allowable Cut (AAC) range between 289,000 and 400 000 m^3, and that an annual cut of 286 000 m^3 per annum could be sustained in perpetuity.[8]

At the same time, the anticipated harvests from existing and future forest plantations (privatised) on government land are expected to accelerate significantly over the next few years. In 1995, approximately 30 000 m^3 of plantation logs were exported. For 1996, the combined volume of harvestable plantation logs is expected to exceed 100 000 m^3, and in 1997 over 150 000 m^3 could be exported. Very conservatively, the combined plantation areas in Solomon Islands (approx. 70 000 ha) have an estimated annual increment, and therefore harvest potential, of 1 000 000 m^3 of round logs per annum by 2005, at which time harvests from natural forests could be reduced to the sustainable cut (Kes, 1996).

[8] Duncan (1994) reported that in terms of distribution of income from logging natural forests, resource owners consistently receive the smallest portion (less than 10%) of the log value, while loggers consistently receive 25-30% in the form of excess profits. Government taxes and levies comprise 30-35%, while logging costs make up the balance (30-35%). The loss of economic surplus to logging contractors in 1993 was estimated to be at least SI$36 million. There is also evidence that the Solomon Islands has been losing large sums of money through under-reporting of log prices. In 1993 the loss from under-reporting of log prices alone could have been SI$94 million. Thus total loss in economic surplus in 1993 is estimated to be SI$130 million.

Atoll forests: conservation and management for community resources and livelihood security

The forest legacy of the copra era on many Pacific atolls is a rapidly aging coconut monoculture now reaching late senescence with declining nut production, vigour and storm resistance. Other atoll tree species long suppressed by informal local management are struggling to survive and without encouragement may disappear completely from many locations, suppressed by the sheer volume of coconut regeneration from unharvested nuts.

The atoll environment for tree growth is characterised by high salinity and pH, and low organic matter. The species that utilise this environment are specialised and relatively few in number compared to tropical forests on soils more favourable to plant growth. Atoll species are distributed by water- or bird-borne seed and have a wide distribution, sufficient that few are regionally endangered. However, on individual atolls there have been significant species losses, particularly from shoreline protection zones where recurrent fire and inundation have given regeneration little chance of survival (e.g. in the Cook Islands). Increasing tourism potential will also depend on there being healthy natural forest for both landscape and resource requirements and many Island nations have a rich history of cultural, medicinal and handicraft uses of forest species that need to be maintained as a natural heritage.

1. Storm Protection. All atolls are open to storm damage and cyclones periodically traverse most island groups. The primary protection in times of storm are the coastal forests that comprise a range of species that together contribute a barrier to storm penetration of the land. This is true for high islands as much as for low islands as most communities are located on coastlines. Persistent fire and the encouragement of coconut close to villages, for convenience, has eliminated coastal forest. Pressure for cropping land has also impacted heavily on coastal forest as fires used to clear fallow have often persisted uncontrolled through coastal vegetation. Regeneration has been prevented and farmers often complain of severe salt and wind damage to crops. Coastal forest species need to be encouraged, protected and managed by those communities for which they provide essential protection.

2. Food Security. On many atolls persistent clearing of understorey and relentless cropping has had two important impacts on productivity of food crops:

- traditional tree cover has been steadily removed particularly where mechanical cultivation is available
- regeneration of tree cover has been prevented and fallow periods reduced

3. Fresh Water Resources. Fresh water resources are held as a lens above brackish and salt water beneath atolls. Contamination of these resources is a constant threat and forest is possibly the only vegetation offering some opportunity for purification both from maintaining or refurbishing soil characteristics with good humus layers and filtration rates, and utilisation of minerals released into soil solutions.

4. Timber Products. Timber for construction, furniture, artefacts and handicrafts are obtained from a range of atoll species. Coconut timber has limited usefulness is difficult to saw, season and work and is subject to rot and insect attack particularly in contact or close proximity to the ground. Braodleafed atoll species are more resistant and some have extremely high quality timber resistant to insects and rot once seasoned. Ground and seawater durability is a feature of at least two major species.

5. Non-timber Forest Products (NTFP): Cultural, medicinal and traditional handicrafts use a range of NTFP. Those that draw on bark and its products need to be carefully managed to avoid over-exploitation of the resource. Natural medicines in some island groups can no longer be produced through loss of the basic resource and there is no organised, formal or informal, effort being made to reinstate these species. Increasing tourism will mean increasing opportunities for marketing of traditional artefacts, all of which will depend on effective management of their natural resource, particularly if that is forest.

6. Landscape and Wildlife. Every Pacific tourist dreams of their own tropical beach fringed with forest. While the forest is traditionally marketed as coconut there are a number of species that contribute to maintaining healthy shorelines and these need to be retained and protected to preserve habitat for coconut and indigenous, birds, turtles, crabs and insects. On many atolls particular motus or motu areas have become vital refuge sites for birds and other wildlife. This is a direct result of the forest characteristics of these sites and their preservation is of huge importance to conservation and biodiversity issues of the region.

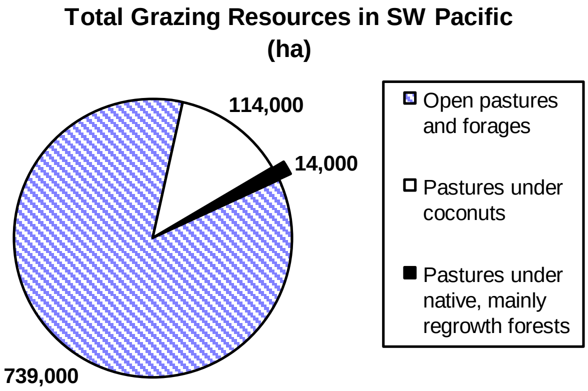
7. Feral Animals. These threaten regeneration on many atolls, pigs and rats being particularly effective at eliminating regenerating seedlings in their most succulent phases. The 'Pacific-free-range-system' carries a cost to the natural forest environment and must be managed in a sensitive way as the animals themselves are a resource valued by local people.

8. Government Programmes. Formal forest management systems for atoll forests have seldom been supported or promoted by official initiatives by Governments. Forests are the resource of the local population and any management issues have largely been left to them. Apart from copra resources have not been perceived as having economic benefit on a national scale and therefore officially they have been largely ignored.

Population pressures, animal introductions, species manipulation for coconut and storm damage have all influenced the forest structure and composition. There is no formal conception of what is an appropriate or inappropriate forest and this problem requires formal recognition.

Source: McCraken, I. 1997

Rangeland degradation



Macfarlane (1993) suggests that ecologically sustainable tropical pasture systems are characterised by stable soil resources, botanically stable annual and perennial herbaceous, shrub and tree components, with an ability to meet the nutritional requirements of pasture plants and grazing livestock. Permanent tropical and sub-tropical pastures (grazing resources) of the South-West Pacific are comprised largely of grasses with varying quantities of native and/or introduced legumes, as well as a range of forage crops. The following sections draw heavily from information by Macfarlane (1993, 1996, 1998).

The total land area of the South-West Pacific is reported by Macfarlane (1998) at 53.9 million hectares, whilst the seven major livestock countries comprise 53.3 million hectares (Table 3). Within the latter, approximately 866,000 hectares are devoted to open and shaded grazing (1.6% of total land area), 448,000 hectares produces coconuts with or without inter-cropping (0.8%) and a further 561,000 hectares (1.1%) is used for arable and permanent tree crops other than coconuts, while about 41 million hectares (78%) is forested (FAO, 1988).[9] Within the countries listed, open grazed pastures represent 85% of total grazing areas, or 40% of all agricultural areas (FAO, 1997).

Table 3 Land use in the South-West Pacific: key statistics

	Grazed pastures ('000 ha)			**Total Land Use ('000 ha)**				**Pot. grazing ('000 ha)**
Major Countries	Open	Under c/nuts	Under trees	C/nuts	Forest	Agric[2]	Land area	Under c/nuts[3]
Fiji	270[1]	27	1	65	993	260	1,835	42
New Caledonia	217	3	-	3	708	13	1,828	3
PNG	191	10	2	270	39,400	440	45,256	80
Samoa	4	13	0.2	47	134	98	282	24
Solomon Islands	6	11	0.3	60	2,560	96	2,835	24
Tonga	1.2	4.5	0.1	35	8	48	72	10
Vanuatu	50	45	10[4]	86	900	144	1,219	30
Total	**739.2**	**113.5**	**13.6**	**562**	**41,495**	**1,123**	**53,341**	**213**

Source: Macfarlane, 1998

[1] Includes an estimated 95,000 hectares of sugarcane and other crop stubble/tops, roadsides and domestic compounds which are grazed annually.

[2] Pasture under coconut areas are also included in permanent crop areas (including tree crops).

[3] Estimated areas for rehabilitation of degraded, ungrazed, weed infested, lowland coconut lands (FIJ, PNG, SAM, SOI, VAN) and/or pasture leys (TON).

[4] Mainly native regrowth forests, or replanted forests/plantations

Grazing under coconuts is the most important livestock agroforestry system practised in the SW Pacific. Most grazing under coconut lands are on coastal soils of low water holding capacity or clay soils on slopes adjacent to the coast and up to approximately 300m in

[9] The minor livestock-producing countries of Cook Islands, French Polynesia, Marshall Islands, Kiribati, Niue, Tuvalu, and Wallis and Futuna contribute an additional area of 20,000 hectares of open pastures, 24,000 hectares of pastures under coconuts, and 69,000 hectares of inter-cropped or unused coconut lands.

altitude. Much of the 114,000 hectares of grazed coconut lands in the region are currently producing below their potential, on pastures of inferior quality with severe weed infestations. The remaining 448,000 hectares of coconut lands are either inter-cropped[10], have no understorey cropping, or are completely un-utilised in terms of silvo-pastoral or agri-silvi-cultural enterprises.

Macfarlane (1998) identified about 100,000 hectares of currently un-utilised "degraded" coconut lands of these remaining 448,000 hectares which could also be rehabilitated and brought into profitable livestock production, with potential benefits for copra production, without compromising arable land currently used for inter-cropping. Such action would also relieve historical pressure on native forests. Regionally derived and proven grazing system technologies are available to achieve the potential for productivity gains from this grazing resource. In some cases the realisation of this potential will be dependent upon correcting critical soil nutrient deficiencies and providing animal mineral, energy and sometimes protein supplementation depending on the edaphic environment and levels of production sought (Macfarlane, 1996b).

Across the region the level of copra cutting appears to be declining because of labour availability and costs, high freight charges and better alternative returns to labour, often resulting in rangeland degradation associated with weed infestations. Given declining regional copra production and declining copra prices, reclaiming degraded coconuts lands through appropriate grazing systems management will be important in maintaining the economic welfare of rural households in the region.[11]

<u>Watershed Degradation and Management</u>

As defined by FAO (1995) a watershed consists of a unit of land or drainage area (catchment) containing productive processes that combine very complex, interrelated and spatially and temporally variable natural, social, economic, political and institutional factors. Many of the islands in the sub-region have much smaller land masses and consequently, smaller watersheds. This means that there is little opportunity for temporary storage of soil, water, and pollutants in their drainage basins. Small island watersheds are closely linked with nearshore marine systems (lagoons and reefs), and must be very carefully managed to maintain ecological balance.

A reconnaissance level assessment of the condition and the susceptibility to deterioration of watersheds in the **Solomon Islands** was undertaken in the early 1990s, in conjunction with an AusAID funded national forest resources inventory (Aldrick, 1993). Catchment conditions were evaluated using only biophysical parameters and were classified into five susceptibility classes, which could then be computer generated using land system boundaries as the basic mapping unit (scale 1:150 000). This study identified 80 of the 147 land systems described by Hansell and Wall (1976), or 54 percent, as having a high susceptibility to deterioration but their spatial extent relative to land capability was not reported other than areas containing high environmental significance or conservation value.

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[10] Within the seven countries under discussion, inter-cropping of cocoa, root crops, bananas, kava, vanilla and other crops under coconuts is significant, but official statistics on areas are not readily available. However, a significant proportion of the currently ungrazed 448,000 hectares of coconut lands are not used for inter-cropping.

[11] Reynolds (1993) reports on the main economic advantages of integrating livestock, pastures and tree crops, using data from Papua New Guinea, Samoa, Solomon Islands, and Vanuatu. Broadly, and relative to monocropping enterprises these include reduced weeding costs (up to 70%); increased copra production (nut pick-up improved from 75% to 90%); labour released for other tasks (up to 40%); increased gross farm income; reduced dependence and thus income risks (20% to 30%); and more complete utilisation of available feed resources (crop by-products and crop residues).

Profile of Land Use Planning and LRIS (At 1997)

LUP

Since 1975, a small Land Use Development section within the Ministry of Agriculture (MAF) has been assisting groups of Solomon Islanders to acquire and develop plantations and to establish medium-scale agricultural projects on alienated customary land, supported by ODA (UK) assistance in land surveys and co-operative registration, farm plans, and provision of agricultural and basic management advice. The importance of a sound land use Policy was recognised in July, 1985 when an inter-ministerial body was proposed, reporting to Cabinet. A MAF Cabinet Paper (Feb, 1986) outlined the need for land use planning in the Solomon Islands, with two major objectives:

- the expansion and improvement of support services to medium-scale agricultural projects on both alienated and customary land, and
- provision of a more comprehensive land use planning and advisory service for government, provinces, and rural people.

> **Issues on land management in the Solomon Islands**
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> - population pressure leading to the intensification of land use and use of marginal lands.
> - lack of political will to implement policies to promote sustainable land management.
> - land tenure and land disputes.
> - loss of soil fertility from present farming practices and reduction in fallow periods.
> - loss of forest land through logging and agricultural activities
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> Source: IBSRAM Highlights 1995

A Cabinet sitting of 27 February 1986 rejected the MAF proposal, and recommended the creation of a separate body to advise on land use planning. ODA advisers were withdrawn in 1988 and little progress has been achieved since. In 1988, FAO provided TCP assistance (project TCP/SOI/6755) whose ambitious objectives were to establish a land use planning capability and to formulate a land evaluation methodology (FAO, 1988). This short-term project essentially analysed the factors affecting land use and soil degradation, and proposed a larger project with the following main components:

1. development of a system or methodology to identify and classify land units or land types, and the definition of appropriate land uses that are socially and economically acceptable for each of these. A necessary foundation for this would be a computerised land information system containing data on climate, soils, topography, crop requirements, production systems, costs, etc.;
2. training of local professional staff in the necessary methods of data collection, land evaluation, land use planning, and conservation-based farming systems; and
3. establishment of an institutional framework for integrated land development planning at national, provincial and watershed levels to effectively establish priorities, advise on the allocation of resources, and draw up and implement development plans. Such a planning and management structure should be able to integrate the contributions, skills and activities of various units within the Ministry of Agriculture and Lands, and of the other Ministries concerned.

Although this project was never funded its recommendations are clearly valid and important today, given the accelerated pace at which resource degradation is occurring in the Solomon Islands. Based on a Cabinet directive dated May 1992, the MAF submitted a request for AusAID assistance to strengthen its land use planning capabilities, utilising the NATRIM and SOLFRIS facilities. Political differences between Australia and the Solomon Islands have prevented its further consideration.

In 1993 a National Environment Management Strategy (NEMS) was developed, based on integrating the involvement of all levels of government in the development of sustainable land and resource management practices. A legislative framework for enacting the strategy was subsequently proposed, which vests powers and responsibilities in the Environment Division of the Ministry of Forests, Environment and Conservation. This legislation is still under consideration.

Managing land and marine resources is also complicated by the need to co-ordinate a land use planning approach with Provincial and Local governments and customary landowner groups. About 90 percent of all land and virtually all inshore reef areas are held under customary systems of tenure, and have developed complex access rights which cannot be solved simply by passing centralised legislation. A more effective strategy would be to focus on increasing the availability of information, to work with local landowner groups to develop mechanisms for rational land resource management and enforcement.

In early February, 1997, the Ministry of Planning and Development held its first meeting to formulate a five-year National Development Plan for all sectors, and stressed that land use planning was closely linked to the ability of this process to rationalise and prioritise development opportunities.

Box Five: Assistance to Land Resource Management in the Solomon Islands

Hansell, J.R.F. and Wall, J.R.D. (1974-76). Land resources of the Solomon Islands. Volumes 1-8. Land Resource Study 18, Ministry of Overseas Development, UK.

Chase, L.D.C. (1981). A preliminary guide to the suitability of land in the Solomon Islands for smallholder crops. Dodo Creek Research Station, Technical Bulletin No1, Ministry of Agriculture and Lands, Honiara.

FAO (1988). Assistance to Land Evaluation. Terminal Statement, project TCP/SOI/6755.

AusAID funded National Forest Resources Inventory.

Aldrick, J.M. (1993). The susceptibility of lands to deterioration in the Solomon Islands. Project Working Paper 12; National forest resources inventory project (SOLFRIS), Ministry of Natural Resources, Honiara.

Pipeline proposal: Australian Defence Cooperation program to complete digital coverage (FACC) of Solomon Islands (Phase Two). Proposed to start end-1997, using RS (radar) in preference to aerial photography.

Pipeline proposal: SIG funded Customary Land Recording of genealogy and customary lands throughout Solomon Islands, Ministry of Lands and Housing. No discussion to date at rural level and will likely take 20-30 years to fully implement.

Land Resource Information Systems

Between 1967 and 1972 the fieldwork for a survey of the land resources of the Solomon Islands was undertaken with UK assistance, published in several volumes between 1974 and 1979. Surveyed territory was divided into 147 land systems (or mapping units) using the main biophysical parameters (geology, landform, soils and vegetation), which were characterised in terms of their potential land use. Some of these land systems were further divided into simpler elements (land facets) for the purposes of identifying land of good agricultural potential for larger-scale planning.

In these volumes the concept of agricultural opportunity areas (AOA) was introduced and briefly defined and mapped at 1:150 000, using criteria of soils and topography. Land capability assessments were not undertaken.

The AOAs number 54 in all and together total 3,381 km^2, or 12 percent of the country. The AOAs are restricted to areas of low population density in which a considerable area of unused and under-utilised agricultural land remains. More detailed surveys of some of these AOAs were undertaken by the government between 1974 and 1977. Many coconut plantations have also been surveyed (1982, 1983) and soil fertility experiments have been carried out on several important soils throughout the islands (Chase, 1981; Cheatle, 1988).

Derivative soil association maps for the Solomon Islands were originally published at scale 1:250 000, with soils classified at the Great Group level in the Provisional Soil Taxonomy (1974).[12] Several profiles were reclassified following the publication of Soil Taxonomy (1975), and the soils of the Solomon Islands were then mapped at 1:1 000 000 in 1979. At this time, an attempt was also made to correlate the USDA classification to the nearest equivalents of the taxa of the FAO/UNESCO system.

An inventory of the natural forests of the Solomon Islands was undertaken between August 1991 and December, 1993 under AusAID funding. This project installed a Forest Resources Information System (SOLFRIS). The principal source of information for forest type mapping was the colour aerial photography flown between 1984 and 1986, at an approximate scale of 1:25 000. This is the most recent and uniform total coverage available for the country. Physical and forest resources are described, commercial forestry aspects evaluated (including species and wood volumes), supported by selected environmental and socio-economic data.

The SOLFRIS enabled the government to determine reliable short and long term strategies for forest development and conservation planning. Unfortunately, political differences between Australia and the Solomon Islands in 1994 resulted in the withdrawal of AusAID funding, prior to the conclusion of project activities. Its results have been officially with-held from public knowledge. The National Forestry Inventory Project, in general, revealed that forest resources are lower than had been expected and emphasised the importance of introducing a comprehensive technical basis for achieving sustainable forest management.

Two LRIS's were installed in the Solomon Islands under the Forest Inventory project:

- National Resource Information and Mapping (NATRIM) at the Ministry of Lands and Housing, whose attributes are predominantly in vector format; and
- Solomon Islands Forest Resource Information System (SOLFRIS) at the Ministry of Forest, Environment and Conservation (MFEC), whose attributes are predominantly in raster format.

Unlike the PNGRIS and VANRIS facilities (refer country profiles), wherein the Resource Mapping Unit (RMU) forms the basic spatial unit of interpretation for resource assessment and evaluation, both the NATRIM and SOLFRIS packages contain separate resource layers at a reasonably crude level of detail, available via the GIS package MAPINFO. For example, digitised 200 meter contours, digitised land systems of Hansell and Wall, detailed forest cover types from the forest inventory, basic topography, geology, landform type attributes, and population (census, 1989). Attribute tables for the land systems data have not been entered. The DBMS used is FoxPro (WIN), and in the case of SOLFRIS supported by an interactive query and analysis facility using a proprietary forestry software package.

Other sources of data also exist. For example; hospitals, schools and rural water supply information can be sourced from the Rural Water Supply and Sanitation Division of the Ministry of Health and Medical Services. The Statistics Office conducted a Village Resource Survey (VRS) in 1995 as a precursor for a planned Agricultural Census. This survey contains basic data for all villages including population, sanitation and water supply, and agricultural and economic activity. The VRS in conjunction with the village mapping recently undertaken will provide a source of very reliable and mapable village data.

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[12] Altogether some 13,450 soil descriptions were made, in addition to 616 profiles sampled for soil analysis, giving an overall density of one soil observation per 2 km^2, or one sampled pit per 45 km^2.