

tongue-like intrusion towards north. The salinity distribution can be attributed to the combined effects of bathymetry, a larger fetch area, greater wind stress, inequality in evaporation and the tidal influx of high saline water. The surface-bottom differences are more pronounced in the shallow areas. The lagoon is well oxygenated, however, extreme values are observed in the northern sector where thick vegetation and poor mixing takes place. pH values varied from 7.6 to 10.2 for the entire lake and the northern sector values varied from 8.32 to 10.2. Nutrients such as nitrate, phosphate and silicate values are found to be highest in the northern sector whereas the lowest values are recorded in the southern sector. Chlorophyll-a values varied from 0.17 to 18.88 mg/m<sup>3</sup> in the lagoon during the entire period of observation. It is observed that saline conditions primarily regulate the fisheries of the lake. Fish landing data reveals that there was a sharp decline in the fish production in the lake from 1988 to 2000. However, fish, shrimp and crab production suddenly jumped to the order of 2.5, 6 and 10 times respectively in the 2000–2001 period after the dredging of a new mouth resulted in considerable increase in

salinity (32 psu). The catch of the major prawn *Penaeus indicus* has increased dramatically. The rivers bring huge sediments (turbidity). IRS data sets for different time periods reveal that the vegetation spread occurs at the rate of 25 km<sup>2</sup>/year. A Chloro-alkali factory that uses mercury is in production a little further away from the lake. Besides that, the lake is surrounded by paddy fields that are major sources for different fertilizers that enter the lake environment. However, the pollution components of the lake are still not properly studied.

Past events in the lake are the best examples of interaction between natural process, human impact, socio-economic conditions of traditional fishing folk and government policies in coastal habitats. A recent observation indicates that the lake is over exploited and lacking proper regulation in relation to resources management. Hence, it is suggested that the involvement and education of the local community and the state Government can play a key role in shaping the future of this pristine environment.

## Ngaremeduu Conservation Area GIS Project Palau

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**GOAL:** To utilize the GIS application to enhance understandings of impacts of the development and other activities on water quality in the Ngaremeduu Conservation Area, and to better equip managers to make wise decisions.

The Ngaremeduu Conservation Area encompasses approximately 29,400 acres of land, mangroves, estuary and reef areas. In order to understand the environmental impacts of the various developments and activities in or near the Conservation Area, water quality monitoring is carried out in rivers, streams, mouths of estuaries, and water bodies in or near the Ngaremeduu Conservation Area.

Currently, with the development of the 53 miles Compact Road around Babeldaob, there is the potential for environ-

mental impacts that may be caused by increased development once the Compact Road is completed. The purpose of the project is to provide managers with adequate decision-making tools that will assist them to manage their resources sustainably. Water quality samples will enable the managers to see the impacts occurring during times of increased sedimentation or nutrient runoffs caused by developments around the Ngaremeduu Conservation Area.

The project will provide managers, landowners and decision makers with adequate decision making tools using the GIS application. The agencies or organizations involved in the water quality monitoring include EQPB, Ministry of Resources and Development and the state governments.

## Mangroves of Samoa and Science Education

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Traditionally, mangroves have been a part of the country's environment and providing goods and services to the Samoans. The goods include firewood, timbers, fishing poles, dyes, and medicines. With services, the mangroves have been playing a role in protecting the islands against strong wave and wind actions. The trees also trap a significant proportion

of sediments from flowing towards the sea and thus sparing the marine environment from unavoidable damages. As far as the nutrients cycles are concerned, mangroves have been involved in carbon sequestration, contributing to the islands' fertile soils. In addition the role of the mangrove ecosystem in providing niches for various organisms have been instrumen-

tal in preserving the country's own biodiversity.

In the light of the current pursuit to implement means for wise management of natural resources, a pilot project was initiated to focus on the mangroves of Samoa. Sponsored by UNESCO as part of CSI Projects, the Science Component looked at raising the scientific understanding among the students with regard to mangroves. It is envisaged this would lead to appreciation and therefore greater awareness of the crucial roles of the trees. Consequently, wise practices would be encouraged.

Thus Practical Activities were written within the framework of the current National curriculum scope. With the support by the Department of Education, the Activities were then presented in the forms of two Booklets, one for Primary School level and another for Secondary level. These Activities would require the students to visit the recommended mangrove areas under supervision. The village people are involved by means of activities that have questionnaires. The Activities are numerous and creative, giving the teachers and students a number of options.

As part of training, workshops were scheduled to introduce the teachers to the Activities. An opportunity was also given to them for critique and discussions.

The final form of the Activities was a result of series of

steps. Firstly the achievable goals of the Activities were drawn up by a panel of writers from a spectrum of professionals—Primary and Secondary School Teachers, University Lecturers and Government Scientists. The Activities were planned after visiting every recognisable mangrove area in both Savai'i and Upolu Islands. The actual write-up took much of the time as each work was constantly scrutinised for improvement. The field testing phase was done by writers themselves and some University students. Some school teachers also volunteered for the task. Afterwards the Activities went through some stages of fine-tuning.

At the grass root level, not only this project provides opportunity for students and village people to be more aware of the mangroves and gain appreciation of their importance, but also the exercise is a Science Education in itself. It includes attempts to interpret some Samoan traditional practices in the light of Scientific knowledge and promotes sustainable management of mangroves.

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## Environmental Monitoring in South East Asia Using Molecular Markers

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In the last decade, Southeast Asian countries have seen an exponential increase in urbanization and industrialization. This change has brought an increasing input of anthropogenic organic contaminants to the coastal zones. Deterioration of the environmental quality due to past and future industrialization is of concern. On the other hand, various measures for environmental protection have been implemented (e.g., construction of sewage treatment plants) and more will be carried out in coming decades. To evaluate the effectiveness of the measures and regulations, understanding of the current status of pollution in the coastal zones is essential. We have been conducting such **benchmark monitoring** during the past several years by using some molecular markers as follows.

**Alkylbenzenes:** Linear alkylbenzenes (LABs) are persistent impurities in synthetic detergents. Determination of LABs in sediments and mussels from South East Asian countries demonstrated input of untreated or poorly treated sewage. Also in some samples from Indonesia and Philippines,

branched-chain alkylbenzenes were detected, indicating pollution by non-degradable detergents, which have been phased-out in industrialized countries.

**Coprostanol:** Coprostanol is a kind of sterol and has been used as a chemical indicator of fecal pollution. The recent application of coprostanol in Asian sediments indicated serious pollution by human feces and inputs from animal feces. We are trying to propose a new criteria of fecal pollution based on the concurrent measurement of the sterols and *E. coli*.

**Polycyclic aromatic hydrocarbons (PAHs):** PAHs, hydrocarbons containing two or more fused benzene rings, are derived from the combustion of fossil fuel and are also contained in petroleum and petroleum products. Some of them are carcinogenic and estrogenic and the source-identification of PAHs is very important. Using fingerprinting of PAHs and other biomarkers, used crankcase oil from Malaysian estuaries was identified as one major PAHs source. There are concerns of similar situations in other South East Asian countries.