Streamlining land-use in the tropics

John van Tiggelen

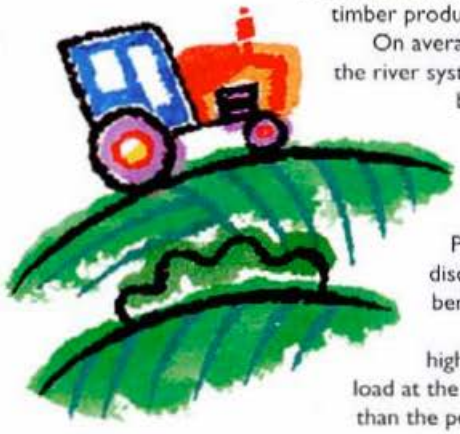
Early last year Cyclone Sadie swept through the Gulf of Carpentaria, spent her squalls on the savanna and finally collapsed north of Townsville. Within two days, 600 millimetres of rain had turned parts of the Herbert River system into flood.

Such tropical deluges can play havoc with topsoil. Minimising the potential downstream effects of rural run-off, particularly during the wet season, is crucial for sustainable resource management.

As a first step in this process, scientists are focussing on the Herbert River drainage basin in order to come to grips with the sources of nutrients, sediments and contaminants and how these are carried down the catchment.

The study's ultimate aim, as part of CSIRO's Coastal Zone Project, is to compile all relevant information into a computerised Decision Support System (DSS) for land-use planners. The process will provide a model for other tropical catchments.

The Herbert River catchment covers some 10 000 square kilometres. Conservation areas comprise a fifth, including the World Heritage-listed rainforested highlands and coastal wetlands, while grazing occupies 70%. The remaining area is used for sugar cane and timber production.



On average, 37% of the region's rain runs into the river system. Four fifths of the run-off occurs between January and March. Following Cyclone Sadie, Townsville's Dr Rob Bramley from CSIRO's Division of Soils and Dr Andrew Johnson from the Division of Tropical Crops and Pastures measured a peak hourly discharge of almost 16 000 megalitres beneath the Ingham bridge.

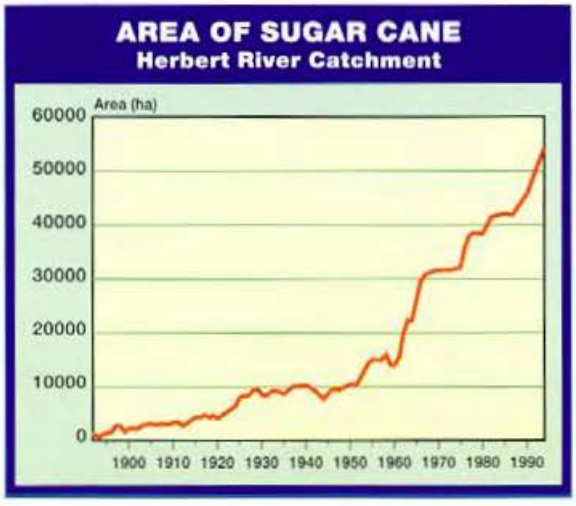
Bramley and Johnson found that during high rainfall the Herbert's peak nutrient load at the Ingham bridge was significantly greater than the peak load at the Abergowrie bridge, 30 km upstream. This difference reflects a loss of nutrients from the subcatchment draining into the Herbert between the bridges.

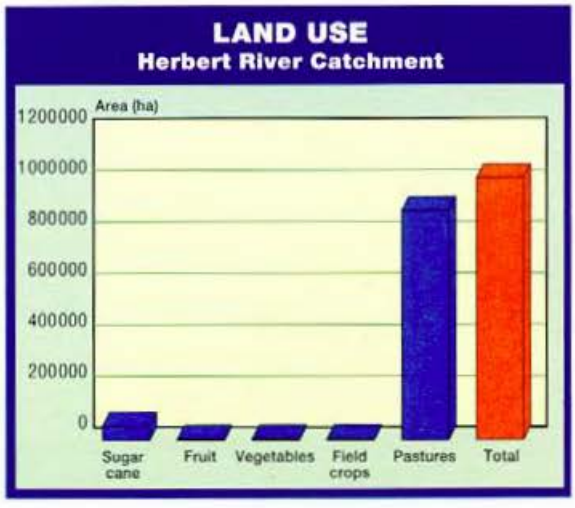
Queensland's Herbert River, during 'the wet'. Scientists are developing a decision support system to help land-use planners minimise the downstream effects of rural run-off.

Monthly sampling of about 30 riverine sites is continuing, but preliminary findings show that between October 1992 and July 1993 these losses of nitrogen and phosphorus nutrient amounted to an equivalent of 422 tonnes of urea (nitrogen fertiliser) and 300 tonnes of superphosphate.

Within the subcatchment, fertiliser use on land other than the 19 000 hectares of cane is virtually negligible. After taking into account that about one fifth of nitrogen is derived from non-fertiliser sources such as rain and nitrogen-fixation by plants, the water-borne fertiliser losses amount to 18 and 16 kilograms per hectare for urea and superphosphate respectively.

For growers such as Ray Quabba, who applies about





400 kg of urea and the equivalent of 300 kg of superphosphate per hectare annually, such losses aren't costly. 'There may be little economic incentive for growers to change their practices and reduce losses,' Bramley concedes.

The scientists emphasise, however, that their figures excluded nutrients stuck to suspended solids, and nutrients bound up in soluble stable molecules (and not measured by their analytical techniques).

While peak nutrient concentrations were found to be below accepted world standards for drinking water, Bramley cautions that 'they may still be significant in terms of possible degradation of the coastal environment'.

The scientists' compilation of past fertiliser and chemical usage shows fertiliser use has increased sharply for 50 years in tandem with agricultural expansion. Comparing such information with findings from coastal sediment cores (see box story on page 20) and nutrient run-off data will determine nutrient export budgets for different land uses.

The Great Barrier Reef Marine Park Authority (GBRMPA) is concerned that nutrient run-off into the reef lagoon is damaging offshore reefs. While the scientific jury is still out on this issue, the authority points to the disappearance of many inshore fringing reefs during the past century as evidence.

Nutrient loading of waters gives algae a competitive edge over corals, and the implication that fertiliser run-off from cane farms is to blame has won GBRMPA few friends in the sugar industry. The authority's water quality extension officer, Sheridan Morris, says GBRMPA can't be expected to say nothing. 'The reef is a national treasure so as its managers we operate on a precautionary principle,' Morris says.

For Ray Quabba, wet seasons no longer spell the huge soil losses of yesteryear. Then, all cane was burnt before harvesting and soil losses amounted to more than 50 tonnes per hectare.

Now the cane is harvested green, the shredded trash is left as a soil blanket, and tillage is kept to a minimum. Annual soil loss is now much reduced. 'Sure, I still lose some soil and fertiliser, but no more than if this area was planted with maize or mangoes,' Quabba says.

'The greenies complaining about cane are going off half-cocked.'

Bramley and Johnson stress that canegrowers have copped a disproportionate amount of flak for rural run-off. 'When driving up the coast, cane farms is all you see,' Johnson says. 'But in fact, sugar cane covers no more than 6% of the entire catchment.'

It could well be, says Johnson, that run-off from the grazing highlands may obscure that from the cultivated lowlands. 'What we're finding is that determining the sources, quantity and effects of lost nutrients is exceedingly complex,' he says.

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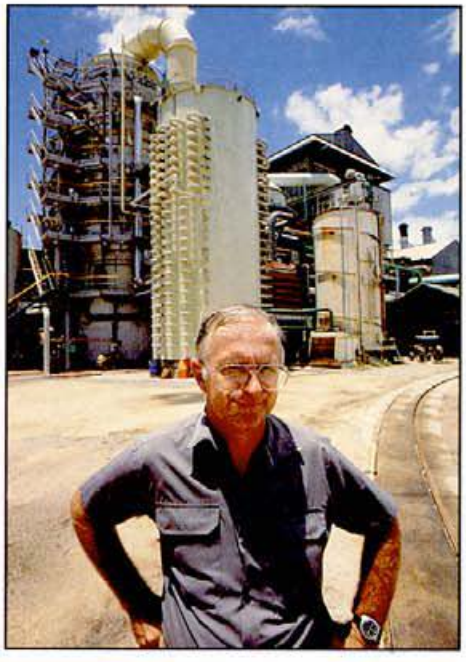
Ray Quabba, canegrower: we need to coordinate water movement from uplying areas to reduce erosion and flooding.



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Dave Horsley, CSR: cane land should be assigned on the basis of sound planning, using current technology and GIS.

Bramley and Johnson have formed links with others in the catchment, such as the shire councils, Colonial Sugar Refineries (CSR Ltd), landholders and government agencies. They realise that the study's potential benefits for sustainable land use will be left by the wayside if stakeholders fail to co-operate with one another.

The scientists are also evaluating the Integrated Catchment Management process (ICM). While the program has been introduced in most tropical coastal districts during the past five years, it remains to be seen whether it will succeed. Lessons learnt in the Herbert basin could be applied elsewhere.

Whole catchment management programs exist in most states. Anti-erosion strategies include minimum tillage, appropriate timing and methods of fertiliser application, streambank revegetation, contour cultivation and controlled stocking rates.

Quabba, who is a grower representative on the Catchment Co-ordinating Committee, sees ICM as a means of improving farm productivity as well as environmental integrity. 'Drainage is very important. We need to co-ordinate water movement from uplying areas to reduce erosion and flooding. Low-lying areas such as swamps and mangroves should be retained as nutrient and sediment sinks,' he says.

Ingham's sugar industry is expanding faster now than at any time since the 1960s. Cane presently covers 55 000 hectares, and is has been growing at an annual rate of 4% (about 2000 ha) since 1987.

As a fervent convert to ICM, Dave Horsley, a technical field officer for CSR, is critical of the local council and the Assignment Committee (which approves land for cane expansion).

'Cane land should be assigned on the basis of sound planning, using current technology and GIS (Geographical Information Systems), but it's not,' Horsley says. 'People who push for expansion just don't understand the land, yet they are in positions of power.'

The region's two CSR sugar mills want production increased from last year's 3.8 million tonnes to 5 million. But Horsley advocates more intensive production rather than horizontal expansion. He points out that neighboring catchments produce yields up to 50% per hectare higher.

Quabba, too, is enthusiastic about the future use of GIS. He says his 220 ha farm contains between six and nine soil types, according to CSR soil surveys which CSIRO has digitised into maps. 'GIS will help determine fertiliser budgets for appropiate soil types, suitable areas for drainage lines and the distribution of RSD (ratoon stunting disease),' Quabba says.

The operational GIS for the catchment developed by Johnson and Bramley so far incorporates data on soils, land use, physical and economical land suitability, hydrology, climate, vegetation, geology, property divisions and topography.

Johnson says the GIS encourages authorities and land users to take a 'corporate view of the entire catchment' and to plan accordingly. Horsley agrees. 'As farmers we need to be smarter, not bigger,' he says.

Digging up the muddy past

Land-based research is fine for determining the present state of agriculture, soil and river run-off to the sea, but about 6000 years of history of riverine inputs to the coastal zone can be found in the adjacent mangrove muds and coastal sediments.

Gregg Brunskill and his colleagues from the Australian Institute of Marine Science and Earth Science at James Cook University have obtained more than 700 surface grab samples of coastal sediments from the vicinity of the Herbert and Burdekin rivers, from the mangrove deltas out to the Great Barrier Reef. These samples allow maps to be drawn of the present-day dispersal path of riverine muds.

Brunskill's team has taken two to four metre cores of these muds, which represent 200 to 2000-year histories of accumulation. The natural radioisotope Pb-210 is being determined in core slices to obtain ages and accumulation rates of the mud.

Under ideal conditions, riverine mud accumulation in the mangroves and nearshore mudbanks should represent pages of a history book, with the most recent pages at the top, and ancient history on the lowest pages of the sediment core. Dr Andrew Murray of CSIRO's Division of Water Resources has completed the measurements of Pb-210 on two cores, and the history book analogy appears to be appropriate for cores in mangrove islands of Hinchinbrook Channel.

Once dating is completed on these 20 cores, Brunskill hopes to see patterns of change in sediment accumulation and dispersal in the vicinity of these river basins. Known history of population growth, agriculture, industrial development, as well as natural floods and cyclones in the river basin can be compared with the coastal sediment core history book.