Capacity building of sea level and climate monitoring in the Pacific region: Fiji case study

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Abstract: In order to enhance capacity building in the Pacific region, and to raise awareness on climate change and sea level issues, teaching and training modules were made available to the Pacific community through the "South pacific sea level and climate monitoring project" funded by AusAID. Numerous training workshops have been conducted through the project since its inception in 1991 and the project is now in its fourth and final phase. It was hoped that the goals of capacity building for the stakeholders on correct information of climate change and sea level have been understood and taken heed of. In addition, "The scientific educational resources and experience associated with the deployment of Argo" (SEREAD) project was also set up especially for ocean science in the Pacific island schools in 2001. However, it has been realized that the data from this project is more relevant to tertiary level rather than to secondary level students. Consequently, a survey was carried out to gauge the students' outlook towards the physical side of marine science. The survey revealed that more than 80% of both tertiary level and high school non-physical science students decided not to take the physical aspect of marine science sighting reasons that it is either a difficult subject, boring, too hard to understand or difficult to pass in the examination. Even amongst students taking physical science, only about 50% believe that the physical aspect of marine science is enjoyable. A minority of students at USP and high school take science as a subject and a small proportion from them take the physical science. From this scenario, it can be predicted that there will be a shortage of physical science graduates in the future. The confidence of the Pacific community in the work of scientists is built on faith. They appreciate the effect of science on their lives and support it but are unaware of the scientific methods involved. Therefore, for the sustainability of physical aspect of marine science in the future for the Pacific region, public awareness of climate change and sea level is vitally important and it should be widely promoted in the community as a matter of urgency.

Key words: climate change; sea level; capacity building

1. Introduction

The climate change debate is still on the international agenda, and through the process of diffusion and sensational reporting, misleading information will continue to reach the region and the governments of the region. It is important that policy advisers, community leaders and journalists receive regular updates on the latest scientific information, including results of the sea level and climate change in the region. We are fully aware that

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teaching and training in ocean and atmosphere related science throughout the world is mainly offered at the university level. In many countries, however, there is little general recognition among the public of the influence of the atmosphere and oceans on climate. It appears that the critical need for the Pacific region could be met by introducing and strengthening concepts of climate change and sea level issues at the primary and secondary school levels, at the post-secondary level even for non-meteorological and non-marine science students and through more formal public education.

Generally, capacity building, which is a learning process that includes the acquisition of knowledge and skills, and involves the sharing of skills and expertise, becomes the relevant need of individual, group or community. In order to enhance this effective capacity building in the Pacific region, appropriate teaching and training modules were produced on "*Climate change and sea level*" and used in general training for raising awareness or easily incorporated into the existing school courses in the region. Since 1998, these modules were made available to the regional educational institutes all over the Pacific region through the AusAID funded by "South pacific sea level and climate monitoring project" based in Adelaide, South Australia.

At the same time, it was necessary to prepare more substantial documentation for the general training programme of the Australian project, in terms of perceived needs, objectives, content, delivery methods and quality evaluation procedures. Such documentation then would facilitate an assessment of the value of effort and provide more scope to make suggestions for improvement in relevance and quality. It further aimed to include formal assessment of the knowledge and skills of all participants in formal training activities in both modes as pre- and post-training. Only through such procedures could the effectiveness of the training activities be properly assessed, and used subsequently to support initiatives leading to continuing quality improvement (The Australian project structured its training activities incorporating the identified training needs of the participants and their home governments, based upon a formal "training needs assessment" carried out beforehand.). This assessment was used more vigorously and formed the basis for post course evaluations of the effectiveness of the training.

The authors have realized the importance of the Competency Based Training (CBT) methodology, which is now becoming widely adopted by education authorities in Australia and elsewhere, particularly for technical training. A CBT approach clearly defines the skills and knowledge relevant to the performance of particular tasks together with appropriate evaluation criteria, and lends itself to clearer documentation and focuses directly on the training outcomes to be achieved. Accordingly, serious consideration to adopting CBT methodologies in documenting and structuring courses and training materials have been used in this paper.

Looking at the past experiences, the authors strongly believe that workshops related to raising public awareness and educating the educators and media on climate and sea level change issues, should be repeated regularly through the project activities. Presentations should be non-technical or minimal-science level to ensure maximum understanding of the issues independently rather than focusing on the importance of science behind the issues. In this way knowledge can be spread throughout governments, agencies and the local Pacific community. The goal of the programme has been to develop basic science awareness on climate change and sea level, critical thinking skills, and improve environmental science capacity building for communities, teachers and students in the Pacific region.

1.1 Background of the Australian project and its present status

In 1988, the Pacific forum countries first expressed their mounting concern over the threat of rising sea levels due to global warming and the consequent exposure of the low lying atoll nations. In a remarkably short time scale, in fact, during the forum meeting in 1989, the government of Australia made a firm commitment to monitor rising sea levels and consequently, the birth of the "South pacific sea level and climate monitoring project" followed.

Phase one of the project began in mid-1991 as an implementation phase and the daily telemetry of observed data was planned and negotiated with the satellite operators. Within four years, a coordinated monitoring array of high-resolution instrumentation for sea level and associated meteorological parameters was fashioned and brought into operation with several awareness workshops in the participating 14 countries. Phase two of the project began in July 1995 as the first truly operational phase. More attention has been paid to information and training for the 14 project member countries in phase two. A programme of short term attachments has been implemented, whereby Pacific personnel spend a period of three weeks at the regional countries or in Australia, where they met specialist resource persons to explore the realities of climate change. In this way, the project meets the need to provide the island nations with the best available information and interpretation of the scientific consensus with regard to climate change and associated modern technology relevant to the issue. Phase three began in early 2001, but the scale and activities on capacity building significantly slowed down due to financial constraints. The project is in its final phase now and the early initiatives on capacity building have become a thing of the past.

1.2 Curriculum modules on climate change and sea level

Until recently, information on climate change and its consequences was rarely available in the present educational materials in the South Pacific region. The review report on phase one of the “South pacific sea level and climate monitoring project” recommended that a specific effort should be made to produce appropriate teaching materials on sea level and climate change issues for the schools in the Pacific region as phase two of the project. There are some outstanding projects related to climate change in the Pacific region. All of these programmes have mandates from their funding agencies to engage in dissemination of scientific information and to improve educational and teaching material in the region. The need to integrate the information from all these programmes is imperative, so that a more complete and understandable message on climate change and sea level can be delivered to the Pacific region.

As a first stage, a four-day meeting for the development of curriculum modules for the Pacific Island Countries (PICs) was held in October 1995 in Adelaide, South Australia. Based upon the decisions made during the meeting, as a second stage, a two-week long workshop on curriculum development on climate change and related effects was successfully held in June 1996 in Apia, Samoa. Fourteen participants from 11 PICs took part in the workshop along with a six-member resource team from Australia, United States of America and the Pacific countries. The substantial outcome of the workshop has produced a draft of eight curriculum modules on climate change and its impacts, mainly targeting the upper primary and lower secondary level of the schools in the Pacific. The subsequent compiling, reformatting, rewriting and editing of the above eight modules were carried out step by step simultaneously in Adelaide and Apia, their work was overseen closely by the Australian professor in Oceanography who was also the director of the Australian project.

In August 1997, after further discussion based upon the edited version and the topics covered, it was decided to produce two parts: Part one as physical science module and part two as social science, both being in text form for teachers as well as for students. In February 1998, the Australian project published part one of curriculum modules and part two was released four months later. The official launching of these was done in June 1998 during the “Pacific regional conference for environmental education and training” by the Australian Ambassador for the Environment at the University of the South Pacific (USP), Suva, Fiji. The books were well received by more than 150 educators from 18 PICs. More copies were later distributed to the project member countries.

In November 1998, the first curriculum implementation workshop for the teachers was conducted very successfully in Nauru. In May 1999, “Atmospheric Radiation Measurement Project” (ARM Project) of USA took the initiative to run the similar curriculum implementation workshop for the teachers in PNG. The second workshop took place in Manus Island (PNG) and the third one was conducted in Port Moresby with similar success.

The aim of the workshops has been for teachers to learn to conduct the scientific activities in the modules, and practice hands-on the ideas and activities using all material during the class. The participants realized that the basic concepts and scientific activities learnt from the workshop could also be incorporated in their existing courses, such as for teaching general science, physics and geography. It was noted that the introduction of a new subject in an education system in any country is not an easy task and the following steps were taken to achieve the major goal:

(1) Bring awareness of the project to host communities through public education relevant to the culture of the region;

(2) Provide opportunities for teachers and students close to the project sites to understand the aims and objectives of the project and have access and use project data for educational programmes as technical resources permit;

(3) Increase the knowledge base for basic science and critical thinking skills using curriculum enrichment activities in climate change and sea level relevant to the region;

(4) Develop and use tools (curriculum, teacher's enrichment, workshops, science fair support, and high school research projects) and teacher internships to promote learning and understanding of climate change and sea level effects.

Although the curriculum development was done successfully in the end of 1998, there were not many follow-up actions and curriculum implementation workshops for the Pacific teachers due to financial constraints in the project. However, in May 2002, ARM Project took the initiatives again to run a week long teachers workshops in Manus Island (PNG) and Nauru respectively for the different teacher groups. It is important to point out why the workshops were conducted only in PNG and Nauru amongst many other Pacific island countries. It is due to the fact that ARM Project has its monitoring stations in Manus Island and Nauru, thus their education component focused on these two areas only. It is unfortunate that other Pacific islands have no funds allocated for these educational activities under the "South Pacific Sea Level and Climate Monitoring Project". However, it is noted that the first two volumes are being used in the *Discipline of Environmental Sciences and Geography* within the School of Natural and Physical Sciences at the University of Papua New Guinea (UPNG).

Obviously, the curriculum modules produced in late 1998 needs further improvement for the future use in the region. In addition, it was realized later that these modules did not cover some important issues in the region such as earthquake, tsunami, and tropical cyclone. In order to cover these missing topics, UPNG is recently taking an initiative to produce a third volume (Part three) titled Environmental Science.

1.3 Additional activity for marine sciences at the University of the South Pacific

The ocean is central to the lives of people in Pacific island nations. The sea provides a source of food and medicines, a medium for transportation, and is a dominating influence on weather and climate of the region. The ocean is a natural and necessary area for study, if students learn that science is inquiry into the operations of the real world, with value and its relevance in everyday life. The new and fully equipped marine studies complex was built in mid-1990s by the funding assistance from the Japanese government at the USP situated at Lower Campus in Suva, Fiji, to promote the marine sciences in the Pacific region especially at tertiary level. In addition, a new project, SEREAD (Scientific Educational Resources and Experience Associated with the Deployment of Argo) was also launched in 2001-2002 for ocean science in the Pacific island schools, funding for which were contributed by a series of regional agencies to run this small scale project.

SEREAD is an educational programme which develops resources that will complement the current secondary teaching curriculum and bring real, regionally focused science into the classroom. The major goal is to generate awareness, discussion and understanding by Pacific island students of the ocean's role in the climate system. The main objective of the project is to provide teaching resources that complements the current teaching curriculum and demonstrates the value of scientific knowledge through realistic and locally relevant applications. Some materials were developed on a collaborative basis between teachers, curriculum developers and ocean scientists from USP. Teachers know what is needed and what works in the local classroom, curriculum developers assist by providing linkages to the current teaching curriculum and scientists provide the scientific and technical expertise. The collaborative effort is aimed at providing an innovative and relevant teaching resource. Several promotional talks for the SEREAD project and teachers' workshops were conducted in Kiribati, Samoa, Tonga and Fiji during 2002 and 2003. Despite several efforts from different sources during the last decade or so, the end results are still not encouraging.

1.4 Present status and degree of success

As mentioned earlier, the capacity building activities from the Australian project and ARM project have diminished since the last 5 or 6 years. SEREAD activities based at USP were not distinctly successful either since SEREAD was purely based on ARGO floats data of temperature, salinity and depth. These data are more relevant to marine research in tertiary level than the normal interest of the school students. It was obvious right from the beginning that the aims and objectives of the project are not compatible to the targeted audience, but was still carried out to honour the wishes of funding bodies and the donors. This led to conduct a quick research on students' outlook in the subject matter in Suva, Fiji, as all the authors are based at USP.

1.5 A quick survey on marine science in Fiji

It is a wonder to note how things have changed in the capacity building of marine science especially for sea level and climate change during the last decade or so within the Pacific region. This paper is purely based upon the assessment and experiences at USP and few nearby schools in Fiji.

According to Padak and Padak (2005, pp.1-4), there are three major characteristics to be taken into account to formulate good research questions: (1) The issue chosen to explore should be important to us, to our programme and to our students; (2) Questions are directly related to the issue or the problem; (3) Questions should be answerable. The questions for questionnaires and interviews have to be in line with the major aims of the survey and they should also be meaningful, feasible, practicable and effective to reach the reliable outcomes and to make the valid conclusions. Based on this, simple and easy research questions were prepared to carry out this survey. In this process, ethical guidelines set in BERA (2000) were fully observed and strictly followed. Some interview with the parents and teachers were also conducted to identify the variables that could have the greatest impact on teaching and learning of marine science, especially the physical aspect focusing in sea level and climate change. The level of thoroughness in this survey provided very informative and decisive results. The summary of data collection, survey and analysis is shown in Table 1.

Different sets of questionnaires, short and simple for (a) USP science students mostly from first year level; (b) USP non-science students; and (c) forms 5 and 6 high school students from some selected schools in Suva were used to implement the major objectives of the survey. The details of these questions are not included in this paper such that not to inflate the length of the paper. In addition to these surveys, few interviews with USP higher level physics students, their parents and few teachers were conducted to substantiate the factors surveyed. Parents and school teachers have major influences on students in choosing the subject they take in their course of study.

Table 1 Summary of data collected in the survey

No.	Data	Analysis
1	Questionnaires for USP non-science students	Attitude toward marine science
2	Questionnaires for USP science students	Feeling about marine science
3	Questionnaires for high school students	Outlook on marine science
4	Interviews	Views on marine science

2. Data analysis and results

Relatively, USP is a typical medium-sized teaching and research university by international standards. In the Pacific, it is the biggest international university and is effectively serving for the 12 Pacific island nations. Consequently the findings in this project will definitely represent the genuine situation for the Pacific region.

2.1 Students response to physical aspect of marine science as a subject

In order to find out the general attitudes of the students towards the physical side of marine science, a quick survey was conducted using a short set of questionnaires. In this survey, students from USP (tertiary level) and students from nearby schools were included. Most of them were non-science students with very few of science background presently taking science in their institutions. The validity of the survey depends on whether the students are actually answering the questions themselves or giving answers as their teachers expect them to.

2.1.1 Responses from non-physical science students

The first survey was conducted with 61 students in their final year of non-physical science course. In answering the survey questions, approximately 84% of the students decided themselves not to take physical aspect of marine science since they were not interested in it. Only 16% were influenced by the teachers and parents, to avoid the hard science course. A similar survey was conducted in nearby schools and 80 non-physical science students took part in it. The results were 88% and 12% respectively. The ratio is consistent for both, in the schools and at the university.

(1) Approximately 39% of students from university and 12% from school believe that physical science (including marine) is a difficult subject and also boring;

(2) Another 39% from university and 63% from schools are convinced that science is hard to understand and difficult to obtain a pass in the examination. The school result is definitely not encouraging for the future of physical science in general and in particular for marine science;

(3) Only 22% from university and 25% from schools believe that physical science is okay and can explain real life events.

When asked about taking physical science (including marine) in future for part of their study programme, 64% from university and 75% from school gave negative answers. The minority 36% from university and 25% from schools said that they may take physical science in future if required.

2.1.2 Responses from students taking physical science

This survey was conducted with students doing the new elective physical science course at USP. 151 students were approached to take part in this survey. It was obvious that these students would be more positive towards science as they were actually taking physical science as an elective subject in programme of study. For the first question regarding their background, it revealed that 72% took physical science before in the schools, and only 28% had no science background.

Amongst them, 60% believe that physical science is too difficult to digest and they are scared of failing in the examination. Only 28% think that they will be successful and 12% strongly believe that teaching and dissemination style of physical science should be improved dramatically.

Approximately 76% of the total does not look forward to taking physical science in the future. It is interesting to note that 60% of participants want to recommend the younger generation to try physical science, although they themselves do not want it.

2.1.3 Responses from marine science students

This brief survey was conducted recently with 185 marine science students who are taking elective Physics as well at USP. A similar survey was also done from the schools. Only 87 physics students from nearby schools, who may be ready to take physical part of marine science at the university, took part in this exercise. Survey results are given below together with results from the schools in brackets. It is to be noted the respondents are marine science students with a physics background and their views on physical aspect of marine science are expected to be positive.

(1) Among these students, 50% from USP (and 38% from schools) decided to take the subject because of their own interest. Only 17% from university (and 25% from the schools) took the subject due to their good scores in their previous physics courses. Of the remaining 33% (and 37%), approximately one-third of these students took the subject because of the study programme set by the education authority of their home countries and not because of their own interest or choice;

(2) Only 26% from university (and 14% from schools) think that the subject is tough and rough;

(3) Approximately one-third (33% and 38%) both from university and schools respectively believe that physical aspect of marine science is boring;

(4) Considering the total number of students, 39% from USP and 62% from schools enjoy the subject as fun. The percentage indicates that learning physics in schools is more enjoyable than the tertiary level physics and the related marine science;

(5) Interestingly, 89% from university and 63% from schools are ready to take the physical side of marine science and physics courses in the future. Some respondents, (approximately 31% and 37%) are taking core physics courses to join medical and engineering programmes in the future.

2.2 Major findings from the analysis

From this brief survey, even among science students with physics background, only approximate 50% believe that physical aspect of marine science (and physics) is an enjoyable subject. The rest of the students are definitely scared of the subject and not enjoying the subject. This situation simply indicates that sooner or later the Pacific region will face the shortage of graduates in these subjects. It is noted that less than half of all students in the schools and at USP take science. Amongst them a tiny proportion takes physical science.

2.3 General view on climate change and sea level issue

During this short-term study, 78 people who include parents of students from the local community, postgraduate students in science and some school teachers were briefly interviewed for their views on climate change and sea level. It is noted that the Pacific community generally like and appreciate science, but they just do not necessarily understand it. A large proportion of the communities fail in formal education, especially in science subjects. The gap between the expectations of their education and those of their home cultures are too wide and difficult to bridge. It is also found that the Pacific community has a huge amount of confidence in the sciences and the work of scientists. But the basis of this support is due to faith, not knowledge. It would be a daunting task in the future and we have to overcome the problem with appropriate strategies.

(1) In a survey of 78 people with basic education, 62% of them agreed that the benefit of scientific research is helpful;

(2) At least 42% of respondents considered themselves “very interested” in scientific discoveries and another 45% considered themselves moderately interested;

(3) When it came to the environmental issue like climate change and sea level rise in the region, even more people take notice, with 63% expressing strong interest and 31% expressing moderate interest.

According to Wieman and Perkins (2005, pp.36-41), interest and awareness is almost directly proportional to the level of a person’s background education: The more educated, the more likely that a respondent was intrigued by science. Regardless of interest level, most Pacific people get their science news from newspaper and television while only about 10% get the information from science-oriented publications.

Interested or not, Pacific people hold scientists and the science leadership with high regards. They also appreciate the effect of science on their lives. More than 8 out of 10 people believe that science and technology continue to make their lives healthier, easier, and more comfortable. They are aware that there is a lot of science involved in their daily lives and environment around them, but they are ignorant and are not able to neither explain nor identify. They support science but are ignorant of the scientific methods. It is like a car owner, who trusts his mechanic but does not understand what the mechanic does.

3. Discussion

Results from different surveys conducted, interviews held, and data analyses in this survey overwhelmingly suggest that good teaching and an enjoyable learning environment are the most important requirements for the wider dissemination of knowledge in climate and marine science in the future. However, if we regard good teaching encourages students to use the higher-order learning processes that students apply spontaneously, standards will not decline. This is not a matter of acquiring new teaching techniques just to use existing knowledge based on teaching and learning appropriately. Through reflective practice, teachers can then create an improved teaching environment suited to their own context (Biggs, 2003, pp.1-9).

As we all may agree, one of the most important skills for scientists and academics, regardless of gender, is giving lectures or making presentations. Lectures (or presentations) are a tremendous opportunity to communicate accomplishments to other academics and scientists. It is also an efficient mode to deliver the knowledge to our students (Newberg, 2005, pp.54-55). Some people are very good at listening and will hear and understand every sentence uttered. Most people, however, lapse in and out of attention during a presentation. One simple way to reach those with questionable listening talent is to outline our main points up front while the audience is still fully awake.

4. Conclusions

Based upon the authors own experiences in the teaching of climate change and sea level topics over the last ten years, our attempt was not successful if not totally wasted. It has been widely known that many schools in the remote islands within the Pacific region do not have sufficient science teachers in general, and physics teachers in particular. This reason alone is answering one of the main questions we are looking at and the blames simply come to us. If we do not train our students properly in physical science and related subjects, they have less chance to become a good physics (or science) teacher in the future. Then, how can they attract students to take physics in their schools? Subsequently, who is going to learn the issue of climate change and sea level rise? We cannot rely on hired teachers from overseas either. Apart from some new graduates who enjoy adventure of life, no experienced teachers will come and help us to solve our long-term problem in the Pacific. No matter how hard they try, new graduates cannot be good teachers over night. It is very much like a chicken and egg problem, however, this unfortunate vicious circle should be stopped somewhere and we have full moral responsibility to reverse this sad situation.

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(5) The rather liberal trading practices of American business guided along by the official free-trade policy, are not visible among U.S. affiliates in foreign markets. They have become major traders in their own right, in some cases even exceeding the trade volumes of small countries. But, they always kept a positive balance on their activities, except for the year 1977 in Table 6.

Table 6 U.S. MOFA foreign trade ($ billions)

Year	Exports	Imports	Balance
1977	138.1	149.2	11.1
1982	221.6	121.0	100.6
1988	280.4	204.4	76.0
1989	282.5	211.7	70.8
1990	346.3	251.6	94.7
1991	365.3	266.8	113.7
1992	383.8	288.6	95.2
1993	384.0	294.7	89.3
1994	426.4	337.4	89.0
1999	630.9	453.3	177.6

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