Low cost technology for monitoring sustainable development

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Abstract

The term 'sustainable development' first appeared in a significant way in the *World Conservation Strategy* (IUCN 1980), but the basic ideas had been discussed much earlier. 'Ecologically sustainable development' became particularly popular after the publication of *Our Common Future*, the Brundtland report (WCED 1987). Many agencies claim that their work is highly dependent on, or governed by, sustainable development or sustainability principles. One of the major problems with the concept of sustainability, however, is that, while many people claim to be utilising sustainability principles, there is often little evidence to confirm this. Supporting data are frequently absent, perhaps because people are uncertain about the information they should collect.

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Low cost technology for monitoring sustainable development

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Introduction

The term 'sustainable development' first appeared in a significant way in the *World Conservation Strategy* (IUCN 1980), but the basic ideas had been discussed much earlier. 'Ecologically sustainable development' became particularly popular after the publication of *Our Common Future*, the Brundtland report (WCED 1987). Many agencies claim that their work is highly dependent on, or governed by, sustainable development or sustainability principles. One of the major problems with the concept of sustainability, however, is that, while many people claim to be utilising sustainability principles, there is often little evidence to confirm this. Supporting data are frequently absent, perhaps because people are uncertain about the information they should collect.

It is probably wise to think about what it is we are trying to monitor before considering methods for monitoring sustainability. *Our Common Future* presents the most commonly quoted definition of sustainable development: 'development that seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future' (WCED, 1987: 40).

Sustainability includes the following (Beder 1993, Dovers 1999):

- the integration of environmental, social and economic issues;
- community involvement — consultation and participation;
- precautionary behaviour;
- equity within and between generations; and
- ecological integrity.

These are not easy concepts to grasp and, as a result, developing suitable indicators to monitor sustainability is a difficult issue. This is particularly true in developing countries, where resources for monitoring of any kind are extremely limited.

Sustainability is being approached on several scales. Globally, numerous treaties and conventions have been developed and implemented that are aimed at more sustainable use of the common resources (for example, atmosphere, oceans and biodiversity). National programs are also being implemented, and mechanisms to assess progress towards sustainability have been developed, for example, the environmental vulnerability index (Kaly et al 1999, Kaly 2002). Last, but not least, local activities are helping communities to determine their sustainability goals and plan actions to achieve these targets.

Sustainability will only be achieved if communities support the concept, and wish to make it work. Involving community members in assessing progress towards sustainability is one obvious way of achieving this. Communities should be able to decide what parameters will most appropriately indicate change, and the best ways for the community to gather the required information, given the other pressures on their time and resources.

Indicators of sustainability

An old English proverb states that 'one cannot manage what one cannot measure'. This is just as applicable to sustainable development as it is to any other component of the world around us. In some environmental situations, monitoring has recently been criticised, partly because data collected were not often used to assess change (rather, they were used to meet a legal requirement). The value to the community of the whole operation was brought into question as a result. It is therefore essential that the purposes of monitoring are accurately defined, and the use of various parameters as indicators is clearly articulated.

In general, sustainability indicators should be defined within the locally accepted understanding, or the legal/political/social definition of sustainability, with parameters that are appropriate to the local situation. The parameters selected should cover society, the economy and the environment, but it is critical that they are locally relevant. As with all modern monitoring activities, efficiency and quality control must be incorporated into data collection. Indicators that are simple to measure are preferred, but they must be able to show clearly if change is occurring. Data analysis and reporting must be carried out in an effective way, and the outputs must be published in a form that is user-friendly for both decision makers and the community (including verbal communication).

Two key issues in selecting sustainability indicators are assessing the scales (temporal and spatial) to be used, and, if possible, allowing for cumulative effects. This latter point is one that requires a good deal of research, as, in the past, studies have tended to follow the impacts of one or sometimes two factors, rather than several. This is a complex research issue and one that requires an urgent global effort to enable us to better understand the impacts of human activities on the environment. Finally, the data must be related to other changes occurring locally, for example, a drop in the quantity of waste going to landfill might be the result of the introduction of incineration or a drop in population, while the amounts of waste generated per capita might be increasing.

Low technology monitoring of progress towards sustainability

Low technology monitoring data have often been treated with scepticism by scientists. There is no reason for this if the monitoring is carried out sensibly, repeating a simple measurement at defined times and places according to a predetermined pattern, and accurately recording and reporting the results. A number of publications outlining low technology monitoring options are available (for example, Dahl 1981, Whippy and Gangaiya 1987). There is no reason why communities, schools or other non-scientific groups should not be able to collect valuable information, provided they are committed to doing so. This is illustrated in the two case studies below.

Some examples of low technology options are:

- surveying waste by counting the number of vehicles entering the local landfill;
- surveying vehicle and fuel use by counting the number of vehicle movements at key points (and possibly interviewing drivers to determine the lengths of journeys);
- surveying energy use by assessing how much fuel is imported;
- surveying changing land use by measuring sediment loads at predetermined points in coastal streams using, for example, a Secchi disc;
- surveying fish catches by assessing sales in local markets (numbers of fish by species and size);
- surveying pesticide use by recording sales at the local agricultural store; and
- surveying the status of coastal ecosystems by counting key indicator organisms (see case studies).

Case studies

Generalised island monitoring in Tuvalu

With the passing of the *Falekaupule Act 1997*, and the subsequent establishment of the Falekaupule Trust Fund, the government of Tuvalu divested to its outer island communities the power to manage their own resources and affairs. This included the sustainable management of their own fisheries and bird, turtle and non-living resources, where any proposed actions would not conflict with national laws and restrictions (for example, offshore fishing licences, or the protection of rare or endangered species). There are nine islands in the Tuvalu group, encompassing eight culturally distinct groups. The Falekaupule Act allows relatively independent actions to be taken on each island, in accordance with its unique lifestyle and aims for development.

In January 1999, the Tuvalu Environment Unit started a project to gather information from all of the separate island communities and institutions available in Tuvalu. The aim was to develop an integrated, but island-specific, set of approaches to meet the needs of each island *Kaupule* (Island Council) and ensure ecologically sustainable use of the natural resources. The intention was to take into account differences in the lifestyles and behaviours of the different island communities, as well as risks to and differences in the existing condition of resources (that is, different islands may have differing amounts or types of resources available, or may use them in different ways).

This project was intended to begin where the Food and Agriculture Organisation (FAO) Tuvalu Land Resources Surveys (for example, McLean and Hosking 1992) ended, and shift the emphasis towards self-regulation and conservation of the island life-support systems. One of the most important feedback mechanisms proposed for self-regulation was a simplified system of generalised smart indicators (see also Kaly et al 1999, Kaly 2002), which could be evaluated repeatedly by the councils or the communities to monitor the sustainability of activities on the islands.

Although the project is still pending, and testing of the approach is required, a draft set of smart indicators was developed and evaluated once for the island of Vaitupu. The indicators selected covered major aspects of hazards to environmental integrity and of the state of the environment on the island (Table 1). Apart from the one that requires a Secchi disc, most of the indicators can be evaluated by simple counts taken around the island. The counts are then converted to scores between 1 and 5 (with 1 revealing poor environmental sustainability) for all indicators and are averaged. The average gives a signal of the overall sustainability of the environment of the island. Where an indicator is not applicable, the score is left blank and the average calculated over the remaining values.

The advantages of this system are potentially many. A single evaluation of the indicators can immediately identify those areas that score poor values and that need attention. This could lead to relevant projects for the island. Repeated evaluations could be used to monitor progress towards sustainability, and measure the effects of diffuse impacts of a large number of projects, any of which on their own might not lead to measurable change. The indicators themselves can also be instructive, in that they show appropriate actions for improving the health of an island. For example, a poor score for indicator 14 could be improved by planting more *Calophyllum* trees along the shoreline, thereby increasing resilience to erosion and storms.

Community marine resource monitoring in Fiji

Many coastal communities in Fiji depend on the sea and coastal ecosystems for their livelihood. During the 1980s and 1990s, many villages noted a decline in their marine living resources because of previous overexploitation. One of the mechanisms available to the communities to address these problems is the use of *tabu* (no take) or refuge areas. One of the main challenges to such an approach is dealing with the limited availability of scientific and other skills for assessing the effectiveness of such protected areas. Historical assessments were based on beliefs and casual observations.

Table 1: Indicators of environmental health proposed for the islands of Tuvalu

ISLAND: FILLED IN BY (Name):

Length of ocean shorelines ________________ Length of lagoon shorelines ________________

#	CAT	SCORE:	1 Poor	2 Med-Poor	3 Medium	4 Med-Good	5 Good	Enter Score (1–5)
1	People	How many people are there per sq km of land area?	800+	600–800	400–599	200–399	<200	
2	Waste	Do you have a rubbish collection service?	No				Yes	
3	Waste	Is there a central rubbish dump area maintained by the *Kaupule* (council)?	No				Yes	
4	Waste	What percentage of the population uses composting toilets?	0%	1–20%	21–50%	51–79%	80–100%	
5	Waste	Percentage of imported aluminium cans recycled (look up # cartons of beer and soft drink brought in over the last year and amount shipped off the island for recycling).	0–20%	21–40%	41–60%	61–80%	81–100%	
6	Waste	Number of pigpens within 5 m of the lagoon/km length of lagoon shoreline.	>20	16–20	11–15	6–10	0–5	
7	Causeways	How many causeways and concrete ramps on the island?	>3	3	2	1	0	
8	Restricted flow	Are any of your natural reef passages or mangrove areas restricted by causeways?	Yes				No	
9	Channels	What is the number of reef channels per 10 km of shoreline?	>3	3?x>2	2?x>1	1?x>0	0	
10	Erosion	Total erosion as percentage of length of lagoon and ocean shoreline (measure length erosion, adding up all areas).	>15%	11–15%	6–10%	1–5%	0%	
11	Fish	What is the largest size of Taea (snapper, *Lutjanus gibbus*) caught by fishers in the last year?	<15 cm		15–20 cm	20–29 cm	>30 cm	
12	Fish	Distance to the nearest reef (not pelagic) fishing ground from the ocean side centre of the main village (km).	>3	3?x>2	2?x>1	1?x>0	0	
13	Resilience	What percentage of the island and reef is a conservation area?	0%	1–9%	10–14%	15–19%	20+%	
14	Trees	How many large Fetau (*Calophyllum*) trees are left on the beaches around the island? (Walk around the beach and count all trees within 5 m of the land/beach edge and divide by the length of the shoreline in km.)	0–10	11–20	21–30	31–49	50+	
15	Culture	Total percentage area of fish ponds/land area.	>5%	5?x>2%	2?x>1%	1?x>0%	0%	
16	Invasions	Do you have any Tilapia in any of your lakes and ponds?	Yes				No	
17	Lagoon	Is the water in your lagoon, nearest to the settlement, ever greenish in colour?	Yes				No	
18	Lagoon	Does the lagoon ever develop foam during windy periods? Or have you had any fish kills in the past three years?	Yes				No	
19	Lagoon	Patches of anoxic mud (black, smelly mud) are present in the lagoon.	Yes				No	
20	Lagoon seawalls	What is the total length of lagoon seawalls as a percentage of total length of lagoon shoreline?	>5%		5?x>2.5%	2.5?x>0%	0	
21	Mangroves	Estimate the percentage of your togo (*Rhizophora*) areas remaining.	0–20%	21–40%	41–60%	61–80%	81–100%	
22	Turbidity	What is the visibility in the ocean side water closest to the village (just past the breakers) using a Secchi disc?	<2 m	2?x<3 m	3?x<4 m	4?x?5 m	>5 m	

This problem was examined in the community of Verata in eastern Viti Levu, Fiji, where a project was established by the Biodiversity Conservation Network and the University of the South Pacific to evaluate community-based monitoring of the introduction of *tabu* areas (Tawake et al 2001).

Using participatory techniques, the community had determined the threats to marine resources, agreed on a common vision for the future, and developed a marine resource management plan. Over-harvesting was identified as a critical problem, and *tabu* areas were established. Community members were trained to monitor the effectiveness of these refuge areas using a series of simple biological monitoring techniques, and two target species — mud lobsters (*Thallasina anomala*) and clams (*Anadara* spp) — were selected for study.

Pictures, stories and examples were used to discuss the theory of sampling and statistics. The community members then practised line transects, first on dry land and then in the water. They selected random compass bearings within *tabu* and non-*tabu* areas, laid out transects with a tape measure, and then sampled the number of clams within a square metre quadrat at ten-metre intervals along a transect line for 500 metres. Each clam was measured using a template that had different-sized holes. The number of clams in each size class was recorded in a logbook, and after the field work the data was analysed using simple descriptive statistics. After two weeks of training, the monitoring team collected baseline data and thereafter sampled the designated areas twice in the first year, and annually after that.

The community assessment was checked by a trained scientist carrying out a rigorous monitoring program in the same areas. Analysis of the data showed that there was no significant difference between the two sets of results. In addition, the monitoring exercise generated much community interest, with everyone wanting to see the data and discuss the implications. The impact of the *tabu* area establishment has been significant with, for instance, thirteen fold increases in clams in the protected areas, and even a five-fold increase in harvested areas. Consequently, new refuge areas have been established involving five target species, and are being monitored by community members (Tawake and Aalbersberg in press).

The project has been so successful, both in terms of biodiversity conservation and knowledge dissemination, that similar projects have been established in several other communities across Fiji. The only constraints are finding sufficient trainers for the community-based participatory exercise, and the availability of community members' time for carrying out the monitoring. The equipment needs are minimal, and the data recording and assessment can be completed with resources available in the community. The former constraint is being met by using established project site community members as trainers.

Conclusion

Low cost technologies are available for monitoring many aspects of sustainable development in the Pacific islands. The major needs are for communities to determine what their sustainability goals are and identify suitable indicators to verify that the goals are being achieved. A great deal can be achieved with minimal equipment and appropriate local training. Monitoring progress towards sustainability also generates interest in the whole concept of sustainability, and will encourage communities to play an even greater role in achieving a more sustainable future.

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