

# CLIMAS ANNUAL PROGRESS REPORT

As reflected in the task-area summaries below, CLIMAS has again experienced a very active year in terms of both research and outreach. The addition of Bonnie Colby, Dan Osgood, and Maria Carmen Lemos to the team added expertise in the key areas agricultural economics (Colby and Osgood) and co-production of science and policy (Lemos).

**TASK AREA:** Climate Variability – Recent

**PI:** Andrew Comrie; **Researchers:** Mary Glueck (postoc)

## I. Progress: 2002 – 2003 Budget Year

### A) Climate and Health/Air Quality

*Description.* The purpose of this task is to provide an improved understanding of how climate variability influences air quality in the Southwest, particularly at interannual and longer time scales, and to better assess the probability of future climate variability threatening air quality across the region. The project examines two key pollutants, ozone and particulate matter, across a range of urban areas in the Southwest in order to determine the climatic component of air quality variability and trends in the region. Local and state agencies (as well as the EPA) are keen to understand how climate variability plays a role in changing air quality from year to year and over multiple years, especially in the Southwest where climate-air quality links are poorly understood relative to other parts of the nation. These stakeholders want to know how climate has influenced their air quality historically, and how knowledge of ENSO, PDV and possibly climate forecasts can help them in their planning and decision-making to manage regional air quality. For ozone, the stakeholders are concerned about the chances for another hot stagnant summer such as 1995. For particulate matter, the stakeholders are concerned about drought issues combined with high wind events in multiple seasons, such as in 1999 and more recently. Furthermore, stakeholders would like to know what the “real” underlying trends in these pollutants are (reflecting management actions) without the confounding effects of climate variability. Current project year tasks (2002-03) are to develop the methodologies and stakeholder groups for Southern Arizona; project year 2 (2003-04) tasks are to expand these tested approaches and groups to a broader set of cities across the Southwest (Phoenix, Albuquerque, Las Vegas, El Paso, etc.).

*Accomplishments.* We carried out literature review and identified candidate analytical methods, developed a southern Arizona stakeholder group via phone and email contacts, and held an initial stakeholder meeting in Tucson in December 2002 to communicate project details and to refine issues of concern among decision-makers. Based on stakeholder input, we decided to focus the first phase of the project in Tucson on tropospheric ozone, followed by particulate matter. We followed up by obtaining and analyzing daily 8-hour average ozone concentrations and daily maximum surface temperature values for the time period 1990 to 2002. We selected the Kolmogorov-Zurbenko (KZ) filter as principal analysis tool for this phase. The KZ filter was used to separate ozone concentrations and temperature values into their short-term components (variation due to weather), seasonal components (solar variation), and long-term trend

components (change attributable to climate or policy). The temperature-adjusted trend we obtained represents percent change from long-term mean ozone concentration due to effects other than temperature. It is most likely a reflection of changes in anthropogenic emissions as well as effects of other climate variables currently being analyzed. Implications are twofold: (i) recent declines in ozone are likely reflect underlying changes in emissions (good news for the stakeholders concerned with the outcome of management decisions); and (ii) higher ozone levels in the mid-1990's indeed appear to be caused by climate variability (temperature in particular), which will enable us to assess potential future climate impacts.

We produced a report covering the literature review and the above initial analyses for Tucson. By the end of the current budget year, we anticipate two additional stakeholder meetings: (i) a report-back session to a broader group of Southern Arizona stakeholders in April 2003; and (ii) the first meeting of the broader Southwest Cities stakeholder group initiating next year's activities will take place in Tucson in May 2003. One of our stakeholder agencies, Pima Association of Governments, will be paying for the costs (~\$10,000) and organizing this workshop/forum on Southwestern Air Quality in tandem with our CLIMAS study. We anticipate completing the Tucson ozone work by including the effects of other meteorological variables, such as mixing depth, specific humidity, and solar radiation. We will also have completed comparable analyses for trends in Tucson particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>), examined air quality and climate variables in other Southwest cities, and evaluate possible other methods to examine time series.

*Plans for the coming year:* Our assessment of climate and air quality will move from Tucson out to the major polluted cities across the Southwest (Las Vegas, Phoenix, Albuquerque, El Paso). Local agencies are sponsoring a stakeholder workshop for these places and state/federal agencies in May/June.

*Leveraging from other projects:* Stakeholder workshop sponsored by Pima Association of Governments (~\$10,000).

## **B) Climate Variability and Diagnostics**

*Description.* The project continued work on the nature and causes of climate variability across the Southwest, with foci on improving our understanding of regional and sub-regional climate variability (emphasizing precipitation), and identifying via diagnostic analyses those factors that may contribute to improved climate forecasts in the region. This task enables us to break up the CLIMAS region into detail rather than treating it as a whole. Current year tasks encompass monthly and annual analyses of sub-regional precipitation variability. Next years' tasks (2003-04) focus further on sub-regional variability and on specific spring/fall variability.

*Accomplishments.* We identified intra-regional patterns of winter precipitation variability in the Southwest and the wider western US, and linked these patterns to large scale ocean-atmosphere forcing. In particular, we identified for the western US the apparent "switching on and off" of significant ENSO forcing under different phases of the PDO. These results have very wide-ranging implications for our understanding and expectations of predictable seasonal climate relationships across the western US (and across the multiple western RISAs).

*Anticipated accomplishments by June 1, 2003 (end of budget year).* Initiate diagnostic analyses of spatio-temporal precipitation and atmospheric patterns to improve understanding of core winter and transitional synoptic-scale precipitation variability & aid predictability of winter precipitation and impacts in the region

### **C) Fine-Scale Gridded Climate Data/Downscaling**

*Description:* A primary objective of this project is to organize and host a workshop and grant-planning meeting for a major cross-RISA climate mapping project for multi-agency funding. This activity is now called WestMap, for the Western Climate Mapping Initiative. WestMap is a new fine-scale climate mapping, data validation/dissemination, climate education initiative focusing on the western United States. Tasks includes establishment of a consortium to develop and operate WestMap, host a planning workshop, compose a white paper introducing and defining WestMap, and compile a major research proposal defining activities and goals of WestMap for the purpose of seeking funding for WestMap activities/administration.

*Accomplishments:* The organizational “Geospatial Climate Mapping Workshop” was held in Tucson, January 8-9, 2003. Attendees included colleagues from USDA-NRCS, Scripps-CAP, CLIMAS-UA, PRISM-Oregon State, NOAA CDC, CIRES, NOAA-WRCC. We established the WestMap initiative and initial working consortium at the meeting. WestMap is conceived as a science plan that will seek funding and buy-in from multiple agencies, with idealized funding circa \$1 million for several years. We produced the final version of the WestMap white paper. A research proposal has been outlined based on the components of the white paper. By the end of the current funding year, we anticipate completion of major research proposal components for WestMap scientific activities and administration and creation of a WestMap project website.

*Non-CLIMAS Partners:* Kelly Redmond-WRCC, George Taylor-Oregon State Climatologist/PRISM, Chris Daly-OSU/PRISM, Robin Webb-NOAA CDC, Sasha Gershunov-SCRIPPS/CAP, Gary Bates-NOAA/CIRES, Greg Johnson-USDA/NRCS

*Leveraging from other projects:* WestMap proposals will seek funding from a variety of federal and other agencies. The central idea is for this to be a “seeded” activity that spins off from CLIMAS and obtains its own funding.

## **II. Publications**

### In print

Wise EK (2003) Assessing trends in ozone air quality. Interim report on the CLIMAS Climate and Air Quality Project for Tucson, Arizona.

Brown DP and Comrie AC (2002) Sub-regional seasonal precipitation linkages to SOI and PDO in the Southwest United States. *Atmospheric Science Letters* **3**: 94-102.

Brown DP and Comrie AC (2002) Spatial modeling of winter temperature and precipitation in Arizona and New Mexico, USA. *Climate Research* **22**: 115-128.

### In the publication pipeline

Wise EK and Comrie AC (2003) Assessing climate and air quality trends in the Southwest United States. In preparation for an applied climate or air quality journal.

- Full WestMap proposal that will be used to seek funding from major agencies.
- NOAA-CDC led WestMap proposal to ESDIM.

Diem JE and Brown DP (2003) Anthropogenic impacts on summer precipitation in central Arizona, USA. *The Professional Geographer*, in press.

### Submitted/will be submitted by June 1, 2003

Brown DP and Comrie AC. "PDO selectively diminishes winter season ENSO-precipitation relationships in the Western United States." To be submitted to *Nature* or *Geophysical Research Letters*.

### Other

Comrie AC *et al.* 2003. WestMap: The Western Climate Mapping Initiative. White Paper produced for consortium and promotional use.

## **III. Presentations at Professional Meetings/Conferences**

Wise, EK and Comrie, AC (2003) Assessing Climate-Related Air Quality Trends in the Southwestern United States. Poster Presentation, Annual Meeting of the Association of American Geographers, New Orleans, March 2003.

Brown DP and Comrie AC (2003) PDO selectively removes winter season ENSO-precipitation signal in the Western United States. Presented at the 20th Annual Pacific Climate Workshop on Climate Variability of the Eastern North Pacific and Western North America, April 6-9, 2003, Pacific Grove, CA.

Brown DP and Comrie AC (2003) ENSO and PDO forcings on regional-scale winter precipitation variability in the Southwest United States. Presented at the 99th Annual Meeting of the Association of American Geographers, March 5-8, 2003, New Orleans, LA.

Comrie AC (2003) WestMap – The Western Climate Mapping Initiative. Paper presented at PACLIM Pacific Climate Conference, Asilomar, CA, April 2003.

## **IV. Outreach Activities**

Comrie AC. Initial Southern Arizona stakeholder meeting held in December 2002. Approximately 12 Participants from Arizona Department of Environmental Quality; Pima County Department of Environmental Quality; Pima Association of Governments; U.S. Environmental Protection Agency. Two more stakeholder meetings are planned before the end of the budget year. (April and May 2003 – see above).

Comrie was a panel member for a press briefing on the drought, summer 2002.

Comrie, AC. Promotion of WestMap at All-RISA meeting in Scottsdale, March, 2003.  
Meetings with Washington D.C. agencies in April 2003.

**TASK AREA:** Climate Variability – Paleo

**PI:** Malcolm Hughes; **Researchers:** Kurt Kipfmuller, Fenbiao Ni (postdocs)

## **I. Progress – 2002 – 2003 Budget Year**

### **A) Reconstructions of winter half-year precipitation.**

*Description and accomplishments.* A paper reporting reconstructions of winter half-year precipitation in each NOAA climate division of both Arizona and New Mexico from AD 1000 to 1988 has been published in the International Journal of Climatology (Ni et al., 2002), and the reconstructions made publicly available through the NOAA NCDC Paleoclimatology program (<http://www.ngdc.noaa.gov/paleo/pubs/ni2002/ni2002.html> and [ftp://ftp.ngdc.noaa.gov/paleo/treering/reconstructions/northamerica/usa/az-nm\\_div\\_precip.txt](ftp://ftp.ngdc.noaa.gov/paleo/treering/reconstructions/northamerica/usa/az-nm_div_precip.txt)). In order to find ways to make these and other paleo data accessible and useful to stakeholders we have been developing fact sheets that describe past droughts in the Southwest. These sheets include information relating to the most extreme drought years and periods over the last 100 years from the instrumental record and last 1000 years utilizing the Ni et al. reconstructions. The drought fact sheets also include information relating to the persistence of past drought in the Southwest as well as a comparison of the most recent drought period to droughts of the past.

Currently, a drought fact sheet is available based on a statewide average for Arizona. The 1000-year reconstructions of cool-season precipitation are being compared with the instrumental period to identify droughts of similar magnitude to that experienced in the Southwest over the last four to seven years. The most recent drought period does not appear to be anomalous with respect to the last 1000 years or even the last 100 years. The most recent drought is similar in magnitude to that of the drought of the 1950s and around the turn of the century, based on a statewide average. There are also notable droughts earlier in the record, particularly a seventeen-year drought from 1654-1670 and an eighteen-year drought from 1773- 1790. During the late 1600s drought only two years received normal or better precipitation and the average percentage of normal was 66%. The late 1700s drought was similar with only one year during the drought experiencing normal precipitation and an average percent normal during the drought of only 64%.

Current work includes development of individual fact sheets for each climate division in Arizona and New Mexico. Additional work includes the development of suitable graphics for presentations and publication to the Internet, and the development of instruments to test their efficacy.

**B) PDO Research.** In collaboration with Nate Mantua of the University of Washington and others, work has progressed on the use paleo data to examine Pacific Decadal Variability and its regional implications. Data were collected and distributed to members of the research group and initial analyses begun. The first public presentation of these analyses was made at the 2003

Pacific Climate Workshop (PACLIM) at Asilomar, California. The lead authors involved two RISA's – Alexander Gershunov of SIO and CAP and Malcolm Hughes and Michael Evans of the University of Arizona, along with the membership of the past PDO group that includes colleagues from the Universities of Washington and Colorado, *inter alia*. We presented a "Proxy reconstruction of the entire Pacific sea surface temperature field" from the late 17<sup>th</sup> century to the late 20<sup>th</sup> century, from which an index of the Pacific Decadal Oscillation was derived. As have other authors, we note that the time scales of the variability were shorter before the observational period. One important question that arises from this is whether these fluctuations, and their effects in the regions of interest to CLIMAS, have undergone significant change in recent decades that may have concomitant effects on, for example, the predictability of ENSO impacts. *Accomplishments*. We have completed our work reconstructing precipitation in Arizona and New Mexico and have made substantial progress toward developing data delivery formats. We have explored the relative utility of neural network versus statistical models for reconstruction purposes. Further work on identifying ways to introduce the reconstructions to stakeholders is being conducted in close liaison with the CLIMAS Core Office.

The paleo reconstruction activity is being phased out of CLIMAS, to be replaced with mesoscale fire-climate research to be headed up by Dr. Thomas Swetnam, Director of the Laboratory of Tree-Ring Research.

## **II. Publications**

### In print

Sheppard, P., Andrew C Comrie, Gregg D Packin, Kurt Angersbach, Malcolm K Hughes (2002) The climate of the US Southwest. *Climate Research*, 21, 219-238.

Fenbiao Ni, Tereza Cavazos, Malcolm K. Hughes, Andrew C. Comrie, and Gary Funkhouser (2002) Cool Season Precipitation in the Southwestern United States since AD 1000: Comparison of Linear and Nonlinear Techniques for Reconstruction. *International Journal of Climatology* 22, 1645-1662.

### In preparation

Hughes, M.K., Ni, Fenbiao and Funkhouser, G. Reconstructed atmospheric/oceanic indices since AD 1000 from tree rings in Western North America.

Hughes, M.K., Funkhouser, G. and Ni, Fenbiao. Spatial reconstructions of summer drought since AD 1000 in the western United States.

## **III. Presentations at Professional meetings/Conferences, etc.**

Hughes MK. ENSO and decadal teleconnections in western North America during recent millennia. Malcolm K. Hughes, Fenbiao Ni and Gary Funkhouser InterAmerican Institute for Global Change CRN workshop, Oaxaca, Mexico, April 18-22. Invited

Hughes MK. Invited seminars, Yale University, New Haven, CT, September 22 – 23.

Hughes MK. Interannual to Century-scale Climate Variability in Western North America. Sierra Nevada Science Symposium, North Tahoe, CA, October 7 – 10. Invited.

Hughes MK. Just Over the Horizon: Climate Variability at Multi-decadal to Century Time Scales From Tree Rings. Workshop on Historical Climate Reconstruction over East Asia, Beijing, China, October 14-16, 2002. Invited.

Hughes MK. Just Over the Horizon: Climate Variability at Multi-decadal to Century Time Scales From Tree Rings. Institute of Earth Environment of the Chinese Academy of Sciences, X'ian, China, October 18, 2002. Invited speaker.

Hughes MK. Some thoughts on IGBP PAGES. Paleoclimate Workshop, Ehime University, Matsuyama, Japan, Nov. 28-30 Invited.

#### **IV. Outreach**

Kurt Kipfmueller – panel discussion on drought at special meeting of all district chairs of the Arizona Farm Bureau, State Capitol, Phoenix.

#### **TASK AREA: Forecast Evaluation**

**PIs:** Roger Bales, Soroosh Sorooshian; **Researchers:** Holly Hartmann (Research Scientist); Jean Morrill (postdoc)

#### **I. Progress – 2002-2003 Budget Year**

##### **A) Assess utility of seasonal water supply outlooks & regional hydroclimatic patterns, with particular emphasis on snowpack**

*Description.* This subtask will use forecast evaluation results to springboard exploration of the role of hydroclimatic variability and uncertainty. Particular emphasis is placed on remote sensing snow products developed under NASA-RESAC (Regional Earth Science Application Center) and both experimental and operational products developed by NWS-NOHRSC (National Operational Hydrologic Remote Sensing Center), as a means to evaluate and improve outlook skill.

*Plans for the coming year.* As a first priority for decision-making, water resources managers want to know how much snow is in the mountains and how rapidly it is being depleted. From feedback at our recent workshops, they also want to see depletion patterns, essentially spatial depletion curves, for past years. User support and feedback will involve our SWE (snow water equivalent) products, NOHRSC's SNODAS (snow data assimilation) product and our SCA (snow covered area) products.

Two separate tasks will be accomplished. The first will involve spatial evaluation of water supply outlooks, gridded (experimental) outlooks and snow products (time series of SCA and SWE). Areas where persistent snowcover is observed versus forecasted will be identified and

patterns evaluated. This is an important step in identifying where improvements in measurements and modeling will have the greatest impact on snowpack estimates. In addition, stakeholders need to better understand the uncertainties associated with snowpack and snowmelt runoff forecasts. This leads to the second task, which is exploring, with the stakeholders, how improvements in the snow products would enhance stakeholder decision-making. In this process, stakeholders will give feedback on the distributed snow information, value added to their decision making process, and a synopsis of what value the information would have provided in previous operational forecast years. Feedback will be facilitated by on-site discussions of the snow product.

*Partners.* Stakeholders will include the Salt River Project, New Mexico state engineer, Colorado state engineer, the California Department of Water Resources and others in the same areas. We will coordinate with the NRCS and NWS forecasting offices, with NOAA's Climate Diagnostics Centre, and with the other western RISA's.

## **B) Evaluate historical official water supply forecasts**

*Description.* We assembled and updated a data set containing seasonal water supply outlook forecasts for the Colorado River Basin (136 sites on 84 water bodies) and reconstructed flow data (what the observed flow most likely would have been in the absence of diversions). Reconstructed flow data came from two different sources – Tony Tolsdorf of the Colorado USDA NRCS office and Steven Shumate of NOAA – with no overlapping points for comparison. The forecast streamflow dataset was originally compiled in 1998 by Paul Whitaker, but required updating for the past several years of data. 63 sites have 20 or more years of both forecast and observed data, and another 40 sites have 7-15 years of data. We used many different methods to compare the forecast streamflows with reconstructed “observed” flows. Our first analysis uses traditional deterministic statistics (root mean square error, bias, correlation coefficient, etc.), categorical tests (probability of detections, false alarm rate), probabilistic measures (Brier score, ranked probability score), and distribution-oriented evaluations (discrimination, reliability, sharpness).

*Accomplishments.* An initial assessment of these results, using 13 of the 15 streams/basins included by K. Franz in her paper shows that the proportion of correct forecasts (based on lower 30% - middle 40% - upper 30% groupings) tend to improve as the forecast season progresses. Forecasts made later in the season are generally better than those made earlier in the season. Moderate flows are correctly forecast 80-95% of the time, low flows less than 25% of the time, and high flows less than 15% of the time. Comparison of the Brier skill scores and ranked probability skill scores (comparing scores using the forecast data with those based on the historical data) do not suggest that the forecasts are significant improvement over the probability distribution of the entire climatological record, although they sometimes are an improvement over the data available at the time they were made. Of the first 13 sites examined, the two with the best forecasts throughout the forecast season (January-May) were Los Pinos River near Bayfield and New Fork River, near Big Piney. The least accurate forecasts occurred for East River near Almont. The most improvement during the forecast seasons occurred for the Florida River inflow to Lemon Reservoir and the Virgin River.

A paper based on the analysis should be ready to submit by June 1.



### **C) Extend evaluation of Extended Streamflow Prediction (ESP) water supply forecasts for downstream locations in the Colorado River basin**

*Description.* At the request of the NWS Office of Hydrologic Development, Kristie Franz evaluated the requirements for applying probabilistic forecast evaluation procedures used in CLIMAS research to evaluate other operational ESP forecasts that have been generated by the NWS, including water supply, peak flow, mean flow, and precipitation forecasts. Due to lack of archived information about forecasts and ancillary modeling conditions (e.g., initial states) complete evaluation of the various ESP forecasts was not possible. However, the project did inform the NWS what forecast information must be archived in order to implement the evaluation procedures at all NWS River Forecast Centers. Activities have led to continued interactions with NWS-OHD about integrating a comprehensive and consistent evaluation procedure into the NWS forecasting system.

Additional work focused on giving presentations and finishing publication of material related to evaluation of probabilistic forecasts, including ESP forecasts.

*Accomplishments.* Progress in this task was delayed by lack of availability of a graduate student. However, based on strong interest and leveraged funding by a significant stakeholder (the federal agency responsible for operational hydrologic forecasts), we succeeded in extending our forecast evaluation framework to a broader variety of hydrologic forecasts. By the end of this budget year, we anticipate publication of a journal article, with NWS-OHD and RFC collaborators, about the current state of archived RFC information and the operational challenges of continuous forecast evaluation (anticipated by end of summer 2003).

*Non-CLIMAS Partner:* National Weather Service Office of Hydrologic Development and River Forecast Centers

*Leveraging from other projects/sources:* Short-term contract with NWS OHD

### **D) Improve seasonal water supply forecasts**

*Description.* Tom Pagano has been working on this task, in his dual role as PhD student in the Department of Hydrology and Water Resources and Lead Forecaster with the Natural Resources Conservation Service. In particular, Tom has been exploring options for developing ESP forecasts based on the operational statistical regression forecast techniques. The technique is based on rescaling historical daily hydrographs so that they are consistent with the available seasonal water supply volume forecast distribution. Most progress will occur this summer, however, after the current water supply forecast season.

*Non-CLIMAS Partners:* Natural Resources Conservation Service

### **E) Extend forecast evaluation web tool (FET) to include seasonal water supply forecasts**

*Description.* The first-cut prototype of the interactive forecast evaluation and interpretation tool has been converted into a functional “product” that became available to selected users in October 2002 and as an open beta-release version in March 2003. Throughout, the web tool in its various stages of development has been presented in a variety of settings (see list below). In the earliest versions, some web tool elements were simply static images illustrating our plans for product

development. Later versions of the prototype varied as different elements became functional. However, in all prototypes, some web tool elements lacked final full functionality due to limitations in data (e.g., an incomplete historical forecast image archive) or programming complexities (e.g., selection of forecast seasons and lead times). Further, elements performing real-time computations and producing user-determined graphics products were slow enough to be frustrating when using telephone Internet connections. However, each prototype allowed us to present controlled demonstrations of the webtool and obtain feedback from potential users about specific aspects of implementation, solicit ideas for extending the webtool, and garner support for the webtool and HyDIS (i.e., developing a HyDIS constituency).

Interactions with stakeholders during the forecast evaluation tool demonstrations confirmed that it is an ideal platform for enhancing understanding of seasonal forecasts and discussing issues associated with seasonal probabilistic forecasts, their use, and accommodation of uncertainty. Uniformly, interest in the online tool was greater than we expected. Indeed, after the prototype demonstrations many individuals wanted personal access to the website. However, comments from stakeholders suggested that websites under development (e.g., with broken links, segments that are down) can result in frustration and poor credibility. Thus, we decided on a staged release of the forecast evaluation tool, whereby individuals could sign up as beta-testers for the first “commercial quality” version, to be followed later by an open release. However, creation of a robust system that could be efficiently maintained and extended required significant foundational development (e.g., developing Java-based graphical tools, implementing a system for managing incremental website enhancements). Further, because interest in forecasts is concentrated near the time of release from the forecasting agencies and the limited resources of some decision makers, our webtool design specifications included achieving reliable support of multiple simultaneous users on a variety of browsers with Internet connections of moderate speed, increasing our programming requirements.

*Plans for the coming year.* Our experience raises questions about the approach used to develop and distribute webtools. On one hand, demonstration of even primitive prototypes enables in-depth dialogue with potential users from a shared vision or concrete experience, as they respond to specific webtool elements (e.g., specific concepts and graphical products) Demonstrations also generate enthusiasm about a project, preparing a ready user-based when the product becomes available. On the other hand, potential users (and webtool developers) can get frustrated with the lag between presentation of project plans and the availability of the webtool for their own use. What is the right balance between showing initial ideas, demonstrating webtool elements under development, and presenting fully functional webtool products? Long-term acceptance of the webtool by resource managers as a useful system to support decision making requires significant commitment to development of a “commercial quality” website, but should users be kept waiting (for months to even a year or two) while a comprehensive web development system is developed? If an intermediary phase webtool is to be made available, should the developers focus on functionality and release the webtool with a less-developed (i.e., less intuitive) interface? Or should the intermediate webtool have limited functionality but a sophisticated interface? Our comparative approaches and experiences with the Forecast Evaluation Tool and other webtools developed under the HyDIS project can help develop insights about the process of webtool development and product release vis-a-vis user interaction and support. Additionally, in every interaction with other scientific groups, we have heard interest in collaboration in

servicing other advanced scientific information. Through demonstration of the FET, the scientists have gained a concrete understanding of the difference between (1) simply providing data or conducting outreach and (2) enabling knowledge development and providing tools to support decision makers. We anticipate extensive publications and newsletter notices about the availability and function of the web tool. We also anticipate preliminary addition of ESP forecasts from the work of K. Franz and historical forecasts from the work of J. Morrill.

*Leveraging from other projects: HyDIS, GAPP*

## **II. Publications**

### In print

Hartmann HC, Pagano TC, and Sorooshian S (2002) Customized on-line climate forecast evaluations: a tool for improving water and watershed management. Preprint Volume, 10<sup>th</sup> Conference on Agricultural, Range, and Aviation Meteorology, American Meteorological Society, Boston, MA.

### In review

Franz KJ, Hartmann HC, Sorooshian S, and Bales R (2003) Verification of National Weather Service ensemble streamflow forecast predictions for water supply forecasting in the Colorado River Basin. *Journal of Hydrometeorology* (in revision).

### Submitted/will be submitted by June 1, 2003

Journal article, with NWS-OHD and RFC collaborators, about the current state of archived RFC information and the operational challenges of continuous forecast evaluation (anticipated by end of summer 2003 for *Journal of Hydrometeorology*).

Hartmann, HC, S Sorooshian, R Bales, BJ Morehouse, TC Pagano, GM Garfin, and H Eakin, Forecast Assessment as Stakeholder Driven Research Process and Product in the Southwestern United States. (in preparation).

Morrill JC, Bales RC and Hartmann HC. Evaluation of water supply outlook forecasts in the Colorado River Basin. (in preparation)

Hartmann, HC. et al. Short article for BAMS (requested by editors) describing the forecast evaluation tool.

### Non-Traditional Products

Forecast Evaluation Webtool, beta-release version 1.0, March 2003. (Available at [hydis6.hwr.arizona.edu/ForecastEvaluationTool/](http://hydis6.hwr.arizona.edu/ForecastEvaluationTool/))

## **III. Presentations at Professional Meetings/Conferences**

Franz KJ, Hartmann HC, Sorooshian S, Bales R (2002) Evaluation of Colorado River Basin Ensemble Streamflow Predictions, 82<sup>nd</sup> Annual American Meteorological Society Annual Meeting, Orlando, Florida, January 2002, 16<sup>th</sup> Annual Conference on Hydrology, J109-J112.

Franz K, Hartmann HC, and Sorooshian S (2003) Evaluation of National Weather Service ensemble streamflow predictions (ESP) for the Colorado River Basin. HWR 03-010, Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ.

Bales R and Liverman D (2002) Reducing vulnerability to hydro-climatic variability through integrated assessment in the southwestern U.S. American Meteorological Society Annual Meeting, Feb. 2002, Long Beach, CA.

Bales, R (2002) Can science help achieve sustainability of water in the Southwestern US? AAAS Annual Meeting, Feb. 2002, Denver. Invited.

Hartmann HC, Pagano TC, Franz K, Sorooshian S, and Bales R (2002) Evaluating the uncertainty of probabilistic predictions: techniques, applications and implications. EOS, Transactions of the American Geophysical Union, Spring Meeting Supplement, Abstract H42E-01, Washington, DC, 29 May – 3 June.

Hartmann HC, Pagano TC, and Sorooshian S (2002) Online interactive seasonal forecast evaluations: a tool for improving water resources management. Mississippi River Climate and Hydrology Conference, GEWEX Continental Intercomparison Project and GEWEX Americas Prediction Project, New Orleans, LA, 13-17 May.

Hartmann HC, Pagano TC, and Sorooshian S (2002) Customized on-line climate forecast evaluations: a tool for improving water and watershed management. 10<sup>th</sup> Conference on Agricultural, Range, and Aviation Meteorology, American Meteorological Society, American Meteorological Society, Portland, OR, 13-16 May.

Hartmann HC (2002) A customizable online forecast assessment tool to support resource management decisions. Informal Seminar Series, Office of Hydrologic Development and Climate Services Division, NOAA, Silver Spring, MD, 31 October.

Hartmann HC, Imam B and Sorooshian S (2003) A user-centric hydroclimatic decision support tool for resource management. Workshop on Managing Water Resources Under Conditions of High Climatic Variability in the US-Mexico Border Region, Centro de Investigaciones Biologicas del Noroeste, La Paz, Baja California Sur, Mexico, 14-17 January. Invited.

Hartmann HC, Pagano TC, Lay E, Imam B, and Sorooshian S (2003) A customizable online forecast assessment tool to support improved resource management decisions. 83<sup>rd</sup> Annual Meeting, American Meteorological Society, Long Beach, CA, 9-13 February.

Hartmann HC (2003) Advanced hydrologic research tools to improve water resource management. Workshop on Soil Moisture Variability in the Rio de la Plata Basin: Assessments of the Impact of its Variability and Forecast Applications for End Users, Centro de Previsao de Tempo e Estudos Climoticos and Intituto Nacional de Pesquisas Espaciais, Cachoeira Paulista, Sao Paulo, Brazil, 17-19 March. Invited.

Hartmann HC, Imam B, and Sorooshian S (2003) Delivering climate and resource information over the internet: HyDIS project, lessons learned on implementing a usable website. Workshop on Soil Moisture Variability in the Rio de la Plata Basin: Assessments of the Impact of its Variability and Forecast Applications for End Users, Centro de Previsao de Tempo e Estudos Climoticos and Intituto Nacional de Pesquisas Espaciais, Cachoeira Paulista, Sao Paulo, Brazil, 17-19 March. Invited.

#### **IV. Outreach Activities**

H. Hartmann and T. Pagano, 2002. HyDIS First Annual User Workshop, University of Arizona, Tucson, AZ, 3-4 October. Hartmann conducted a 2-hour intensive training and usability assessment of the forecast evaluation webtool, while Pagano participated as a water resource management stakeholder in his professional capacity as a forecaster for the Natural Resources Conservation Service.

Hartmann, H. Demonstration of Prototype Online Forecast Evaluation Tool:

- Capitol Hill Demonstration, NASA/Raytheon Synergy Project, Dirksen Senate Office Building, Washington, DC, 4 June 2002
- HyDIS First Annual User Workshop, University of Arizona, Tucson, AZ, 3-4 October 2002
- Office of Hydrologic Development and Climate Services Division, Silver Spring, MD, 31 October 2002
- Climate Prediction Center, NOAA, Camp Springs, MD, 1 November 2002
- Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI, 14 November 2002

H. Hartmann and T. Pagano, 2002. Climate Predictions Assessment Workshop, Universities Consortium for Atmospheric Research and National Oceanic and Atmospheric Administration, Alexandria, VA, 28-30 October.

H. Hartmann, 2003. Workshop on Managing Water Resources Under Conditions of High Climatic Variability in the US-Mexico Border Region, Centro de Investigaciones Biologicas del Noroeste (CIBNOR) and the National Oceanic and Atmospheric Administration, La Paz, Baja California Sur, MX, 14-17 January. Invited.

H. Hartmann, 2003. Regional Integrated Sciences and Assessments (RISA) National Program Meeting, Scottsdale, AZ, 11-13 March. Panelist on research validation and verification.

H. Hartmann, 2003. Workshop on Soil Moisture Variability in the Rio de la Plata Basin: Assessments of the Impact of its Variability and Forecast Applications for End Users, Centro de Previsao de Tempo e Estudos Climoticos and Intituto Nacional de Pesquisas Espaciais, Cachoeira Paulista, Sao Paulo, Brazil, 17-19 March. Invited.

Hartmann, H.C., 2002. END-Insight Press Briefings held in Albuquerque, NM; Phoenix, AZ; and Tucson, AZ.

H. Hartmann, 2003. Policy Forum on Improving Responses to Climate Predictions. American Meteorological Society and Columbia University, Washington, DC, 23-24 April.

**TASK AREA:** Border Research

**PI:** Diana Liverman

### **I. Progress: 2002 – 2003 Budget Year**

*Description.* This task area saw little activity during 2002 – 2003 due to the fact that the PI served as acting Dean for the UA School of Social and Behavioral Sciences. Dr. Liverman has, however, continued to serve on graduate committees of students doing CLIMAS-related border work and to serve as a valuable spokesperson for CLIMAS and the RISA program throughout the Southwest, the US, and abroad. As indicated in the proposed research plans section below, Dr. Liverman will be conducting border research activities during the 2003-2004 budget year.

*Plans for the coming year.* Collaboration will be initiated with UNAM (through Hallie Eakin and Cecilia Conde) on theorizing relationships between globalization and global climate change in Mexico. A pilot study will be conducted and survey development in Mexico will be undertaken during summer of 2003 to understand the role of livelihood strategies and climate information in adaptation to climate variability and change. Plans also include preparation of major research paper to be presented at IHDP meeting in Montreal on the relationship between neoliberal policy and vulnerability to environmental change in northern Mexico in session on "Vulnerability to Multiple Stressors: Globalization and Climate Change." It is anticipated that a paper will be completed for publication on the drought of the 1950s in Sonora which will combine existing fieldwork and data analysis on the social impacts of the 1950s drought using new data from Art Douglass. This paper will illustrate some important points about environmental explanations of migration, adaptation to drought, and lessons we can learn from earlier periods of climate impacts. In addition, a co-authored paper will be completed with Dr M. Wilder (Center for Latin American Studies) and Dr P. Romero (UNAM) on the restructuring of water management and vulnerability to climate change and variations in Mexico.

**TASK AREA:** Institutional Analysis

**PI:** Maria Carmen Lemos

### **I. Progress: 2002 – 2003 Budget Year**

#### **A) Introductions of Innovations into Water Management**

*Description.* The primary goal of this task is to assess capacity for innovation as a means of mitigating vulnerability to climate variability in Arizona's urban water sector. We seek to understand what formal and informal institutions constrain or provide opportunity for the use of climate related decisionmaking tools in water management in Arizona. One additional goal of the research is to compare results from Arizona with previous research carried out in California, Pacific Northwest and DC Metropolitan region and NE Brazil.

*Accomplishments.* Design of protocol and theoretical model has been completed. Interviews have been completed with local, state, federal, public and private water institutions in Phoenix, Yuma, and Tucson, Arizona. A short writing retreat is planned to draft two articles: one analyzing the role of climate information in Arizona and another comparing institutional flexibility of the adoption of innovation (in this case climate information) in NE Brazil and Arizona. An abstract of the second article has been accepted for presentation in the World Water Congress to be held in Madrid in October 2003.

**B) Institutional Analysis of Vulnerability to Climate Variability in Rural Water Sector-Safford AZ** (in collaboration with the Vulnerability Analysis group—Marcela Vasquez, Co-PI)  
*Description.* We are examining the types of multi-scaled governance regimes that have arisen in the Upper Gila River Valley to manage uncertainties concerning resource availability and institutional complexity.

*Accomplishments.* Interviews have been completed in Safford with farmers, ranchers, BLM officials, and cotton gin owner. A first draft of graduate research assistant Alison Schneider's MA thesis, entitled: "Polycentric governance and managing uncertainty in water resources: Upper Gila River Valley, Arizona" has been completed. She is expected to defend her thesis in the Spring of 2003.

*Other:* Melissa Hart, who worked for the project as a graduate research assistant in 2001, will defend her Master's thesis, which analyzes the institutional arrangements affecting binational conservation in the Upper San Pedro River watershed, especially water management and use in the face of scarcity. Co-PI Maria Lemos has been also working on two articles with other CLIMAS Co-PIs. Publication of these papers is anticipated in the near future: one with Barbara Morehouse which is at an advanced draft stage and one with Andrew Comrie, Malcom Hughes and Jonathan Overpeck

*Leveraging from other projects:* National Science Foundation – NSF: "The Impact of the Use of Techno-Scientific Knowledge in Water Management: institutional adaptation and public participation in a comparative perspective. US\$ 135,000 and National Oceanographic and Atmospheric Administration—NOAA "Climate, Water Scarcity and Management in Brazil and Chile" with M. Keck and A. Leon. US\$ 229,900.

## **II. Publications**

Submitted/will be submitted by June 1, 2003

Lemos, MC and BJ Morehouse. In preparation. Modeling the Co-Production of Science and Policy in the Context of Integrated Climate Assessment.

Lemos, MC (submitted). Techno-scientific knowledge and water management: lessons from Brazil and United States. Submitted to the Proceedings of the XI World Water Congress of IWRA.

### Related publications

Lemos, MC (2003) "A Tale of Two Policies: the Politics of Seasonal Climate Forecast Use in Ceará, Brazil." *Policy Sciences*, in press.

Lemos, MC, T Finan, R Fox, D Nelson and J Tucker (2002)"The Use of seasonal climate forecasting in policymaking: lessons from Northeast Brazil." *Climatic Change*, vol. 55, issue 4, pp. 479-507.

**TASK AREA:** Economic Strategies to Address Climate-related Water Supply Variability

**PIs:** Bonnie Colby and Daniel Osgood

### **I. Progress: 2002 – 2003 Budget Year**

#### **A) Research and Outreach with Agricultural, Environmental, and Municipal Stakeholders**

*Description.* Work with the agricultural sector is directed toward two groups. For the first group, ranch operations, modeling is based on the theoretical structure behind the Calfweight Web project. Osgood's Cooperative Extension program provides ongoing outreach to ranchers, including internet tools used to help make management decisions. Calfweight is a new Web-based GIS product to assist ranchers in analyzing profitability tradeoffs, such as deciding how long to wait before they sell their calves. The second group in the agricultural sector is ranchette owners. Ranchettes are small ranches operated for recreation instead of profit. These now constitute a major land use in much of the rural Southwest. Research has shown that the recreational benefits accrued from these operations are highly linked to precipitation supplied vegetation. Ranchette analysis is ongoing and will enable quantification of the value of climate forecasts to this growing sector.

We also are analyzing the effects of climate variability and climate information on those urban constituencies that rely on healthy riparian habitat for a mix of services including recreation, wildlife habitat, flood control, water filtration and open space. Such constituencies include property owners, regional residents, water utilities and public agencies responsible for water supply, water quality and flood control. Riparian issues are at the forefront of policy discussions in Arizona and New Mexico, and this work provides valuable information for developing riparian protection recommendations. Policymakers and stakeholder groups have been active in research design and in disseminating research findings.

*Accomplishments:* Data are currently being collected and analyzed to quantify the relationships between property values and proximity to riparian habitat with differing vegetation characteristics, characteristics that are influenced by climate variability. A user-friendly menu of policy instruments is under preparation for use by municipal, state, tribal and federal water managers during drought to mitigate water supply variability. Analysis of the role of climate information in ranch management and in rural land development decisions is underway.

*Plans for the coming year.* Ranchette analysis is ongoing and will enable quantification of the value of climate forecasts to this growing sector. We are collecting new data on riparian habitat



characteristics that will enable us to more precisely identify the components of riparian corridors that provide various types of economic benefits. We plan to complete and disseminate a menu of policy instruments for managing water supplies in the face of increased climate variability.

*Non-CLIMAS Partners:* SAHRA

*Leveraging from other projects:* “Measuring the Economic Value of Desert Riparian Habitat,” mini-grant from SAHRA, NSF Science and Technology Center, Semi-Arid Regions, funds one research assistant, 2002-03.

## **II. Publications**

### In print

Colby BG and Wishart S (2002) Quantifying the Influence of Desert Riparian Areas on Residential Property Values. *The Appraisal Journal*, 2002.

Colby BG (2003) Economic Characteristics of Successful Dispute Resolution Outcomes. Chapter in *Evaluating Environmental and Public Policy Dispute Resolution Programs and Policies*, R. O’Leary and L. Bingham, editors, Resources for the Future Press.

Colby BG (2003) The Role of Markets in Reallocating Irrigation Water. Chapter in *Encyclopedia of Water Science*, New York: Marcel Dekker.

### In the publication pipeline

Colby BG and d’Estrée TP (2003). *Braving the Currents: Resolving Conflicts Over the Water of The American West*, Kluwer Academic Publishers, 207 pages, forthcoming.

Colby BG (2003) Economics of Urban Water Demand and Supply. Chapter in *Managing Urban Water Demand*, N. Buras, editor, Kluwer Academic Publishers.

Orr P and Colby BG (2002) Institutions and Incentives to Protect Water-Dependent Amenities. Forthcoming in *Water Resources Research*.

### In review

Carrion C and Colby BG (2003) Climate Variability, Water Supplies and Implications for Native American Water Settlements in the Southwestern U.S., to be published in Colby, B.G. and John Thorson, *Smoke on the Water: One Hundred Years of Litigation and Negotiations Over Tribal Water Rights*, book manuscript under review, 489 pages.

## **III. Presentations at Professional Meetings/Conferences**

Colby, B.G. Keynote Speaker for *Interstate Waters: Crossing Boundaries for Sustainable Solutions*, Snowbird, Utah, 2002

Colby, B.G. Invited speaker, "Economic Incentives for Successful Inter-jurisdictional Water Management," University Council on Water Resources Research Annual Meeting, Michigan, 2002

Colby, B.G. Invited Speaker, Environmental Conflict Resolution: *The State of the Field and its Contributions to Environmental Decision-Making*, Tucson, Az, 2002

Colby, B.G. Invited Panelist, University of Colorado Natural Resources Law Center Conference, Boulder, 2002

Osgood, D.E., D. Bronson, and M.K. O'Rourke "Trade-offs in agriculture and children's health: A space, time, climate, occupational, and household based damage function for pesticide exposure." AERE session of annual ASSA meetings, January 2003. Washington, D.C.

**TASK AREA:** The Assessment and Monitoring of Vulnerability and Adjustment  
**PI:** Timothy J. Finan; **Researchers:** Marcela Vásquez León (postdoc)

#### **I. Progress: 2002 – 2003 Budget Year**

**TASK AREA:** The Assessment and Monitoring of Vulnerability and Adjustment  
**PI:** Timothy J. Finan; **Researchers:** Marcela Vásquez León (postdoc)

#### **I. Progress: 2002 – 2003 Budget Year**

##### **A) Monitoring of vulnerability and adjustment among groundwater-dependent livelihoods – Case Study of the Sulphur Springs Valley**

*Description.* The purpose of this task is to provide an improved understanding of the ways in which groundwater-dependent farmers are vulnerable to climate variability in the Southwest. This task was started on the previous budget year and was finalized at the beginning of the 2002-2003 budget year, with the completion of our second in-depth case study of communities in the Southwest. In this last phase, we finished and published the report of our findings. The process of finalizing the report included sending drafts of the report to stakeholders for comments. After the proper revisions were made the document was printed (Vasquez-Leon et al 2002). An executive summary of the report was sent to the stakeholders that participated in the project and a form was attached for those interested in receiving a copy of the full report. Our results were also presented at the 2002 Cochise County Ag Day held on February.

*Accomplishments.* We have published a report based on our research, which has been distributed to stakeholders in the study area. We have submitted three papers to peer reviewed journals, we anticipate submitting several more papers by June 2003. We have produced a variety of materials (newsletter articles, fact sheets, web-based summaries) for stakeholders. Data collected was used to create baseline profiles that represent the vulnerability of groundwater-dependent farmers and migrant farm workers in the Southwest (see GIS-based vulnerability map below).

*Plans for the coming year.* We plan to continue to participate in “Ag Day” on February of 2004. This is critical to give the project continuity and to strengthen our partnership with stakeholders.

*Leveraging from other projects.* Two projects on the implications of climate variability and environmental change in rural communities contributed to the theoretical development of the concept of vulnerability and served as case studies for comparison.

- “Economic and Demographic Causes of Land Use Change in Mexico” Latin American Area Center. Funded by NASA
- “Responding to Crisis: Rapid Environmental and Economic Change in the Mid-Gulf of California Fisheries” Bureau of Applied Research in Anthropology, funded by NSF
- Use and Usefulness: a Comparative Study of Seasonal Climate Forecasting Systems in Drought-affected Regions of Latin America

*Non-CLIMAS Partners:* University of Arizona Cooperative Extension

### **B) Surface water dependent livelihoods – Case study of the Middle and Upper Gila River**

*Description.* The objective of this case study is to examine the vulnerability of livelihoods that depend on surface water. We have identified two broad communities: Safford and the San Carlos Apache Tribe (SCAT). We have conducted background research on history of Indian tribes in the Gila River Valley, water law and the background of the water conflict in Safford Valley; history of San Carlos Apache cattle ranching; development of cotton farming along the Gila, and ecological change along the Gila. We have completed 90 percent of the fieldwork on surface water dependent agriculture and recreation in the community of Safford. We have conducted over 30 interviews with farmers, ranchers, BLM and NRCD staff, local government and irrigation district officials, Hispanic farmers, forestry and recreational personnel.

We also initiated contact with San Carlos Apache Tribe to obtain permission to conduct fieldwork with the tribe. A Memorandum Of Understanding (MOU) was drafted and we attended two formal presentations to tribal committees prior to full Tribal Council review. We originally planned to start fieldwork in the fall, but the process of finalizing the MOU has been slower than expected. Fieldwork, however, is scheduled to start in May. Our research is molded by what we find when we start going to the field; however, we anticipate that the most relevant livelihoods in this case will be timber, recreation and tourism, and ranching. We anticipate finishing fieldwork sometime in June.

*Accomplishments.* The fieldwork phase of this task was started later than expected, this was due to several factors. First, we had to wait for human subjects approval by the University of Arizona, this took more time than expected because it was decided that it would be better to obtain approval for all of CLIMAS research for the next 5 years. Second, in the middle of our negotiations with the Tribe, there were significant changes in the composition of the Tribal Council and a new chair was elected. This meant that we had to start again from zero. In terms of the fieldwork that has been completed to date, we have started to set up interview documents for text analysis software. We are also keeping apprised of developments in the pending legal cases concerning the water dispute, and monitor the local newspaper of Safford for relevant news. We have done substantial work in the writing of a report chapter on water law, and history and status of the water conflict in Upper and Middle Gila River Valley.

Data collected in this case study is being used to contribute to the creation of baseline profiles that represent the vulnerability of surface water-dependent rural livelihoods in the Southwest (see GIS-based vulnerability map below).

*Plans for the coming year.* After fieldwork is completed in June, we will continue writing up our results into a final report. The report will be presented and distributed to stakeholders in the study area. We anticipate submitting several papers to peer reviewed journals by June 2004. We will also use findings from this case –study to present at professional meetings and conferences.

We will also extend the vulnerability analysis to a fourth and fifth in-depth community/livelihood case studies in order to continue to provide baseline profiles that represent the most vulnerable communities/livelihoods/stakeholders in the Southwest. The fourth-case study will be carried out in northern New Mexico, focusing on traditional irrigated and rainfed agriculture. The fifth case study will focus on timber, recreation, and tourism livelihoods in northern Arizona and New Mexico.

*Non-CLIMAS Partners.* University of Arizona Cooperative Extension and San Carlos Apache Tribe.

### **C) Vulnerability Map – Construction of a GIS Vulnerability Map of the Southwest**

*Description.* The objective of this task is to synthesize our findings by constructing a GIS-based vulnerability map for rural communities in the CLIMAS region. Based on findings from our case-studies, we are developing a typology of community vulnerability, including definition of a set of critical characteristics. These are being compiled into a GIS vulnerability database and accompanying vulnerability map, which will depict vulnerability by geographical area across the region. This GIS product, in addition to classifying and mapping vulnerability types across the region, will incorporate data layers revealing the intensity and major drivers of vulnerability in each mapped area. Work on the vulnerability map started in the Fall 2002. At this point we are focusing on the development of a prototype drought vulnerability map for the southwest.

*Accomplishments.* The principal activity in the fall was data surveying. Agricultural and census data was collected, compiled and coded for spatial attribution. This was accomplished through online searches, personal interviews with field contacts, and through contact with persons and institutions at the University of Arizona, including the Agricultural Economics department, the Arizona Water Resources Research Center, Renewable Natural Resources, as well as individuals at the state Health and Human Services. Based on the data survey and key informant interviews and the ethnographic data collected over the past three years, several key variables were identified as significant indicators of vulnerability to drought. Currently the team is working to derive the core variables from collected data and to develop the data at appropriate scales for the different users envisioned.

*Plans for the coming year.* To calibrate the vulnerability map we will rely on secondary sources of information about other areas throughout the Southwest. We will start building the GIS of New Mexico using the same data sources as for Arizona. We will also start building a database on disaster payments as opposed to subsidy payments. In addition, we will systematically engage

in stakeholder outreach and consultation through meetings, mailed in questionnaires, and phone interviews with selected stakeholders that will provide information about their assessment of the accuracy and utility of the information provided by the vulnerability map.

*CLIMAS Partners.* Center for Applied Spatial Analysis (CASA). To initiate the vulnerability map project, a grant was obtained from the College of Social and Behavioral Sciences at the University of Arizona. The grant provided a quarter-time graduate assistant from CASA dedicated to the initial phase of the mapping project in the fall of 2002.

*Leveraging from other projects.* The NOAA-funded project in Northeast Brazil (Use and Usefulness: a Comparative Study of Seasonal Climate Forecasting Systems in Drought-affected Regions of Latin America), for which Tim Finan is PI, addresses issues in drought mitigation planning, using climate forecasts as a trigger for interventions. Work on this project by Don Nelson helped to develop some of the methodological approaches that are being applied to the CLIMAS vulnerability mapping project in the Southwest. Partners and colleagues include individuals from the state planning and agricultural secretaries, agricultural economics department at the federal university of Ceará, and from county level officials in all three of the participating counties.

## **II. Publications**

### In print

Finan, T. J., C. T. West, D. Austin, and T. McGuire. 2003. Processes of Adaptation to Climate Variability: a Case Study from the U.S. Southwest. *Climate Research* 21(3): 299-310.

Vásquez-León, M., C. West, B. Wolf, J. Moody, and T. Finan, 2002, Vulnerability to Climate Variability in the Farming Sector: A Case Study of Groundwater Dependent Agriculture in Southeastern Arizona. CLIMAS Report CL1-02. Institute for the Study of Planet Earth. University of Arizona, Tucson, Az.

### In the publication pipeline

Vásquez-León, M., C. T. West, T. J. Finan. 2003. Vulnerability and Adaptation to Climatic Variability: Agriculture and Ranching on Both Sides of the US-Mexico Border. *Global Environmental Change*.

West, C.T. and M. Vasquez-Leon. 2003. Testing Farmers' Perceptions of Climate Variability with Meteorological Data: a Case Study from the Sulphur Springs Valley, Arizona. In *Weather, Climate, Culture*, S. Strauss and B.S. Orlove, Eds. New York: Berg Publishers.

### Related publications in print

Lemos, Maria Carmen, Timothy J. Finan, Roger W. Fox, Donald R. Nelson, Joanna Tucker. 2002. "The Use of Seasonal Climate Forecasting in Policymaking: Lessons from Northeast Brazil", *Climatic Change*, 55(4):479-507.

Vásquez-León, M. and D. Liverman. 2003. The Political Ecology of Land-Use Change: The Case of Affluent Ranchers and Destitute Farmers in the Mexican Municipio of Alamos. *Human Organization*.

Under review

Vásquez-León, M. and J. Moody. Hispanic Farmers and Agricultural Migrant Workers: Social Networks and Adaptation to Climate Variability in Southeastern Arizona. *Human Ecology*

Submitted/will be submitted by June 1, 2003

Finan, T., M. Vásquez-León, D. Liverman  
Social Science Methods for Climate Assessment. Likely Journal: *Bulletin of the American Meteorological Society*.

Vásquez-León, M., C.T. West, T.J. Finan. Agricultural Diversification and Climate Forecasting Information Needs. *Ambio or Climatic Change*.

West, C.T. Misreading the Arizona Landscape: Questioning the Received Wisdom on Ecological Destruction in Southeastern Arizona. To be submitted to *The Kiva*.

West, C.T., G. Garfin, and T. Pagano. unknown. Farmers' Perceptions of Rainfall Variability: Validation with Meteorological Data and Links to ENSO and PDO. To be submitted to *Climatic Change*.

Wolf, B. and M. Vásquez-León  
The Role of Crop Insurance and Government Assistance in Mitigating the Impacts of Climate Variability: a case study of agriculture in the US Southwest. Likely Journal: *Global Environmental Change/Bulletin of the American Meteorological Society*.

### **III. Presentations at Professional Meetings/Conferences**

Vásquez-León, M. 2002. Climate vulnerability in the Post Global Age: Agriculture and Ranching of Both Sides of the U.S.-Mexico Border. Paper presented at the El Niño Symposium and Workshop. August 7-10, Viña del Mar, Chile.

Vásquez-León, M. 2002. Assessing Vulnerability to Climate Risk: A Case Study of Groundwater-Dependent Farmers in Southeastern Arizona. Paper presented at the Climate Prediction Assessments Workshop October 28-30 Alexandria, VA

West, C.T. 2002. Testing Farmers' Perceptions of Climate Variability with Meteorological Data: A Case Study from the Southwest. Paper presented at the American Meteorological Association's Applied Climatology Annual Meeting, April, 2002. Portland, Oregon

Wolf, Barbara 2002. The impact of institutions on perceptions of vulnerability to climate change in the Southwest U.S. Paper presented at the Society for Applied Anthropology

#### **IV. Outreach Activities**

West, C. Stakeholder interaction at the 2002 Cochise County Ag Day. Feb. 7, 2002. Willcox, AZ with Dr. Gregg Garfin and NASA Space Grant Intern Melissa Chavez.

Vulnerability Assessment Team. Sent mailings concerning the Sulphur Springs Valley Report to interview participants and distributed copies as requested by stakeholders in the valley.

Vásquez-León, M and West, C. Prepared summary of our report for the CLIMAS Newsletter to distribute to stakeholders throughout the Southwest.

West, C. Corresponded with officials of the Tucson National Weather Service Bureau, Joint Institute for the Study of the Atmosphere and Ocean, Albuquerque National Weather Service Bureau regarding data on the effect of ENSO and PDO on stakeholder production decisions.

Vásquez-León M and Wolf B. Participated in the San Carlos Apache Tribal Council meeting to present the CLIMAS project, the vulnerability component, and to ask for collaboration from the Tribal Council to conduct research in tribal lands (March 10, 2003).

**TASK AREA:** Sectoral Analyses

**PIs:** Barbara Morehouse, Jonathan Overpeck

#### **I. Progress: 2002 – 2003 Budget Year**

##### **A) Vegetation Dynamics for Fire Management** WILL BE PROVIDED

*Description.*

*Accomplishments.*

*Plans for the coming year.*

*Non-CLIMAS Partners.*

*Leveraging from other projects.*

##### **B) Water Policy**

*Description.* Work during 2002-2003 has focused on consolidating findings of earlier research, with the goal of producing a series of peer-reviewed publications. See the “Institutional Analysis” section, above.

*Accomplishments.* We published a report on interviews previously conducted with water managers to determine their perceptions of the vulnerability of their water systems to various stressors, including climate impacts. A peer-reviewed paper based on the study results is in preparation.

Barbara Morehouse participated in a workshop sponsored by the Utton Center at the University of New Mexico to begin work on creating a model protocol for interjurisdictional and transboundary water management. She is also co-authoring a paper with Kathy Jacobs of the Arizona Department of Water Resources for presentation at a conference on Water, Climate, and

Uncertainty, sponsored by the Natural Resources Law Center of the University of Colorado-Boulder. The conference is scheduled for June 11-13, 2003.

*Plans for the coming year.* Sectoral analyses will be largely focus on the drought planning and fire initiatives described above.

### **C) Climate Variability, Globalization and the Fresh Produce Industry in Arizona**

*Description.* This new research undertaking will examine Arizona's role in the national and global fresh produce industry, and the impacts of climate variability on this industry. Areas of investigation will include delineating the importance of fresh produce production, processing and marketing to Arizona's economy; mapping the state's global fresh produce import and export connections; and investigating the role of climate variability, the use of climate information, and the potential for expanding the use of forecasts and other climate-related information products.

*Accomplishments.* Preliminary background research has been conducted regarding predictions of the potential effects of climate change on world agriculture and the structure of the global fresh produce industry. A basic research outline has been produced.

*Plans for the coming year.* The research plan includes creating and administering surveys to fresh produce growers, distributors and marketers, and analysis of the results.

**TASK AREA:** Core Office

**PIs:** Jonathan Overpeck, Barbara Morehouse; **Researchers:** Gregg Garfin (Assistant Staff Scientist), Rebecca Carter (postdoc)

### **I. Progress: 2002 – 2003 Budget Year**

#### **A) Fire Research and Outreach**

*Description.* CLIMAS remains active in fire-climate research and outreach. Much work over the past year was devoted to collaborating with partners at NICC Predictive Services to begin the process of operationalizing climate forecasting for fire management. This effort built on the 2002 CLIMAS fire-climate workshop, where a group of forecasters produced the first fire season consensus climate forecast, and predictive services specialists from the Southwest Coordination Center used the consensus forecast to inform their assessment of fire potential in the Southwest. This consensus forecast effort has been spearheaded by CLIMAS collaborator Tim Brown (CEFA, Desert Research Institute, Reno), in collaboration with Core Office researchers and others.

CLIMAS, NICC, and CEFA worked closely during the fall of 2002 and winter of 2003 to marshal resources, garner institutional support, lobby potential participants, prepare protocols, and design a fluid and productive workshop process for the February 2003 fire-climate workshop. The workshop was designed to produce climate-informed regional- and national-scale seasonal fire potential outlooks for the 2003 fire season, for each of the Geographic Area Coordination Centers (GACCs) in the United States, and for the United States as a whole. The



workshop, which featured climate forecast presentations by CPC, CDC, IRI, Scripps, and CEFA, was designed to bring together fire meteorologists and fuels specialists to employ the forecasts and protocols in the production of these pre-season fire potential outlooks.

*Accomplishments:* The process was a significant success: participants from each of the 11 GACCS not only worked together successfully to produce outlooks for their region, but for the first time had opportunities to interact with the other groups face-to-face in order to reconcile boundary discrepancies between regions, and to share assessment and forecast techniques and insights. The NICC Predictive Services experts, Tom Wordell and Rick Ochoa, subsequently developed a national fire season outlook map from the individual regional assessments. An informational flier was distributed to national-level entities and the outlook map was printed in various news media. The head of the USDA Forest Service Region 3 also used the map in her presentation at a conference on wildfire convened by the Governor of Arizona. Proceedings from the workshop will soon be published as a CLIMAS white paper. Operationalization of the fire-climate assessment process continues and assessment workshops are anticipated to continue on an annual basis. Updates to the assessments will continue to be done as the fire season progresses in each of the GACC areas.

*Plans for the coming year.* We plan to hold our annual fire-climate workshop, and to continue our research into the collaborative development of knowledge with our stakeholder partners. We plan to continue our involvement in planning and conducting the pre-season National Seasonal Assessment Workshop (NSAW), in conjunction with NICC Predictive Services and CEFA. Goals for the 2004 NSAW, include the following: (1) obtain increased commitment by forecast agencies and Climate Services; (2) improve climate education and methods used by Geographic Area forecasters; (3) improve communication and participation by Geographic Area personnel, (4) improve communication between the GACCs and the RISAs. In addition, we expect to work with NICC Predictive Services and CEFA on planning and conducting a post-season assessment workshop. We will be continuing with our vegetation modeling research, which is intended to provide input to fire-climate-society modeling activities underway (eg, through the Wildfire Alternatives initiative). With Dr. Thomas Swetnam joining the team, we will also begin mesoscale research into fire history in the Southwest. Further, we plan to explore opportunities for developing additional interdisciplinary and cross-agency collaborations for the purpose of conducting further stakeholder-relevant fire-climate-society research in the region.

*Partners:* The fire workshop entailed partnering with Rick Ochoa and Tom Wordell of NICC Predictive Services and with Tim Brown of CEFA. Funding was provided by the USDA Forest Service, NOAA OGP and the UA Institute for the Study of Planet Earth.

*Leveraging:* Other initiatives that support CLIMAS fire work include the EPA-STAR funded project to build an integrated fire-climate-society GIS model and a recent workshop process initiated by the Joint Fire Science Program to identify and address crucial research needs. Barbara Morehouse headed up the effort to host one of workshops in Tucson in March 2003 (two others were held – one in Corvallis and the other in Fort Collins). The workshop was funded by JFSP and involved a planning committee consisting of Tom Swetnam (UA Tree-Ring Lab), Steve Yool (UA Geography Department), Carl Edminster (USFS Rocky Mountain Research Station-Flagstaff), Kirk Rowdabaugh (Arizona State Lands), Keith Burnette (BIA), Mark

Jackson (BLM), and John Szymoniak (USFS). We hope that a result of the workshops will be a call for proposals for specific stakeholder-relevant research on climate-fire interactions.

## **B) END Insight Initiative**

*Description.* In July 2002, CLIMAS began a major new initiative to provide stakeholders and the media with information about the ongoing drought in the Southwest, and the El Niño event then forming in the Pacific Ocean. A primary goal of the initiative is to provide stakeholders with timely information about these climate conditions and forecasts using techniques designed to generate regular stakeholder feedback. Another goal is to use the information and insights gained to stimulate climate research aimed at addressing the information needs of CLIMAS stakeholders. The third major goal is to provide useful feedback to NOAA and other producers of climate information. We recruited a group of 35 stakeholders who agreed to provide monthly feedback throughout the yearlong duration of the initiative. Participants include land, wildlife and water resource managers; agricultural extension agents; fire managers; ranchers; environmental organizations; members of the media and tourism sectors; community development specialists; and representatives of the energy sector.

Participants receive monthly information packets that contain a variety of forecasting and recent conditions products, along with regionally relevant interpretation and notes written by Core Office staff. The intent of these value-added features is to enhance the comprehensibility and utility of the information to stakeholders. Each packet also contains an executive summary of recent climatic conditions and forecasts, and a newsletter that synthesizes scientific publications, news reports, and interviews with researchers on timely climate-related topics. The newsletter also features a “Product of the Month” section that assists stakeholders in exploring the Web to locate and understand information on the selected topic. Our stakeholder group is surveyed monthly to collect information about their perceptions of the usefulness and ease of understanding of the information provided that month. We send out a quarterly report to participants and to the product providers that summarizes the survey responses.

At the same time, we are collecting and archiving articles from the media about climate and its impacts in the region. We will be conducting a content analysis of these articles at the end of the initiative. We plan to hold a workshop at the end of the initiative that will bring together the participants and producers of the climate products featured. The goal of the workshop, which is tentatively scheduled for July 2003, is to assess the initiative and to determine what information should be provided on a regular basis, including the logistics of producing and disseminating the information.

Based on positive reactions to the newsletter and executive summary, we began mailing these items to state and federal representatives and senators on a monthly basis. We also make all package contents available on our web site. We actively encourage END Insight participants to access the information we provide and to share it with others. We have evidence that such sharing is indeed occurring.

In addition, we hold regular press briefings; these briefings are carried out with varying combinations of CLIMAS partners including the UA SAHRA project, the National Weather Service, the Arizona State Office of Climatology, Salt River Project, Arizona State Land

Department, Arizona Department of Emergency Management, Sandia National Laboratory, and others. The briefings focus on current and forecasted climate conditions that are of timely interest to the public.

*Accomplishments:* We have developed a suite of climate products that, based on interim feedback from participants, provides regionally relevant information of value to stakeholders. Well-informed articles have appeared in the press that clearly reflect participation by the reporters in the press briefings. We anticipate that the content analysis of news articles and the stakeholder workshop will highlight additional accomplishments. In addition, the process has brought CLIMAS recognition as a hub of information for drought and other climatic processes. As a result of the aforementioned, CLIMAS has received numerous requests to speak at regional meetings, conduct workshops and Southwest climate training sessions. Moreover, the effort has resulted in more frequent and better communication and exchange of information with climate and hydrological information centers within the Southwest.

*Partners:* SAHRA (press meetings), Western Regional Climate Center (research), NOAA Climate Diagnostics Center/Western Water Assessment (research), California Applications Program (research), University of New Mexico (research), Natural Resources Conservation Service, National Drought Mitigation Center, NOAA Climate Prediction Center, National Weather Service, and others.

*Plans for the coming year:* Maintain the bulk of END Insight climate information flow via the CLIMAS Southwest Climate Outlook web site.

### **C) Climate and Water Research on the San Pedro River**

*Description.* Since summer 2002, CLIMAS core office researchers have been collaborating with the Udall Center for Studies in Public Policy on a project funded by the Dialogue on Water and Climate (The Netherlands) to encourage community dialogues on the impacts of climate variability and change on water resources in the watershed of the upper San Pedro River. The DWC work focuses primarily on the Sonora, Mexico, side of the border, but activities are also underway to generate ongoing interaction among residents on both sides of the international boundary. CLIMAS's role is to assist in identifying climate information needs and identifying products that may address those needs. Notification was recently received that funding from NOAA will be available to continue this work over the next three years.

*Accomplishments:* Three dialogues have been held to date: two in Sonora (Cananaea and Naco) and one in Sierra Vista, Arizona. Surveys for urban and rural water users, and one for municipal water managers, have been designed, and will be administered and the results analyzed over the 2003-2004 research year.

*Plans for the coming year.* Assessment of climate-related products and tools available to stakeholders in the study sites, research into ways to improve the accessibility and usefulness of such products, and identification of appropriate measures to further integrate science and policy are slated to begin this year.

*Leveraging:* An additional \$437,500 in funding was received from the NOAA/OGP GEWEX Americas Prediction Program (GAPP).

*Partners:* The project is headed by the Udall Center for Studies in Public Policy at the University of Arizona, in collaboration with the Southwest Watershed Research Center and the Grazinglands Research Laboratory (Agricultural Research Service, USAID). The San Pedro is a UNESCO-designated operational “HELP” (Hydrology for the Environment, Life and Policy) basin.

#### **D) CLIMAS Project Management**

*Description.* The Core Office continues to coordinate the project. We continue to hold bi-weekly team meetings and to publish the quarterly CLIMAS Update newsletter, which is mailed to approximately 1,200 stakeholders in the U.S. and Mexico. A new feature allows stakeholders to subscribe to the newsletter via our website. With receipt of approval from NOAA-OGP for another five years of funding for CLIMAS research and outreach, the Core Office undertook the complex process of obtaining UA Human Subjects approval for the new funding cycle.

*Accomplishments:* The CLIMAS web site was redesigned and reorganized, and substantial new content was added to the site. Among the additions were up-to-date climate information and interpretations developed through the END Insight initiative (see above), and a fire-climate online searchable bibliography. Web site usability testing and evaluation was conducted in order to ensure the effective transfer of information and ease of web site use. In addition, a literature review of usability testing methods was produced; a white paper and peer reviewed publication are expected to be produced during 2003. CLIMAS usability testing expertise and written usability procedures have become an important resource for synergy projects such as SAHRA. A listserv has recently been established to provide stakeholders with information about upcoming conferences, new publications, and other news from the project.

The human subjects format and procedures we developed are innovative in covering five years’ work being carried out by multiple researchers and in providing, on a password protected portion of the CLIMAS web site, a framework for multiple research tasks involving human subjects over the five years of the project. CLIMAS team members were introduced to the rules for conducting human subjects research and to the web site during a team meeting.

*Plans for the coming year.* The Core Office will spearhead a new drought planning initiative, the annual fire-climate workshop, the National Seasonal Assessment Workshop, and a new outreach initiative in conjunction with Arizona Cooperative Extension. Goals of our proposed work with Cooperative Extension include: working with Cooperative Extension to (1) determine extension agent and specialist climate information needs; (2) partner with other Arizona climate information agencies (e.g., National Weather Service, NRCS, USGS) to provide off-the-shelf products and interpretation to extension agents and their communities; (3) produce a series of low-input products, such as a “Climate 101 for Extension Stakeholders Primer”; (4) seek funding for a Community Partners Climate Education Pilot Project. The Core Office will also devote considerable time to identifying and initiating next steps emerging from the END Insight stakeholder workshop scheduled for July 2003. The Office will continue supporting the web site and issuing publications such as the quarterly CLIMAS newsletter. The Office will also

continue to collaborate with other team members on research and outreach activities, to organize team meetings and other meetings and workshops as needed, and to monitor the project budget.

### **E) RISA and OGP Coordination**

The Core Office remains the focal point for sustaining interactions with other RISAs and with OGP and the RISA program. The Core Office participates regularly in RISA conference calls and meetings, and assures that CLIMAS is represented in important RISA-related conferences and symposia. The Core Office also responds regularly to requests for information and materials.

## **II. Publications**

### In print

RH Carter and BJ Morehouse. 2003. Climate and Urban Water Providers in Arizona: An Analysis of Vulnerability Perceptions and Climate Information Use. CLIMAS Report Series No. CL1-03, Institute for the Study of Planet Earth, University of Arizona, Tucson, Arizona.

BJ Morehouse. 2002. Integrating climate into water policy. *Southwest Hydrology* 1(2): 16-17, 28.

BJ Morehouse, R Carter, and P Tschakert. 2002. Sensitivity of urban water resources in Phoenix, Tucson, and Sierra Vista, Arizona to severe drought. *Climate Research* 21(3): 283-297.

RH Carter and BJ Morehouse. 2002. An examination of Arizona water law and policy from the perspective of climate impacts. CLIMAS Report Series CL2-01, Institute for the Study of Planet Earth, University of Arizona, Tucson, Arizona.

### In the pipeline

Diaz, HF and BJ Morehouse 2003. *Climate and Water Resources in the Americas*. The Netherlands: Kluwer Press. Publication anticipated summer 2003.

JL Gamble, J Furlow, AK Snover, AF Hamlet, BJ Morehouse, H Hartmann, T Pagano. Forthcoming. Assessing regional water resources: the implications for stakeholders of climate variability and change. In (eds.) D Fort and R Lawford, *Science and Water Resource Issues: Challenges and Opportunities*. American Geophysical Union Monograph. Forthcoming.

R Varady and B Morehouse. Forthcoming. Moving Borders from the Periphery to the Center: River Basins, Political Boundaries, and Water Management Policy. In (eds.) D Fort and R Lawford, *Science and Water Resource Issues: Challenges and Opportunities*. American Geophysical Union Monograph. Forthcoming.

### **III. Presentations at Professional Meetings/Conferences**

Garfin, G. 2002. Climate Variability and Fire Management in the U.S. Southwest. Paper presented at the Association of American Geographers Annual Meeting. March 19-23, Los Angeles, California.

Garfin, G. 2003. Climate Information And Water Resource Management: Two Initiatives In The Southwest. Paper presented at the American Meteorological Society Annual Meeting. February 10-13, Long Beach, California.

Garfin, G. 2002. Long Term Climatic Patterns in the Southwest. Paper presented at the Navajo County Cooperative Extension meeting on Grazing Resource Management During Extended Drought. June 19, 2002, Show Low, Arizona. Invited.

Garfin, G. 2002. Drought Impacts. Paper presented at the University of New Mexico/University of Alabama workshop on Drought in Mesic and Arid Environments: Climatology, Biotic Responses, and Feedback. September 17-19, University of New Mexico/Sevilleta Long-Term Ecological Research Station, Socorro, New Mexico. Invited.

Garfin, G. 2002. Geographic Area Coordination Center Seasonal Fire Danger Outlooks NICC Predictive Services Workshop. November 5-7, 2002, Reading, California. Invited.

Morehouse, B. Social science applied to studying wildland fire across a gradient. Paper presented at Social Science Fire Conference, Tucson, Arizona, January 29-31, 2003. Invited paper.

Morehouse, BJ. Thinking about decision support tools for the US-Mexico border region. Presentation at Workshop on Managing Water Resources under conditions of high climatic variability in the US-Mexico border region, La Paz, Baja California, Mexico, January 14-16, 2003. Invited.

Morehouse, BJ. Chapter 4: View from the SW. Comments Climate Change Research Initiative, CCSI/USGCRP Meeting, Washington, DC, December 3-4, 2002. Invited.

Morehouse, BJ. Human dimensions of environmental change. Presentation at Workshop on Interstate Waters: Crossing Boundaries for Sustainable Solutions, Snowbird, Utah, October 9 - 12, 2002. Invited.

Morehouse, BJ. Climate variability, vulnerability and adaptation in the US Southwest: Insights from the Climate Assessment for the Southwest (CLIMAS). Presentation at International Workshop on Regional Integrated Assessment of Climate Impacts, Castelvecchio Pascoli, Italy, September 16-20, 2002. Invited.

Carter RH. Responding to Stakeholder Needs for Improved Climate Information: The END InSight Initiative. Society for Applied Anthropology Annual Meeting, Portland, OR, March 18-22.

Carter RH. Tracing the Trail of Table Grapes: The Effects of Neoliberal Policies on Fieldworkers in Sonora, Mexico. Society for Applied Anthropology Annual Meeting, Portland, OR, March 18-22.

Schmidt N, Garfin GM, Carter RH. The CLIMAS END InSight Initiative: A rapid response to drought and stakeholder need. Climate Prediction Assessments Workshop: Research and Applications on Use and Impacts. Alexandria, VA Oct. 28-30, 2002.

#### **IV. Outreach Activities**

Garfin, G. Participated in the San Carlos Apache Tribal Council meeting to present the CLIMAS project overview component. (March 5, 2003).

Garfin, G. Co-developed format, speaker and press contacts and provided logistical coordination for the CLIMAS-SAHRA Press Briefings (July 2002/Tucson, August 2002/Phoenix, September 2002/Albuquerque; January 2003/Tucson, March 2003/Phoenix). (Gave presentations on the following topics: The END InSight Initiative; The Paleoclimate Record of Drought; The Current Drought and Prospects for 2003).

Garfin, G. Assisted in developing web product usability survey and served as moderator for the Value Added Products breakout group at the HyDIS First Annual User Workshop (October 2002).

Garfin, G. Stakeholder interaction at the 2003 Southeastern Arizona Ag Day and Trade Show, February 5, 2003. Willcox, AZ with CLIMAS graduate research assistant Colin West, and NASA Space Grant Intern Melissa Chavez.

Garfin, G. Mentored NASA Space Grant Intern Melissa Chavez. Research topic: The climatology of frost occurrence in southeastern Arizona agricultural settings.

Garfin, G. Regular contributor to US Drought Monitor.

Garfin, G. Visited the following state and federal agencies: Southwest Coordination Center (Albuquerque, New Mexico), National Weather Service Albuquerque Forecast Office, University of New Mexico (Dr. David Gutzler), National Weather Service Tucson Forecast Office, Arizona Department of Emergency Management.

Morehouse, BJ. Co-chaired committee to organize a fire research workshop under the auspices of the Joint Fire Science Program. Meeting held in Tucson, Arizona, March 25-27, 2003.

Carter, RH. Logistical coordination of a fire research workshop under the auspices of the Joint Fire Science Program. Meeting held in Tucson, Arizona, March 25-27, 2003.

Morehouse, BJ. Panel participant, annual NOAA-OGP Regional Sciences and Assessment (RISA) Program co-investigators' meeting, Carefree, Arizona, March 11-13, 2003.

Morehouse, BJ. Participant, Governor's annual Forest Health and Fire Conference, Prescott,

Arizona, March 10, 2003.

Morehouse, BJ, Garfin GM and Carter RH. Participated in meeting organized by Arizona ranchers to discuss climate forecasts and potential for persistence of drought in the region; gave presentation on Southwest climate with special emphasis on El Niño, Pacific Decadal Variability, and drought. Winkleman, Arizona, February 15, 2003.

Morehouse, BJ and Carter RH. Participated in binational meeting organized under Dialogue on Water and Climate grant, Naco, Sonora, Mexico, January 10, 2003.

Morehouse, BJ. Organized meeting to explore uses of climate information in decision making with regard to operating desalination plant in Yuma, Arizona. Institute for the Study of Planet Earth, University of Arizona, Tucson, Arizona, January 7, 2003.

Morehouse, BJ. Served as emcee for a joint CLIMAS-SAHRA press briefing, Phoenix, Arizona, August 26, 2002

Morehouse, BJ. Participated in meetings organized under Dialogue on Water and Climate grant, Cananea, Sonora, Mexico, July 16 and September 27, and Sierra Vista, Arizona, August 28, 2002.

Carter, RH. Participated in meeting organized under Dialogue on Water and Climate grant, Cananea, Sonora, Mexico, September 27, 2002.

**TASK AREA:** Partner Research Initiatives

**PIs:** **Barbara Morehouse, Timothy Brown (CEFA), Anthony Westerling (CAP), Henry Diaz (CDC)**

**A) Fire-Climate Consortium (with Tim Brown of CEFA)**

An outline has been developed and work is proceeding on producing a peer-reviewed, co-authored paper on the creation of a consortium in Nevada and California to produce climate and weather information for fire management in that region.

**B) Decision Calendar for Fire Management (with Anthony Westerling of CAP)**

A survey instrument has been developed and is currently being administered to fire managers and decision makers in California to develop a decision calendar that will reveal where and when climate information and forecasts could be most productively directed. Interviews are planned for May and June in Arizona and New Mexico. A co-authored paper on decision calendars for fire management will be produced.

**C) Climate and Water Resources in the Americas**

We have completed the preparations for publication of our co-edited book, *Climate and Water Resources in the Americas*. Galley proofs have been reviewed; publication is anticipated to occur in summer 2003. Work is proceeding on other initiatives, including development of RISA in Mexico that would have close connections with CLIMAS.



**TASK AREA: Overarching Research and Outreach Plans for the 2003-2004 Budget Year - Drought**

*Description and plans for next year.* Given the significant budget cut CLIMAS has received for the coming budget year, and the fact that some PIs have (or intend to) move away from Arizona, CLIMAS activities are being fairly sharply curtailed.

However, given the climate conditions in the Southwest over the past few years and the escalating interest in drought planning and response (especially in Arizona), we propose to make drought planning a significant focus of work being carried out by CLIMAS over the next year. The overarching theme of drought allows opportunities for integrating all task areas within the project around a common theme of identifying climate information needed to reduce vulnerability and enhance adaptation capacity. This initiative will follow on the END Insight project and will allow a sharper focus on drought planning and the role of climate information in developing and implementing drought plans. Kathy Jacobs, Arizona Department of Water Resources, is heading up a Drought Task Force initiated by Governor Napolitano. Ms. Jacobs is most interested in having CLIMAS participation on the technical advisory committee of the task force.