21 Sustainability Science in Indigenous Communities: Reconciling Local and Global Agendas

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Introduction

Over the past decade, indigenous peoples in Latin America have started to demand that scientific research conducted in their communities leave behind some tangible benefit (see Tituaña, Foreword this volume). The age has passed when outsiders, regardless of nationality and affiliation, freely enter indigenous territory or homes without prior consent and take information, biological samples, botanical specimens or cultural materials. Although the colonial mentality of superiority and authoritarian dominance over indigenous people still remains in many universities and government agencies, most experienced sustainability scientists consider it highly unethical to pursue only 'extractive' research aimed at clients outside the local context (Fairhead and Leach, 2003). Indigenous people are not opposed to scientific research, as the case of Cotacachi illustrates, but they are also looking for research which is 'enriching' for them (Waters-Bayer, 1994). This basic principle of human rights and ethics of research has been respected by the SANREM–Andes research team throughout 7 years of activities in Cotacachi (see Rhoades, Chapter 1, this volume). We were aware that if our research benefited only ourselves as scientists or our donors in Quito or Washington, DC, our Cotacachi hosts would have little interest in giving time, resources and their knowledge to something which returns nothing of value.

The problem we faced, however, was how to carry out technical scientific activities on global research questions which on the surface did not have an obvious or immediate local benefit. Our interdisciplinary team was composed of several academic disciplines with specific data and methodological needs. As funded researchers and members of the academic community, scientists also faced pressure from fellow scientists, donors and technical reviewers to meet high standards of rigorous methods and data gathering. Field activities, such as collecting soil or water samples, setting up rain simulators or climate monitoring stations, analysing people's ablution activities, administering long questionnaires or measuring farm sizes, were not locally beneficial in the minds of local people. We always tried to explain why an activity was required; for example, digging a soil profile trench would help us to improve 'their' agriculture. Such explanations typically fell on deaf ears. With a history of > 500 years of exploitation, more plausible explanations to indigenous people were that we were seeking gold buried by the Inca or robbing antiquities to take back to the USA. In the

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context of the global news system and activist education by non-governmental organizations (NGOs) and the indigenous movement, politically charged words such as 'biopirate' or 'imperialist' are now common currency in Cotacachi. For scientists willing to listen to indigenous people, however, the rewards of modifying research to make it relevant far outweigh the tensions of facing local accountability. After all, accountability upward to donors and administrators is a constant and time-consuming necessity; why not the same accountability to local people?

The purpose of this chapter is to describe and analyse the trade-offs and experiences of the SANREM–Andes team as they carried out basic sustainability research in the social and political contexts of indigenous communities in Cotacachi, Ecuador. In presenting this case, we will look at how the encounter between outside scientists (and their social and knowledge systems) with indigenous people (and their social and knowledge system) unfolds through time. Honest assessments and descriptions of 'how it really works' as opposed to 'how it should work' are rarely written up in participatory manuals and guidebooks on working with local communities. Although this chapter is from my view as an outside scientist, and ideally we need another chapter from the indigenous view, I will attempt to move from sugar coating the participatory research process in order to discuss in realistic terms what is needed for the global–local encounter of sustainable development to succeed.

To describe our experiences with what worked and what did not, I will first frame the conditions under which our interdisciplinary team agreed to work in Cotacachi and what it meant for the scientific method. This will be followed by a discussion of the required negotiations, trade-offs and compromises reached by scientists and local people. Thirdly, I will present six case studies of applied research which benefited communities in exchange for doing more basic research. Finally, an analysis of pluses and minuses of 'enriching research,' especially the sharing and use of data generated in the project, will be made.

Sustainability Research in Indigenous Cotacachi: Conditions and Implications

Indigenous Cotacacheños do not easily understand what scientists do or why. If research means anything at all to villagers, it carries negative connotations based on past exploitative experiences. Investigators came to their villages before, asked a lot of questions, carried away information or items and never returned anything to the community. Some NGOs working the area add to the mistrust by giving lectures on the neo-colonial evils of researchers, especially foreign ones. Debate in anthropology has tended to pit 'advocacy research' against 'basic research' in which advocacy supporters say that researchers should only work on problems of interest to local people and basic researchers argue that this compromises the integrity of the research findings (Gross and Plattner, 2002). This polarized debate was never a factor in Cotacachi simply because indigenous communities require relevancy as an a priori condition to other activities such as research.

The rules governing the conduct of sustainability research in Cotacachi were agreed upon in 1997 between myself (acting on behalf of SANREM) and officials of the canton (Mayor's office) and UNORCAC. In the Foreword of this book by the indigenous Cotacachi Mayor Auki Tituana Males and in my acknowledgements, the first contact between our project and the people of Cotacachi was described as a somewhat serendipitous event. After almost 5 years of conducting research in the mestizo Nanegal region of Pinchincha Province, our team was interested in transferring activities to a high Andean location. During several temporary visits by myself and other researchers, we formally approached Cotacachi's leadership to explore areas of mutual interest and to seek research permission. Cotacachi is not a location in which outside researchers, development practitioners or tourists can do whatever they wish. Indigenous communities demand directly or through the agency of UNORCAC that research or development take place on their terms and on topics they see of benefit to the community. Permission to do research, while not always a formal bureaucratic procedure, requires approval by a range of local authorities, including government, UNORCAC, *comunas* or individual landlords. Within the Cotacachi-Cayapas Ecological Reserve, for example, this means that the Ministry of the Environment must issue a research permit and a pass to enter the reserve. To enter the large hacienda, El Hospital, one needs written permission from the Ministry of Environment which is then presented to the *mayordomo* (foreman) who has absolute power to grant passage across the reserve part of the hacienda. Within the communities outside the reserve, one will be met with cold stares and even aggressive rejection unless the activities are explained and approved by at least one indigenous body such as the *comuna* President, directorate or the assembly of UNORCAC. Project researchers, individually and jointly, have presented their research proposals to numerous levels of indigenous bodies. As the programme manager, I presented the overall SANREM project to the Assembly of UNORCAC, composed of 43 communities, and later the same proposal to the assemblies of several communities where specific activities would take place. In cases of projects by individual scientists, permission from the President or the Committee of Directors of the affected community would be requested by the scientist in visits to the *casa comunal* (communal house). If the scientist was working on water issues, then the permission from the *junta de agua* (water committee) of the water system being studied was required. Regardless of the local approval route, it was always necessary that local people know who we were, that the research was explained and approved upfront, and that someone (preferably a Quichua speaker) representing UNORCAC accompanied the researchers. Our scientists always respected this permission protocol and, as a result, received excellent support over the 7 years of the research activity. Finally, it is worth noting that unlike many NGOs and bilateral projects in the area, SANREM did not as a policy utilize logos, banners, posters, marked cars or public advertisement, preferring instead to maintain a quiet presence in the landscape.

The dilemma arising from this local approval process is that scientists frequently had basic research priorities and data gathering requirements that were not understandable or obviously relevant to local people. Our university-based researchers were interested in basic research using the conventional methodology of testing hypotheses related to basic scientific questions. The project was truly interdisciplinary, with scientists representing soils, aquatic resources, hydrology, biology and botany, economics, rural sociology and anthropology. Each discipline has its own themes and methods of inquiry. Within the team, a great deal of time was spent trying to communicate between these various disciplines characterized by differences in scale, subject matter, research design and methodology. Some researchers were graduate students who needed to complete a Master's thesis or PhD dissertation with theoretical as well as empirical results. Researchers also arrived at different times during the research programme and a constant new set of permissions was required. SANREM's annual work plans had to be approved by a US-based technical committee which had little to no knowledge of working conditions in the field. Juggling between these various interests and levels of understanding was always a frustrating and uncertain process for the researcher. Rarely was it immediately obvious to local people how such research would benefit them.

Three possible scenarios of differences between local people and scientists were: (i) scientists wanted to do research not understood by and of no interest to local people; (ii) scientists had needs that required local resources (land, time, water, plants and knowledge) which local people controlled; and (iii) local people had interest in seeking solutions to problems of no interest to scientists. Only in rare cases was there an automatic overlap of scientists' and local people's interests. Such differences in needs and understanding are commonplace but are rarely discussed in methodologies of sustainability science or development. A great deal of ink is spilled in the development literature over how different disciplines should work together, but little is said about how scientific interest can be reconciled with community needs. In general, NGOs do not have the same problem since they rarely conduct research and tend to work on applied problems of concern to local people. Science, however, with its global questions and principles to test, operates under a different set of commands.

Negotiations, trade-offs and compromises: give and take of participatory research

An operational challenge arises as to how the interests of scientists and local people can be addressed so that both are reasonably satisfied. While it is clear why SANREM researchers wanted to work in Cotacachi, it is not so obvious why Cotacacheños wanted to have researchers in their presence. Ours was not a donor programme providing large sums of funds for local development; rather our operating budget was small and earmarked only for research. For diverse reasons, however, Cotacacheños believed we possessed valuable resources for them, beyond money. The leadership of UNORCAC and the canton expressed genuine interest in having data and any information which they could use for obtaining grants, justifying projects to the government, leveraging in negotiations with donors, or political reasons. For example, in the mayoral election of 2000, political interest peaked in whether or not drinking water in Cotacachi's urban area was safe. The opposition party to the incumbent Mayor publicly declared it was unsafe, but the Mayor retaliated with evidence to the contrary from the SANREM water monitoring project (see Ruiz-Córdova *et al.*, Chapter 16, this volume). Our water data were published in the local papers and, according to the Mayor at the victory celebration, our water data played a key role in his party's victory. Although we brought little money to communities, we hired local indigenous assistants and provided minor equipment support such as computers, recorders, supplies and the promise to leave our project vehicle behind. SANREM also gave small funds for workshops, tickets for international travel, and networking with foreigners who were sympathetic with their indigenous goals. Cotacachi, unlike nearby Otavalo, does not yet have a global network of connections nor an economic niche such as textiles and Andean music to sell on the global market (Meisch, 2002). Cotacachi is in the early stages of this globalization process. SANREM's small capital investment could not compensate for the time and resources required by local people to support our activities. Fortunately, throughout our stay in Cotacachi, specific interests based on real problems were expressed by Cotacacheños on ways that we could help them achieve their goal of 'development with identity.'

The process of arriving at a common consensus of exchange of research for local benefits did not occur in a straightforward or systematic way. A great deal of negotiation and 'give and take' on the part of researchers and local people took place on many levels: the leadership of UNORCAC; with individual communities and their leaders; with farmers; with schools and professors; and with water associations. Agreements were often reached through informal conversations or gatherings in which local people would express certain needs which we could fulfill. By addressing these special requests, SANREM was allowed to stay and continue to do research of interest only to scientists. In the process of this negotiation, friendships were formed, co-madres and co-padres declared and alliances sealed. Over time, trust and confidence between researchers and local people put a very human face on our project and its interactions.

Case Studies or Examples of Research Addressing Requests of Indigenous People

By accepting the responsibility of directing some resources, time and energy to priority research topics identified by local people, a social credit was created for us to use in pursuit of other research questions not prioritized by local people. This sometimes meant in the course of daily interaction we would be informed of a local interest or request and it was up to us how to make it fit with research. Six examples will illustrate this process.

Memory banking and the scholarship fund (investigators: Virginia Nazarea and Maricel Piniero)

The leadership of UNORCAC and many families with whom we collaborated always stressed the critical need for education of indigenous children. The illiteracy rate is very high and few indigenous people can fill roles of leadership in their own communities, organizations or schools. Many key positions for managing UNORCAC are held by mestizos or educated indigenous personnel from Otavalo. Through our main collaborator in UNORCAC, Magdelena Fueres, we agreed to provide funding to select indigenous children to attend primary, secondary and even college if they were willing to conduct memory banking research with their elders on the topic of landraces. Each child was allocated around US$20 (sufficient for entering school each term) if they would interview their parents, grandparents or other elders using the memory banking method.

The purpose of the memory banking project was to document and preserve local knowledge associated with agricultural crops so that neither seeds nor knowledge would be lost (Nazarea, 1998). While old varieties are of keen interest to local people, it is unlikely they would give their own time and energy to recovering this knowledge on a wider scale than their own household. However, if memory and seed collection are connected with the possibility that a child in their family can attend school, then parents were enthusiastic to participate. From July 1999, until the SANREM project closed in 2004, 15 indigenous children annually received funding for school activities if they documented vanishing agrobiodiversity knowledge. They asked a series of basic questions ('What varieties did your grandparents grow?' 'How did farming change over time?'). In addition to learning how to interview, record information and store it in the project database, they also collected culturally significant plants (leaves, seeds and roots) and prepared them for display and herbarium storage. In addition, the scholarship students (*becarios*) planted and maintained a biodiversity garden on the grounds of Jambi Mascaric. Children also made public exhibitions of the plants and elders' knowledge during special days at the school. Two goals were accomplished: scientists gained information about changing agrobiodiversity and children were able to attend school. The memory banking collaborative project illustrates how both scientists and local people gained in a collaborative effort of dovetailing interests.

Farm of the ancestral futures (investigators: Robert Rhoades and A. Shiloh Moates)

An outgrowth of the memory banking project was the establishment of a participatory farm in the high zone of Cotacachi called the Ancestral Futures's Farm. Two main objectives of the ancestral farm were: (i) to create an *in situ* farm whereby vanishing or culturally significant Andean crops could be grown out and re-distributed to local people; and (ii) to collaborate with the national genetic resources bank (INIAP: Instituto Nacional Autónomo de Investigaciones Agropecurias) by obtaining and growing out disappearing Andean crops with local participation. The local farm would be a mechanism to recuperate Andean crops that have been mostly or completely abandoned and an educational tool for dialogue between indigenous collaborators, scientists (SANREM, NGOs and INIAP), and young people with elders, on the issue of loss of local landraces.

Cotacachi is losing its traditional agrobiodiversity due to multiple factors including climate change, the Green Revolution, declining family labour and minifundization (see Skarbø, Chapter 9, this volume). The Ancestral Futures Farm activity was seen by UNORCAC as an important element in the larger indigenous cultural revitalization movement. In Andean cultures, an inextricable link exists between biology/culture and the past and present. The focus of that ritual nurturance is on the field (*chacra*) and the *ayllu* (disappearing in Cotacachi but still known) or the family. Bringing back the old crops was symbolic of the recovery of their traditions.

The Ancestral Farm was established in Ushugpungo in October 2002, with the families of 13 memory banking students. Shiloh Moates, coordinator of SANREM–Andes, and Magdalena Fueres, leader of Jambi Mascaric, took the lead. The parents provided knowledge and labour in exchange for scholarships for their children. Since the children were mainly in school when the farm was worked, the parents organized weekly *minga* (planting, weeding and harvesting). The farm was divided into halves: one dedicated to local varieties and planted under the direction of the parents; the other half was planted in INIAP varieties using their specifications on spacing and planting depth. The local side was driven as much as possible by indigenous planting rules, their perceptions and desires. In keeping with traditional practices, the farm was entirely organic and managed using local knowledge. The parents led this process by planting 'ally' crops together and keeping the crops that 'don't get along' apart, just as they had learned from their parents. The crop they had least knowledge of was *mashua*, but it was planted similarly to *oca* which it strongly resembles (Moates, 2003). The mothers provided the seed they planted in their part of the farm. They provided two types of quinua, peas, chochos, habas, mellocos, chaucha potato, mashuas and ocas, all from their own farms.

We signed an agreement with Dr Jaime Estrella, Head of Ecuador's national gene bank (INIAP), for the donation of clean seeds. The contract specified that 25 varieties of *oxa* and *mashua* as well as four varieties of *achira* be donated in exchange for rights to visit the plot and the return of well-documented data on the production of their varieties. Through our later focus group survey with the parents, we learned that maize and beans would have been more relevant crops for repatriation or returning from the gene bank due to their strong ritual significance. At the time of harvest, we conducted structured interviews with the participants to see how they regarded the experience and the varieties. There was a kitchen follow-up on the food preparation, cooking and consumption of the crops. The women provided detailed insights on the cooking quality, taste and overall performance of different varieties.

The Ancestral Futures Farm turned out to be positive for both scientists and local people. Local people received new varieties, exchanged them among themselves, took home some food and received support for their children to go to school. SANREM, in turn, received a great deal of information about local varieties: why some had disappeared; what still existed; and what was desired through repatriation. The Ancestral Futures Farm continued operation after the SANREM programme officially closed in May, 2005.

The participatory 3D 'maqueta' model (investigators: Robert Rhoades and A. Shiloh Moates)

UNORCAC is a second degree indigenous organization which depends almost entirely on external funds for its activities. UNORCAC's leadership needs natural resource information and decision support tools which can be used in negotiation with donors and bilateral projects. They also request information which helps them interact with member communities and to help establish planning priorities. One example of how SANREM contributed to UNORCAC's decision support was the construction of a three-dimensional physical model of the Cotacachi Andean landscape. Called the P3DM (participatory 3-dimensional modelling), or 'maqueta' in Spanish, this tool recently has been made popular by IAPD

(Integrated Approaches to Participatory Development) in the Philippines (see http://www.iapad.org/participatory_p3dm.htm). However, use of the *maqueta* in the Andes goes back to Inca times when physical models were used to plan towns, agricultural fields and irrigation systems (Hyslop, 1990). We built and used the model at a scale of 1:10,000 as part of a participatory process whereby spatial information is combined with people's knowledge for advocacy, awareness raising, community planning, conflict resolution, and participatory monitoring and evaluation.

The relief model of the landscape is built by placing layers of cardboard on top of one another, each layer having been cut out to represent the contour lines of a topographical map. Because of an emphasis on the vertical dimension, this tool is particularly suited to application in mountain environments. Verticality is a fundamental feature of Andean landscapes and livelihoods, which rely on exchanges of goods and services among production zones and social spaces at different altitudinal levels. In Cotacachi, this layered system structures agricultural practices, migratory patterns, community relationships and cognitive perspectives. In participatory mapping exercises, local people tend to draw their communities in terms of vertical arrangements. A relief model is therefore better able to represent key ecosystem linkages as well as to be more consistent with local understanding of the environment than two-dimensional maps or images. Using the *maqueta* is inherently dynamic and never completed, since information is constantly revised and updated as new stakeholders or processes intervene and affect the landscape.

After the basic relief model was laid out, the specific features and properties of the landscape were filled in by local people through a participatory workshop. This exercise offered a unique educational opportunity that enabled local people clearly to visualize and understand issues of human–environment interactions. Among stakeholders, it also provided a platform for dialogue concerning watershed management and mediation of conflicts surrounding natural resource use. For instance, it served as a visual aid to indigenous communities and their neighbours in the facilitation of agreements surrounding grazing rights and resource use in the Cotacachi-Cayapas Ecological Reserve. The model allowed concrete discussion of territorial boundaries, often the subject of tension because of contradictions between ancestral rights, formal deeds and land reform provisions. In the effort to promote rural ecotourism and generate revenues in the region, UNORCAC uses the *maqueta* to highlight locations of cultural and natural interest, such as sacred places (i.e. where ritual baths or cleansings are held) and hiking trails leading to Cuicocha lake and to the summit of Mount Cotacachi.

The *maqueta* was also an important tool for researchers as it was useful for integration and analysis of natural resource data. In interaction with local people, we were able to pinpoint on the *maqueta* local geographical knowledge on the landscape and analyse it in the broader context of regional economy/ecology and natural and social system interactions (see Fig. 21.1). For example, water quality data can be used to pinpoint contamination points and examine how those may be affected by production strategies, settlement patterns and household interaction. Likewise, soil data can be overlain on the model in a workshop to illustrate issues of erosion and fertility in relation to land use and climate at various altitudes. The *maqueta* was used in a climate change workshop to talk about the retreat of the glacier on Mount Cotacachi (see Rhoades and Zapata Ríos, Chapter 5, this volume). The *maqueta* was used by an NGO project studying upstream–downstream interactions surrounding the Pitzambitze river, a tributary of the Ambi river. By plotting their data on the model, they showed how upstream processes of contamination and deforestation affect downstream communities. For instance, the common practice of burning grasslands at high altitudes results in erosion problems and water table disturbances downstream.

Fig. 21.1. Researchers Juana Camacho and Xavier Zapata Ríos listen to Cotacacheños explaining climate change using the participatory 3D model (*maqueta*) (Photo: Jenny Aragundy).

The *maqueta*, therefore, was a product from SANREM research that was seen by the indigenous leadership of UNORCAC as an extremely valuable tool. It is a powerful instrument for information exchange and analytical reflection on landscape change, conflict resolution and watershed management. The *maqueta* is located today in the training conference room of UNORCAC and is used almost daily for training activities.

Studies of Cotacachi folklore: legends, customs, ancestral sayings and food recipes (investigators: Virginia Nazarea, Maricel Piniero and Juana Camacho)

Another direct request of the indigenous community, primarily from Magdalena Fueres of Jambi Mascaric (UNORCAC), was to collect and publish the folklore of Cotacachi, especially folk tales (see Nazarea *et al.*, Chapter 6, this volume), ancestral sayings, dreams and beliefs, customs and rituals, traditional food and medicinal recipes. This research was not originally a part of any project, but Dr Virginia Nazarea of the Ethnoecology team accepted this request and through her field assistants conducted a study of Cotacachi's folklore (see Fig. 21.2). UNORCAC's expressed interest was specifically to rescue the oral traditions before they disappeared as a strategy of cultural revitalization. Thus, they wanted the memory banking concept applied to this cultural recovery and to publish booklets in Spanish, English and Quichua for schools and the emerging tourist trade in the area. The book *Stories of Creation and Resistance* presents the legends and myths (Nazarea and Guitarra, 2004). A similar volume, *Recipes for Life: Counsel, Customs, and Cuisine from the Andean Hearth* by Virginia Nazarea and her team was published by Abya-Yala Press in 2005 (Nazarea *et al.*, 2005).

The collection of folklore also brought joy and pleasantness to the relationship between researchers and local people. Circles of elders were invited to talk not only about their old varieties but also about the legends and myths. The elders enjoyed

Fig. 21.2. Rosita Ramos, SANREM assistant, tape records a folktale for the memory banking project (Photo: Natalia Parra).

immensely talking about the old ways. Although this project activity was criticized by our US technical committee as 'documenting the demise', it not only brought good will but gave us insights into how local knowledge is adaptive in the landscape. The recipes and sayings are time-tested insights into the Cotacachi landscape and offers practical remedies that are certainly worth saving and might even have practical value in the future. As in any culture's folklore, many stories and sayings are for entertainment or education in best manners. One saying goes 'When children stick their tongue out, it is said they will look like lizards' or 'One must not sing while eating because one can bite one's tongue'. There are also omens and secrets, such as 'when the left ear burns, it is because the enemies are talking' or 'when the dogs howl, one must not go out because the evil spirits are passing by'. In a similar vein, there are many local recipes for everyday living, for hunger, famine and illness. This activity bought us a great deal of social capital and, when we asked to do research in the community on a topic they did not understand or maybe even annoyed them (administer a questionnaire), they were open to our request.

Diagnosis of water systems in Cotacachi: university extension project for the benefit of local communities (investigator: Olga H. Mayorca)

Water is the most critical natural resource in Cotacachi because of an essential role in human survival and its increasing scarcity as a clean and ample resource. The local water systems have multiple problems: poor service, inability to collect user fees, high costs, limited supply, sanitation, conflict over access and control of water between communities, individuals and government agencies. They also lack essential information about the water systems. Local water associations (*juntas*) have organized over the past decades in response to new infrastructure and changes in needs of users in the landscape. Given limited government support and subsidies for water, local communities are often left to their own resources and ingenuity.

Due to water's central role in the lives of Cotacacheños, we were regularly called upon to help with some aspects of the water systems: providing training on citizen water monitoring, generating data on quality and quantity of water, GIS mapping of water system, or lending time of our research assistants to help water associations in collecting funds. The SANREM office, in fact, was also the water association office for two of the largest water association, Chamuvi and Cambugan. Interested in improving their service, the *juntas* of these two association requested that SANREM help gather specific data on quality, coverage, trends regarding numbers of users, and supply capacity.

Olga H. Mayorga and her students of the Geography School at the Catholic University-Quito agreed to conduct the study for the water associations (Mayorga, 2004). The Cambugan water system serves six communities (1177 users) and Chumavi serves seven (1504 users). Typically, the administration of a local water system is done through water *juntas*: a central one and others in each one of the communities which are integrated by a president, a vice president, a secretary, a treasurer and an operator. The funds come from the collection of water service fees paid by the communities, although there is little support. There is one operator per community in charge of repairs and installation of new pipelines. There is a central operator who receives a US$100 monthly payment and each community operator receives US$13 per month.

In carrying out the research, Professor Mayorca and her students conducted office work and field work. They surveyed and digitized each of the water systems, designed surveys for users (n = 490) and administrators, and held workshops. The information from the points collected with GPS (geographical positioning system) equipment and the information tabulated in Excel were integrated with Arc View. The final report to each water system association was presented in digital format and in hard copy. They also developed maps of the pipelines. Biodegradable garbage was revealed to be disposed of in the fields or thrown in nearby streams which are mainly dry. Plastics were typically incinerated. Garbage was often blown by the wind and scattered throughout the agricultural fields. Sources of water have also been channelled into illegal pipes to provide water to different communities other than those in the water association.

Water from potable water systems has multiple uses beyond drinking: washing clothes, cooking, irrigation and watering farm animals. The majority of women wash their clothes in their homes, but if water is scarce they wash in a stream or irrigation channel near their house. Users of the Cambugan water system distrust the water so much that many users rely on other water systems. People also reported numerous diseases related to water: diarrhoea in children, colds, head and stomach aches, fever and parasites. Treatment is largely by traditional methods of curing, often through a shaman. The Catholic University team submitted reports containing detailed infrastructure information to the two water system authorities, along with suggestions on how to improve the systems. Recommendations are now being implemented by the water associations with outside funding. The study, although requested by local water authorities, also provided excellent information for our own scientific work on water in Cotacachi.

Creating local databases and leaving them behind: SANREM data files, Cotacachi atlas (investigator: Monserrath Mejía S.)

Ironically, the most desired product from our research was data. Indigenous leaders of UNORCAC as well as NGO personnel sought information on varied topics for securing funding or grants. Since little systematic information on Cotacachi existed, we were constantly called upon for data on water, soils, climate, agricultural production or secondary government statistics which were also available to anyone but had not been gathered systematically. The information was put into the SANREM computers or placed in hard copy in two open access filing cabinets. We placed no restriction on these data and left all control in the hands of the UNORCAC's leadership. We only asked that all hard copy information be returned to the filing cabinets after their use.

In addition to these archives, a data node was established in the Catholic University-Quito where all available secondary and primary data on Cotacachi at the cantonal level were processed. 'The Digital Atlas of Cotacachi Canton,' headed by Monserrath Mejia of the School of Geography has produced a rich integrated GIS database which brings together biophysical, socioeconomic and demographic information for the characterization of different parishes in the canton. This digital atlas is geared toward professionals, technical personnel, planners, policymakers and institutions involved in natural resource and rural development. Cotacachi as a canton is in the process of formulating a Cantonal Territorial Ordinance (*Ordenanza Territorial*) and this atlas serves to identify priorities through geographic analysis of vital statistics and biophysical data. The atlas contains an ordered collection of maps which represent spatial distribution and temporal variation of biophysical aspects and socioeconomic indicators of the parishes.

Prior to developing the atlas, Monserrath Mejia and her team met in Cotacachi with individuals from different institutions, including UNORCAC and the Planning Direction of the Cotacachi Municipality. Through this participatory dialogue, it was decided to structure the atlas around four themes: (i) *natural space* with information about biophysical aspects (cartographic base, relief, satellite images, soils, climate, erosion, geomorphology, etc.); (ii) *cultural space* which delineates parish divisions, political–administrative units, evolution of population, tourist activities, etc.; (iii) *space and infrastructure* which shows roads, health facilities, housing, schools, and services such as water, electricity, sewage and garbage collection; and (iv) *synthesis maps* of sociocultural and natural interest sites, natural potentialities, natural and anthrogenic threats and natural limits to agricultural production. These colour maps visualize the spatial characteristics and problems of canton Cotacachi. The final atlas was produced in two forms: a hard copy atlas and a digital version. The digital atlas can be managed from various locations, including from the Catholic University or from Cotacachi itself. Periodic updates with new data and thematic maps are possible, although those making changes would need to be trained in the use of Arc View in order to manage and operate the atlas. The atlas has been incorporated in the canton's initiative on 'transparency through democracy' and will be available at the municipal library for public access.

Conclusion

The purpose of this chapter has been to present our experiences with reconciling differences between the agendas of sustainability scientists and those of local people. Examples other than the six highlighted here could have been mentioned. We also researched and published histories of 15 communities for distribution in the communities. A CD version of all SANREM data was created and distributed in the 'tool book' format with different levels of analysis, including embedded raw data. These examples illustrate creative ways to address the needs of local people while simultaneously pursuing basic research. However, some caveats must be mentioned. Scientists who freely leave project data with local people as a form of exchange should be prepared that the data will be distributed or used in ways not always in accordance with intellectual property ethics of researchers.

Virtually all of these data were quantitative, descriptive or geographic, with no confidential material about individuals or families. Any data of a personal issue remained confidential human subjects matter between the individual researcher and the individual or group who provided them. The project data sources were used not only by the local people but also by unaffiliated researchers who passed through, NGOs looking for information for their own reports or proposals, as well as local officials. Due to the continual rummaging through these files, a state of disorganization prevailed. The archived materials also became a source of leverage and currency for the indigenous people who would exchange the information for new projects or funds. NGOs were especially notorious for extracting the raw data and marketing them as their own. Publications in the form of booklets, pamphlets and flyers based on SANREM research would appear in workshops or annual reports, typically without any credit to the original researchers.

While such trafficking in data generated so arduously by a researcher may seem disconcerting, we have concluded that this form of plagiarism or data lifting is a minor issue and should be overlooked for a number of reasons. First, raw data typically cannot be understood by anyone except the person who generated it in the first place. The odds that such data will end up in a significant publication are remote. Second, the information was generated thanks to the good graces of the local people and it is within reason that such information should be left in the communities, even in raw form. This step renders the need to repatriate the data back to the community unnecessary; although there is the risk the data will be lost or misunderstood. Third, if local people can use the data as currency and gain advantage, we should welcome the opportunity to help in exchange for research support.

Sustainability science projects justify themselves and receive funding to create decision support tools, research findings and policy advisement that will improve natural resource management. Rarely, however, do such projects succeed in the short term in generating impacts that local people understand and appreciate. Sustainability science, as an academic discipline, and sustainable development, as the applied outcome, are still in their infancy. We do not yet fully understand the principles of sustainability or how it is to be achieved, even in the long term. This will require decades of systematic interdisciplinary investigation on the complexities of nature–society interactions. In the meantime, we need the full cooperation of local people who should not be expected to sacrifice for the benefit of researchers. The case studies in this chapter illustrate how to create a win–win situation for both scientists and residents of a watershed.

References

Fairhead, J. and Leach, M. (2003) Does globalised science work for the poor? *Forest Perspectives.* IDS Research Direct 1, 1–4.

Gross, D. and Plattner, S. (2002) Anthropology as social work: collaborative models of anthropological research. *Anthropology News* November, 2002, p. 4.

Hyslop, J. (1990) *Inca Settlement Planning.* University of Texas Press, Austin, Texas.

Mayorga, O.H. (2004) *Piped Water Systems of Cambugan and Cumavi, Canton Cotacachi: A University Extension Project for the Benefit of Local Communities*. SANREM–Andes, Quito. Ecuador.

Moates, S. (2003) *Reduced Biodiversity in Highland Ecuador*. SANREM–Andes, Athens, Georgia.

Meisch, L.A. (2002) Andean Entrepreneurs: Otavalo Merchants and Musicians in the Global Arena. University of Texas Press, Austin, Texas.

Nazarea, V. (1998) *Cultural Memory and Biodiversity*. University of Arizona Press, Tucson, Arizona.

Waters-Bayer, A. (1994) The ethics of documenting rural people's knowledge: investigating milk marketing among Fulani women in Nigeria. In: Scoones, I. and Thompson, J. (eds) *Beyond Farmer First: Rural People's Knowledge, Agricultural Research, and Extension Practice.* Intermediate Technology Publications, London, pp. 144–150.