WORKSHOP REPORT

PACCLIM WORKSHOP: MODELLING THE EFFECTS OF CLIMATE CHANGE AND SEA LEVEL RISE IN PACIFIC ISLAND COUNTRIES

Under the Pacific Islands Climate Change Assistance Programme (PICCAP)

Auckland, New Zealand

23 – 25 August 1999

SPONSORED BY
THE ASIA-PACIFIC NETWORK (APN)

WORKSHOP SUMMARY

INTRODUCTION

This document reports only on the Asia Pacific Network for Global Change Research (APN) supported component of a 5-day PACCLIM Workshop that was also supported by the World Bank. On 23-25 August 1999, two delegates from each of 13 Pacific Island countries (PICs) attended a workshop in Auckland to review and evaluate a prototype of the PACific island CLimate Impacts Model (PACCLIM), developed as a tool for application in climate change vulnerability and adaptation (V&A) assessment. They were joined by modellers, other scientists and various donor groups invited by the workshop organisers— the International Global Change Institute (IGCI) and the South Pacific Regional Environment Programme (SPREP), respectively. The first three days of the PACCLIM Workshop were sponsored by APN with support from System for Analysis, Research, and Training (START).

PACCLIM was developed by the IGCI for the Pacific Islands Climate Change Assistance Programme (PICCAP), a project of SPREP implemented through UNDP-GEF. The United Nations Institute for Training and Research (UNITAR) CC:TRAIN programme is integrated with PICCAP to avoid duplication and ensure complementarity of effort.

The current version of the PACCLIM model is a prototype, including a regional climate change scenario generator and an impact modelling capability developed for two exemplary islands (Viti Levu, Fiji, a high island; and Tarawa, Kiribati, a low atoll island). As an integrated assessment model, PACCLIM is designed for multiple uses: scenario generation, impact assessment; training; environmental analysis; policy development; and decision-making. The workshop was designed in order to show the potential uses of PACCLIM and provide an opportunity for Pacific Island countries to provide feedback on the model.

This seven-page workshop summary outlines the PACCLIM prototype model, states the goals and objectives of the APN workshop, summarises the main activities undertaken during the workshop, and then provides a synthesis of critical feedback on the PACCLIM prototype model from PIC delegates. Details are provided in Appendices 1-6.

PACCLIM PROTOTYPE MODEL

PACCLIM is an integrated assessment model (IAM), for use in climate change V&A assessment, of the "end-to-end" sort, as described by the IPCC (Weyant, et al., 1996) (***Appendix 3B***). The basic structure of the system is modelled after the CLIMPACTS system, an IAM developed by IGCI for New Zealand (Kenny et al., 1999; Warrick et al., 1996), which was later extended to Bangladesh (as BDCLIM) and Australia (as OZCLIM). More specifically, PACCLIM derived from VANDACLIM, an IAM for the imaginary Pacific island country of Vanda Islands, developed for PICCAP by IGCI for use in a 6 month training course on *Climate Change Vulnerability and Adaptation Assessment in Pacific Island Countries.*

There were two main aims to the PACCLIM prototype development:

- Develop a regional climate change scenario generator;
- Develop a modelling capability for V&A assessment in two exemplar countries (Viti Levu in Fiji, a high island; and Tarawa in Kiribati, a low island).

The PACCLIM prototype model consists of three major components:

- A ***regional climate change scenario generator*** which links together output from a simple global climate model for different greenhouse gas emissions (GHG) scenarios, regional patterns of climate change derived from complex general circulation models (GCMs), and historical climate data for the region. It's primary purpose is to enable individual PICs to develop their own scenarios of climate change, for use in on-going V&A assessment work;
- An interlinked ***scenario generator*** and ***impact assessment component*** for Viti Levu in Fiji, which includes information from the regional scenario generator, spatial climatologies for the island, soil attribute data, and sectoral models;
- An interlinked ***scenario generator*** and ***impact assessment component*** for Tarawa in Kiribati, which includes information from the regional scenario generator, climate data for Tarawa, and sectoral models.

Currently, four sets of sector models for climate impact analysis are available for:

- The ***coastal zone sector***, where the focus is on erosion and flooding based on the Bruun rule which takes into account storm effects, local sea-level trends, and lag effects, in order to provide time-dependent response of the shore-line to sea-level rise at selected sites in Viti Levu and Tarawa (***Appendix 3D***).
- The ***water resources sector***, where for the high island (Viti Levu) a rainfall-runoff model allows examination of changes in areas at risk from river flooding, and where for Tarawa atoll a ground water model (Falkland, 1995) provides running 6 monthly, 2 dimensional images of changes in depth of the ground-water lens to the year 2100, as forced by daily rainfall and perturbed by scenarios of climate change (***Appendix 3C***)

- The ***agricultural sector***, where the environmental limitations for a range of important tropical crops can be examined in Viti Levu using a modified version of the PLANTGO model (Hackett, 1988). This model has been linked to spatial climate and soil attribute data to enable assessment of areas of greatest limitation and suitability for different crops, under present climate and climate change conditions. (***Appendix 3E***)

- The ***human health sector*** where malaria and dengue fever are modelled (Martens, 1995; Pastz, et al., 1998) to allow spatial analyses in Viti Levu of the changes in indices of epidemic risk through the relationship between climate and mosquito vectors of these diseases (***Appendix 3F***)

The value of a country-level integrated assessment model, such as PACCLIM is that it:

- is quick running and user-friendly
- is modular, and therefore easily updated with new information
- promotes sensitivity analyses of model inputs and assumptions
- allows examination of ranges of uncertainties associated with climate change
- provides spatial as well as temporal analyses

WORKSHOP GOAL AND OBJECTIVES

Goal: To advance development of the PACCLIM model as a tool for technical training, environmental analysis, policy development, and decision-making for use by Pacific Island Countries (PIC's).

Objectives:

- To provide orientation to PIC delegates on the prototype PACCLIM model.
- To provide training to PIC delegates in use of the prototype PACCLIM model.
- To seek feedback from PIC delegates, and other invited experts, on the possible future development of the PACCLIM model.

ORGANISATION

In May 1999 the APN provided financial support for a 2.5 day workshop, in order to address the above objectives. As part of this support, two delegates from each of 13 Pacific Island Country were invited to Auckland to learn about, and interact with, the prototype PACCLIM model and then provide feedback on its application and use.

In June, the World Bank approached SPREP for assistance in developing an economic report on adaptation to climate change in Pacific island countries. Support was given by the World Bank to extend the APN workshop by 2.5 days so that modelers and other

scientists could meet to discuss advancing the PACLIM model as a basis for evaluating adaptation to climate change.

Thus, the APN workshop was held as part of a larger 5-day PACCLIM Workshop with support from two independent sources: the Asia Pacific Network (APN) and World Bank.

PROGRAMME

The programme for the 2.5 day APN workshop is contained in ***Appendix 1***.

PARTICIPANTS

The entire week-long workshop was attended by a total of 75 delegates, of which 36 attended under the auspices of the APN, including 26 participants representing 13 Pacific island countries. The remaining participants included invited modellers and scientists, representatives of regional institutions and donor agencies, who attended under the auspices of the World Bank. A full list of participants is contained in ***Appendix 2***.

ACTIVITIES

The main workshop activities are summarised in the following sub-sections: welcome and overviews; explaining the PACCLIM model; training sessions, group discussions, open forum, and final session.

Welcome and Overviews:

In welcoming participants to the workshop, the Director of IGCI, Dr Neil Ericksen, highlighted the developing partnership between PICCAP, IGCI, and UNITAR and the range of activities in the area of human response to climate change that were being carried out in association with Pacific island countries. He thanked the sponsoring agencies (APN, START and World Bank) for providing the opportunity for bringing together modelers, scientists, and end-users from Pacific island countries to share information about the PACCLIM model development. The value of this collaborative activity was also highlighted by Mr Gerald Miles, speaking on behalf of SPREP.

Ms Kazuko Watanabe, Deputy Director, Asia-Pacific Network, outlined the objectives of APN, placed the workshop in that context, and wished participants a productive experience. Ms Sofia Bettencourt, Senior National Resource Economist, World Bank, outlined the Bank's interest in reporting on an economic evaluation of adaptation to climate change in Pacific island countries, and how use of PACCLIM might help facilitate this aim.

Mr Wayne King, PICCAP Manager, outlined PICCAP outcomes to date, while the co-ordinator of each Pacific island country team succinctly summarised progress (***Appendix 3A***).

Explaining PACCLIM

Led by Dr Warrick, IGCI staff explained the PACCLIM prototype model, its scenario generator and sectoral impact components, including water resources, coast, agriculture, health (***Appendices 3B – 3F***). Although not part of the PACCLIM prototype, fisheries was outlined as an example of what could be readily included in future developments of PACCLIM (***Appendix 3G***). This demonstrated to participants the flexibility of the PACCLIM model's architecture.

Training Sessions

Training sessions were conducted in six groups-- four comprised of PIC delegates; one of scientists and the other of donor agencies. Training exercises were designed for the scenario generator and for each sectoral impact model. Copies of these are in ***Appendix 4***. This hands-on instruction was designed to provide sufficient familiarity of the PACCLIM model as to enable participants to comment on its usefulness and further development. (Most PICs had at least one person present who had earlier received training in use of VANDACLIM— the island version in a V & A course at IGCI (June-December 1998). VANDACLIM is an integrated computer model with similar structure to PACCLIM, but based on an imaginary PIC with a high and low island.

Group Discussions

Participants were divided in four groups in order to discuss and evaluate the extent to which the PACCLIM model was addressing issues of concern to PIC. Groups were asked to identify what they saw as the strengths and weaknesses of the prototype model, how existing sectors might be further developed, and new ones added, and how this could be achieved. A full list of questions is contained in the programme (***Appendix 1***).

Open Forum

In open forum each of the four groups reported back the results of their discussions and evaluations of the PACCLIM prototype model (***Appendix 5***). A synthesis of this feedback from PIC delegates to the modelers is contained in ***Appendix 6***. It provides a detailed PIC needs assessment regarding the PACCLIM model development.

There was overwhelming support from PIC delegates, and others, for further development of the PACCLIM model. Major conclusions are in the section on Workshop outcomes.

Final Session:

At the request of PIC delegates, IGCI staff selected aspects of the PACCLIM model to explain in greater detail (scenario generator and coastal and water resource sectors), as basis for further discussion and evaluation in open forum. This was done in order to deepen their appreciation of the model and its capabilities, and therefore the value of adapting it to their countries.

ACHIEVEMENTS

The objectives of the APN Workshop were ***achieved*** with regard to participants from Pacific Island Countries:

- Participants were shown PACCLIM's scenario generator and sectoral impact models, and the ability for these to be expanded and/or added to.
- Participants gained hands-on experience with, and training in the use of, the PACCLIM prototype model.
- Participants understood that PACCLIM had multiple capabilities and uses, including: training, analysis, policy development, and decision-making.
- Participants evaluated the PACCLIM prototype model in terms of: further developments; various applications; and necessary resources for its multiple uses.

KEY OUTCOMES

As noted earlier in the report, the key objective of the workshop was to obtain feedback from Pacific Island Country delegates and invited guests, in order to guide the future development of the PACCLIM model. Detailed documentation of feedback and discussion sessions is provided in ***Appendix 5*** (PIC delegate presentations) and ***Appendix 6*** (Needs analysis for future PACCLIM development). The key outcomes of this workshop consultation process are summarised below under the four headings of: approach to PACCLIM model development; PACCLIM capabilities; implementation and operational support; and training.

1. Approach to PACCLIM model development

The workshop provided valuable feedback in terms of the overall approach to PACCLIM development, as follows:

- There was strong support for the urgent development of country-specific PACCLIM models. It was recognised that each country needed to identify priorities, needs and constraints which should be addressed and taken into account in the development of country-specific PACCLIM models;
- The development of country-specific models should be an ongoing process which follows a progression from a prototype containing simple models to more complex model components as the skills, expertise, and data increase within country.

2. PACCLIM capabilities - climate scenarios, impact sectors and exposure units

Notwithstanding the need for country-specific models, the following were identified as indicative of the needs of PICs in terms of capabilities, sectors, and exposure units which should be included in PACCLIM:

- Enhanced ability to analyse effects of climate variability and extremes including ENSO events, tropical cyclones, droughts and flooding;
- Modelling of fisheries at a regional (tuna) and country (reef fish) level;
- Terrestrial and marine biodiversity;
- Coral reefs;
- Agricultural and plant pests and diseases;
- Tourism;
- Enhancement of ability to model linkages and interdependencies between sectors.

3. Implementation and operational support

In terms of implementation and operational support PIC delegates emphasized that:

- PACCLIM development should be accompanied by ongoing co-operation and consultation with end-users from governmental, non-governmental, and private sectors;
- In each country there is a need for a PACCLIM focal point, such as a ministry, department or committee, with responsibility for managing PACCLIM related activities;
- The above needs to be facilitated by ongoing training and financial and technical support.

4. Training

Ongoing training in PACCLIM use and activities related to PACCLIM was identified as an essential need:

- Ongoing training needs to accompany each step of PACCLIM development and use;
- Training should address a range of levels from data collection for PACCLIM development, to sectoral specific analysis, integrated assessment and policy analysis;
- There is a need to identify the range of possible end-users who would benefit from training including senior personnel with policy influence; and
- Possible training strategies should include, a "train-the-trainer" approach, secondment of personnel to assist in model development, in-country training programmes as well the possible extension of training to regional institutions.

Appendix 1: Programme

AGENDA

PACCLIM Workshop

Modelling the effects of climate change and sea level rise in Pacific Island countries

supported by
The Asia-Pacific Network and the World Bank
implemented by
the IGCI and SPREP
as part of the
PICCAP Programme

PART I: APN SUPPORTED:
PACCLIM Training and Proposed Developments
(23-25 August 1999)

Monday, 23 August 1999	
8.30-10.30	**Opening Session - Facilitator Prof. Roger McLean**
	• Welcome
	• Opening statements by SPREP, UNITAR, IGCI, UNDP, APN and WB (5 mins)
	• Objectives, tasks and schedule of the Workshop (Dr R. Warrick, IGCI)
	• PICCAP: Report on progress (Mr W. King, SPREP)
	• Brief summary by PIC representatives (13 reports, 5 minutes each)
10.30-10.45	**Coffee/Tea Break**
10.45-12.30	**Introduction to PACCLIM – User Training (Facilitator – Roger McLean)**
	❖ Presentations on the prototype PACCLIM system (modelling teams):
	•Overview of system development (Richard Warrick)
	•Water resources (Tony Falkland, Wei Ye)
	•Coastal (Paul Kench, Peter Cowell)
	•Agriculture (Gavin Kenny, Richard Ogoshi)
	•Human health (Neil deWet, Simon Hales)
	•Regional Fisheries – overview (Paul Kench)
	❖ Open Discussion (Facilitator – Roger McLean)
12.30-13.45	**Lunch**
13.45-15.30	**Training exercises (parallel sessions):** Pacific Island delegates will be divided into 4 groups in order to undergo specific training in use of the PACCLIM model. Each group will be facilitated by a member of IGCI and exercises have been designed in order to provide practical understanding of model operation and outputs. *Climate models:* for the first two sessions each group will undergo the same training. • 13.45-14.15: Climate science and MAGICC Exercise • 14.15-14.45: Scenario construction using PACCLIM *Sectoral impact models:* for this and the subsequent session the groups will rotate through each sectoral model. • 14.45-15.15: Sectoral impact models - exercise 1 * A fifth group comprising representatives of donor agencies will be invited to attend a seperate session on the PACCLIM model to be presented by Richard Warrick.
15.15-15.30	**Tea break**
15.30-17.00	**Training exercises continued (parallel sessions):** Groups will continue to rotate through each sectoral model and undertake the designed exercises. • 15.30-16.00: Sectoral impact models - exercise 2 • 16.00-16.30: Sectoral impact models - exercise 3 • 16.30-17.00: Sectoral impact models - exercise 4
17.00-17.30	**Plenary Session – Closure of Training Session (Facilitator – Roger McLean)**
	•Open discussions, summary, conclusions
	•Instructions for next morning's session
18.30	**Workshop delegates are invited to a reception and conference dinner.**

Tuesday, 24 August 1999	
Facilitator: Dr Graham Sem, SPREP	
9.00-10.45	**Parallel Working Sessions:** The delegates will be divided into 6 working groups to discuss future PACCLIM development. The objective of this session is to discuss to what degree the prototype PACCLIM integrated assessment model is addressing issues of concern relating to climate and sea-level change in Pacific Island countries. Each group should consider the following issues/questions: • What are the key issues of concern in Pacific Island countries? • What gaps are there in the PACCLIM prototype in relation to these key issues of concern? • What climate features should be included in PACCLIM? Are these features incorporated into the prototype and how can different aspects be included? • Are the sectors presently modelled within PACCLIM the most appropriate (taking account of the diversity of island types in the region)? What others could be included? Are there issues of regional concern that should be included and/or better modelled? What methodologies could be employed? • Should socio-economic effects be considered in PACCLIM? • What are the priorities for future PACCLIM development, in terms of geographic coverage, (regionally and in-country), scenario development, sectoral development? How should such developments proceed? • What are the general data needs for these future developments and what are some of the key constraints? • What are the main limitations to PACCLIM and to what degree, and in what manner should future development of PACCLIM be accompanied by other capacity building activities? * At the beginning of the session each group should appoint people to record the discussion and conclusions of each group and a person to later present the group's findings to the workshop.
10.45-11.10	**Coffee break**
11.15-12.30	**Parallel Sessions (continued):** The six groups will continue to discuss issues related to training and implementation of PACCLIM and its future development. Issues to be addressed include: • End user training requirements and mode of delivery. • Ways in which PIC can maintain a collaborative involvement in PACCLIM development. • The support that is needed (e.g. computer/network/technical assistance) to ensure that PACCLIM is adopted and used within each Pacific Island country.
12.30-14.00	**Lunch**
14.00-15.30	**Workshop Forum on PACCLIM Development (Facilitator – Graham Sem)**
	• Group reporting (10 minutes each)
	• Plenary discussion (30 minutes total)
15.30-15.45	**Tea Break**
15.45-17.30	**Parallel Sessions by Model Component Group** (i.e. climate scenarios, water, health, etc)
	Workshop delegates will be divided into 5 groups reflecting the sectoral interests (climate scenarios, water resources, coast, agriculture, health). These groups will be facilitated by members of IGCI and supported by identified experts in each group. The purpose of this and the following session is for each sectoral impact group to discuss the impact model and any changes that are required to better model impacts in the Pacific. Issues to discuss include: • Development of a strategy for long-term model component development. What new model components should be developed? • What are the information and data requirements for such developments? • Begin drafting a needs analysis and statement of what is required to enhance the existing model.

18.00 -	**PICCAP special sub-meeting on the Pacific Climate Conference April 2000 (planning group)**
Wednesday, 25 August 1999	
Facilitator: Dr Graham Sem, SPREP	
9.00-10.45	**Parallel Sessions by Model Component Group (continued)**
	• Groups finalise needs analysis and statement
10.45-11.00	**Coffee Break**
11.00-12.30	**Workshop Forum: PACCLIM Sectoral Model Development (Facilitator – Graham Sem)**
	• Group presentations of needs analyses
	• Discussion
12.30-14.00	**Lunch**
14.00-15.30	**Workshop Forum on PICCAP II - (Facilitator - Dr Richard Warrick)**
	• Presentation on Proposal for PICCAP II (W. King)
	• Discussion on PICCAP II (facilitated by PICCAP team)
15.30-15.45	**Coffee Break**
15.45-18.00	**Workshop Forum on PICCAP II (continued)**
	• Discussion on PICCAP II (continued)
	• Closing of Part I of the PACCLIM Workshop
19.00	**Delegates are invited to cocktails to farewell Pacific Island Representatives**

PART II: WORLD BANK SUPPORTED
Technical PACCLIM Model Developments and Sensitivity Analyses
(26-27 August 1999)

Thursday, 26 August 1999	
Facilitator: Prof. John Hay, IGCI.	
9.00-10.45	**Paper Presentations and Discussions: Scenarios of Change**
	9.00 – 9.20 Goals of the World Bank assessment (World Bank representative)
	9.20 – 9.50 Scenarios of change in climatic variability in the Pacific (Peter Whetton)
	9.50 – 10.20 Generating scenarios of sea level change in the Pacific (Bill Mitchell)
	10.20 – 10.30 Questions and Discussion
10.30-10.45	**Coffee Break**
10.45-11.15	**Paper Presentations and Discussion: Vulnerability and Adaptation**
	10.45 – 11.15 Vulnerability and social impacts of extreme events (John Campbell)
	11.15 – 11.45 Adaptation – What do we mean? (Neil de Wet)
	11.45 – 12.00 Questions and Discussion
12.00-13.00	**Lunch**
13.00-14.45	**Paper Presentations and Discussion: Modelling Impacts and Adaptation**
	13.00-13.30 Agriculture (Gavin Kenny and Richard Ogoshi)
	13.30-14.00 Fisheries (Patrick LeHodey)
	14.00-14.30 Human health (Simon Hales)
	14.30 – 14.45 Discussion
14.45-15.15	**Tea Break**
15.15-17.00	**Paper Presentations and Discussion: Modelling Impacts and Adapatation**
	15.15 – 15.45 Water resource modelling (Tony Falkland)
	15.45 – 16.15 Coastal impact modelling (Paul Kench and Peter Cowell)
	16.15 – 16.45 Methods of valuation (Bob Rauscher)
	16.45 – 17.00 Discussion

Friday, 27 August 1999		
	World Bank Workshop (con't) **Facilitator – Dr Neil Ericksen, IGCI.**	**PICCAP PAG* Meeting** **(concurrent session)**
9.00-10.00	**Setting scenarios for climate change and sea level rise.**	**PAG meeting convenes**
10.00-10.45	**Parallel sessions by impact group: Validating impact models**	
10.45-11.00	**Tea break**	**Tea Break**
11.00-12.30	**Parallel Sessions (continued): Conducting sensitivity and preliminary impact analyses.**	**PAG meeting (continued)**
12.30-13.30	**Lunch**	**Lunch**
13.30-16.00	**Closing Session**	**PAG meeting (continued)**
	• Reports of findings from impact groups and recommendations	
	• Development of Plan of Action for Phase 3	PAG meeting concludes
	• Closure of the Workshop	Closure of Workshop
17.00 – 18.00	**Farewell Drinks**	

*PAG – PICCAP Advisory Group

Appendix 2: Participants List

SPREP

PACCLIM WORKSHOP:
Modelling Climate Change and Sea-Level Change Effects in Pacific Island Countries

23 – 27 August 1999
Auckland, New Zealand

The University of Waikato
Te Whare Wānanga o Waikato

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Appendix 3: Presentations

3A. Workshop Objectives:

Richard Warrick – International
Global Change Institute

- The PACCLIM Workshop -

FOCUS

- Assessing V&A to climate change
- PACCLIM model

What is PACCLIM?

An integrated assessment model for climate change in the Pacific Islands

The Prototype PACCLIM Model

Developed for

PICCAP

by:

International Global Change Institute (IGCI)

CC:TRAIN / UNITAR

SPREP

supported by:

UNDP-GEF
APN
World Bank

- The PACCLIM Workshop -

OBJECTIVES

- to provide PACCLIM orientation and training
- to obtain guidance on future model developments
- to share knowledge of impacts, vulnerability and adaptation
- to review and develop PACCLIM components
- to coordinate short-term model applications and analyses

- The PACCLIM Workshop -

STRUCTURE

PART 1:
- APN-sponsored
- first 3 days
- capacity building issues

PART 2:
- World Bank sponsored
- last 2 days
- technical modelling and assessment issues

3B. Introduction to PACCLIM Model:

Overview of System Development and Scenario Generator - Richard Warrick (IGCI)

The Prototype PACCLIM Model

Developed for
PICCAP
by
International Global Change Institute (IGCI)
CC:TRAIN / UNITAR
SPREP
supported by:
UNDP-GEF
APN
World Bank

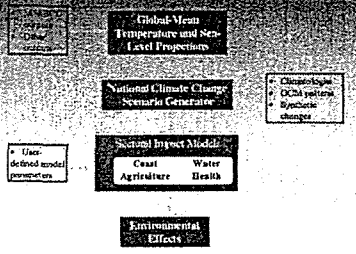
What is PACCLIM?

An integrated assessment model for the Pacific Islands

Main Features of PACCLIM

- Output from a simple global climate model
- Regional patterns of climate change
- Temperature and rainfall climatologies
- Sectoral models for:
  - agriculture
  - coastal environment
  - health
  - water resources

PACCLIM Model Structure



Stages of PACCLIM Development

- **Stage 1** - regional climate change scenario generator
- **Stage 2** - prototype impact modelling (for two islands)
- **Stage 3** - Pacific-wide development

PACCLIM can be used to:

- Describe and examine baseline climates
- Create climate change scenarios
- Validate and evaluate impact models
- Conduct sensitivity analyses
- Project sectoral impacts
- Examine uncertainties
- Facilitate integrated impact analyses

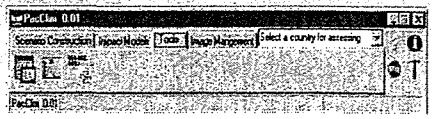
Using PACCLIM

Creating Climate Change Scenarios

PACCLIM (Prototype Version)

The main menu allows the user to:

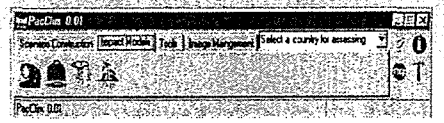
- examine data bases
- carry out assessments of impacts
- create climate change scenarios



PACCLIM (Prototype Version)

The main menu allows the user to:

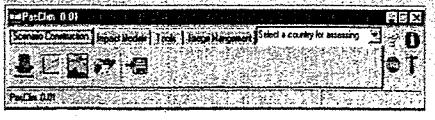
- examine data bases
- carry out assessments of impacts
- **create climate change scenarios**



PACCLIM (Prototype Version)

The main menu allows the user to:

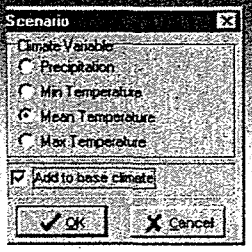
- examine data bases
- carry out assessments of impacts
- **create climate change scenarios**



Developing climate change scenarios using VANDACLIM

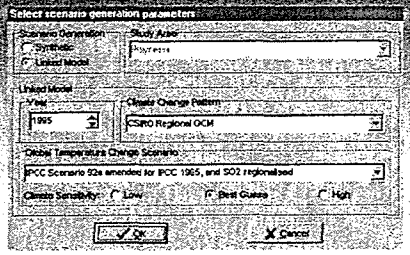
- Select global temperature change - scenario, year and case
- Select regional pattern of climate change
- Scale pattern by global temperature change
- Adjust present climate by change

Choosing the Variable

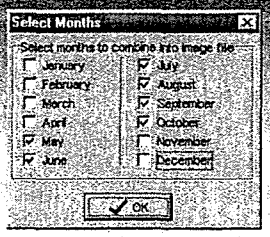


The user selects the climate variable of interest.

PACCLIM scenario menu options

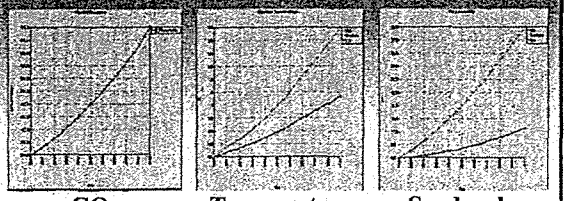


Defining the Season



The user can select any combination of months.

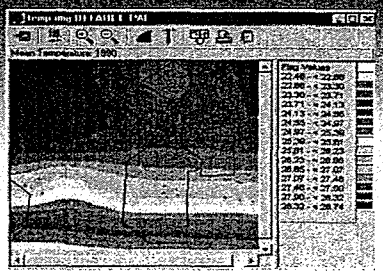
- Global - Projections



CO_2 Temperature Sea level

- Regional - Mean Temperature - Polynesia

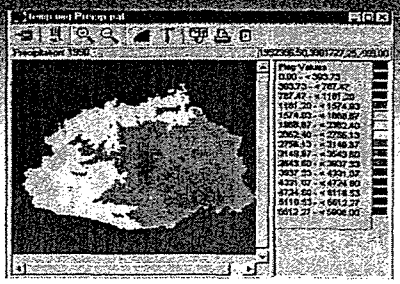
Current

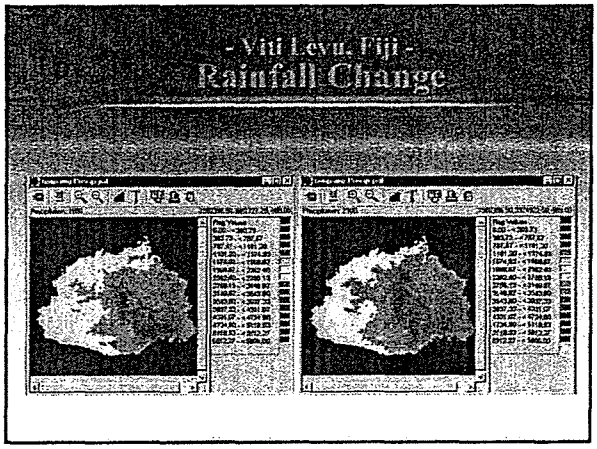


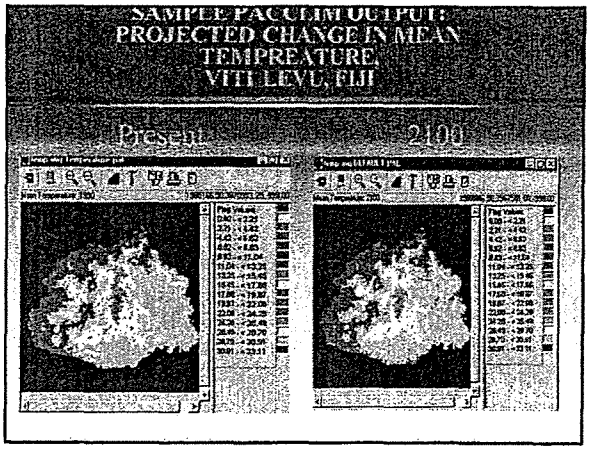
- Regional - Mean Temperature - Polynesia

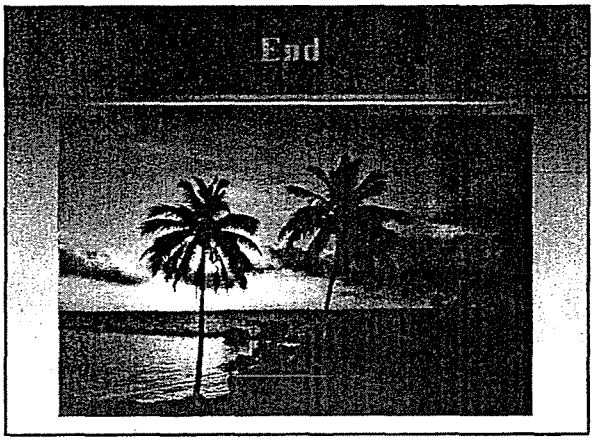
Current 2100

- Viti Leva, Fiji - Rainfall




- Viti Levu, Fiji -
Rainfall Change


SAMPLE PACCLIM OUTPUT:
PROJECTED CHANGE IN MEAN
TEMPREATURE,
VITI LEVU, FIJI
Present
2100


End

3C. Introduction to PACCLIM Model:

Water Resources - Tony Falkland (Ecowise, Australia) presentation not available.

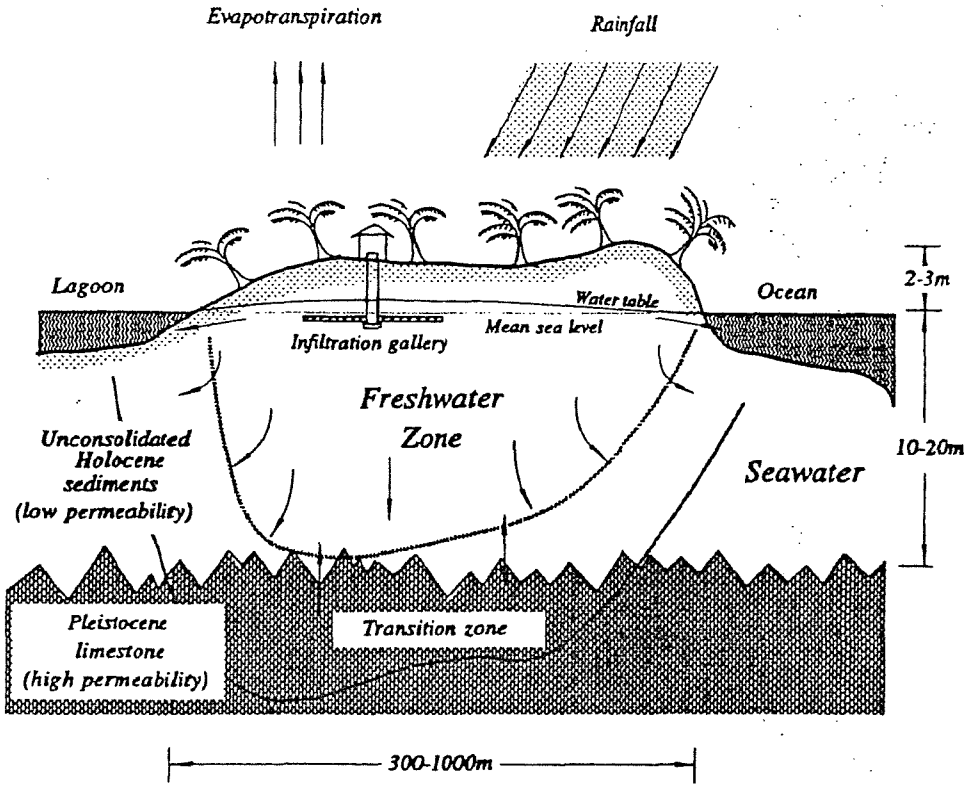


Figure 1 Cross section through a small coral island showing main features of a freshwater lens (exaggerated vertical scale) and location of an infiltration gallery (used for groundwater extraction)

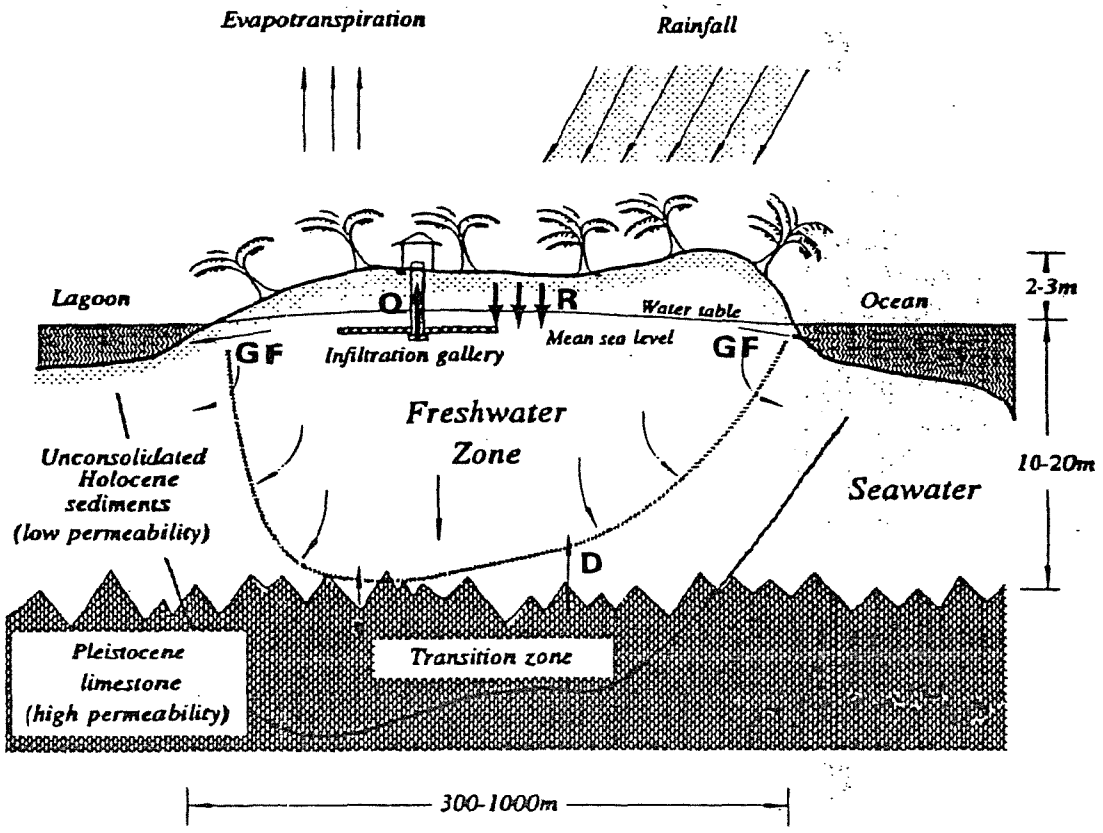


Figure 4 Groundwater balance for a typical coral island freshwater lens

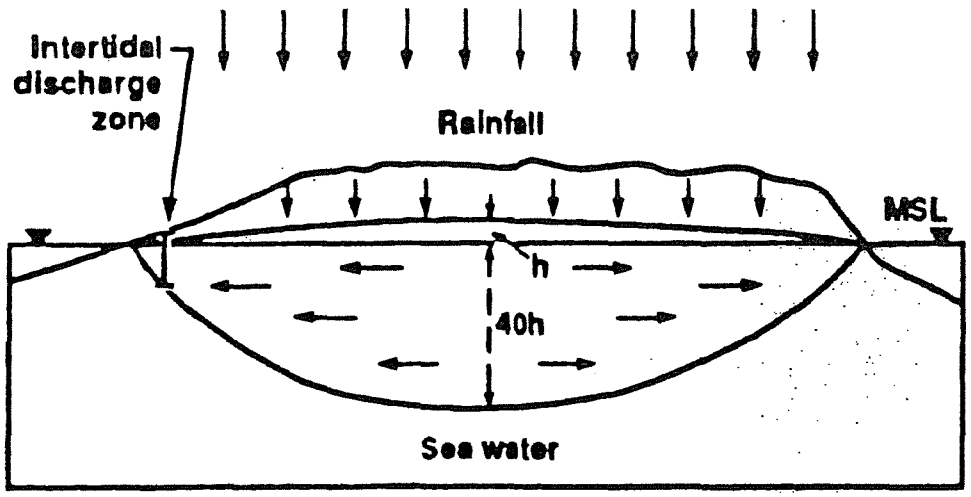


Figure 5 Ghyben-Herzberg model of groundwater flow in a freshwater lens. The model incorporates the Dupuit assumption of horizontal flow (after Buddemeier, 1991)

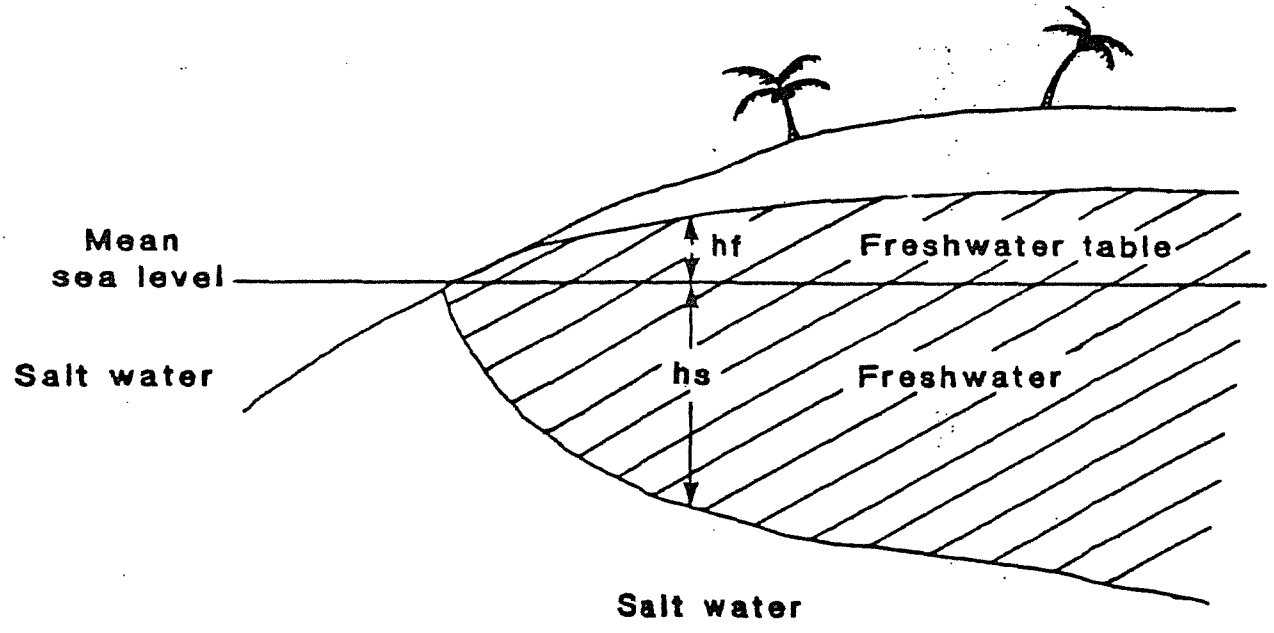


Figure 6 Ghyben-Herzberg relationship for the edge of an island (from Dale et al, 1986)

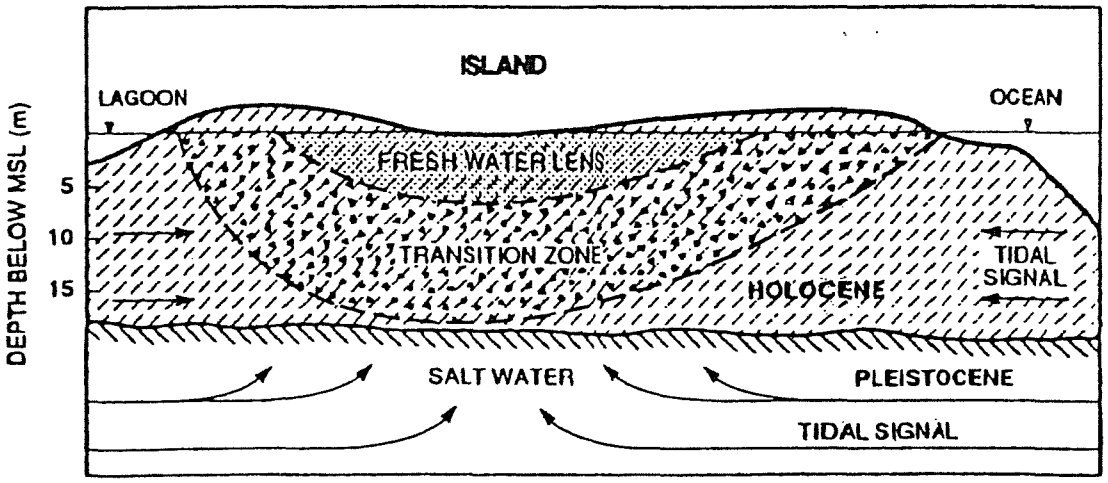


Figure 7 Conceptual flow model of an atoll island allowing for a transition zone between freshwater and seawater (after Peterson, 1991)

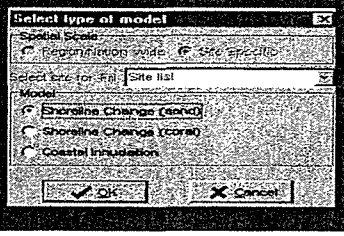
3D. Introduction to PACCLIM Model:

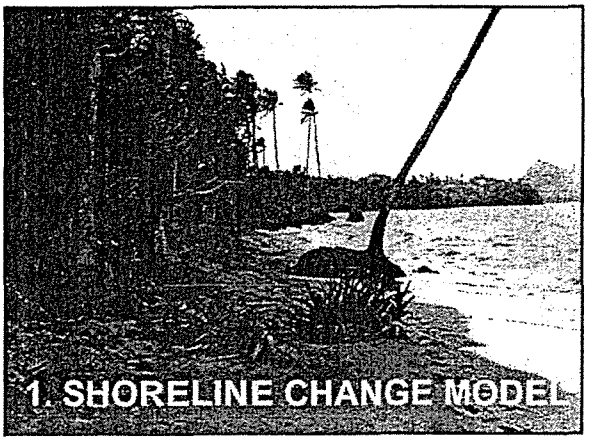
Coastal Impacts – Paul Kench (IGCI)

PACCLIM: COASTAL IMPACT MODELS

Coastal Impact Models in PACCLIM?

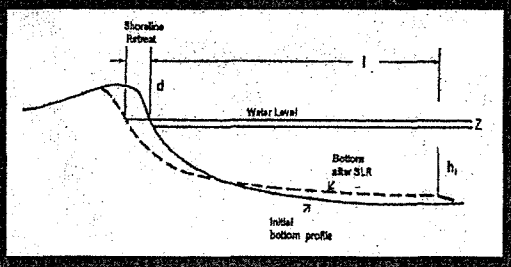
1. Shoreline Change
2. Inundation





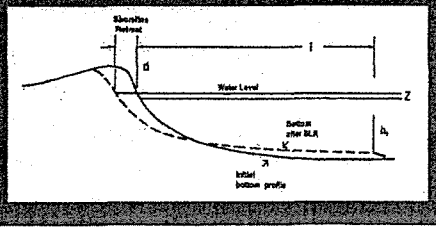
1. SHORELINE CHANGE MODEL

Principles of the Shoreline Change Model



Parameters Required to Run the Shoreline Change Model

Basic equation: $C_{eq} = zl/(h+d)$



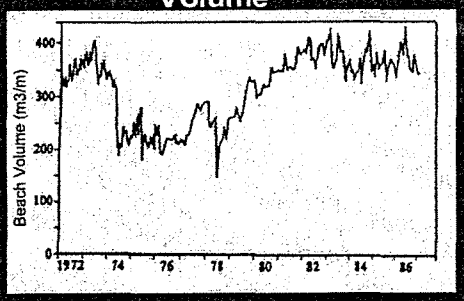
Modifications to Basic Equation

To reflect:

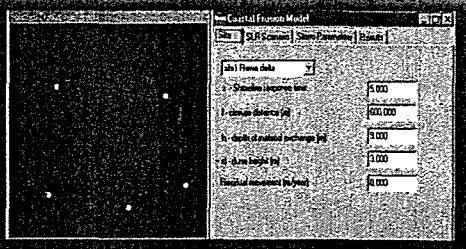
1. Short-term variability in shoreline position (time lag in response) [τ - in years].

2. Interannual variations in storminess [s]

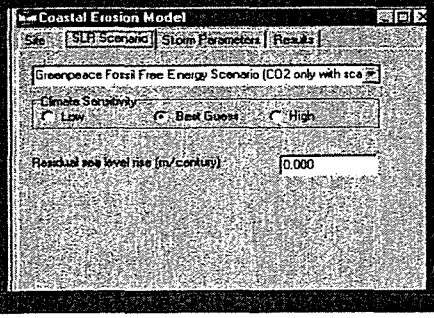
Temporal Changes in Beach Volume



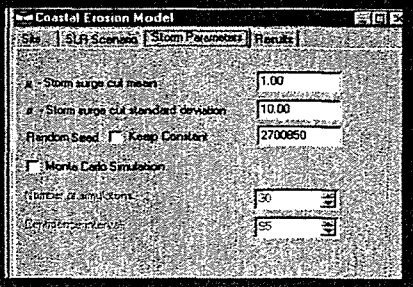
PACCLIM Input Screens



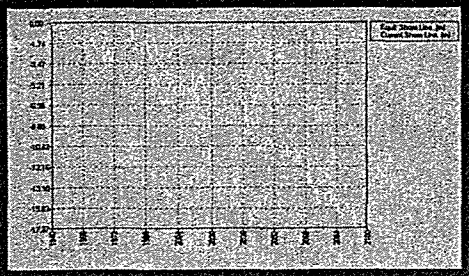
PACCLIM Input Screens



PACCLIM Input Screens



Shoreline Change: Sample Output

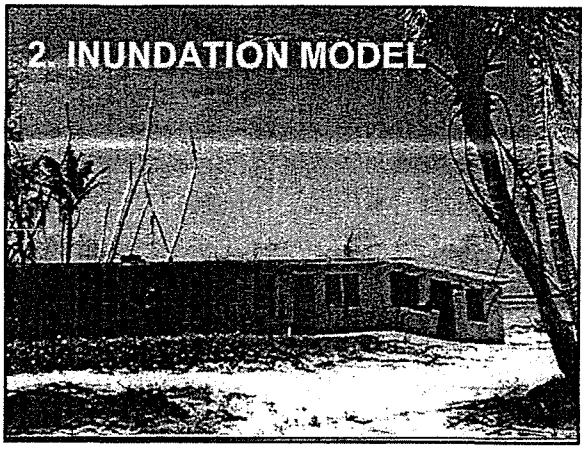


Application of Model

- Provides projections of shoreline movement at a single location.
- *Needs to be replicated for the range of different* coastal settings.
- Model can be used to generate scenarios of shoreline change under a range of different sea level scenarios.
- Can assess the impact of change in storminess.

Application of Model

- Limited to situations where Maximum level of storm surge and wave run-up is lower than the maximum elevation of the coastal margin.
- Parameters need to be carefully considered as in many instances beach profiles are truncated by a reef flat.



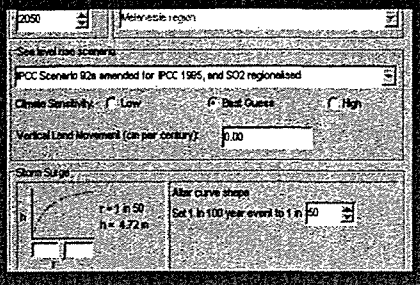
Principles of the Inundation Model

- Model based on a simple 'drowning' concept where high water mark is shifted landward by the same amount of projected relative sea level rise.

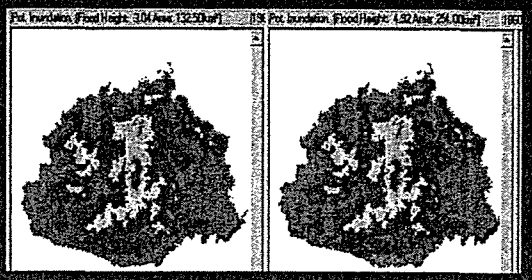
Parameters Required to Run the Inundation Model

- Sea Level Rise:
- Net vertical land movement:
- Storm flooding: user defined storm surge magnitude and return period.

Inundation Model: Sample Output



Inundation Model: Sample Output



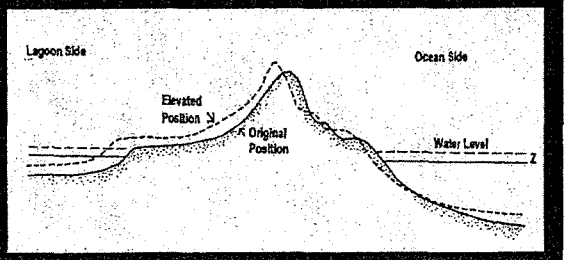
Application of Model

- Provides spatial estimates of inundation.
- Inundation estimates provided for an indivdual year.
- Can manipulate model to determine impacts of increased storminess.

Future Model Development

1. Shoreline Change: To account for situations in which storm surge can overtop an island.

2. Generalised Bruun Rule:



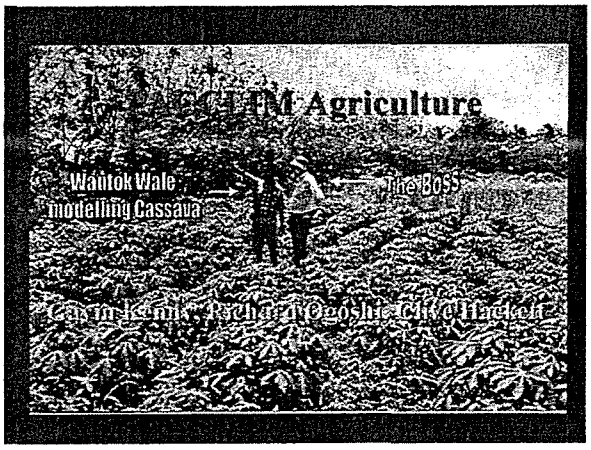
Future Model Development

2. Reef Response Model:

To simulate the range of possible reef responses to sea level rise.

3E. Introduction to PACCLIM Model:

Agriculture – Gavin Kenny (IGCI) and Richard Ogoshi (Hawaii)



Issues to consider

- A few key cash crops
- A wide range of subsistence crops
- Little formal knowledge on plant/climate relationships
- Limited data availability

Modelling Approaches

- PLANTGRO - designed to capture both formal and informal forms of knowledge on lesser known crops
- Process models - limited to a few high value crops, require detailed site data on climate, soil and crop responses

PLANTGRO

- Originally developed for matching plants and land in PNG

What PLANTGRO does

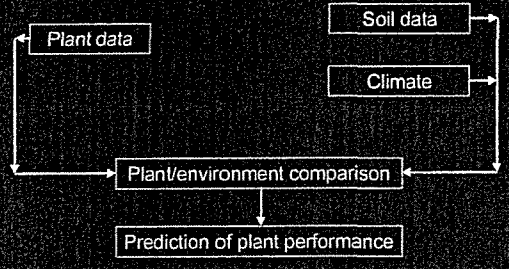
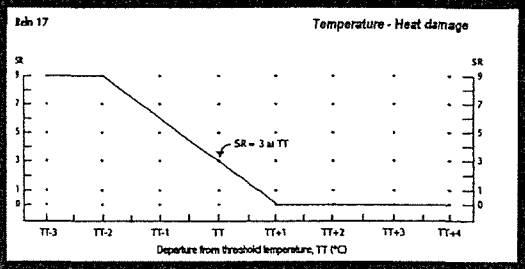
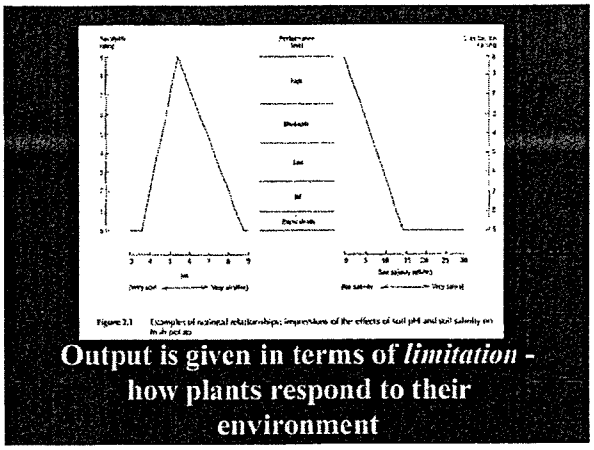


Figure 1 General View of PLANTGRO's functions. (from Hackett, 1991)

Notional relationships between plant and 23 soil and climate factors

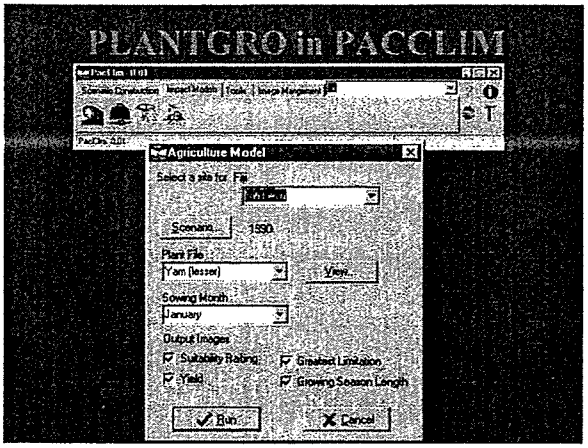


Notional relationships relate each factor to *suitability*

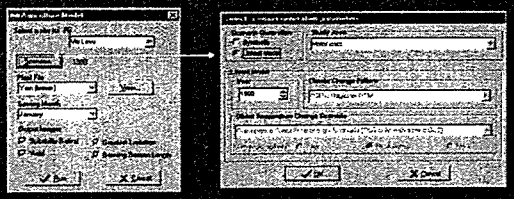


Output is given in terms of *limitation* - how plants respond to their environment

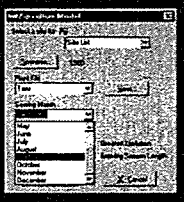
PLANTGRO in PACCLIM



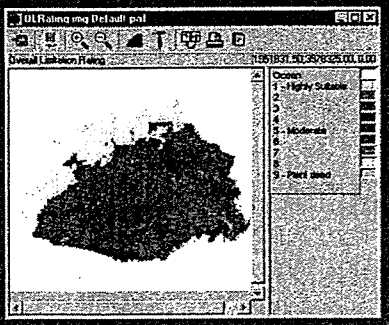
Select scenario parameters



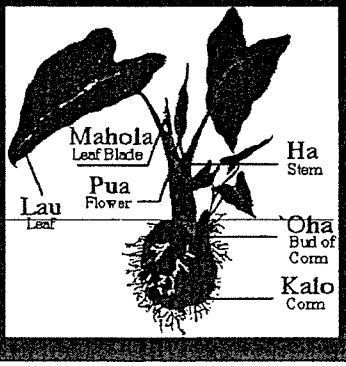
Select plant file and sowing month

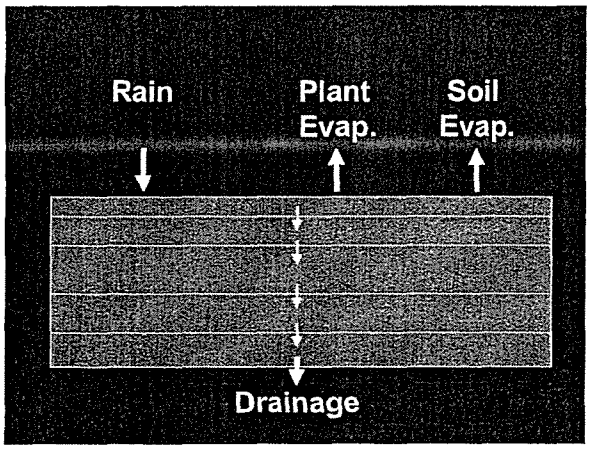


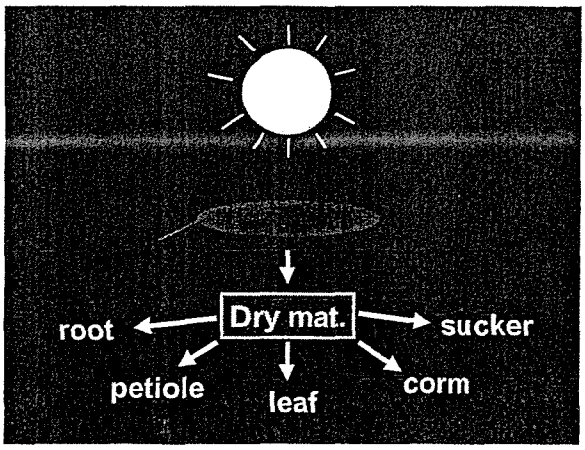
Run the model

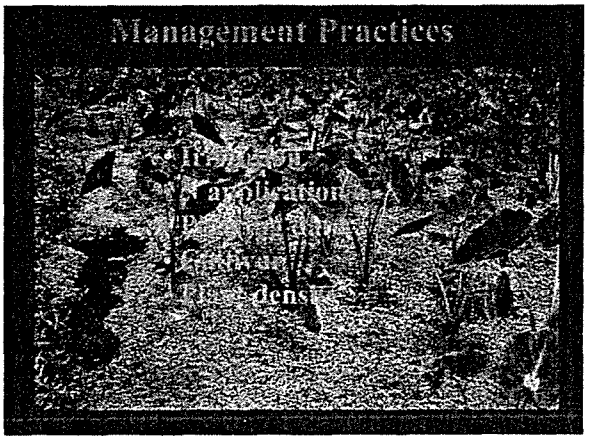


SUBSTOR - AROID Model for Taro









Set weather and soil

- Screen management options for best practices

Set management and soil

- Quantify production variation
- Climate change impact

3F. Introduction to PACCLIM Model:

Human Health – Neil de Wet (IGCI)

PACCLIM
Sectoral Impact Models

HUMAN HEALTH

Health sector impact models

- **Mosquito-borne diseases**
  - Malaria epidemic potential model
  - Dengue fever epidemic potential model
  - Mosquito population distribution model (*under construction*)
- **Ciguatera (fish poisoning) model**

Mosquito-borne diseases

Malaria

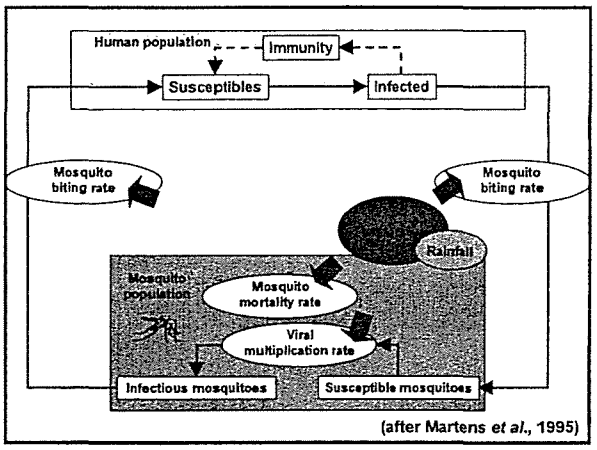
- **Malarial parasites**
  - *Plasmodium falciparum*
  - *Plasmodium vivax*
- **Mosquito vectors**
  Anopheles species
- **Present distribution in Pacific**
  Solomon Islands
  Vanuatu

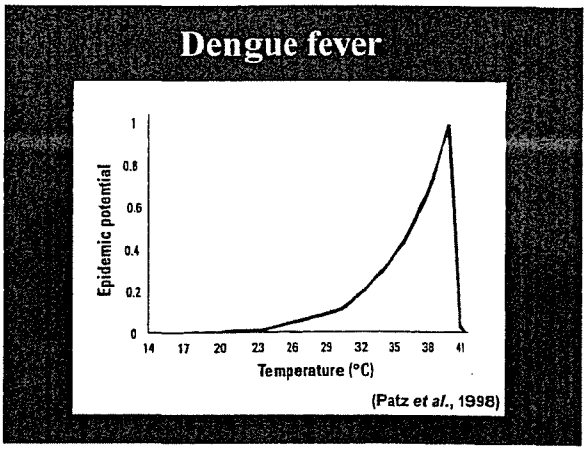
Dengue fever

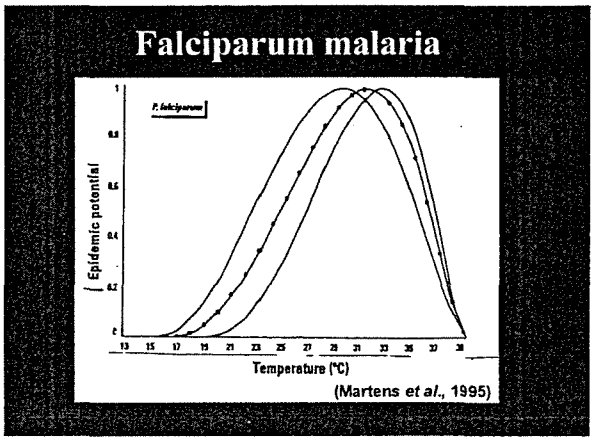
- **Dengue fever virus (Types 1, 2, 3 and 4)**
- **Mosquito vectors**
  Aedes Aegypti (container breeding)
  Aedes Albopictus (cold adapted)
- **Widely distributed in the Pacific**

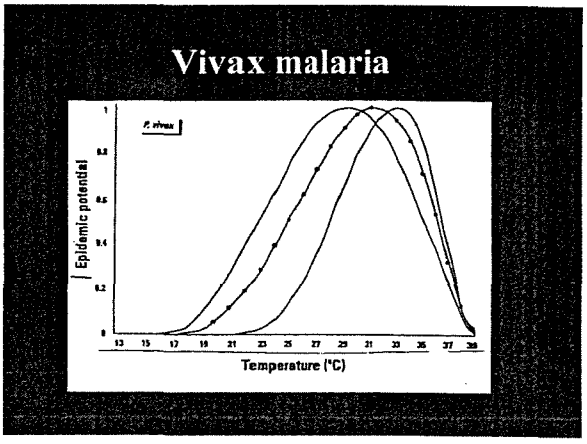
Mosquito-borne diseases

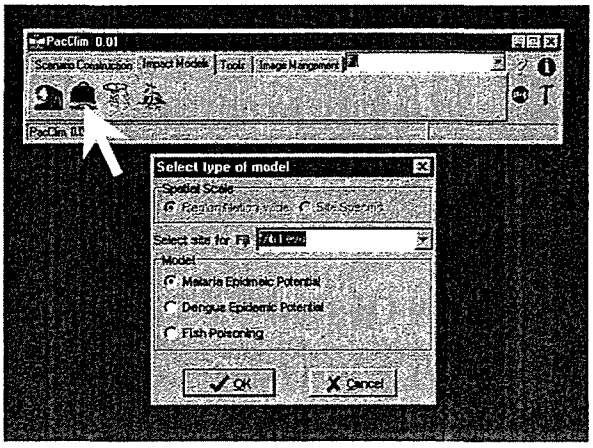
- **Spread of disease requires**
  - Human population
    Mosquito (vector) population
  - Dengue virus / Malarial parasite

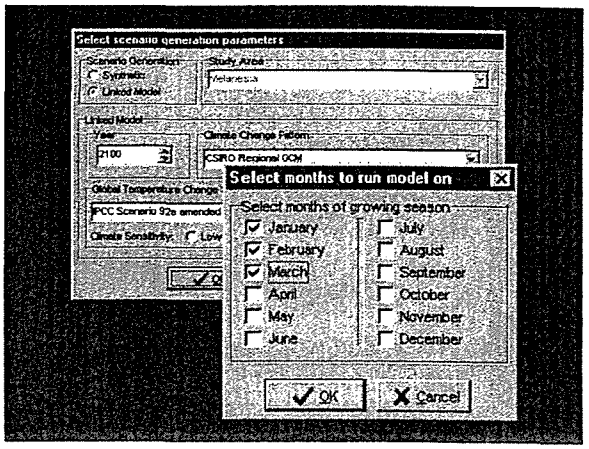

Human population
Immunity
Susceptibles
Infected
Mosquito biting rate
Mosquito biting rate
Rainfall
Mosquito population
Mosquito mortality rate
Viral multiplication rate
Infectious mosquitoes
Susceptible mosquitoes
(after Martens et al., 1995)

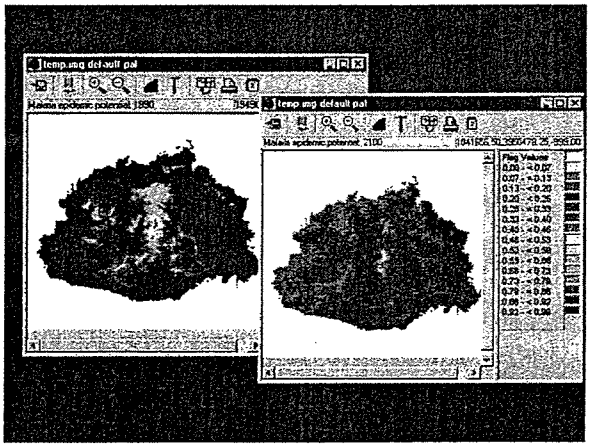

Dengue fever
Epidemic potential
Temperature (°C)
(Patz et al., 1998)

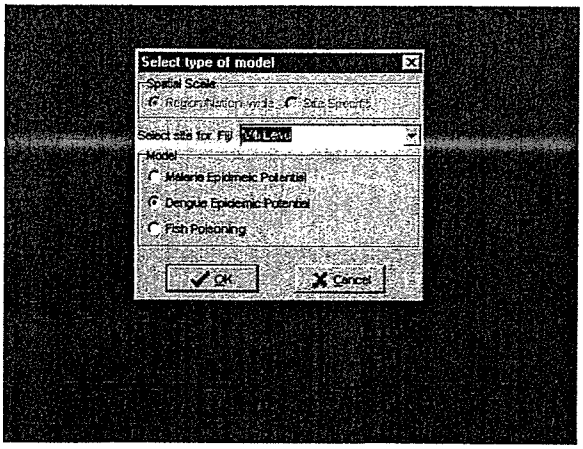

Falciparum malaria
Epidemic potential
Temperature (°C)
(Martens et al., 1995)

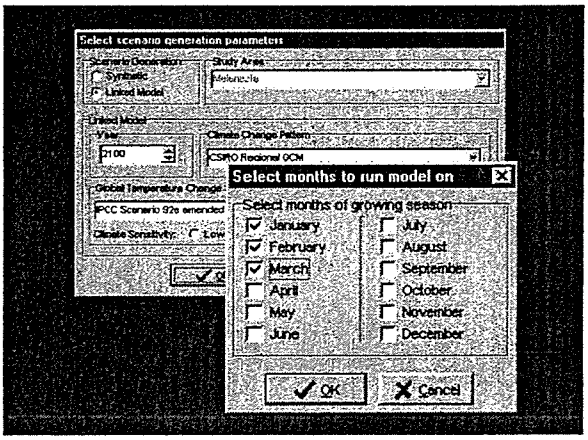

Vivax malaria
Epidemic potential
Temperature (°C)

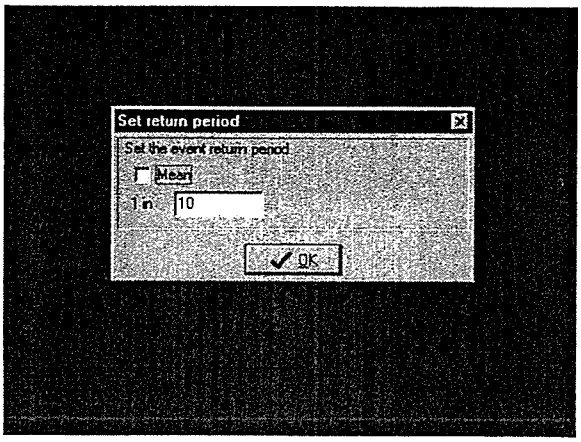

PacClim 0.01
Select type of model
Malaria Epidemic Potential
Dengue Epidemic Potential
Fish Poisoning
OK
Cancel

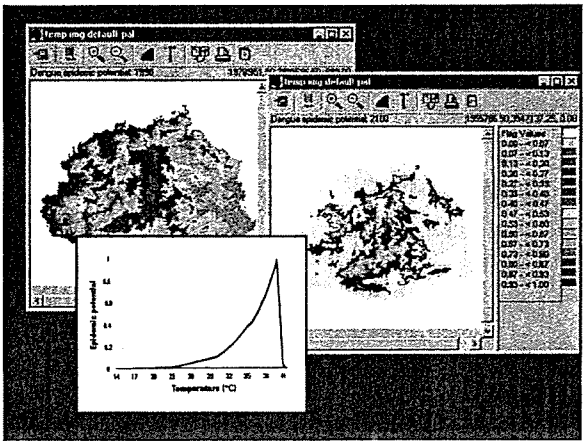

Select scenario generation parameters
Select months to run model on
Select months of growing season
January
February
March
April
May
June
July
August
September
October
November
December
OK
Cancel









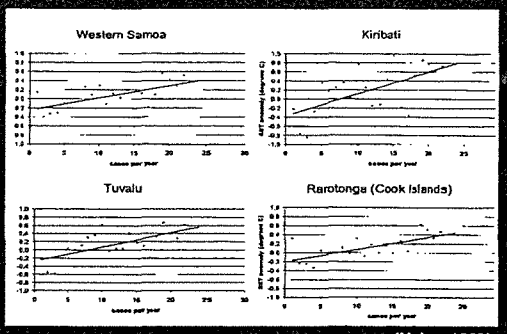


Mosquito population distribution model

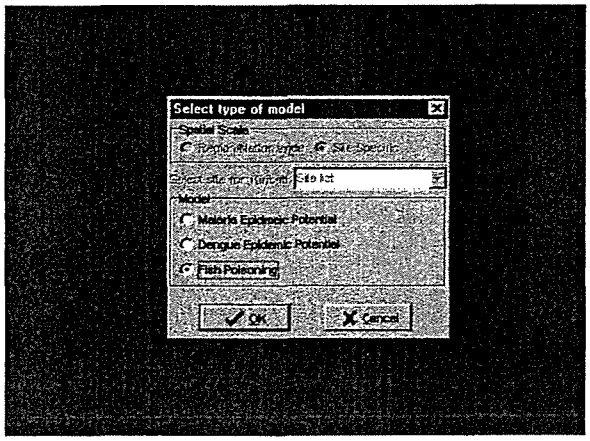
- **Based on PLANTGRO**
  - insect files
  - climate files
- **Map possible climate related changes in mosquito distribution**

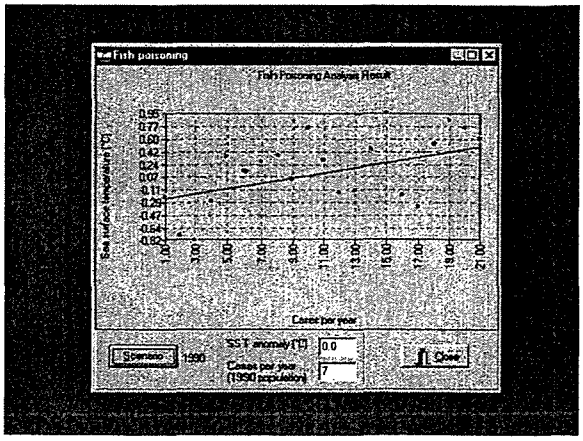
Ciguatera fish poisoning model

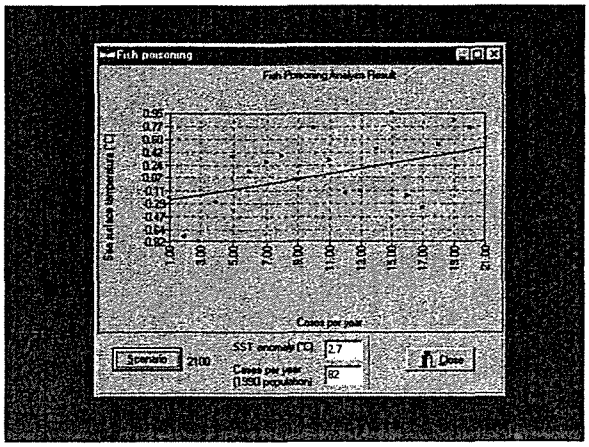
Sea Surface Temperature and Ciguatera



(Hales, 1999)







3G. Fisheries – Potential Inclusion in PACCLIM:

Paul Kench (IGCI)

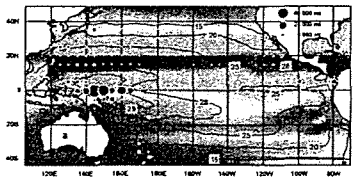
Secretariat of the Pacific Community

Oceanic Fisheries Programme

Patrick LEHODEY

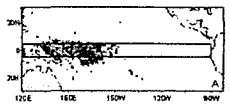
Noumea, New Caledonia

IMPACT OF ENSO ON TUNA HABITAT IN THE WESTERN AND CENTRAL EQUATORIAL PACIFIC



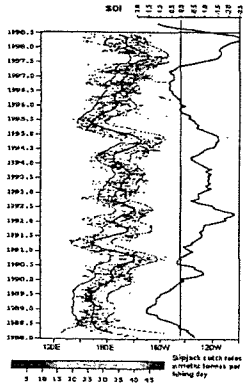
Distribution of skipjack tuna catch (tonnes) and mean sea surface temperature (SST, in °C) in the Pacific Ocean: a, in the first half of 1988 (La Niña period); b, in the first half of 1992 (El Niño period).

Aggregating data between latitudes 5N and 5S



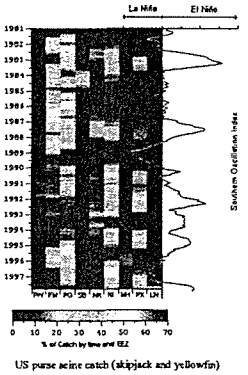
highlights the correlation between the oscillation of ENSO and the longitudinal location of high catch rates

An important result since statistical and coupled ocean-atmosphere models can predict ENSO events several months in advance



There is an obvious economic impact for the Pacific Island Nations through the level of catch in their Exclusive Economic Zones

PW - Palau
FM - FSM
PG - Papua New Guinea
SB - Solomon Islands
NR - Nauru
KI - Gilbert Islands (Kiribati)
MH - Marshall Islands
PX - Phoenix (Kiribati)
LN - Line Islands (Kiribati)



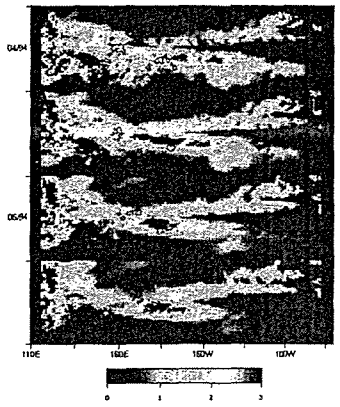
US purse seine catch (skipjack and yellowfin)

We are developing a model to simulate the distribution of tuna forage at a large horizontal scale

Inputs to the model are oceanic currents and primary production levels.

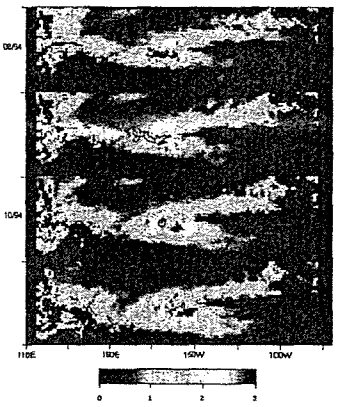
Habitat index and skipjack catch rates

In the mid-year of 1994, the El Niño reaches its maximum development. A very attractive area for surface tunas appears in the central Pacific, with effectively high catch rates (black contours) of the US purse seine fleet



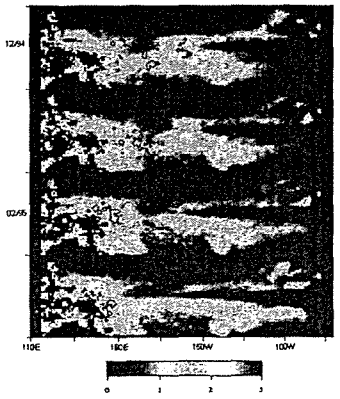
Habitat index and skipjack catch rates

As the oceanographic conditions return to a normal situation, the attractiveness decreases in the central Pacific and increases in the western Pacific



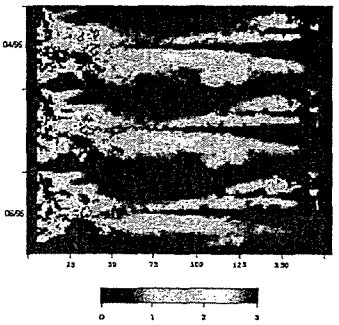
Habitat index and skipjack catch rates

In the beginning of 1995, normal conditions are prevailing. The US purse seine fleet has moved westward...



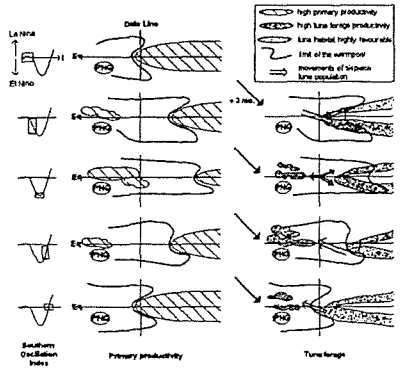
Habitat index and skipjack catch rates

... where the attractiveness is maximum



Conceptual model

Schematic diagram of the biological consequences of the development of an El Niño event in the pelagic ecosystem of the equatorial western and central Pacific ocean. The lag between each step is approximately three months.



Future Model Developments

- ENSO vs long-term change.
- What will be the impacts at the regional/national scale.

Future Model Developments

- Is fisheries a sector that end users would like to see built into PACCLIM?

Future Model Developments

- Scale of model (Regional, Country, Local)
- What will be the impacts at the regional/national scale.

Appendix 4: Training Exercises

PACCLIM APN Workshop

Modelling the effects of climate change and sea level rise in Pacific Island Countries

23rd – 25th August 1999

PACCLIM TRAINING EXERCISES

Prepared by the
International Global Change Institute
(IGCI)
University of Waikato
New Zealand

supported by
the Asia-Pacific Network
implemented by
the IGCI and SPREP
as part of the
PICCAP Programme

PACCLIM WORKSHOP

Training Session Schedule – Monday Afternoon

		Group 1	Group 2	Group 3	Group 4
13h45 – 14h15		Introduction and Organisation into groups			
	Exercise	Climate scenarios Part 1: Climate science (Exercise 1)			
	Facilitator	*Neil de Wet*	*Paul Kench*	*Gavin Kenny*	*Wei Ye*
14h15 – 14h45	**Exercise**	Climate scenarios Part 2: Constructing a scenario of climate change using PACCLIM (Exercise 2)			
	Facilitator	*Neil de Wet*	*Paul Kench*	*Gavin Kenny*	*Wei Ye*
14h45 – 15h15	**Sector**	**Health** (Exercise 6)	**Coast** (Exercise 3)	**Agriculture** (Exercise 5)	**Water** (Exercise 4)
	Facilitator	*Neil de Wet*	*Paul Kench*	*Gavin Kenny*	*Wei Ye*
15h15 – 15h30	**Tea Break**				
15h30 – 16h00	**Sector**	**Water** (Exercise 4)	**Health** (Exercise 6)	**Coast** (Exercise 3)	**Agriculture** (Exercise 5)
	Facilitator	*Wei Ye*	*Neil de Wet*	*Paul Kench*	*Gavin Kenny*
16h00 – 16h30	**Sector**	**Agriculture** (Exercise 5)	**Water** (Exercise 4)	**Health** (Exercise 6)	**Coast** (Exercise 3)
	Facilitator	*Gavin Kenny*	*Wei Ye*	*Neil de Wet*	*Paul Kench*
16h30 – 17h00	**Sector**	**Coast** (Exercise 3)	**Agriculture** (Exercise 5)	**Water** (Exercise 4)	**Health** (Exercise 6)
	Facilitator	*Paul Kench*	*Gavin Kenny*	*Wei Ye*	*Neil de Wet*
17h00 – 17h30	**Plenary**	Discussions , summary, conclusions Introduction to Tuesday morning's session			

Exercise 1: Examining uncertainties in global temperature and sea-level change using MAGICC

Introduction: When using the scenario generator in PACCLIM, it is important to have an appreciation for two of the key uncertainties in projecting temperature and sea-level changes, namely the value of the climate sensitivity and possible future greenhouse gas emissions. The scenario generator of PACCLIM makes use of library files of output from a global temperature and sea-level change model, called **MAGICC** (**M**odel for the **A**ssessment of **G**reenhouse-gas **I**nduced **C**limate **C**hange; Wigley, 1994) which allows the user to examine the effect of these uncertainties in analyses.

Objective of exercise: Use MAGICC to examine the effects on global temperature and sea level change of:

- the value of the climate sensitivity;
- future emissions of greenhouse gases.

A. Climate sensitivity

One of the key uncertainties in climate change science is the value of the "climate sensitivity" (ΔT_{2x}), the equilibrium global mean temperature change for an equivalent doubling of CO_2. The different values of ΔT_{2x} arise from differences in the ways in which General Circulation Models (GCMs) model such factors as changes in clouds, snow cover, sea ice, oceanic effects, etc. As "climate feedback effects", these factors tend to enhance or dampen the direct warming effect of greenhouse gases. It is currently thought that the value of ΔT_{2x} lies in the range of 1.5 to 4.5 degrees for a CO_2 doubling. By following the steps below, use MAGICC to examine the implications of this range of uncertainty in the climate sensitivity:

1. Open MAGICC.
2. On the main toolbar click on the Edit menu. Select 'Emission Profiles'. In the left hand column displayed select IS92c and click on the arrow in the Policy Scenario box. In the left hand column displayed select IS92a and click on the arrow in the Reference Scenario box. Press 'OK'.
3. On the main toolbar click on the Edit menu. Select 'Model parameters'. Set the climate sensitivity to 1.5^0C. Press 'OK'.
4. On the main toolbar click on the Run menu. Click on 'Run Model'.
5. On the main toolbar click on the View menu. Under 'Graphs' select 'Temperature and Sea-level'.
6. Select 'Temp' and 'Ref. user'. Note the projected change in global mean temperature for 2100. Compare this to the projection using the best guess climate sensitivity 'Ref.best'.
7. Select 'Sea-level' 'Ref. user'. Note the projected change in global mean sea level for 2100. Compare this to the projection using the best guess climate sensitivity 'Ref.best'.
8. Repeat Steps 3-7, but enter a value of 4.5^0C for climate sensitivity at Step 3.
9. Compare the two sets of projections for temperature and sea-level by clicking on 'Ref.range'.

B. Greenhouse gas emission uncertainties

There are considerable uncertainties regarding the future rates of emissions of greenhouse gases, even in the absence of explicit policies to reduce emissions. As a consequence, the IPCC devised a set of six emission scenarios – the IS92a-f scenarios – which reflect these uncertainties. The highest scenario, in terms of radiative forcing, is IS92e, the lowest is IS92c while IS92a is a mid-range estimate. Use MAGICC to examine the implications of this range of emission uncertainty:

1. Open MAGICC.
2. On the main toolbar click on the Edit menu. Select 'Emission Profiles'. In the left hand column displayed select IS92a and click on the arrow in the Policy Scenario box. In the left hand column displayed select IS92e and click on the arrow in the Reference Scenario box. Press 'OK'.
3. On the Edit menu under 'Model parameters' select the default settings by clicking the column of buttons on the right. Press OK.
4. Run the model.
5. On the view menu select temperature and sea-level.
6. Select 'Temp' and both 'Ref.best.' and 'Pol.best.' (Note the values projected for 2050 and 2100.) Now also select 'Ref.range.' and 'Pol.range.' to illustrate the additional range of uncertainty arising from uncertainty in climate sensitivity. To capture this image press CTRL/ALT/PRINT SCREEN. Open MS WORD and press CTRL/V to paste the image.
7. Select 'Sea-level' and both 'Ref. best.' and 'Pol.best.' (Note the values projected for 2050 and 2100.) Now also select 'Ref.range.' and 'Pol.range.' to illustrate the additional range of uncertainty arising from uncertainty in climate sensitivity. Capture this image and paste to the same Word document.
8. Compare the projections.

What is the difference between the mid-range estimates using IS92a and IS92e?

What is the range of uncertainty of the climate sensitivity at 2050 and by 2100?

What difference do the emission uncertainties make during the next several decades (say, until the year 2050)? Why? And by 2100?

Exercise 2: Examining baseline climate and constructing climate change scenarios using the PACCLIM Scenario Generator

Introduction: The PACCLIM scenario generator allows the user to generate two types of climate change scenario: **synthetic** and **model-based**.

The synthetic scenario generator enables users to make incremental adjustments to temperature and rainfall. These adjustments are applied uniformly to the baseline climate data.

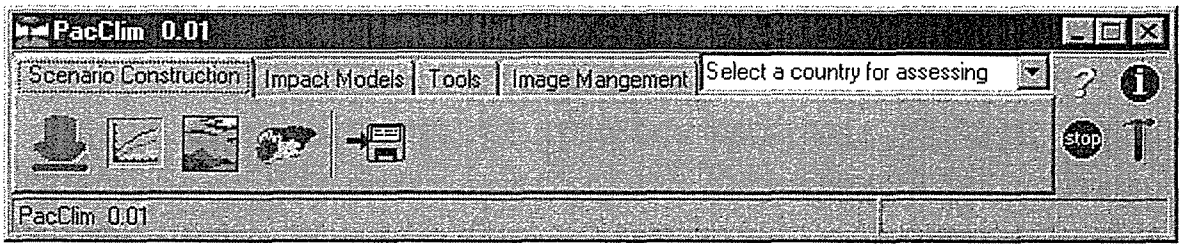
The model-based generator involves the **linked-model** approach. There are two components to this approach. Library files of output from MAGICC describing global temperature and sea-level changes are used as input to the scenario generator. The global temperature changes are used to ***scale*** temperature and rainfall changes for Viti Levu and Kiribati, which have been extracted from the patterns of change for the Pacific region as projected by complex global climate models (GCMs). These changes are applied to the present climate (1990 baseline) to create climate scenarios for the year of interest (e.g. 2100).

Objective of exercise: Use PACCLIM to examine present climate and construct two possible scenarios of climate change for Viti Levu using the linked-model approach.

A. The baseline climate and future climate scenarios

Follow the steps described below to produce a baseline climatology (1990 baseline climate) for Viti Levu:

1. Open PACCLIM. The main menu is displayed.



2. Select Fiji from the country list.
3. On the scenario construction toolbar click on the icon which is labelled "Generate a scenario".
4. Select mean temperature as the climate variable of interest and click on OK.
5. On the scenario construction window which is displayed select the linked model approach (default setting) and set the year to 1990 (the baseline climate). Click OK.
6. On the month selector window select all the months of the year. Click OK.
7. Leave the resultant image on the screen.
8. Repeat steps 3 – 6 but in step 5 select the following to create a future climate scenario:

- 2100 time horizon
- IPCC Scenario 92a amended for IPCC 1995, and SO2 regionalised (IS92a)
- CSIRO Regional GCM
- Best Guess climate sensitivity.

9. Click OK. To make the legends of the two images the same click on the Link Images tool on one image and then click on the other image. Leave the images on the screen.
10. Construct another climate scenario based on the following:
    - 2100 time horizon
    - IPCC Scenario 92e amended for IPCC 1995, and SO2 regionalised (IS92e)
    - CSIRO Regional GCM
    - High climate sensitivity.

11. Click OK. Link the images.
12. Examine the three images and note your observations in the box below and on the next page.
13. Close these images.
14. Repeat the whole exercise but in step 4 select **precipitation** as the climate variable of interest instead of mean temperature. Compare the 1990 precipitation patterns of Viti Levu with the two scenarios of change for 2100 and note your results in the box below and on the next page.

Briefly describe the 1990 baseline climate for Viti Levu.

Mean temperature:

Mean rainfall:

Based on the projections, how may climate change in the future?

Mean temperature:

Mean rainfall:

B. If you have time, repeat the exercise using one of the other GCM patterns and focus on rainfall as the climate variable of interest.

Comment on your results.

Exercise 3: The sectoral impact models – Coast

Introduction: The prototype PACCLIM model contains two coastal impact models. These models can evaluate changes in shoreline position (shoreline change model) and island inundation (inundation model) in response to climate and sea level change. These are simple models that can be used to examine a range of climate change scenarios and subsequent impacts on Pacific Coasts.

Objectives: Participants will explore the potential of the existing models for application to Pacific Island coastlines. The specific aims are:

- To examine changes in shoreline position using different sea level rise scenarios.
- To explore how changes in storminess can impact on shoreline position.
- To understand the importance of recent (past 100 year) sea level history and its implications for future response to accelerated sea level rise.
- To gain practical experience in use of the PACCLIM inundation model.

A. Examining the effects of different sea level rise scenarios on shoreline response

1. Open PACCLIM.
2. Click on the **'Impact Models'** toolbar.
3. Select **Fiji** from the country list.
4. Click on the **wave icon** (left icon) in the Impact Models toolbar to start the coastal models.
5. Select **'Shoreline Change (sand)'** and press **O.K.**
6. In the site sub-menu select **'Site 3 Sigatoka Beach'** in the first open window.
7. Using information provided in Table 1 for Sigatoka Beach insert the parameter values for (□, l, h, d and residual) in the site sub-menu.
8. Select the **'SLR Scenario'** sub-menu.
9. In the top window select the **'IPCC 1992a'** emissions scenario.
10. Select the **'Best Guess'** climate sensitivity.
11. Select the **'Storm Parameters'** sub-menu.
12. Insert values for **'Storm cut mean'** and **'Standard deviation'** using the Information provided in Table 1 for the Sigatoka Site.
13. Click on **'Run Simulation'.**

A small spreadsheet is displayed under the 'Results' sub-menu.

14. To plot results – move the cursor to the centre of the spreadsheet and **click the left-hand mouse button**. A small window appears named 'Select Items'.
15. Using the mouse click on **'Equilibrium Shoreline (m)'**, then move the cursor to the line stating 'Current Shoreline (m)' hold down the Control key and click on **'Current Shoreline (m)'**. Both the 'Equilibrium Shoreline (m)' and 'Current Shoreline (m)' lines should be highlighted. Click O.K. A line graph is displayed that shows the

projected displacement of the equilibrium and actual shoreline using the scenario chosen.

16. By visually reading the graph **record** the amount of retreat (in metres) of the equilibrium shoreline to the year 2100 in the **Results Table** below. Also identify and record the maximum Actual shoreline change in the assessment period.

Repeat the exercise (steps 2-16) for Sigatoka Beach. However, in this simulation use the **'IPCC 1992e'** emissions scenario and select the **'High Estimate'** climate sensitivity.

Once you have run the simulation and plotted the results, record the amount of shoreline displacement to the year 2100 and maximum actual shoreline retreat in the results table below.

B. Examining the effect of changes in storm magnitude and frequency on shoreline change

Examine how changes in storm frequency and magnitude affect projections of shoreline change at Sigatoka Beach. Repeat steps 2-16 but at steps 11 and 12 use the **'Increased Storminess'** scenario storm parameters for Sigatoka Beach provided in Table 1.

*Remember to record the results for the total change in equilibrium shoreline and maximum change in actual shoreline position in the table below.

C. Explore the differences that might be expected in shoreline response if sea level has been changing over the past 100 years

Repeat steps 2-16 for Sigatoka Beach, Fiji.

Run the simulation 3 times, each time changing the **Residual Sea Level Rise** information in the SLR Scenario sub-menu. The Residual sea level rise values you should use for the simulations are:

0.0 m
+0.2 m
- 0.2 m

After each simulation plot the equilibrium shoreline graph and record the amount of shoreline displacement in the Results Table.

D. Inundation

Use the follow steps to estimate possible future inundation.

1) In the PACCLIM menu panel click on the **'Impact Models'** icon.
2) Select **'Fiji'** from the country list.
3) Click on the **wave icon** (left icon) in the Impact Models menu to start the coastal model.

4) Select **'Viti Levu'** from the '**Select Site for Fiji'** panel.
5) Select **'Coastal Inundation'** from the model options menu and click O.K. [the 'Select sea level rise scenario window will appear].
6) Change the year in the **'Year'** panel to 2100.
7) Select the '**IPCC 1992a'** emissions scenario and choose the **'Best Guess'** option.
8) Click on the sliding bar at the bottom of the Storm Surge box (below the graph on the bottom left of the window) slide the bar along until the value reads **r = 1 in 50**.
9) Alter the curve shape by setting the 1 in 100 year event to **1 in 50**. By doing this you are effectively increasing the frequency of storms.
10) Click on **O.K.** at the bottom of the window. An image of Viti Levu will appear.
11) In the top bar an inundation area is provided for the particular scenario used.
12) Record this value on your exercise sheet.

Table 1: Coastal environmental parameter data required for the PACCLIM model.

Parameter	**Sigatoka**	**Increase in Storms**
Parameters for 'Site' Window		
τ – shoreline response time (yrs) for beach recovery.	5.0	
l – closure distance (m):distance from shoreline to base of shore profile.	120.0	
h – depth of material exchange (m):	7.0	
d – dune height: height of coastal margin (m) above maximum storm water level.	15.0	
R – residual shoreline movement (m) (i.e. has shoreline been eroding or accreting?).	0.0	
Parameters for 'Site' Window		
μ – mean storm cut (m): mean shoreline erosion in a storm event.	2.0	6.0
s – standard deviation of storminess: controls the occurrence of storms in the model 0 = non stormy.	5.0	15.0

Table 2: RESULTS: Insert results in the available boxes.

	Sigatoka Equilibrium Shoreline Change (m), 2100	**Sigatoka: Max. Actual Shoreline Change (m)**
Shoreline change using – IPCC 1992a Best Guess		
Shoreline change using – IPCC 1992e High Estimate		
Shoreline change – with altered storm conditions		
Shoreline change in 2100 using 0.0m historical SLR		
Shoreline change in 2100 using +0.2m historical SLR		
Shoreline change in 2100 using –0.2m historical SLR		

Area of Viti Levu inundated (Km^2)	Km^2

1) What do results from part A of the exercise show about the sensitivity of the shoreline change model?

2) Compare results of parts A and B of the exercise.
   a. What do results say about increased magnitude and frequency of storms on possible shoreline response?

   b. What are the management implications for Pacific Island countries?

3) What do results of task C reveal about future shoreline change with accelerated sea level rise?

4) What do the results of tasks A, B and C mean for the future application of PACCLIM for Pacific coastal environments?

Exercise 4: The sectoral impact models – Water Resources

Introduction: PACCLIM contains two hydrological models which can be used to assess the possible effects of climate change on water resources. The **flow analysis/flooding model** is used to assess the climate change impact on surface water in high islands with river catchments. A freshwater lens model is used to assess the possible effects of climate change on the groundwater of an atoll island.

Objectives: Use PACCLIM to analyse the possible effects of climate change on river discharge of the Teidamu river in Viti Levu and possible changes in the freshwater lens in Bonriki in Kiribati.

A. Analyse the possible effects of climate change on the river flow of the Teidamu river in Viti Levu

1. Open PACCLIM.
2. Select Fiji from the country list.
3. Select the Hydrology (cloud) icon from the Impact Models toolbar.
4. Select Viti Levu from the site list and select the flow analysis / flooding model. Click OK.
5. Select the Teidamu river and check that the scenario is set for 1990.
6. Select the Low Flow analysis. Note river flow in a 1 in 10 year low flow event. Change the return period to 50. Note river flow in a 1 in 50 low flow event.
7. Select the High Flow analysis. Note river flow in a 1 in 10 year flood event. Change the return period to 50. Note river flow in a 1 in 50 flood event.
8. Click on Scenario. Select the year 2100. Select the IS92a emissions scenario. Select the CSIRO GCM. Select the Best Guess estimate climate sensitivity. Click OK.
9. Note the magnitude of the 1 in 10 low flow event and 1in 10 flood event.
10. Click on Scenario. Select the year 2100. Select the IS92e emissions scenario. Select the CSIRO GCM. Select the High estimate climate sensitivity. Click OK.
11. Note the magnitude of the 1 in 10 low flow event and 1in 10 flood event.

Consider both scenarios and comment on how climate change may affect river flow for the Teidamu river.

B. Analyse the possible effects of climate change on the freshwater lens at Bonriki in Kiribati.

1. Go to the main menu.
2. Select Kiribati from the country list.
3. Select the Hydrology (cloud) icon from the Impact Models toolbar.
4. Select Bonriki Island from the site list and select the freshwater lens model. Click OK.
5. Select Bonriki again on this window. On the Parameters menu ensure the abstraction rate is set to 750 cubes per day.
6. Click scenario. Set the year to 1990. Click OK.
7. On the water balance model leave the default settings unaltered and click Run. Close.
8. Also click Run on the parameters window.
9. When the model has finished running, click on the middle of the generated image and record what the depth of the lens is likely to be under 1990 climate conditions and with this abstraction rate.
10. Run the model again for 1990 but enter an abstraction rate of 2000 cubes per day.
11. Record the depth of the lens.
12. Repeat the exercise with the 750 cube per day abstraction rate but at step 6 set the year to 2100 and select the IS92e emissions scenario, High climate sensitivity, and Hadley centre GCM. Note results.
13. Repeat but use the CSIRO GCM. Note results.

Assume that water quality decreases to unacceptable levels when the lens depth falls below 20m.

- **Is the present day abstraction rate of 750m^3/day sustainable under 1990 climate conditions? Comment.**

- **Is the abstraction rate of 2000m^3/day sustainable under 1990 climate conditions? Comment.**

- **Is the present day rate of 750m^3/day sustainable under conditions of the two climate scenarios? Comment.**

Exercise 5: The sectoral impact models - Agriculture

Introduction: The PLANTGRO model in PACCLIM was developed for application in a Pacific Island context as a means of capturing and expressing local knowledge about plants and how they perform in different environments. There are three important components to PLANTGRO: climate files, soil files and plant files. The climate and soil files provide the basis for examining suitability of specified crops at either specific sites, or over areas. A total of 23 climate and soil factors are considered. There are two key elements to output from PLANTGRO: suitability, which reflects how people perceive plants are suited to their environment; and limitation, which is how plants respond to their environment.

Objective of exercise: Use PACCLIM to examine the possible effects of climate change on agriculture in Viti Levu.

A. Baseline conditions
Follow the steps below to generate baseline conditions for Taro cultivation in Viti Levu:

1. Select Fiji on the main PACCLIM menu.
2. Select the Plantgro icon on the Impacts menu.
3. Select Viti Levu as the study site.
4. Check scenario option is 1990 (the default Scenario option).
5. From the Plant File menu, select Taro.
6. From the Sowing Month menu, select September.
7. Of the four possible Output Images, leave only the Overall Limitation Rating checked.
8. Run the Model. (This simulation will take a couple of minutes.)
9. Leave the resultant image on the screen.

B. Analysing the effects of climate change
Follow the steps below to analyse impacts on taro using one synthetic scenario of climate change and two scenarios produced by the linked-model approach:

1. Activate the Plantgro menu again.
2. Select the Scenario option and then select Synthetic. Enter 2 in the temperature box (for an increase in average temperature of 2°C) and enter –50 in the rainfall box (for a decrease in rainfall of 50%). This "synthetic" scenario is comparable to conditions during the 1998 El Nino drought.
3. Select Taro and September.
4. Check only the Overall Limitation Rating.
5. Run the Model and leave the resultant image on the screen.
6. Re-run the above for the IS92a, best guess, CSIRO GCM pattern scenario for 2100.
7. And again for the IS92e, high, CSIRO GCM pattern scenario for 2100.
8. Leave these images on the screen.

Arrange the four images so that you can view them all.

How does the drought "anomaly" compare to the 1990 result?

What are the relative effects of the two scenarios?

If the two scenarios reflect future "average" conditions, what would one expect to see in drought years?

Exercise 6: The sectoral impact models – Human Health

Introduction: The vector-borne disease models relate temperature to epidemic potential. Epidemic potential is an indicator of how easily an epidemic will be triggered and escalate if the disease along with the disease vector were introduced to a susceptible population. Where epidemic potential is high epidemics will occur more easily, grow faster and smaller vector (mosquito) numbers would be required to sustain the epidemic. Conversely, where epidemic potential is low, epidemics will be less likely to occur, increase more slowly and require a larger vector population to be sustained. The ciguatera model describes how climate change may affect the incidence of ciguatera fish poisoning.

Objective: Use PACCLIM to examine the possible effects of climate change on the epidemic potential of malaria and dengue fever in Viti Levu and how the incidence of ciguatera fish poisoning may change in Kiribati.

A. Examining changes in epidemic potential of malaria in Viti Levu

Malaria does not presently occur in Fiji however climate conditions are suitable for malaria. It is possible that malaria could become a public health problem in Fiji if it were introduced. Assess the possible changes in malaria epidemic potential in Viti Levu by following the steps below:

1. On the main PACCLIM menu select Fiji from the country list.
2. Click the Health models icon on the Impacts menu.
3. Select the malaria epidemic potential model and Viti Levu from the site list and click OK.
4. In the scenario generator window set the year to 1990 and click OK.
5. Check on January, February and March – Fiji's wet season. Click OK. Leave the image on the screen.
6. Repeat steps 2-5 but in step 4 set the year to 2100 and select the IS92a emissions scenario, CSIRO GCM pattern and Best Guess climate sensitivity. Leave the image on the screen.
7. Repeat steps 2-5 but in step 4 set the year to 2100 and select the IS92e emissions scenario, CSIRO GCM pattern and High climate sensitivity. Leave the image on the screen.
8. Link the images.

Describe the changes in epidemic potential of malaria in Viti Levu for the two scenarios compared to the baseline.

B. Examining changes in epidemic potential of dengue fever in Viti Levu

Fiji has experienced several outbreaks of dengue fever in the past, the most recent being in 1998. Dengue fever outbreaks in Fiji often appear to be followed by outbreaks in other PICs. Assess possible changes in epidemic potential in Viti Levu by following the steps below:

1. On the main PACCLIM menu select Fiji from the country list.
2. Click the Health models icon on the Impacts menu.
3. Select the dengue epidemic potential model and Viti Levu from the site list and click OK.
4. In the scenario generator window set the year to 1990 and click OK.
5. Check on January, February and March – Fiji's wet season. Click OK.
6. De-select the box for mean temperature and set the return period to 1 in 10 (a warm season with a return period of 1 in 10). Click OK. Leave the image on the screen.
7. Repeat steps 2-6 but in step 4 set the year to 2100 and select the IS92a emissions scenario, CSIRO GCM pattern and Best Guess climate sensitivity. Leave the image on the screen.
8. Repeat steps 2-6 using but in step 4 set the year to 2100 and select the IS92e emissions scenario, CSIRO GCM pattern and High climate sensitivity. Leave the image on the screen.
9. Link the images.

Describe the changes in epidemic potential of dengue in Viti Levu for the two scenarios compared to the baseline.

What is the epidemic potential in Suva for the 1990 baseline, the first scenario and for the second scenario? (Click on the map.)

C. Climate change and the incidence of ciguatera fish poisoning in Kiribati.

Follow the steps below to analyse the possible effect of climate change on the incidence of ciguatera fish poisoning in Kiribati.

1. Open PACCLIM
2. Select Kiribati from the country list
3. Select the health icon
4. Select the fish poisoning model. Click OK.
5. Note how many **reported** cases of ciguatera fish poisoning would be expected under present (1990 baseline) average conditions. (It is estimated that only about 10% of cases are reported.)
6. Using the scenario button examine how this rate may change in the year 2100 using the following scenario parameters:
    - IS92a, Best Guess, CSIRO GCM
    - IS92e, High, CSIRO GCM.

Note and comment on your results.

Appendix 5: PACCLIM Feedback

Presentations Providing Critical Feedback on PACCLIM and Needs and Priorities of Pacific Island Countries.

GROUP 1

Summary of Discussions

Commonalities

- Sea-level Rise/Change
  - Inundation - PACCLIM could be helpful in relocation of settlements
  - Land mass area decrease
- Coral reefs
  - Pollution or sea-level rise
- Agriculture & Health
  - Pests and new diseases
  - Research for control measures
- Water Resources

New Issues for PACCLIM

- Land degradation
- Effects of CC on biodiversity
  - plants & animals
  - CC effect on lifecycle
  - effect on reef animals
- Agricultural Sector
  - interaction with water resources and saltwater intrusion, (water quality)
- Data Accessibility
  - e.g. Fiji - existing protocol on use of data
  - Need for Forum directive

New Issues for PACCLIM (contd)

- Country Data
  - need our own data in the program
  - constraint issues relating to access to data
  - lack of data

Issues for Application of PACCLIM

- Trial Run
  - Prototype for each country to be developed through PICCAP
- Requirements
  - make available to departments
  - training within each country
  - integrated into job description - human resource constraints and work priorities
- Needs to be more user-friendly
- Needs to be integrated to other sectors - easier to get acceptance by country policy-makers

Technical Assistance

- IGCI - to provide technical in-country training
  - workshop
  - provide training for 1 expert
- SPREP/PICCAP
  - Facilitate training programmes

In-country Consultations

- Government departments
- Private sector
  - tourism organisations
  - farming associations
  - traditional groups
- What role does the private sector play?
  - Financial
  - Technical - data

THE END

GROUP 1

- Key Issues of Concern
  - Survival
  - Safety
  - Health
  - Food and Security
  - Inundation and Erosion
  - Socio Economic Factors

- Gaps in Pacclim Prototype
  - Presently more gaps than model
  - Tourism sector
  - Different sectoral priorities for each country
  - Model should be more country specific
  - Information of how Pacclim works
  - What information is required now to generate country specific modelling

- Climate features to be included
  - ~~El Nino and~~ La Nina
  - Tropical Cyclones
  - Droughts and Flooding
  - Specific Data requirements (wind speed and cloud cover or solar radiation)
  - Data sets as long as possible e.g. 20 - 30 years or more

- Additional Sectors to be modelled
  - ~~Fisheries~~
  - Tourism
  - Biodiversity

- Priorities for Pacclim Development
  - Data needs and time lines required urgently
  - Understanding type of data required
  - Understanding data collection and training if necessary
  - Development priority depends on individual country needs
  - Pacclim must be user friendly and well documented - this should address a development process of simple to more complex models with clearly defined objectives being achieved at each level
  - Limitations of the model to be specified

- General Data Needs
  - ~~List of data~~ requirements for each model in each sector
  - Assistance with collating of data and the agencies that would support data collection
  - Support and encouragement to Governments for ongoing data collection programmes in identified priority areas

- Training Requirements and Collaboration
  - Training at various development stages of Pacclim
  - Sector specific training
  - Incountry Training
  - Regional Training
  - Extension of Training Institutions as required
  - Train the trainer programmes
  - Secondment of PIC personnel to assist in development of Pacclim
  - Encouragement of incountry support for Pacclim through mainstreaming of model in ministries

SelukaTeam

- **Key Issues**
- socio-economic
- marine resources

•**Gaps**

•data type and quality

•database underlying

•compatibility of PACCLIM

•shorter time frame

•training at national level

• **climate features**

•frequency and severity of cyclones

•elevation

- Clear differentiation eg ENSO and integration
- **Coastal**
- include fisheries and coral reefs
- **Socio-economic (SE)**
- PACCLIM results into SE database
- cultural, landuse & village info.

•**Priority**

•compartible with MAPINFO, IDRISI etc

•**General Data Needs**

•baseline enviro.data (to collect, collate)

•Key Constraints eg trained personnel & funding

•**Main limitations** (as above)

•**User Training**

•define users eg modeller, data technicians & operators

•suitable format

•Manual (software & operational)

•training to be phased in thru'whole process

•**PIC**

•active users & refinement to national scale

•**Support**

•identify people (operators) in institutions

•wider acceptance (awareness & demo.) of the use of PACCLIM

• hotline

•hardware & software

Appendix 6: Synthesis of PACCLIM Feedback Provided by PIC Delegates

Neil de Wet (IGCI)

Pacific Island Country Needs Assessment for Future PACCLIM Model Development

PACCLIM Workshop

23 – 27 August 1999

1 Evolution of PACCLIM

PACCLIM is the acronym for Pacific Island Climate Change Integrated Model. PACCLIM is based on a model called CLIMPACTS that has, since 1993, been developed by the International Global Change Institute (IGCI) at the University of Waikato for the New Zealand government in collaboration with five Crown research Institutes and one other university. CLIMPACTS has also been adapted by IGCI for use in Bangladesh (BDCLIM) and Australia (OZCLIM) by the CSIRO, and was the basis of VANDACLIM, a mythical land that provided simulation exercises in a 2 week professional training course developed by IGCI for the UNITAR project CC:TRAIN. BDCLIM and VANDACLIM were in turn adapted by IGCI for PICCAP (jointly implemented by SPREP and UNITAR) into a simulation tool that illustrates climate change impacts on the water, coastal, agricultural, and health sectors of a high and low island. This simulation tool (VANDACLIM- the island version) was central to a 6 month training course on *Assessing Vulnerability and Adaptation (V&A) to Climate Change in Pacific Island Countries.* The course was developed by IGCI and offered to 20 trainees from 10 Pacific Island countries (PICs) at the University of Waikato in the second half of 1998. At the same time, PICCAP provided funds through UNDP-GEF to start developing a real world model for Pacific Island countries called PACCLIM. In other words, PICCAP was keen to see the simulation model extended from one that was for education and training, to one that could be used for technical analyses, policy development, and decision making in real world settings.

The PACCLIM prototype model that was demonstrated at the PACCLIM Workshop in Auckland (23-27 August 1999) addresses many issues of concern in Pacific Island Countries (PICs) in terms of their vulnerability to climate change. PACCLIM aims to facilitate analysis and provide policy support information for the following Vulnerability and Adaptation (V&A) issues:

- The probability of survival (continued existence) of some of the most vulnerable islands and low-lying areas;
- The safety of island communities;
- Inundation and erosion;
- Loss of land area;
- Loss of marine resources and effects on coastal ecosystems;
- Agricultural productivity;
- Land degradation;
- Food security;
- Public health and well-being.

In addition, PACCLIM provides a tool for the spatial analysis and mapping of areas of vulnerability, and, through its scenario generator, enables various policy options to be quickly interrogated as to their sensitivity and utility in adapting to adverse changes. PACCLIM can, therefore, be used as a policy development and decision making tool.

2 PACCLIM Workshop

The PACCLIM Workshop had two related aims: the first was to provide a forum and process for consultation with potential PACCLIM model end-users in Pacific island Countries (PICs), in order to identify relevant needs and in so doing guide the next stages of development of PACCLIM. This first section of the Workshop occupied days 1-3 and was supported by the Asia Pacific Network for Global Change Research (APN). The second section of the Workshop was to provide a forum and process for modelers, scientists, and others to review, refine, and extend components of the PACCLIM prototype model, including the scenario generator and impact sectors. This second section of the Workshop occupied days 4 and 5 and was supported by the World Bank. PIC representatives were also invited to attend this part of the Workshop. Some wished to do so but were unable due to lack of funds.

The PACCLIM Workshop was jointly organised and run by IGCI and SPREP with the former taking the lead role. As developers of the PACCLIM prototype model, it was the role of IGCI staff and associated modelers to make presentations and run training sessions, while the role of SPREP/PICCAP was to facilitate sessions where PICs provided feedback on the use and application of the model.

Present at the first section of the Workshop (days 1-3) were two delegates from each of the 13 PICs. This included the 10 original country members of PICCAP, plus three new entrants (see Annex 1). The country co-ordinators of the 10 PICCAP countries were present and accompanied by a member of the country team. The three new entrant countries each had two delegates present. Of the 26 PIC delegates, eight had previous experience with VANDACLIM through participation in the V&A training course held at IGCI in 1998. Some other were well versed in the model as a consequence of feedback from the V&A trainees and through country visits by IGCI staff when providing technical assistance in developing V& A reports and statements. While it is recognised that there were time constraints on consultation during the workshop, it has provided valuable information which will be used to guide the PACCLIM development process.

This document outlines: the consultation process (section 3); the issues and needs identified by the PIC delegates in the first half of the Workshop (section 4); and additional feedback from the second half of the Workshop (section 5). Conclusions and recommendations are given in section 6.

3 Consultation process and objectives

The first two and half days of the workshop were funded by the Asia Pacific Network for Global Change Research (APN). They were specifically dedicated to consultation with individual from the 13 PICs. On the morning of the first day IGCI staff presented an ***overview*** of the PACCLIM prototype model focussing on the capabilities of the PACCLIM scenario generator, each of the sectoral models available for demonstration in the PACCLIM prototype (water, coast, agriculture, and health). Preliminary modeling work undertaken at South Pacific Commission (SPC) for Tuna fisheries in the region, but not included in the PACCLIM prototype was also presented, to illustrate the flexibility of PACCLIM and how new components can be readily added. This was followed by an ***intensive training session*** in the afternoon in which the PIC delegates, working in four groups, facilitated by IGCI staff, gained hands-on experience with PACCLIM. Each group worked through six training exercises which had been prepared for the workshop. The first two exercises focussed on climate change science and climate scenario generation while the remaining four exercises provided delegates with first hand experience with the models in each of the four impact sectors – coastal zone, water resources, agriculture and human health.

On the second morning, PIC delegates worked in four groups to consider ***key issues and country needs*** for possible future PACCLIM development. The four groups were chaired by:

- Mike Ariki (Solomon Islands PICCAP co-ordinator);
- Joseph Cain (Nauru PICCAP co-ordinator);
- Nelson Rarua (Vanuatu PICCAP co-ordinator); and,
- Seluka Seluka (Tuvalu PICCAP co-ordinator).

In order to guide discussion, the groups were asked to focus on, but not be limited by, the following questions:

- What are the key climate change issues of concern in Pacific Island countries?
- What gaps exist in the PACCLIM prototype in relation to these key issues of concern?
- What climate features should be included in PACCLIM? Are these features currently incorporated into the prototype and how can different aspects be included?
- Are the sectors presently modelled within PACCLIM the most appropriate (taking account of the diversity of island types in the region)? What others could be included? Are there issues of regional concern that should be included and/or better modelled? What methodologies could be employed?
- Should broader socio-economic effects be considered in PACCLIM?
- What are the priorities for future PACCLIM development in terms of geographic coverage (regionally and in-country), scenario development, sectoral development? How should such developments proceed?
- What are the general data needs for these future developments and what are some of the key constraints?

- What are the main limitations to PACCLIM and to what degree, and in what manner, should future development of PACCLIM be accompanied by other capacity building activities?

Each of the four groups prepared a presentation to provide formal feedback to the workshop plenary in the afternoon (see **Annex 2**). The key issues which were raised in this forum and subsequent discussion on the third day are summarised in section 3 below.

Apart from this formal consultation process, valuable information and feedback was also gained through informal discussion with PIC delegates during the course of the Workshop. Important feedback was also gained from a complementary discussion session on the afternoon of the last day (day 5) of the Workshop where key issues raised in the course of the week were reflected upon. This discussion group comprised a selection modelers and other scientists (including IGCI staff) who had contributed to development of the PACCLIM prototype model, and some PIC delegates. Key points raised in this session are documented in section 5 below.

4 Summary of main issues raised by PIC delegates

Having gained some experience with the PACCLIM prototype and an understanding of the capabilities of the demonstration model, country representatives were unreservedly enthusiastic in their support for further development of PACCLIM at the country scale for each of the countries represented. Country representatives highlighted the need for a modeling tool to assist with V&A analysis and policy development, and noted the benefits of using PACCLIM to address such needs at the country level. It was indicated that realising the potential of PACCLIM would require a process which includes, *inter alia*, customisation of the model for the country level, customising the existing sectoral impact models, developing new models for existing sectors and additional important sectors not present in the PACCLIM prototype, and ongoing technical and professional training and support. Details of needs and issues raised by PIC representatives are documented below.

4.1 Overall approach to future PACCLIM development

While the workshop did not propose or discuss in detail an overall strategy for PACCLIM, the following points were highlighted in this regard:

- The PACCLIM model should be country specific;
- A prototype PACCLIM model should be developed for each PIC through the PICCAP mechanisms and channels;
- Each country has different and unique sectoral needs which will need to be addressed in a country specific PACCLIM model;
- At the country level each country should identify priority needs which should be addressed in the country specific PACCLIM models;

- The development of the country specific models should be ongoing. This would follow a progression from a country prototype containing simple models to more complex model components as the skills, expertise and data increase within country;
- Key constraints will be the availability of trained personnel and funding;
- Such on-going model development will require training support, technical support and financial support;
- There is a need for PICCAP teams to encourage in-country support for PACCLIM by "mainstreaming" the use of PACCLIM through a range of relevant ministries and departments;
- There should be a PACCLIM focal point in each country - a ministry, department or committee with responsibility for managing PACCLIM related activities;
- In regard to all of the above, defining an overall strategy, identifying data needs and drafting time-lines for implementation are an urgent priority to ensure that countries obtain PACCLIM as soon as possible.

4.2 PACCLIM content

All of the features for which the model was designed and outlined in section 1, were endorsed as matters of concern for PICs by their delegates: low-island survival; safety of communities; inundation and erosion; loss of land area; loss of marine resources; loss of agricultural productivity; land degradation; effects on food security and on health and well-being.

In addition to the climate features included in the prototype scenario generator and impact models, PIC delegates highlighted the need for an increased ability to analyse the possible effects of climate variability and extremes including ENSO events, tropical cyclones, droughts and flooding.

The Workshop identified additional impact sectors which were highlighted as needs for inclusion in future PACCLIM development. It was recognised that the sectors presently represented in PACCLIM were of relevance to all PICs, and that the inclusion of additional sectors in country specific PACCLIM models would be guided by the specific requirements of each country. Important sectors and aspects highlighted as additional model components needed were:

- Fisheries. It was recognised that tuna fisheries would require a regional modelling approach, while inshore fisheries could be represented in country specific models.
- Biodiversity. Several countries indicated that the effect of climate change on biodiversity was a priority area and modelling tools for this application are urgently required. PACCLIM should address both terrestrial and marine biodiveristy.
- Coral reefs. There is an urgent need to understand possible responses of coral reefs to climate change and this should be a priority area for PACCLIM development.

- Pests and diseases. Agricultural pests, and other plant and human pathogens, were noted as possible areas to incorporate into PACCLIM.
- Tourism. While it was recognised that tourism impacts would arise from impacts in other sectors (e.g. coast, water and health), the need for specific tourism models was highlighted.
- Linkages. The need for PACCLIM to link impact sectors (e.g. water and agriculture; water and health) was also noted.

4.3 Development and distribution process

Although the Workshop did not detail a protocol or process for proceeding with PACCLIM at the country level, a process involving four stages emerged from the discussion:

1. Development of the country specific prototype PACCLIM;
2. In-country training support;
3. Trial period of use in analyses within country; and,
4. On-going in-country data collection, and on-going model enhancement and development.

4.4 Data issues

The Workshop forum discussed several issues related to data. Discussion in this regard followed two broad themes. The first theme which emerged related to the sensitivity of ownership and use of country specific data. The second theme related to limitations in data availability due to lack of research, monitoring and inability to access existing data. PIC representatives identified needs related to these two themes as follows:

- In terms of the sensitivity of ownership and use of country data there may be a need for a forum directive or PICCAP initiative to resolve such issues. This issue was not resolved at the Workshop nor was the Workshop considered an appropriate forum in which to attempt to resolve this type of issue.
- It was noted that there is a need to define and list the data requirements for PACCLIM model development (including sectoral model development) for each country.
- A future need to assist PACCLIM development is the training of in-country personnel in data collection, management and analysis. It was suggested in this regard that data collection programmes would be of value.

4.5 Training and technical support

Training was highlighted as an essential component to complement further advancements of PACCLIM. In terms of training the following points were highlighted:

- There is a need to define and identify the range of possible end-users in each country who would benefit from training in PACCLIM use;
- Those selected for training in PACCLIM use should include senior personnel with policy influence;
- Training must be ongoing and accompany each step of PACCLIM development as it proceeds both in-country and/or regionally;
- Training in PICCAP would need to focus on different levels, such as for: sectoral specific analysis; use as a tool for integrated assessment; use as a decision support tool; and application in policy analysis;
- In the development of a training strategy, a "train-the-trainer" approach would be a useful component. Such an approach may be facilitated by the secondment of PICCAP personnel to assist in model development;
- It was suggested that IGCI could provide in-country training as well as facilitate the possible extension of training to regional institutions. This is a process which SPREP/PICCAP could co-ordinate.

4.6 On-going review and evaluation

PIC delegates emphasized that each step of PACCLIM development would require ongoing in-country review and evaluation to assess needs, priorities and customise PACCLIM for the country level. It was noted that consultation should include a wide range of possible end-users from governmental, non-governmental, and private sectors.

4.7 Presentation of software

Finally PIC delegates highlighted several points in terms of the presentation and format of the software:

- PACCLIM should be user friendly, well documented, and aim for simplicity;
- Limitations of the model should be explicit (an important aspect to consider in training);
- Where possible, PACCLIM should be compatible with other GIS packages such as MAPINFO and IDRISI;
- PACCLIM should include a manual as well as on-line HELP;
- PACCLIM hybrids (or components) suitable for public awareness programmes should be developed. This could include, for example, animation versions illustrating inundation.

5 Additional feedback

A special discussion session was convened on Friday afternoon (day 5) to reflect further on the key issues raised earlier in the week, in terms of how to proceed with PACCLIM. Due to the reduction in numbers the discussion was held as a single group.

Points raised in discussion in this group included the following:

- It was recognised that PIC delegates to the workshop had had an expectation that they would have use of a country relevant PACCLIM and that there was an urgent need to deliver such models to countries as soon as is feasible;
- In this regard, there is a need for simple models with simple data requirements to be made available as soon as possible as a starting point from which to proceed;
- It was noted that it is possible within PACCLIM to have a suite of models that progress from the simple to the more complex as data availability and in-country expertise increase;
- Technical experts stressed that the water model in the PACCLIM prototype cannot be simply transferred to other islands. However, other simple groundwater models are available that would be appropriate for islands where data availability was limited;
- It was re-iterated that it is imperative that distribution of PACCLIM models needs to be accompanied by training to optimise use, and prevent misuse or inappropriate application;
- Given sensitivities related to data, the group discussed whether open architecture would be appropriate, acceptable to all parties concerned, and technically feasible;
- In the light of issues raised by PICs, and considering the feasibility of development options, other models that could be added to PACCLIM and extensions to existing models include: fisheries (pelagic & artisanal), biodiversity, coral reefs, land degradation, and water quality.

6 Conclusion

There was unanimous support and enthusiasm for further development of PACCLIM. Countries consider that PACCLIM is a key tool for education and training, impact analysis, policy development, and supporting decision making. Countries emphasized the need to develop country specific versions and have these operational within countries as soon as possible. PACCLIM development at the country level should be customised to the needs, priorities, available data and available expertise of each country. PACCLIM development would likely progress from the inclusion of simple impact models to more complex models covering a wider range of sectors, inter-sectoral linkages, and address higher order effects such as social and economic effects. Each step of this process should be accompanied by ongoing training and technical support addressing issues ranging from model development to model application in policy analysis and decision support.