Decision Systems Research and Tool Development at the IRI

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The International Research Institute for Climate and Society

Introduction

We are seeking to contribute to better incorporation of climate risk in decision-making, through collaborative research activities and associated exploratory decision tool development. The goal is the promotion of management capabilities that are adaptive to information about climate risk, across the breadth of climate-related problems spanning such sectors as water resource management and agriculture. Experience to date has focused on using monitored information and forecast information for several months ahead, the major source for such forecasts being predictable ocean-atmosphere variations like the El Niño/Southern Oscillation (ENSO) phenomenon.

Climate-related information relevant to decisions

This research component draws on understanding of climate variability and predictability. It translates climate information into relevant biophysical information. The translation tools can themselves lead directly to indices and maps that can be viewed as tailored decision support products, especially when the variables are ones familiar to decision-makers, such as streamflow, crop yield and widely used vegetation indices.

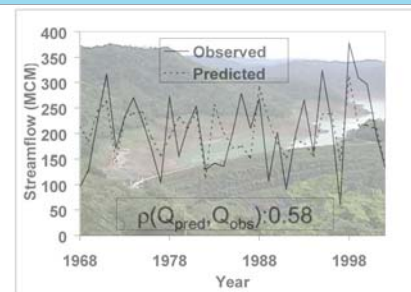

Figure 1a: Forecasting the Oct-Feb inflow total for the Angat Reservoir, Philippines. The forecasts are made using information that would be available in early October each year. These forecasts, when expressed in probabilistic form, are the input to models that explore reservoir management strategy (see top columns 2 and 3). The forecasts shown are based on output from a General Circulation Model (GCM) driven with September sea-surface temperatures. The GCM used here is the ECHAM4.5 that was developed at MPI, Germany.

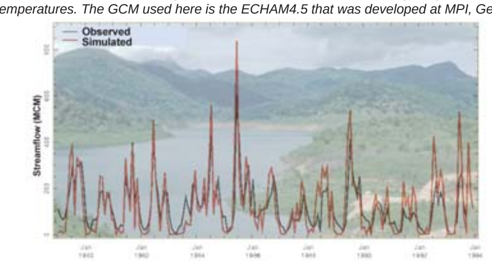

Figure 1b: Simulation of monthly streamflow at a site in the Mahaweli catchment, Sri Lanka. A high resolution, physically based, land surface model has been driven by observed climate variations. This is part of an ongoing effort to evaluate monitoring and prediction capability for various land surface features including soil moisture and inundated area, motivated by interest in these variables for various applications, including public health. Simulations shown are driven by ECMWF reanalyses, blended with a set of high resolution rainfall observations. The land surface model was developed and run at NASA. Research in collaboration with NASA/ Global Modeling and Assimilation Office (S. Mahanama) and the Mahaweli Authority of Sri Lanka (J. Chandimala).

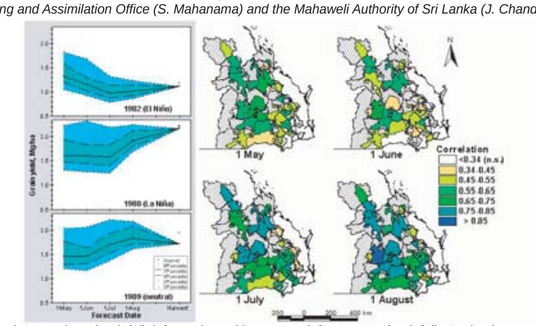

Figure 2: Merging monitored rainfall information with seasonal forecasts of rainfall. A simple crop model integrates antecedent rainfall observations and GCM-based rainfall forecasts, to estimate wheat yields at a range of lead times in Queensland, Australia. Maps show correlations between observed and best estimate predicted yields. Shaded graphs illustrate for three selected years, how uncertainty decreases as forecasts are updated (increasingly using actual observations of rainfall) as the copping season progresses. (Hansen, Potgieter and Tippett, 2004).

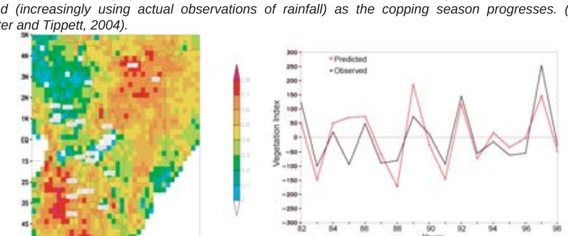

Figure 3: Translating output from GCM seasonal forecasts (made in early October) into information about the expected pattern of a remotely sensed vegetation index in December (Indeje et al., 2005, in press). The right panel shows the predicted and observed vegetation index (NDVI) for northeastern Kenya (correlation skill = 0.76), and the shading in the left panel shows the pattern of correlation skill over the region. Developing a forecast capability of this index has been motivated by various climate risk management opportunities, including fodder and health issues for livestock.

The above results illustrate the fruits of applied research into downscaling methodologies combined with statistical and biophysical modeling that exploit our understanding of linkages between climate and related aspects of the environment.

Understanding, fostering and guiding decisions

We represent decision options, such as water allocation by a reservoir manager, in quantitative models that allow exploration of "what if" scenarios. The software that underpins this analysis can be packaged in the form of easy-to-use tools.

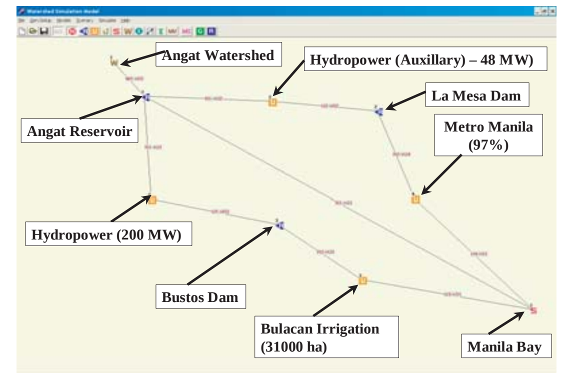

Figure 4: A reservoir management software tool, that uses probabilistic seasonal climate forecasts and which can be tailored to different reservoir settings through input of reservoir parameters, has been developed.

The importance of participatory approaches is recognized for all problem settings, so that research and tools best match with decision-making opportunities in society.

Figure 5: Group discussions in Eastern Province, Kenya and Andhra Pradesh, India, foster the co-learning among farmers, intermediaries and researchers needed to understand, adapt and adopt a new technology such as seasonal climate forecasts.

Strategically developed games for stakeholders, often drawing on multiple academic areas of expertise including probability theory, game theory and psychology, can be used to communicate to decision-makers a range of complex concepts about the climate risk management problem that they face, leading to better appreciation of the options available for all stakeholders. Some of the climate risk aspects that can be explored include strategies for monitoring and reporting diseases and general issues on insurance and resource allocation.

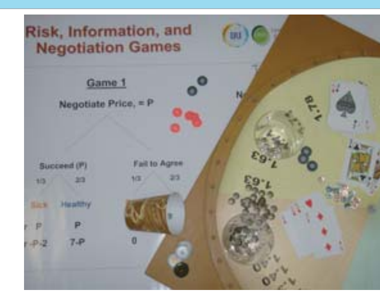

Figure 6: A game that is being developed to explore different stakeholder strategies in the presence of information about the risk of climate-related disease outbreaks in livestock (in collaboration with the Center for Research on Environmental Decisions, Columbia University). A broad collaborative effort is engaged in developing similar concepts for water allocation in NE Brazil.

Insurance and credit schemes, informed by climate risk information, are being explored as potentially powerful tools to help buffer the impact of climate extremes in a range of settings from rural livelihoods to regional food security.

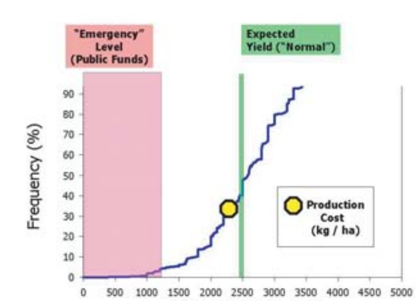

Figure 7: Analyses of climate risk and agricultural production provide a basis for consideration of a rural insurance scheme in Uruguay (from W. Baethgen).

Assessing value of improved decisions

Estimating the value of adaptive management strategies that use climate risk information is seen as a key element of influencing stakeholders to adopt, and for providing justification for investment in the technology.

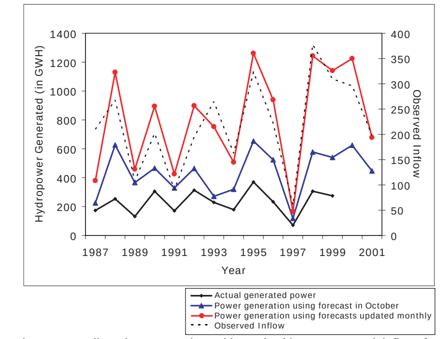

Figure 8: Comparing water allocation strategies with and without seasonal inflow forecasts for the Angat reservoir. The graph shows the estimated improvements in hydroelectric power production each year when water allocations are based on seasonal forecasts. This research is being conducted in collaboration with water managers at the Angat dam facility.

The role and value of climate forecasts in decision-making can be explored by looking at the past. By 'backcasting' (using forecasting technologies to provide forecasts for past years), one can analyze simulations of how well a decision-maker performs when using the forecast (compared to not using the forecast). This is the methodology applied in Fig. 8. Research is also considering other ways of estimating potential value of climate risk information (for example, see Fig. 9).

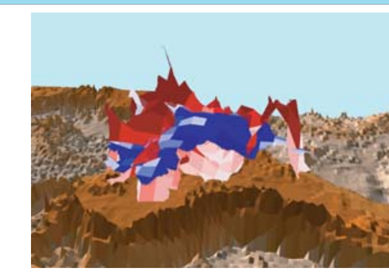

Figure 9: By comparing people's responses to an unanticipated precipitation shock for a single year with their adaptation to the long-term historical climate patterns, we gain insight into decision-making, the costs of climate risk, and the value of forecast information. In this example, Brazilians face significant wage losses years after they have migrated from rural to urban areas because of large precipitation shocks, even when from regions where they are well adapted to high precipitation variability. The colors on the map reflect the estimated connection between climate and the wages of those who migrated out of agriculture during 1983, with darker shading reflecting lower long-term wages in non-agricultural jobs.

Conclusions

Research is delivering methods that reliably translate climate information and forecasts into more relevant biophysical variables for decision-making. This creates the opportunity to explore enhancements to decision strategies through a suite of research analysis and tool development. We have to date focused on climate information on seasonal timescales (monitored information, and forecasts for the upcoming season). Experience is being gained in participatory approaches to explore decision options across a range of climate-related problems, as well as exploring innovative ways to communicate with and between stakeholders. This provides context for models that seek to estimate the enhanced value of using information about climate risk, as well as for more general development of decision tools. Emerging results here and elsewhere, suggest substantial gains from management strategies that are adaptive to climate risk on seasonal timescales, which can be viewed as a contribution to increased resilience to the stresses of climate changes. In the reservoir management example given, for a region where seasonal prediction skill leads to a moderate ability to forecast seasonal inflow, the benefits for hydroelectric power generation are estimated to be considerable, when the water allocation strategies are tuned to the seasonal forecasts. Tools like the reservoir management software product, are proposed to be a useful component of a broader process aimed at effectively sharing the new insights and opportunities with stakeholders.

References:

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The IRI was established as a cooperative agreement between U.S. NOAA Office of Global Programs and Columbia University.