WHY INSTITUTIONS RESIST INCORPORATING CLIMATE CHANGE SCENARIOS INTO AGENCY PRACTICE

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ABSTRACT

While the sophistication and accuracy of climate models increase, these models are not yet being incorporated into the practice of water agencies. We study why this happens and use this knowledge to suggest avenues for reforming both practice and the institution of climate modeling. We study institutional issues constraining the use of a near-term climate change model used to predict the El Niño Southern Oscillation (ENSO). The model was developed by NOAA (National Oceanographic and Atmospheric Agency), a U.S. Federal agency. The finding is that agencies cannot use climate change models because its scale and scope are not designed for everyday practice, does not provide information in a form they can utilize readily, and because it is presented as a simply black box without institutional linkaging. We end the paper with some directions for reform.

Key words: climate change, practice, institutions, water agencies, water management.

1. INTRODUCTION

The ongoing quandry: on the one hand, there have been remarkable improvements in our ability to predict short-term climate variability with ever more sophisticated models, while on the other, remains a fundamental intransigence on the part of water agencies to utilize newer and better information. The easiest answer if, of course, bureaucratic interia, but this ready explanation is increasingly wanting as newer and better information is seen as allowing these agencies to better avoid drought shortages, flood damage, and resulting litigation and congressional review. Better hydrologic management strategies may not only improve water supplies, but also help mitigate tensions in areas where there is ongoing conflict over water rights. Moreover, the blanket category, "inertia", begs to be precisely described and separated into the different avenues of resistance, if we are to reform agency practice and utilize better knowledge.

Beginning in the mid 1980s, scientists achieved remarkable improvements in probabilistic forecasting of seasonal and interannual variation in climate conditions with regard to the El Niño Southern Oscillation (ENSO). Most recently, NOAA (National Oceanographic and Atmospheric Agency) has developed decision support models that allow agencies to conduct such modeling in-house. Acquisition of this capability raises the question of how this information can be incorporated into societal decision benefit of affected communities, regions, and economic sectors. The stimulus for our study was the remarkable advance in probabilistic forecasting of seasonal and interannual variation in climate conditions associated with the El Niño Southern Oscillation (ENSO) achieved by scientists over the course of the decade beginning in the mid-1980s.1 Techniques available in the early 1980s were inadequate to fully monitor the evolution of an ENSO event already in progress. By 1995, it was possible to observe daily changes in surface winds, sea-surface temperature, upper-ocean thermal structure, and ocean current on a basin scale in the tropical Pacific. Using models ranging in complexity from purely statistical to fully coupled dynamical ocean–atmosphere models, scientists are now able to routinely issue reasonably accurate forecasts up to one year ahead for some parts of the world.

There is, by now, an extensive literature on institutional constraints to the transmission of information. Insights from the area of cultural anthropology have shown us that different institutions and policy actors within those institutions exhibit differing cultures, and knowledge cannot simply pass from culture to culture (e.g., see Douglas, 1985, and in the area of climate change, Rayner and Malone, 1998). Organizational studies suggest that agencies and other policy actors are not simply rational actors but, instead, pick and choose only those bodies of knowledge that further agency goals like power maximization (e.g., see Pfeffer and Salancik, 1978; March, 1989). There are a number of general reasons that emerge from these literatures, as described above. However, what is needed is to uncover the specific reasons, in practice, found among water agencies. It is this level of knowledge that is needed to be able to suggest reforms to water institutions and practice.

2. OBJECTIVES AND PROCEDURE

The authors sought to understand, over various levels of detail, what impedes the use of climate forecasts. They did this by combining results of a national survey of water agencies with an examination of water agency practice closer up. The survey was conducted by one of the co-authors and colleagues and consisted in a large number of interviews with water agency management and staff in three regions in the USA: California, the Pacific Northwest, and thePotomac River watershed (Rayner, Lach, and Ingram, 2005). These interviews provided broad rationales behind the reluctance to use new forecast models. We then proceeded to develop more detailed accounts behind each rationale by examining water supply management institutions and practice. Lastly, having a somewhat explicit explanation for the agency phenomenon, we than develop a set of recommendations that might better narrow the gap between technology and practice.

We then proceed to analyze, more thoroughly, the institutional misfit of the ENSO model. To do this, we refer to the following figure (Figure 1), which portrays how and why an institution is formed.

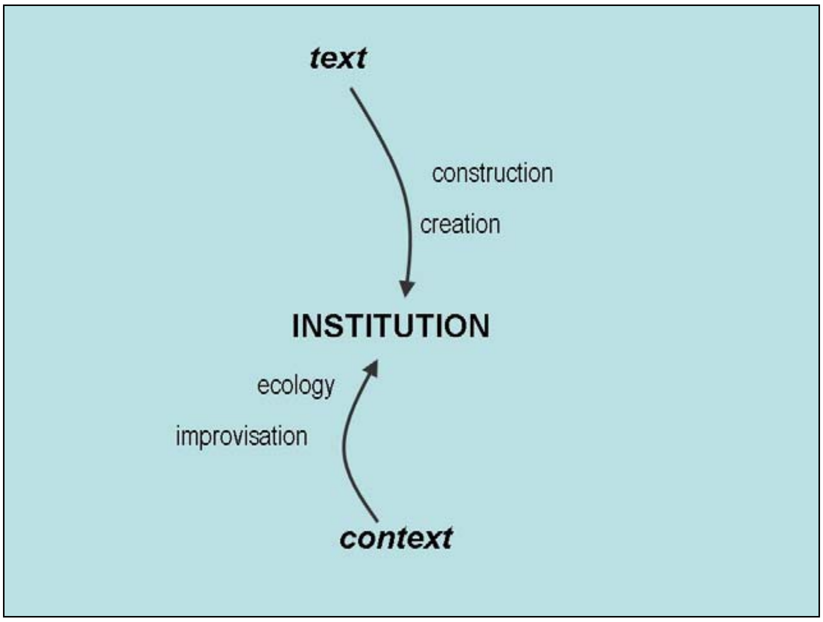

Figure 1 Depiction of institution formation (Source: Lejano, 2006).

In the figure, we depict how an institution (in this case, the use of the ENSO forecasting model), is not just constructed by central policy actors (in this case, the NOAA) and then imposed upon the field. Rather, the bottom half of the figure pertains, also --that is, the new institution or practice must also take root in the various contexts of implementation. This requires that it fit the needs, priorities, and practices found in each local agency. It also means that, to some extent, its form or function may need to be modified to better match the local institution.

3. RESULTS

The survey provided several general reasons behind this gap. These include: (i) Fundamental conservatism in the environment and practice of water supply; (ii) Mismatch in incentives to use new information; (iii) Mismatch in scope and scale of the technology; (iv) Uncertainty not so much over the accuracy of the model, but about the implications for its use; (v) Incentive compatibility issues on an individual and organizational level; (vi) Demands on policy actors of deliberative policy-making, and (vii) American republicanism. We then further expound on these by translating these general accounts to the level of practice --e.g., engineering design procedures for water supply systems. This explicit account of the gap then allows us to propose possible remedies, e.g., creating inter-agency networks, locating climate forecast science within the engineering profession, and simply, waiting for the art and science of modeling to exceed a cognitive and professional threshold for more widespread acceptance.

4. DISCUSSION

An extensive survey, carried out by one of the co-authors and colleagues, involved semi-structured interviews with over a hundred water agency managers and staff in three regions across the USA. These interviews provided evidence of a handful of key factors behind the gap between knowledge provision and knowledge use. Let us discuss each one of these in turn.

(i) Conservatism

Water agencies have too much invested in the existing system and way of doing things. This occurs from the highest to lowest levels of the institution. The interviews suggested that it may take 15 years or so for a water agency to learn how to utilize forecast models. The reasons are numerous. First, there is the design approach that engineers are educated to using. That is, engineers do not design probabilistically --rather than consider multiple scenarios probabilistically, the practice is to choose a high enough factor of safety that one can treat the design problem as completely determinate. Factors of safety occur in numerous overlapping ways: in selecting a 20-year flood for design conditions, selecting peak flows, sizing structural elements, and aggregating demands on the water system. Related to this is the practice of designing structural elements (civil works, reservoirs, pipelines, etc.) rather than planning operational strategies. That is, rather than optimize the use of water structures, the historical practice has been to overdesign them so that there is less need to pay attention to day-to-day operation. The historical precedents for large capital improvement projects has also to do with the origin of the water system (i.e., in the United States, through one-time large Federal grants through the Bureau of Reclamation rather than through rents or rate payments). The principal goal of these practices is routinization --that is, to help the engineering profession cope with uncertainty by building it into design. For example, by building structures designed for a 20 year flood, then there is less need to more finely tune daily or weekly system operation. The problem, of course, is that, in California and other states, these additional capacities have been used up. In the case of Colorado River water, California has historically been drawing down in excess of its allocation, as the other states did not need the water. However, over the last decade, increasing demands from Arizona and Colorado have forced California back to its contractual allocation of 4.4 million acre-feet a year (from a historical usage of 5.2 MAF).

The need for invisibility affects the policy frame that the agency uses to view its mission. A new focus on optimizing system operation, as opposed to design, would need to extend ultimately to the users themselves. However, the American public is thought to be highly inflexible --i.e, there would be no ability to get the public to more aggressively conserve, to tailor demands to the diurnal or seasonal swings in system supply, or to shift uses from one use to another (e.g., urban landscaping to agricultural) depending on weather variations. The thought is, whether right or wrong, that water users insist that they can use as much water as they want whenever they want it. In a survey of water agencies, it was learned that the order of priorities in terms of agency mission was: reliability of service, quality of service, and cost with cost being much behind the other two. Invariably, when agencies were asked to point to innovative agency practices, they would cite technical measures rather than changes in demand-side management.

(ii) Technical Mismatch

The product does not meet the needs of the agency in form and in content. As some water managers put it, the need of the water agencies are either for very near-term forecasts (1-5 days) that can influence their daily operations of the system, or very long-term climate change forecasts (20 years) that can influence their long-term planning and construction. But the ENSO models deliver a mid-range type of forecast (1 year) that they do not know how to work into water system practice. Spatial resolution is another source of mismatching, as the ENSO models provide a regional-scale modeling that does not fit the decision boundaries of the agency. For the agency, most relevant are watershed-level forecasts that can give information on water yields, as well as finer-grained forecasts on sub-watersheds that influence capacities of pipelines and canals.

(iii) Cultural Mismatch

There is a more basic reason behind the gap between engineering practice and climate forecasting science, and this has to do with the differing "cultures" behind the two. Literally, it is the difference between the fields of oceanography and atmospheric science on the one hand and engineering on the other. This is expressed, indirectly, as a mistrust of the ENSO model as a black box. Several water managers gave the opinion that the model was unreliable, although further probing suggests that they do not actually have had occasion to compare model performance against actual events or against other models. Part of the 15 year adjustment period, according to those interviewed, would undoubtedly be due to the need to hire a new kind of engineering staff, including 'translators' who could make the ENSO model less of a black box.

(iv) Uncertainty

Another source of inertia is basic system complexity (see Callaghan et al., 1999; Miles et al., 2000). Reservations about the use of the black box have larger consequences. At a more fundamental level, water agency managers are unsure about the effect on the larger system of switching to the use of climate forecasts. Part of this is due to the the complexity of the water supply system in the U.S. The State of California is a case in point, as interviews with the Metropolitan Water District (MWD, the largest water wholesaler in the state) suggest that the institutional complexity makes it difficult how much change is necessitated by this switch. As the middle link in the water supply chain (literally, water can pass through the hands of 7 different agencies before the consumer receives it), the MWD can best predict what the implications of new forecasting would be to just their own organization. Even here, the consequences are significant, as all their units would need to be able to interpret the probabilistic information received from the ENSO model. But, higher up the chain, undoubtedly, the State Water Project would need to recalculate all the expected yields of their water supply sources. Going down the chain, purchasers would need to recalculate their water supply predictions, operators would need to develop new rule curves for pump stations and reservoirs, retailers might need to recalculate their rate equations, etc. Part of this is due to the inherent conservatism built into water supply systems that have evolved over almost a century.

(v) Incentive Incompatibility

On the plane of motivation, there are multiple reasons for the ENSO model not to be utilized. Part of the inherent conservatism is an agency culture for which the main edict is "out of sight, out of mind." That is, the less the agency gets the attention of the public, the better. However, the more dynamic and shifting mode of operation necessitated by the probabilistic forecasting model exposes the agency to greater public visibility. For the water manager, there is little motivation to switch methodologies, as system optimization is not one that will provide rewards (since, to begin with, system operation is invisible to the public). For the agency engineer who may have ownership of the existing system of supply forecasting, the agency's procedures (e.g., design curves) may be jealously guarded. On the other hand, on the part of NOAA, there is not such a great incentive that the ENSO forecasts be actually utilized. NOAA's mission is completed once the models are created and run. Integrating these into water agency practice, once not anyone's priority, is getting more attention, however (Dilling, 2005).

What would motivate a change in orientation. According to some managers, the threshold for change lies in a large enough drought or other emergency condition that would move agencies beyond the institutional inertia. Large swings in rainfall and snowmelt could bring this about, but we have not exceeded these threshholds yet.

Another aspect of the institutional inertia has to do with the fixed, long-term nature of water supply contracts. Water purchases are bought for well into the future. Renegotiating allocations of Colorado River water among three states requires lengthy formal compact amendments.

(vi) Deliberative Nature of Practice

Lastly, use of a more sophisticated tool like the ENSO models allows real-time refinement of policy decisions. The provision of forecasts that can be modified on a weekly or monthly basis should be an advantage, taken from a purely rational point of view --one only needs to incorporate this better information into an already established decision procedure. However, this does not recognize that many of the policies in place are the outcome of many years of deliberation among many policy actors. Such deliberation is difficult to sustain on a frequent basis. Take the case of the allocation of water from the California State Water Project. These allocations are developed on the basis of a formula that is applied in the beginning of a planning year. The insertion of a real-time climate forecast model like ENSO means that these allocations may be recalculated on a more frequent basis (e.g., quarterly) --otherwise, much of the strengths of the additional modeling capability is not utilized. However, this requires more flexible contractual arrangements and/more more frequent inter-organizational deliberations. This requires much, in terms of organizational and legal resources, of the different policy actors.

(vii) American Republicanism

The last factor is not something that we obtained directly from the interviews but read into them. In the rather unjustified claims that the forecasting model is unreliable, critiques of the mismatched nature of the black box, and truculent inertia behind the agencies' response, is what seems to us to be a distinct disapproval for Federal intrusion. This fear of an overweening state government has a long history in civic American life, dating back to (and perhaps pre-dating) the civil war. The issue here is not that this is another forecasting model, but that it is a Federal mandate being imposed on the agencies. The model almost of necessity cannot fit our needs, because the Federal government could not possibly understand our context.

This brings us back to Figure 1. Here, we see clearly the limitations of an institution that is simply imposed upon an agency "from above" without the necessary grounding in the local context. Rightly or wrongly, the Federal government, by virtue of its power and remoteness (i.e., in Washington, D.C.), cannot possibly create a program that has roots in the local conditions. There is perhaps some truth to this, as there is apparently insufficient attention paid to the task of "institutionalizing" the ENSO model so as to increase the linkages to local practices and policy actors. This is akin to the problem of *configuring the user* which is “defining the identity of putative users, and setting constraints upon their likely future actions”(Woolgar, 1991).

However, there is another side to this, in that the creation of this new institution will require the concerted effort of the local actor to make the new practice fit --to hone it down to a form that does work for local agencies. We also see an unwillingness of water agencies to go about the task of *contextualizing* the ENSO model. True, the Federal government cannot be expected to deliver a *black box* that fits, but this means that the burden of creating this fit falls on the local water agencies, acting in concert with the Feds, co-designing the model and creating an institutional niche around it (by hiring appropriate technicians, hosting knowledge sharing forums, creating other "translational" objects such as tutorials, extension agents, and graphic user interfaces).

5. CONCLUSIONS

In short, developing a climate forecasting model is not simply the production of software code. Rather, product development has to move from the level of creating pure knowledge to that of recreating practice. The linkages to water institutions needs to be built into the model. This means, first, that the informational output has to match that needed by agencies for short-term operations and long-term planning. This means that the model needs to include procedures for recalibration of water supply curves, pump

There is a need for people or organizations or objects operating on the boundary of agencies. That is, whether housed in water agencies, in NOAA, or other organizations, there is a need for people whose job is to interpret NOAA supplied forecast information into forms and predictions most useful to local agencies. In one example, successful integration of ENSO model forecasts were traced to the actions of an emergency resonse leader who would summarize ENSO model information, combine it with explanatory maps, and transmit this to agencies downstream. In some cases, his recipients used the information without even knowing that these came from the ENSO model. In other cases, water agencies contracted with private weather forecasting companies to reinterpret weather information.

There is also need for agencies and NOAA to be able to present the benefits of improved forecasts to multiple publics. For example, would the forecasts help justify purchase of new emergency equipment or services (e.g., standby pumps, water delivery trucks)? Could they be used to rationalize new rate schedules? Could farmers use the forecasts to optimize irrigation and better control the application of fertilizer or the timing of planting.

6. ACKNOWLEDGMENTS

The authors would like to thank Professors Steve Rayner of Oxford and Denise Lach of OSU for their participation in the water agency survey with Helen Ingram.

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