Summary Report for the
Pacific Climate Scenarios & Impacts on Agriculture Meeting

Kapiolani Community College
Honolulu, Hawaii
October 25 – 26, 2012

Sponsored by the Agricultural Development in the American Pacific Project (ADAP)
and the Pacific Land Grant Alliance (PLGA)
with a grant from the US Department of Agriculture (USDA 2010-38826-20733)

A publication of the Land Grant Institutions of the Pacific: American Samoa Community College, College of Micronesia, Northern Marianas College, University of Alaska Fairbanks, University of Guam, and University of Hawaii, through the Agricultural Development in the American Pacific (ADAP) Project. ADAP Year 23 is funded the US Department of Agriculture, National Institute of Food and Agriculture, Grant #2010-38826-20733.

ADAP Directors (PLGA Directors)

Daniel Aga, *American Samoa Community College*

Singeru Singeo, *College of Micronesia*

Ross Manglona, *Northern Marianas College*

Carol Lewis, *University of Alaska Fairbanks*

Lee Yudin*, University of Guam*

Sylvia Yuen, *University of Hawaii at Manoa*

Summary Report for the Pacific Climate Scenarios & Impacts on Agriculture Meeting

Prepared by Vanessa Zimmermann, ADAP Coordinator

All of part of this publication may be reproduced for educational purposes. When doing so, please credit the ADAP Project and USDA-NIFA.

For more information, contact:

ADAP Project
College of Tropical Agriculture and Human Resources
University of Hawaii
3050 Maile Way, GIL 112
Honolulu, HI 96822.

Phone: 808.956.8140
Email: adap@hawaii.edu

Produced for online or electronic distribution at http://www.ctahr.hawaii.edu/adap/

Summary Report for the
Pacific Climate Scenarios & Impacts on Agriculture Meeting

Table of Contents

Preface

In 2008, the ADAP project, while in a board meeting in Palau, adopted five strategic focus areas to direct our efforts and resources: Climate Change, Food Security, Energy Security, Invasive Species and Biological Threats, and Health and Lifestyle Impacts. In our efforts to address both food security and climate change, we planned the Pacific Islands Climate Scenarios and the Impacts on Food and Agriculture Project. Three project objectives were identified:

- Pilot study evaluation of General Circulation Models (GCMs) performance for the Pacific Islands domain, and statistical downscaling of select best performing models for some defined subregion(s) of the Pacific Island domain, and
- Stakeholder meeting between UAF's Scenarios Network for Alaska and Arctic Planning (SNAP) scientists and Pacific-wide researchers and extension agents to review methods and climate scenarios for studying climate change in the Pacific region.
- Collaboration between climate scientists working in Hawaii and the other Western Pacific territories and countries

October 25 and 26, 2012, ADAP hosted a meeting of 47 agricultural professionals from Alaska, Hawaii, American Samoa, Guam, Northern Mariana Islands, Micronesia, Marshall Islands, and Palau, and representatives from the Pacific Land Grant Alliance– a consortium of the Pacific Land Grant Schools. Day One of the workshop was devoted to technical presentations of ongoing climate-related extension or research projects. The diversity of the presentations highlighted the many ways that climate change can affect the Pacific region, from impacts on agriculture, plants, and insects, to water use, tourism, and the local economy. Day Two of the workshop was focused on change adaption, and was devoted to facilitated discussions of regional needs and areas for

regional collaborative research/extension. During the discussions, we utilized a unique pictorial note taking method, to further spark ideas and innovative thought.

This publication, *Summary Report for the Pacific Climate Scenarios & Impacts on Agriculture Meeting*, contains the meeting agenda, the final report of the ADAP Pilot study evaluating General Circulation Model (GCM) performance, meeting attendee list, notes from the facilitated discussions, and follow-up materials supplied by the newly formed, regional working group.

This workshop resulted in a list of regional needs and resources, which is valuable in directing research goals for the region. Also, as a follow-up to this workshop, a group of attendees drafted a one-page overview of a potential regional project, “Climate Change Adaptation Through Outreach Teaching and Extension Capacity Building Activities Within the PLGA (Pacific Land Grant Alliance)”, page 25. The first effort of this working group to submit a Letter of Intent to a competitive project with USDA-NIFA, resulted in many Letters of Collaboration for University of Alaska’s submission to FY2013 Agriculture and Food Research Initiative - Agriculture and Natural Resources Science for Climate Variability and Change. The University of Alaska was not asked to submit a full proposal, but we remain hopeful that our efforts will continue to unite the region to think about climate change in a larger context.

James R Hollyer
ADAP Project Manager

Agenda

Climate Scenarios and Impacts on Agriculture
October 25 - 26, 2012,
Honolulu, Hawaii

October 25 - Thursday – Day 1 Location: Kapiolani Community College

Time	***Activity***
8:00am	**Registration**
8:30am	**Welcome and Introductions**
9:00am	**Purpose of Meeting; Expectations; Meeting Outcomes and Outputs**
9:30am	**Technical presentations:** • **Recent Major Initiatives in Climate Science for the Pacific Islands**, by Kevin Hamilton (10 mins) • **Decision Support for Food and Environmental Security in the American Pacific** by Tak Sugimuraand and Kevin Hamilton (30 mins)
10:10am	**Break**
10:20am	***Continuation of technical presentations*** • **Impact of Climate Change on Water Resources in Hawaiian Watersheds,** by Ali Fares*, Ripendra Awal, Mohammad Safeeq, Hector Valenzuela and Samira Fares • **Irrigation Water Requirements for Some Major Crops in Response to Potential Climate Change Scenarios,** Ali Fares*, Ripendra Awal, Samira Fares, Hector Valenzuela, and Hla Htun • **What does tourism have to do with agriculture? Climate change impacts on natural resources and economy in the Pacific,** by Luisa Cristini • **The prospects for Agroecology research to help mitigate the impacts of climate change in the Pacific Region,** by Hector Valenzuela*, Kathie Pomeroy, Ali Fares, and Samira Fares. • **Pacific Islands Climate Education Partnership's (PCEP) Region-Wide Strategic Plan and Opportunities for Collaboration Over the 5-year Implementation,** by Marylin Low
Noon	**Lunch (provided)**

Climate Scenarios and Impacts on Agriculture
October 25 - 26, 2012,
Honolulu, Hawaii

October 25 - Thursday – Day 1 Location: Kapiolani Community College

Time	***Activity***
1:00pm	***Continuation of technical presentations***
	• **Connecting the Dots: Forestry, Energy Needs, and Climate Change in Interior Alaska** by Tom Grant (10 mins)
	• **Mental Modeler: A Stakeholder-Driven Scenario Planning Software,** by Steven Gray
	• **InVEST Model: applications for agriculture and climate change in HI,** by Kirsten L.L. Oleso**n**
	• **K-20 Education/Outreach: Full STEAM Ahead,** by Janice Dawe (10 mins)
2:00pm	**Local responses and on-the-ground programs**
	• **Alaska** (20 mins)
	• **Hawaii** (5 mins; Hawaii-based programs are represented in the technical presentations)
	• **Guam** (20 mins)
3:00pm	**Break**
3:15pm	***Continuation of Local responses and on-the-ground programs***
	• **American Samoa** (20 mins)
	• **Northern Mariana Islands** (20 mins)
	• **Federated States of Micronesia** (20 mins)
	• **Republic of Palau** (20 mins)
	• **Marshal Islands** (20 mins)
4:30pm	**Meeting adjourned**

Climate Scenarios and Impacts on Agriculture
October 25 - 26, 2012,
Honolulu, Hawaii

October 26 - Friday – Day 2 Location: Kapiolani Community College

Time	***Activity***
8:00am	**Check-In**
8:30am	**Introduction to Facilitation and Graphical Recording**
8:35am	**Facilitated Discussion of Regional Needs and Priorities** • **Laboratory and Field Research** • **Staffing and Personnel** • **Climate Change Models** • **Data Collections and Archives** • **Extension Materials** • **Community Awareness and Outreach**
Noon	**Lunch (provided)**
1:00pm	**Program-Level Needs – Let's Collaborate!** • **Does your project/program have a specific need that may be filled by someone in the room? Bring your ideas for sharing and collaboration.** • **Is your institution interested in collaborating in a regional project? Bring your ideas and expertise to the table.**
3:00pm	**Meeting adjourned – Thank you for your time and participation!**

Meeting Participants

	First name	Last name	Institution	Email Address
1	Dan	Aga	American Samoa Community College	danaga98@yahoo.com
2	Ripendra	Awal	University of Hawaii - CTAHR - NREM	
3	Corrin	Barros	Pacific Resources for Education & Learning	barrosc@prel.org
4	Tagaloa	Cooper-Halo	Secretariat of the Pacific Regional Environment Programme	tagaloac@sprep.org
5	Linda	Cox	University of Hawaii - CTAHR - NREM	lcox@hawaii.edu
6	Luisa	Cristini	University of Hawaii - Sea Grant College Program	cristini@hawaii.edu
7	Janice	Dawe	University of Alaska - Department of Forest Sciences	jcdawe@alaska.edu
8	Aurora	Del Rosario	Palau Community College	Aderose929@yahoo.com
9	Carl	Evensen	University of Hawaii - CTAHR	EvensenC@ctahr.hawaii.edu
10	Ali	Fares	University of Hawaii - CTAHR - NREM	afares@hawaii.edu
11	Samira	Fares	University of Hawaii - CTAHR - NREM	sfares@hawaii.edu
12	Thomas	Grant	University of Alaska - Department of Forest Sciences	tagrant@alaska.edu
13	Steven	Gray	Water Resources Research Center, University of Hawaii - NREM	sagray@hawaii.edu
14	Robert	Greene	Northern Marianas College	
15	Kevin	Hamilton	Director, International Pacific Research Center (IPRC), University Director, Pacific Islands Climate Science Center (PICSC)	kph@hawaii.edu
16	Rosslyn	Harris	University of Hawaii - CTAHR - NREM	
17	Jim	Hollyer	University of Hawaii - CTAHR - ADAP Project	hollyer@hawaii.edu

	First name	Last name	Institution	Email Address
18	Hla	Htun	University of Hawaii - CTAHR - NREM	hlahtun@hawaii.edu
19	Viliamu	Iese	University of the South Pacific	viliamu.iese@usp.ac.fj
20	Mark	Kostka	College of Micronesia, Federated States of Micronesia National Campus	mkostka@comfsm.fm
21	Raaj	Kurapati	University of Alaska	rkurapati@alaska.edu
22	James	Leary	University of Hawaii - CTAHR - NREM	leary@hawaii.edu
23	Carol	Lewis	University of Alaska	celewis@alaska.edu
24	Thomas	Lim	University of Hawaii - CTAHR	limt@ctahr.hawaii.edu
25	Daniel	Lin	Pacific Resources for Education & Learning	
26	Rebecca	Lorennij	Ministry of Resources and Development, Republic of the Marshall Islands	rlorennij@hotmail.com
27	Marylin	Low	Pacific Resources for Education & Learning	lowm@prel.org
28	Trisha	Macomber	Water Resources Research Center, University of Hawaii - NREM	macomber@hawaii.edu
29	Ross	Manglona	Northern Marianas College	rossm@nmcnet.edu
30	Madelsar	Ngiraingas	Palau Automated Land & Resources Information System	madelsar.ngiraingas@gmail.com
31	Kirsten L.L.	Oleson	University of Hawaii - CTAHR - NREM	koleson@hawaii.edu
32	Netatua	Pelesikoti	Secretariat of the Pacific Regional Environment Programme	netatuap@sprep.org
33	John	Peterson	University of Guam	
34	Scott	Rupp	University of Alaska	tsrupp@alaska.edu
35	Biuma	Samson	College of the Marshall Islands	bisamson@cmi.edu
36	Fred	Schlutt	University of Alaska	fred.schlutt@alaska.edu
37	Singeru	Singeo	College of Micronesia	ssingeo@mail.fm
38	Steve	Sparrow	University of Alaska	sdsparrow@alaska.edu

	First name	Last name	Institution	Email Address
39	Tak	Sugimura	University of Hawaii	takasug@hawaii.edu
40	Gibson	Susumu	Federated States of Micronesia - Dept. of Resources and Development	Gibson.susumu@fsmrd.fm
41	Thomas	Taro	Palau Community College	tarothomas@yahoo.com
42	Vanessa	Troegner	University of Hawaii - CTAHR - ADAP Project	troegner@hawaii.edu
43	Hector	Valenzuela	University of Hawaii - CTAHR - PEPS	hector@hawaii.edu
44	Murukesan	Vazhaveli	College of Micronesia, Federated States of Micronesia Yap Campus	muru@comfsm.fm
45	Virendra	Verma	College of Micronesia, Federated States of Micronesia Kosrae Campus	Vmv_vmv@hotmail.com
46	Lee	Yudin	University of Guam	lyudin@uguam.uog.edu
47	Sylvia	Yuen	University of Hawaii	syuen@hawaii.edu

Final Report of ADAP's Pacific Islands Climate Scenarios Project

Final Report - Pacific Islands Climate Scenarios

Background. General Circulation Models (GCMs) are the most widely used tools for projections of global climate change over the timescale of a century. Periodic assessments by the Intergovernmental Panel on Climate Change (IPCC) have relied heavily on global model simulations of future climate driven by various emission scenarios.

Different coupled GCMs have different strengths and weaknesses, and some can be expected to perform better than others for different regions of the globe. Greenhouse-driven climate change represents a response to the radiative forcing associated with increases of carbon dioxide, methane, water vapor and other gases, as well as associated changes in cloudiness. The response varies widely among models because it is strongly modified by feedbacks involving clouds, the cryosphere, water vapor and other processes whose effects are not well understood. Thus, the ability of a model to accurately replicate seasonal radiative forcing is a good test of its ability to predict anthropogenic radiative forcing.

Because of the mathematical complexity of GCMs, they generally provide only large-scale output, with grid cells typically 1°-5° latitude and longitude. Finer scale projections of future conditions are not directly available. However, local topography and water bodies can have profound effects on climate at much finer scales, and almost all land management decisions are made at much finer scales. Thus, some form of downscaling is necessary in order to make GCMs useful tools for regional climate change planning.

Identification of best performing GCMs for a region and the development of an associated suite of downscaled climate scenarios is a key first step required to address regional climate change issues – both in terms of mitigation and most importantly with respect to adaptation planning. These climate scenarios provide the key linkages with biophysical processes and thereby to social change and ultimately management and policy choices.

Proposed Activities. This initial pilot project funded by ADAP will follow established methodologies developed and utilized by the Scenarios Network for Alaska and Arctic Planning (SNAP; www.snap.uaf.edu). The pilot activities will include (1) engagement of climate scientists working in Hawaii and the other Western Pacific territories and countries, (2) evaluation of GCM performance for the Pacific Islands domain, (3) statistical downscaling of select best performing models for some defined subregion(s) of the Pacific Island domain, and (4) participation by SNAP scientists in a project meeting where the methods and climate scenarios will be formally presented to ADAP members.

Engagement with Climate Scientists in the Pacific will include periodic discussions with scientists in Hawaii and other Western Pacific entities. These discussions were initiated in April with the Pacific RISA's participation (Victoria Keener, Project Manager, East-West Center) in a climate downscaling workshop held in Anchorage, Alaska and hosted by SNAP, UAF, and the DoI Alaska Region Climate Science Center. A teleconference followed in May 2011 with the Pacific RISA program (Melissa Finucane, Project PI, East-West Center) and the International Pacific Research Center (IPRC; Kevin Hamilton, Director), SNAP (Scott Rupp, Director), the Pacific RISA's sister Alaska RISA (Alaska Center for Climate Assessment and Policy, Sarah

Trainor, Project PI) and IPRC's sister institute – the International Arctic Research Center (John Walsh, Chief Scientist). A meeting in Hawaii with UH researchers, the Pacific RISA, IPRC, NOAA, SNAP, ACCAP, and IARC to review findings and discuss appropriate approaches/methodologies and share insights is expected to be scheduled to coincide with the Summer meeting of the ADAP-PLGA directors (July 2011).

Model performance will be evaluated using the methodology of Walsh et al. (2008). The set of fifteen global climate models used in the Coupled Model Intercomparison Project as part of the IPCC AR4 will be evaluated for the Pacific Islands region. We will calculate the degree to which each model's output concurred with actual climate data for the years 1958-2000 for several climatic variables (e.g., surface air temperature, air pressure at sea level, and precipitation).

The core statistic of the validation is a root-mean-square error (RMSE) evaluation of the differences between mean model output for each grid point and calendar month, and data from the European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Analysis, ERA-40. The ERA-40 directly assimilates observed air temperature and sea level pressure observations into a product spanning 1958-2000. Precipitation is computed by the model used in the data assimilation. The ERA-40 is one of the most consistent and accurate gridded representations of these variables available.

To facilitate GCM intercomparison and validation against the ERA-40 data, all monthly fields of GCM temperature, precipitation and sea level pressure will be interpolated to the common 2.5° × 2.5° latitude–longitude ERA-40 grid. For each model, we will calculate RMSEs for each month, each climatic feature, and by region to create a composite score for each model. These scores will allow ranking of the models by performance and provide the basis to choose specific models for downscaling.

Model downscaling will follow current statistical methods used by SNAP and commonly referred to as the delta method. Downscaling as part of this pilot project will be focused on a select subregion(s) of the Pacific Islands domain. Historical climate data estimates for the domain at 800 m resolution are available from PRISM (Parameter-elevation Regressions on Independent Slopes Model; http://www.prism.oregonstate.edu/), which was originally developed to address the sparse climate observation data. PRISM uses point measurements of climate data and a digital elevation model to generate estimates of annual, monthly and event-based climatic elements. Each grid cell is estimated via multiple regression using data from many nearby climate stations. Stations are weighted based on distance, elevation, vertical layer, topographic facet, and coastal proximity.

We will calculate mean monthly precipitation and mean monthly surface air temperature for PRISM grid cells for 1971-2000, creating PRISM baseline values. Concurrently, we will calculate GCM baseline values for selected top performing models using mean monthly outputs for the same 1971-2000 period. We will then calculate differences between projected GCM values and baseline GCM values for each year out to 2099 and create "anomaly grids" representing these differences. Finally, we will drape these anomaly grids to PRISM baseline values, thus creating fine-scale (800 m) grids for projected monthly mean temperature and

precipitation for every year out to 2099. This method effectively removes model biases while scaling down the GCM projections.

ADAP Member input and feedback will be sought through a project meeting to be held in Hawaii at a future date to be determined. SNAP scientists will present methods and preliminary climate scenarios to the ADAP members. Member input will be used to shape an ongoing research agenda and define potential funding strategies. Both components will seek to develop broad collaborative relationships among ADAP members and seek to build member capacity in climate change science and planning.

Results of Activities. We conducted the following pilot activities (1) engagement of climate scientists working, (2) evaluation of GCM performance, (3) statistical downscaling for some defined subregion(s) of the Pacific Island domain, and (4) presentation of pilot activities to ADAP members.

Engaging Scientists. In order to build partnerships and establish the basis for cross-regional, scientific collaborations between the Pacific and Alaska, scoping meetings and a half-day symposium were held at the University of Hawaii in July 2011. A team of Alaskan scientists (T.S. Rupp, J. Walsh, S. Trainor) met with the Director of the International Pacific Research Center (Kevin Hamilton), the Principle Investigator for the Pacific Island Regional Integrated Science Assessment (RISA) (Melissa Finucane), the Director of the East West Center (Nancy Lewis), and a team of scientists, students, and post-doctoral fellows. The meetings and symposium included presentation of research results, exploration of research ideas, and brainstorming potential future collaborations.

Trainor, Rupp and Walsh are principle investigator and co-principle investigators respectively of the Alaska Center for Climate Assessment and Policy, a sister organization to the Pacific RISA; both are funded by the NOAA Climate Program Office. These organizations have been actively working to build collaborations since the July 2011 meeting. Exploration of research ideas for cross-regional research collaboration has been on-going. A collaborative letter of intent to the USDA NIFA program was submitted in October 2011, "Analyzing Cross-Regional Capacity for Climate Change Extension Services in Alaska and the Pacific Islands", but was not selected. In addition, a collaborative proposal, "A Framework for Seasonal Climate Risk Assessment for Coastal Community Stakeholders in Hawai'i and Alaska" was submitted to NOAA in November, 2012.

Data assemblage and standardization

SNAP obtained the required datasets to perform a model selection and subsequent downscaling procedure over the Pacific Islands region. This included temperature, precipitation, and sea-level pressure across 1) 16 AR4 global climate model (GCM) datasets and 4 scenarios (20c3m, B1, A1B, A2), 2) the ERA40 reanalysis dataset covering 1958-2000, and 3) the 1971-2000 high resolution PRISM climatology datasets (Figure 2). All data was standardized into compatible formats, units, projections, and temporal and spatial resolutions for input into the model selection and downscaling procedures.

Model selection

Model selection methodologies closely followed Walsh et. Al. 2008, but was customized for the Pacific Islands region by focusing on a bounding box encompassing all islands of interest (Figure 1). In general, the procedure compares monthly temperature, precipitation, and sea level pressure values at every 2.5 degree pixel location from 1958-2000 ERA40 outputs to the same variables output from 16 AR4 GCM twentieth century scenario runs (20c3m), calculates RMSE values and ranks them by a composite RMSE across all 3 variables (Table 1). This resulted in 5 models being chosen as top candidates for downscaling:

1. Meteorological Institute of the University of Bonn, ECHO-G Model – miub_echo_g
2. Meteorological Research Institute Coupled General Circulation Model version 2.3.2a – mri_cgcm2_3_2a
3. L'Institut Pierre-Simon Laplace Coupled Model version 4 – ipsl_cm4
4. Max Planck Institute for Meteorology European Centre Hamburg Model 5 – mpi_echam5
5. Canadian Centre for Climate Modelling and Analysis (CCCma) Coupled General Circulation Model version 3.1 (CGCM3.1) – cccma_cgcm3_1

Downscaling

SNAP chose the island group of the Commonwealth of the Northern Mariana Islands as well as Pohnpei, Micronesia as case studies for downscaling. PRISM data was used as baseline climate, and because it was such high resolution data (440m for Hawaii, 90m for all other islands), and due to the fact that an individual island fell into a single GCM grid cell, the procedure was slightly modified to accommodate this large disparity and high resolution output (Figure 3). Outputs include temperature and precipitation from the top 5 models and three future climate scenarios (B1, A1B, A2) from 2001-2100 (see examples Figure 4 and 5). For more details about the delta downscaling method, please visit snap.uaf.edu.

Project Meeting

Rupp and Trainor met with PLGA representatives during their meeting in San Francisco, in November, 2011. The pilot project downscaling results were presented to the group (see attached pdf presentation). Additionally, the letter of intent for a cross-regional proposal to the USDA was presented and discussed. Also discussed were specific details of potential points of contact at specific PLGA member institutions as well as administrative and scientific opportunities and challenges inherent in taking next steps to implement cross-regional research and collaboration (see attached pdf presentation).

Future opportunities. SNAP has developed the methodology, processing code, and computational capacity to produce high resolution projections of climate variables across the Pacific region. If the opportunity arises, we would be able to continue this project and provide outputs for all islands where high resolution climatological data exist. In addition, we have scripts developed to produce derived products including summary statistics (min, max, mean, median, etc) and annual, seasonal, and decadal averages that are useful for various impact analyses.

Table 1.

GCM	RMSE Composite Rank	RMSE Rank Sum (temperature, precipitation, sea level pressure)
miub_echo_g_20c3m	1	7
mri_cgcm2_3_2a_20c3m	2	17
ipsl_cm4_20c3m	3	18
mpi_echam5_20c3m	4	18
cccma_cgcm3_1_t63_20c3m	5	21
ncar_ccsm3_0_20c3m	6	22
cccma_cgcm3_1_20c3m	7	23
gfdl_cm2_1_20c3m	8	23
gfdl_cm2_0_20c3m	9	25
giss_aom_20c3m	10	27
csiro_mk3_5_20c3m	11	29
iap_fgoals1_0_g_20c3m	12	38
giss_model_e_r_20c3m	13	39
miroc3_2_medres_20c3m	14	43
bccr_bcm2_0_20c3m	15	45
csiro_mk3_0_20c3m	16	46
ukmo_hadgem1_20c3m	17	47
ukmo_hadcm3_20c3m	18	48
giss_model_e_h_20c3m	19	51
cnrm_cm3_20c3m	20	53
inmcm3_0_20c3m	21	57
ncar_pcm1_20c3m	22	62

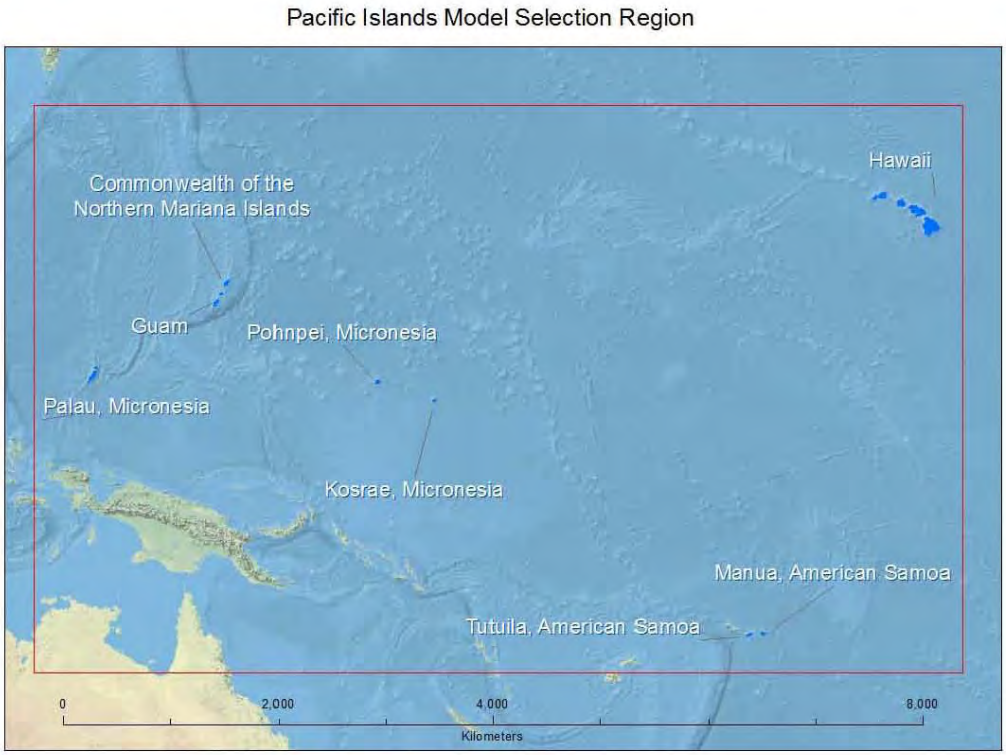
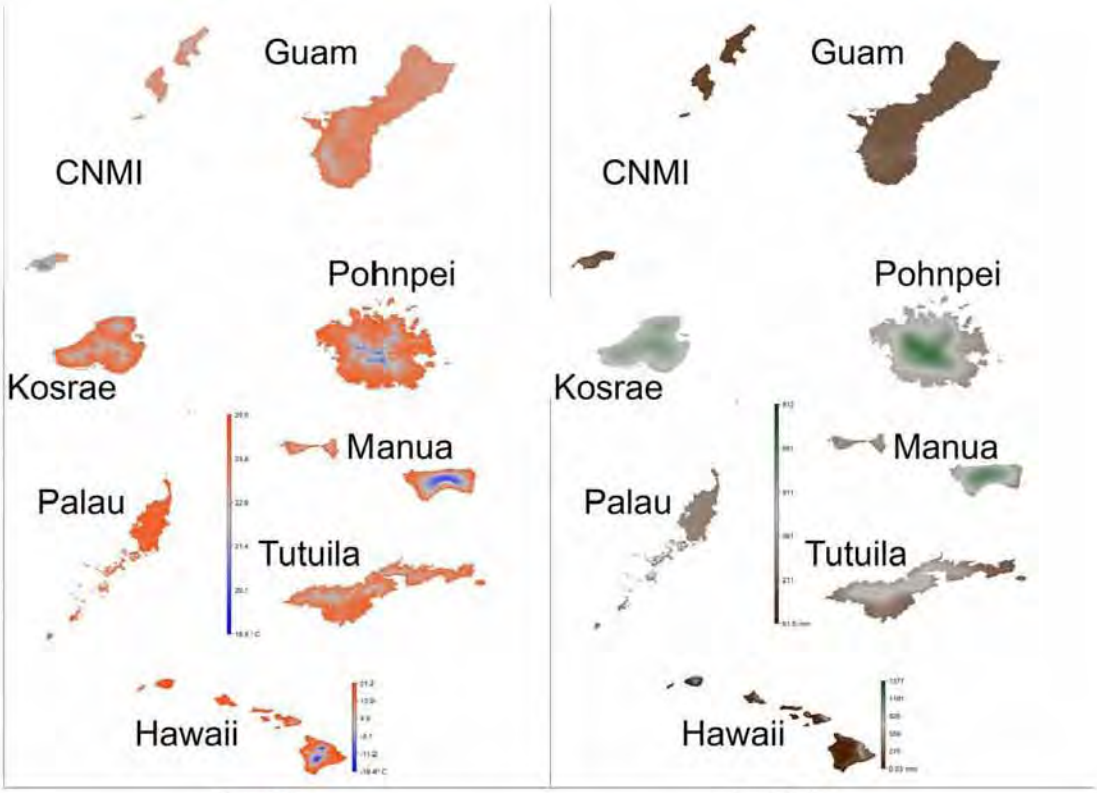

Pacific Islands Model Selection Region
Commonwealth of the
Northern Mariana Islands
Hawaii
Guam
Pohnpei, Micronesia
Palau, Micronesia
Kosrae, Micronesia
Manua, American Samoa
Tutuila, American Samoa
0
2,000
4,000
8,000
Kilometers

Figure 1.



Temperature Precipitation

1971 – 2000 Annual Composite PRISM Climatologies

Figure 2.

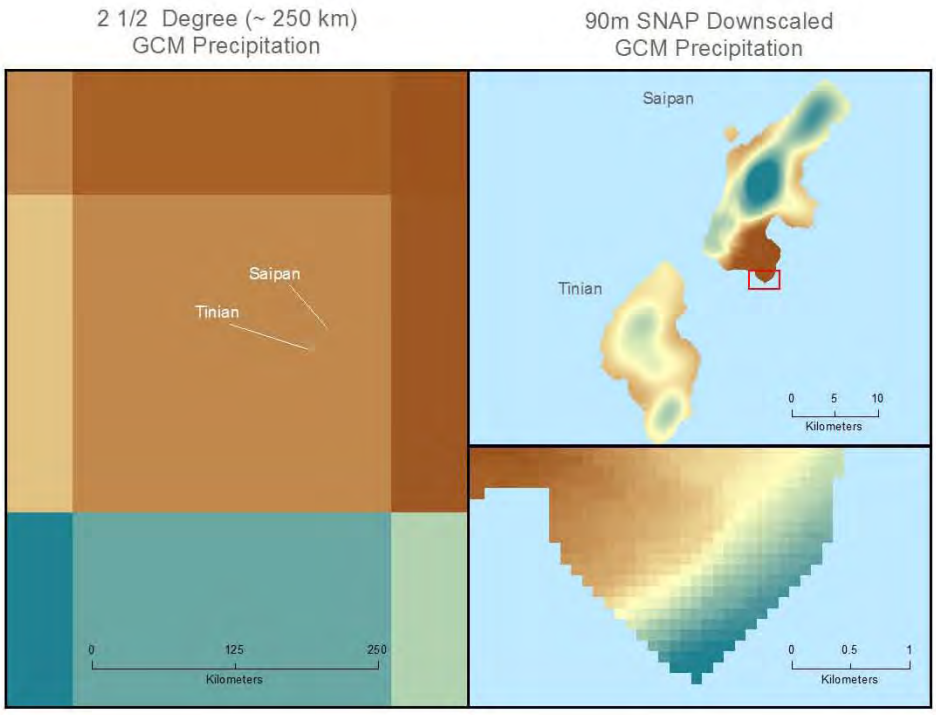
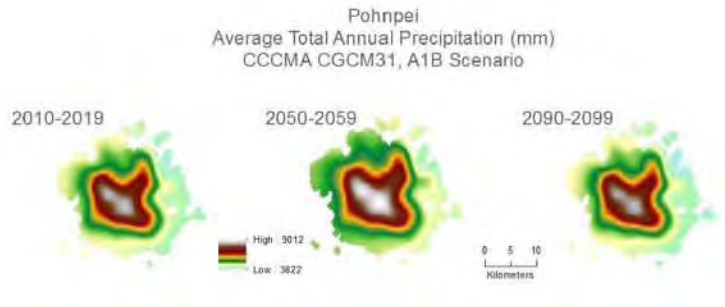

2 1/2 Degree (~ 250 km)
GCM Precipitation
90m SNAP Downscaled
GCM Precipitation
Saipan
Tinian
0
125
250
Kilometers
Saipan
Tinian
0
5
10
Kilometers
0
0.5
1
Kilometers

Figure 3.


Pohnpei
Average Total Annual Precipitation (mm)
CCCMA CGCM31, A1B Scenario
2010-2019
2050-2059
2090-2099
High : 9012
Low : 3822
0 5 10
Kilometers

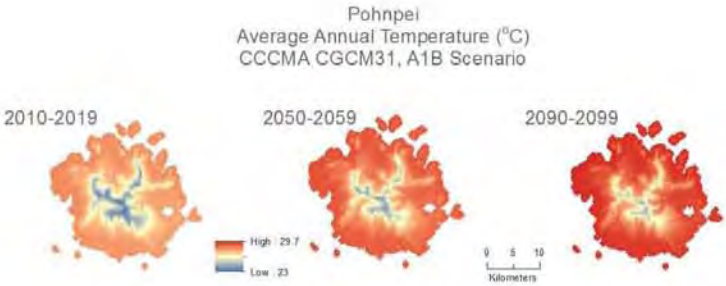

Pohnpei
Average Annual Temperature (°C)
CCCMA CGCM31, A1B Scenario
2010-2019
2050-2059
2090-2099
High : 29.7
Low : 23
0 5 10
Kilometers

Figure 4.

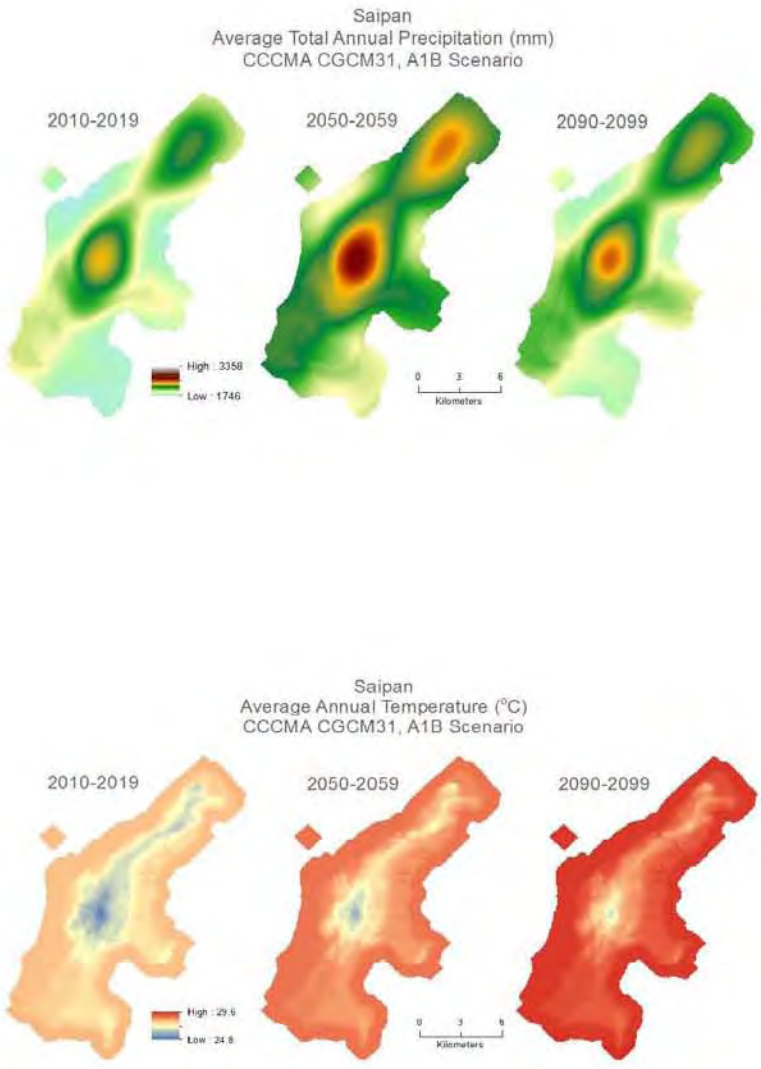

Saipan
Average Total Annual Precipitation (mm)
CCCMA CGCM31, A1B Scenario
2010-2019
2050-2059
2090-2099
High : 3358
Low : 1746
0 3 6
Kilometers
Saipan
Average Annual Temperature (°C)
CCCMA CGCM31, A1B Scenario
2010-2019
2050-2059
2090-2099
High : 29.6
Low : 24.8
0 3 6
Kilometers

Figure 5.

Notes from Facilitated Discussion (Day 2)

What did you learn from Day 1?

- Happy to learn a lot of things
- Need to collaborate
- It's [climate change] happening / it is a reality
- Must do something about it
- (interesting) how many climate change projects are going on
- (interesting) how tourism and agriculture impact each other
- It's valuable to see how climate change is impacting the community
- (interesting) to see the decision support tools
- modeling – amazing / need to connect them to what is happening on the ground
  - models are technical, but it is good to know they exist
- There is "uncertainty in paradise" – how to restore equilibrium?
- Model vs on-the ground: people are approaching this from different angles
- Technology is power!
- The Samoan word for climate "change" is the same as for climate "variability".
- Good to hear what other projects are doing
- (it is important) to learn from the past
- We should think of ourselves as "large ocean states" rather than "small island states" – i.e. count the water in the EEZ as part of the entire "state"
- Cooperation!
- Lots of benefit/opportunity in knowledge sharing
- Need to build up communication
- How to build bridge?
- Make action on a community level to create change
- Together we have research, outreach, (classroom) education
- Seeing relationships and scaling issues (in the presentations)
- How can we write a grant together?
- How to cooperate – how to respect each other and the environment?
- Share with group!
- Respect and cooperate
- Impressed with the level of research that exists
- How do we move forward?
- Learned a rich amount of information and about programs on insular islands
- Complex and interconnected
- Lot of opportunity to work together
- Tangible work
- Very organized
- Our problems are different than US mainland

- Pacific Region and Alaska is having two extremes. Working together can bring new learning
- Connect islands with needs – sea level is rising
- Micronesia can provide data points
- We want to build connections
- Work (seen in presentations) is broadly applicable
- Taking this knowledge home with me

Image from Discussion Pictogram

Focus on Change Adaptation

As opposed to confronting Climate Change, a focus on **Change Adaption** is key when approaching the issue from a regional perspective and with a large diversity of communities.

Change Adaptation for the Pacific region means:
- salt-tolerant taro (adapting staple crops to new growing conditions- agricultural response)
- lessen dependence on fossil fuels while still looking at the affordability of other energy sources
- active use of GIS in community planning (following Palau's example)
- address anthropological significance when dealing with such a change (learning from the past)
- building the linkage between the Arctic and the Tropics – Alaska's presence in the working group strengthens our efforts through having the two extremes working on a concerted effort

Compelling Case for Action

What would things look like if we did nothing – or no more than is being done already? What is the evidence telling us? What is the compelling case for action?

- Progress toward a mono-culture (loss of ethnic identities and people)
- Children detached (from real world and their part in it)
- Disruption of the social structure
  - displacement of people / out migration
- Endanger food security – people go hungry
- Low-lying islands not able to produce their own food or capture their own fresh water
- Loss of biodiversity and knowledge
- Loss of traditional knowledge
- Increased natural disasters
- Disruptive innovation
- Severe disruption of coral reefs & entire ocean ecosystem
- The "swim of tears"
- Negative impact on marine-based tourism
- Loss of way of life
- Loss of native plants
- Missed opportunities for funding & sustainability
- Rich get richer and poor get poorer – overall, on average, decrease in standard of living
- We'd be in heaven
- Will not meet Millennium Development Goals (MGD)
- Increase in plant diseases
- Loss of forest
- Increase in insects
- Could be good for agriculture production in colder areas

Image from Discussion Pictogram

Program Needs for a Regional Initiative

What do we need to do to avoid the potential negative consequences of Climate Change and what's now in progress?

- Write the grant – get the money
- Prioritize needs
- Create major themes (that tie it all together)
- Understand resilience in ecosystems
- Education starts with children
- Document traditional knowledge
- Need a paradigm shift
- Need a unique Pacific-based model for adaptation and litigation
- Language barriers
- Extension, participatory action research
- Need to strengthen research in small island states
- Effort needs a "star" or symbol
- Centralize data
- Need bandwidth capacity on some of the islands to use some databases
- Need an inventory / statistics / baseline data (standardize methodologies, allow for diversity with conversion factors)
- Need a scorecard of climate change indictors
- Efficient coordination of program – don't duplicate efforts
- Ground level action
- Learning communities – "learning exchanges": professional exchanges and student exchanges
- Strengthen links between education and outreach
- Multi-disciplinary, multi-generational, multi-sector approaches
- PACIS – Pacific Climate Information System (see http://www.pacificcis.org/)
- Faculty sabbaticals
- Build capacity across different agencies at the same time
- Local capacity building
- Involve children in research
- Educated, informed infrastructure – including investors
- Policy changes that include language that compels implementation
- Strong legal framework for policy
- Policy mainstreaming
- administrative capabilities to manage grants
- Strong program management to implement and oversee regional objectives
- Equipment needs: Satellites to monitor and get data, ground station, unmanned aerial vehicles (UAV)
- Good, updated LIDAR imagery and high resolution maps

Technical Resources for a Regional Initiative

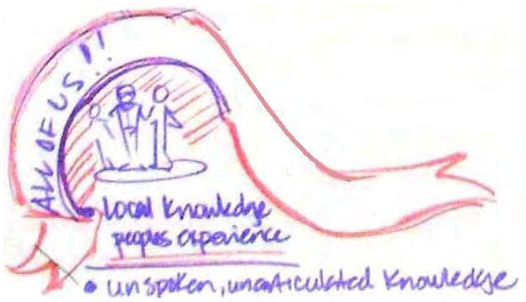
Within the region, what other programs already exist and what technical resources are available?

- UH & UAF doing modeling work – super computers
- On-going / existing programs
- Pacific Disaster Center
- East-West Center
- UN CROP agencies / UN
- Land Grant colleges / Extension Service
- USP (University of the South Pacific)
- UAF Resilience & Adaptation Program
- National Disaster Preparedness Training Center (at UH)
- School teachers
- Local farmers and fishers
- PREL
- Sea Grant
- Micronesian Conservation Trust (MCT)
- Institute of Pacific Island Forestry (IPIF)
- International Long-term Ecological Research Network (ILTER)
- Google Earth – good teaching tool. Expensive.
- NOAA – weather station (currently not accessible)
- NOAA Digital Coast
- Already established advisory groups
- Unmanned aerial vehicles (UAV)

Community Resources for a Regional Initiative

What community resources do we have to work with?

- Islands and surrounding waters
- Family lands
- Hokulea
- PACIS – Pacific Climate Information System
- SPREP – South Pacific Regional Environment Program
- All of us! Local knowledge and experience. Unspoken, unarticulated knowledge.
- Climate Change is a priority area in the USDA-NIFA plan of work, thus it is a priority for Pacific Land Grants
- Local languages
- Climate Adaptation Knowledge Exchange (CAKE)
- 4H programs as well as other youth programs



Partners and Collaborators for a Regional Initiative

Who can we partner with? Let's keep moving forward.

- Can we write a collaborative grant? (CTAHR? UAF?)
- PREL can help with model for NSF grant
- ADAP/PLGA directors are going to meet and work on smaller grants to build a system/momentum and get data …. then go for larger one.
- Large universities can lead, BUT, we are all equal

Challenges, Questions and Concerns

Questions to be answered?

- Why the US will not sign the Kyoto Protocol?
- How we can break out of our own silos?
- What are the human-related activities that need to change?
- How can we get access to knowledge and knowledgeable people that we don't now have?
- (Some people are reluctant to share their knowledge – Clan ID, sacred, secret knowledge)

Possible Funding Sources

- Global Environment Facility
- ADB
- EU
- USAID
- AUS AID
- GIZ
- IOM – International Organization for Migration
- USDA – NIFA
- USDA – AMS
- USDA – NRCS
- USDA – Forest Service
- SERDP
- DOD
- EPA
- Department of Energy
- Conservation International
- FAO
- Nature Conservancy
- Department of Interior
- NOAA
- JICA
- CROP agencies (in Pacific) – Connected to UNDP
- WHO
- Cooperative Ecosystems Study Unit (at University of Hawaii at Manoa)
- NSF
- USGS
- UNDP
- EPSCOR
- NZA
- NASA
- Philanthropy groups
- PREL

Outline of Potential Regional Project

Descriptive Title. Climate Change Adaptation Through Outreach Teaching and Extension Capacity Building Activities Within the PLGA (Pacific Land-Grant Alliance)

Rationale. Nowhere in the U.S. are the effects of climate change more pronounced than those in the Pacific Islands and Alaska. The PLGA made up of Alaska, Hawaii and the four land-grant insular islands hosted a Climate Scenarios Stakeholders Meeting in late October to begin developing adaptive management strategies to deal with climate change effects. Many islands and coastal areas in the region are experiencing sea level rise and increased storm frequency and severity resulting in increased flooding, salt water intrusion, endangered food supplies, reduced availability of fresh water, loss of biodiversity and traditional knowledge, degradation of forests and severe coastal erosion. Warmer, drier conditions are causing increased extent of wildfires, degradation of forests, and loss of potential food production in some areas but increased forest productivity, better range conditions, and increased potential for crop production in other areas.

Overall Goal. The overall goal of this multi-state and integrated (Teaching and Extension) project is to develop the capacity of the Pacific Islands and Alaska to address climate change issues in small island and rural communities through university outreach science-based information.

Specific Objectives. The specific objectives are to use climate research forecasting models from UA-Fairbanks and UH-Manoa to develop climate change scenarios for the islands and Alaska to: 1) develop a climate change development training program based on climate projections, local indigenous knowledge, and relevant applied climate change research for land-grant professionals and 2) deliver Extension outreach climate change science-based information to local communities, using a variety of delivery methods.

Approach Objective 1. Develop capacity of PLGA employees and K-12 teachers to increase their knowledge about climate change through in-depth climate change training sessions.

Approach Objective 2. Build on existing climate change learning networks in the Pacific to develop and deliver Extension outreach climate change science-based information to local communities and indigenous populations.

Potential Impact and Expected Outcomes. Create the capacity at land-grant institutions and communities to address climate change and its impacts through extension of science-based knowledge that is culturally responsive and blends western science and indigenous knowledge and by educating professionals and community leaders in climate change science and adaptive management.

Post-Meeting Clustering Activity

Clustering of Meeting Notes for Collaborative Climate Change Work. Clustering of themes based on Jim Hollyer's notes and images of facilitator's notes. Edits by Verma Virendra, Dan Aga, Vazhaveli Murukesan, and Tom Grant (December 17, 2012)

General Areas or Programmatic Themes:

1. Social/Cultural
2. Educational and Outreach
3. Ecological
4. Food Security – Agriculture and Fisheries
5. Sustainable Energy
6. Tourism?
7. Climate Change

Opportunities for Research/Education/Outreach related to Themes:

1. Social/Cultural:
    i. Traditional Knowledge – support, document, utilize, protect
    ii. Cultural/ethnic identity – prevent loss, evolve
    iii. Emigration/displacement – If people have to leave, where do they go? What international laws are in place or are needed?
    iv. Anthropological research
    v. Participatory action research
    vi. Including Local languages
    vii. Arts & Crafts
2. Educational and Outreach:
    i. Education starts with children
    ii. Involve children in research
    iii. Involve investors
    iv. Exchanges (students, sabbaticals, professional)
    v. Degree programs for island students
    vi. Develop Pacific Curriculum
3. Ecological
    i. Biodiversity conservation (native plants, forests, oceans, restoration projects)
    ii. Sea level rise/Salt water intrusion
    iii. Fresh water supplies
    iv. Natural disasters
    v. Coral reefs & Oceans ecosystems
    vi. Plant diseases and insects (increasing?)
    vii. Computer modeling

4. Food Security and Agriculture
    i. Increase local food production
    ii. AG research (plant breeding)
    iii. 4H programs
    iv. Climate resilient crops
    v. Climate smart agriculture
    vi. Small farms
    vii. Food Policy Councils

5. Energy
    i. Fossil fuel dependency
    ii. Affordability
    iii. Alternative energy sources
6. Tourism?
7. Climate Change
    i. Climate adaptation measures
    ii. Unique Pacific-based model for adaptation and mitigation
    iii. Biodiversity: Salt-tolerant taro

Shared Values:

- Respect, Cooperate, Share, Need to Collaborate, Address Conflicts
- Learn from the past, Document traditional knowledge
- Lots of opportunities to work together
- Education starts with kids
- Technology is power
- Need paradigm shift (?)

Methods for Achieving Goals (items from Oct 26 picture) :

- Capacity Building
- Data – centralized, monitoring methods, shared
- Learning Commonalities/Learning Exchanges
- Project Management and Coordination
- Administration (grants and financial management)
- Equipment (satellites, UAV, spatial data, supercomputers, etc.)
- Strengthen links between education and outreach – Extension activities
- Strengthen research in small islands