FORESTS AND WATER

Effects of forestry activities on surface water quality in the Pacific region: a case study of the Rewa River catchment, Fiji Islands

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INTRODUCTION

A large proportion of the world's population is supported by the Pacific Region, from as far south as New Zealand, reaching the coastlines of China. Over the last 50 years, there has been a marked increase in this region in terms of agricultural productivity, industrial activities and not least, in the regional population (Naidu *et al.*, 1997). Such changes can have profound effects on forest resources and associated issues related to water quality and availability.

Water supply and demand in the Pacific, in general, is small due to the small land areas and the small watersheds. For example, in Fiji, the average water demand is 200–250 L/day/person, Cook Islands [Rarotonga] has a rate of 267 L/person/day and the small atoll of Kiribati has a water consumption rate of 40L/person/day. Papua New Guinea, on the other hand, with a much larger landmass, has a water consumption rate of 600 L/person/day (Table 1).

This article presents an overview of the Rewa River Catchment, the largest fluvial system in Fiji, which has an exceptionally high sediment yield due to excessive soil erosion from the upland reaches of the rivers' four main tributaries.

Study area

The Rewa River is the largest river system in Fiji and the tropical South Pacific islands, spanning an area of 2,900 km , or approximately one third of the main island

TABLE 1 *Water consumption rates in the Pacific islands*

Country	Population	Land Area (km^2)	Water consumption rate L/person/day
American Samoa	68,688	199	Not available
Cook Islands	16,800	237	267 (1999 est.)
Fiji	810,500	18,333	200–250 (1999 est.)
Federated States of Micronesia **	116,400	701	Kosrae – 1.2 million gallons/day Yap – 1.2 million gallons/day Chuuk – 1.6 million gallons/day Pohnpei – 3.2 million gallons/day
Guam	149,600	541	Not available
Kiribati	88,600	811	40 (1999 est.)
Marshall Islands	63,200	181	Not available
Nauru	11,300	21	Not available
New Caledonia	212,800	18,576	Not available
Niue	2,000	259	Not available
Papua New Guinea	4,692,400	462,243	600 (1999 est.)
Solomon Islands	408,400	28,370	250 (1999 est.)
Tahiti (French Polynesia)	163,000	1,042	Not available
Tonga	100,000	649	102 (1999 est.)
Tuvalu	9,600	26	50 (1999 est.)
Vanuatu	193,200	12,190	Not available
Western Samoa	168,000	2,935	600 (1999 est.)

* Population estimates from 1999 except American Samoa where the estimate is from 2002

** Federated States of Micronesia uses the American metric system and the readings are for the four separate states as a whole. Per head consumption figures could not be obtained. All the figures are 1999 estimates.

of Viti Levu (Terry *et al.* 2002). The Rewa Basin is economically important for commercial forestry on the catchment slopes and cattle grazing and horticulture on the floodplains, but the effect of human activity in clearing the forest vegetation for timber and agriculture is suspected to be the main cause of catchment erosion and problems of lowland channel sedimentation (Terry *et al.* 2002).

Land use conditions

The forest cover in the Rewa watershed is estimated at 2,164 km or 70%, with dense to medium forests dominating. In some parts of the catchment of Monasavu dam, the forest has been logged out and landslides occur after heavy rain or a cyclone due to the impacts of such human activities (JICA, 1998).

A study of the watershed by a team of JICA experts ranked the erodibility of the Rewa as being "high", with the likelihood of high sediment loads. Because the watershed is in the wettest part of the country, with annual rainfall between 6,000–8,000 mm, rainfall intensity and run off is high. The resulting sedimentation build up at the river mouth and resulting dredging that has to be carried out costs the Fiji Government in excess of F$1 million annually (Ministry of Agriculture, Fisheries and Forests (MAFF), 1995–1997).

Present conditions of forests

For management purposes, forests are classified as production forests, protection forests, non-commercial forests and mangrove forests, and in the Rewa watershed, about 9% of the watershed is available for logging (Table 2).

Production forests are those considered suitable for commercial exploitation where felling of 33 commercial species with a minimum diameter at breast height (DBH) of 35 cm is permitted. Protection forests are those that have slopes in excess of 30° (usually 40° to 60°), with shallow and unstable soils. In Fiji, logging of protection forests is not permitted except for firewood and cultivation on a small scale for subsistence (Department of Forestry, 1993). Non-commercial forests are those whose stock rates are too low for commercial exploitation (less than 30m /ha of trees with a DBH equal to or more than 35 cm) but felling of trees for firewood and cultivation on a small scale for subsistence is practised (Department of Forestry, 1993).

TABLE 2 *Rewa catchment information*

Catchment area by forest types Forest type	Area (ha)	Volume (m)
Protection	6, 445. 3	242, 034
Production	53, 422.6	1, 884. 220
Non commercial	8, 879	152. 280
Total	68, 746.9	244, 070. 5

- Current percentage of logged areas within the Rewa catchment is 3% of the total area of 68, 746.9 ha.
  i.e. 3% of 68, 746.9 = 2062.407 ha.
- A total area of 2, 269.0 ha. of indigenous forest has been logged of which 609.0 ha. has been re-logged.
- The above information has been obtained from GIS data taken from JICA studies carried out in 1998.

Present situation of deforestation

The principal factors leading to deforestation on the watershed of the Rewa apart from commercial exploitation include demand for firewood, requirement of land for small-scale cultivation and fires (Department of Forestry, 1993). In addition, large scale developments such as the building of access roads, conventional farming and the development of settlements, urbanisation and other infrastructure all lead to forest clearance (JICA, 1998).

Water quality evaluation

Water in the Rewa River meets stringent quality criteria for several tests, but due to high sediment loads being discharged into the Rewa, a high concentration of nutrient substances is considered to be the main problem for the estuary area of the river. A study by Terry *et al.* (2002), discovered that the Rewa River has had an accretion rate of 3.2 cm/year over the last 45 years and this rate exceeded rates recorded in humid regions elsewhere. In addition, shifting cultivation occurring in the Waimanu catchment has resulted in large amounts of sediment ending up in the Rewa and thus contributing to the growth of aquatic plants. Glatthaar (1988) estimated that the average soil loss in the Waimanu, a tributary of the Rewa, stood at 50–55 ton/ha/year, where shifting cultivation and logging were progressing

Future land use direction

Since erodibility of the area is high from the south Nakauvadra Range to the Wainibuka River, agriculture and grazing should be developed in such manner as to mitigate soil erosion. The forest should be gradually expanded by conserving the existing forest and replanting the deforested areas. In addition, the mangrove at the estuary should be preserved in order to assist in the conservation of the coastal marine environment. In order to assist these measures, the existing "Fiji National Code of Logging Practice" should be reviewed and updated as appropriate.

CONCLUSION

Although activities harmful to the environment need to be regulated in order to avoid degradation, enforcement of these regulations is problematic especially given the issues of land tenure in the Pacific. In this regard, public awareness and education will be essential to securing the cooperation of customary landowners. Proper land use practices should

be implemented and the land should be utilised effectively and efficiently. Because the land concerned is largely owned by the people, mutual consent of the parties concerned is necessary for any land use development.

With agriculture and forestry increasing in Fiji, there is evidence that the soil and water environment are gradually becoming contaminated. In the Rewa River catchment the degree of future contamination is primarily the responsibility of the individuals and the organisations involved in management activities in the area.

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Water resources of Pacific Island counties*

Water is the most abundant environmental resource, which covers more than 70% of the earth's surface. Of the total global water resources more than 97% constitutes salt water. Of the 3% fresh water resources, 75% of it exists as polar ice caps. Overall the rivers, streams and lakes account for approximately 0.75% of the global fresh water resources.

TABLE 1 *Water resources of Pacific island countries (PICs)*

		Estimated percentage from each source		
Country	Water source	River	Ground	Rain/other
Cook Islands	Ground aquifer, rain water, rivers	30	60	10
Fiji	Rivers, rainfall	90	7	3
Palau	Rivers, lakes	97	–	3
PNG	Rivers, rainfall	90	5	5
Samoa	Rivers, rainfall, lakes	55	40	5
Solomon Islands	Rivers, rainfall, lakes	85	10	5
Tonga	Ground water, rain water, surface	30	60	10
Vanuatu	Rivers, rainfall, lakes	65	20	15

The PICs fulfil their water requirements from various sources. The table above clearly shows that 80% of water supply requirements of the volcanic islands are met from rivers and streams, 14% from groundwater and 6% from rain and other sources. This is largely due to the lower cost of using gravity water supply systems rather than tapping groundwater bodies. Whereas in coral and limestone islands 60% of water supply requirements are met from groundwater, 30% from rivers and streams and 10% from rainwater and other sources. In the absence of groundwater and/or surface water sources, rainwater and other sources are used.

Overall 68% of the water supply requirements of the PICs are met from rivers, streams and lakes, 25% from groundwater and 7% from rainwater and other sources. All rivers and streams form their own watershed area, which needs management for maintaining a sustained water supply system in those countries.

However, water is becoming a scarce resource due to population growth, tourism, industrial development and agricultural uses.

Natural causes of watershed degradation

In PICs, the natural causes of watershed degradation are many, which include:

- tropical cyclonic effects
- high intensity short duration rainfalls
- weak and unstable geological formation
- steep landforms
- high stream gradients
- volcanic surfaces on steep slopes
- mass movement and soil erosion.

Man-made causes of watershed degradation

- deforestation
- use of marginal lands
- use of unsuitable lands
- development activities
- fire
- improper use and diversion of water.

* Source: BAISYET, P.M. 2002. Status of Watershed Management in Selected South Pacific Island Countries. Paper prepared for the FAO. Unpublished. FAO, Rome.