# INTEGRATING KNOWLEDGE AND ACTION THROUGH BOUNDARY ORGANIZATIONS: A STUDY OF THE ARIZONA WATER INSTITUTE

by

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A Thesis Presented in Partial Fulfillment of the Requirements for the Degree Master of Arts

## ARIZONA STATE UNIVERSITY

August 2009

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has been approved

July 2009

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ACCEPTED BY THE GRADUATE COLLEGE

#### ABSTRACT

Disconnects between science and policy are common and problematic, especially because they obfuscate already complex sustainability challenges facing contemporary societies. This thesis develops an analytical framework to study these disconnects and highlights the importance of institutional arrangements to enhance the relationships between knowledge and action for broader societal benefit. Informed by science policy scholarship and shaped by qualitative empirical research, this thesis identifies three themes as particularly significant to the institutional dimensions of knowledge-action integration: (a) governance and ownership; (b) reconfiguration; and (c) managing dynamic processes. This framework is then applied to the Arizona Water Institute to demonstrate its "real-world" applicability and to draw practical conclusions for boundary organizations trying to manage the relationships between knowledge and action. Results indicate that paying careful attention to institutions and their place within the broader political landscape is especially critical to both designing and evaluating efforts to integrate knowledge and action. To my extraordinarily supportive family, Jason, and friends (including dogs and a cat), wherever they are. They helped remind me that, ultimately, "the reward of a thing well done is to have done it" (R. W. Emerson).

#### ACKNOWLEDGEMENTS

I have been so very honored and fortunate to have had the opportunity to work with the individuals who sat on my committee. Their expertise on thinking about how different types of knowledges and actions come together is awe-inspiring. Their support of me through conversation, review of my work, and encouragement not only enabled me to move forward, but to find pleasure in the process.

For the enjoyment and for what I learned from the experience of developing this thesis, I am ever grateful to Dr. Clark Miller and his generosity with his time, patience, and thoughtfulness. His mentorship went well beyond his supervision of this thesis, helping me to find my own voice, sense of self-efficacy, and way in my graduate studies, as well as within the science policy and sustainability discourses. I very much appreciated the understanding and warmth Kathy Jacobs extended to me. Her experience in knowledge-action integration and her willingness to share some of this with me was invaluable to this process. I sincerely thank Dr. Dave Guston for his very thoughtful and extensive review of my work and contribution to conversations that provided greater learning opportunities for me than most class time. The community at the Consortium for Science, Policy and Outcomes became like a family for me, most especially due to the help and genuine kindness from Lori Hidinger and Geri Eastman.

I also gratefully acknowledge Drs. Jim Holway and Chuck Redman for mentorship their over the past several years.

Finally, I want to acknowledge my parents. My dad played many roles during this process; as a listener and friend, he was my greatest support.

# TABLE OF CONTENTS

P	age
LIST OF FIGURES	viii
SECTION	
INTRODUCTION	_ 1
CURRENT THEORY	_6
Efforts to Manage Knowledge-Action Boundary – Organizations	_9
Modifications within Each Side of & Across the Boundary	12
Addressing Complexity & Change Across & Beyond the Boundary	18
RESEARCH AND APPLICATION	_27
Research Design	_27
Arizona Water Institute	_29
Beginnings	_30
Purpose	_33
Organizational Approach	35
Findings and Analysis: AWI as a "Boundary Organization"	41
Governance and Ownership	_43
Establishing authority at the boundary and a role within	
the broader landscape	_44
Challenges of a Democratic Approach, Lines of	
Accountability	47
Setting Expectations	50

	Helping users Identify with Boundary Organization _	52
	Financial Sustainability	55
	Reconfiguration	58
	Structure and functions for reconfiguration	60
	Operations	65
	Scope	71
	Legacy as a catalyst	74
	Managing Dynamic Processes	76
	Adaptive management approach	79
	Gathering demand	85
CON	CLUSIONS AND FURTHER RESEARCH	90
	Further Research	98
REFE	ERENCES	103
APPE	ENDIX	
А	ASU INSTITUTIONAL REVIEW BOARD (IRB) HUMAN SUBJECTS	
	RESEARCH MATERIALS	108
В	ARIZONA WATER INSTITUTE STAKEHOLDERS	112
С	DEVELOPING MECHANISMS FOR ELICITING FEEDBACK: AN	
	EXAMPLE OF A STAKEHOLDER QUESTIONNAIRE FOR AWI	116

Page

## LIST OF FIGURES

Figure	Page
1. Arizona Water College One-Page Concept Flyer	32
2a. Official Organizational Structure Diagram of the Arizona Water Institute	37
2b. Unofficial Organizational Structure Diagram of the Arizona Water Institute	38
3. An Interpretive Institutional Diagram of the Arizona Water Institute	63-4

#### Introduction

A gap exists in US decision-making between knowledge and action. Consider, for example, the case of Hurricane Katrina. Katrina devastated the city of New Orleans. For years beforehand, researchers had studied and modeled the potential impacts of tropical storm activity of the magnitude of Katrina. Their work was showcased on National Public Radio in the hours before Katrina hit. In the end, their models were almost exactly correct. Yet, policy responses after Katrina hit gave little evidence of being based on the models or the broader research on which the models were based. Hindsight, in this case, provides a picture of a fundamental disconnect between the research done by the scientific community and government policy choices (both complicated concepts, in and of themselves).

Hurricane Katrina is not the only case. The disastrous events surrounding Katrina's landfall exemplify a much deeper problem, highlighting functional separation between scientific information and decision-making within and across myriad political, administrative, and geographic scales. Research in science policy has identified a mismatch between the supply of and demand for scientific research, with science too often producing research portfolios that decision-makers do not find useful, cannot use, and/or simply do not use (Cash, Borck, & Patt, 2006; Sarewitz and Pielke, 2007; Sarewitz et al, 2008). Such failures rest on a multitude of factors, including issues of power, access, justice, resource capacity, administrative and operational methods, and problem framing. On the one hand, scientific research often fails to engage the needs of civil society and, as a result, fails to produce meaningful, topical, timely research presented in a useful format to decision-makers (Jasanoff & Wynne, 1998; Jacobs, 2002; Sarewitz & Pielke, 2007). On the other hand, users of knowledge may also choose to exploit scientific information for pre-determined political agendas; may prove unwilling or unable to access and make use of research; or may simply be too marginal or disenfranchised to impact societal outcomes (e.g. Schneider & Ingram, 1993; Sarewitz & Pielke, 2007).

This thesis argues that efforts to improve the links between knowledge and action must pay careful attention not just to knowledge production and use but also to the institutions set up to make and mediate the connections in the first place. To pursue this argument, the thesis builds on the concept of boundary organizations (Guston, 1999; 2001). Recent scholarship in science policy and social studies of science has focused considerable attention on the work that occurs at the "boundary" between knowledge-making and decision-making<sup>1</sup> and to the wide range of actors and stakeholders involved in such work (Jasanoff, 1990; Gieryn, 1983). In this work, a boundary organization is defined as a set of institutional arrangements designed to forge a bridge between scientific research and decision-makers in a position to act on that research.

Drawing on the theory of boundary organizations, as well as other relevant contemporary theoretical models – such as hybrid management (Miller, 2001); knowledge systems for sustainable development (Cash, Clark, Alcock, Dickson, Eckley,

<sup>&</sup>lt;sup>1</sup> Depending on the context, this issue may be alternatively framed in terms of "information and decision-making," "science and policy," "research and practice," etc. This point is reiterated and further explained in the Scholarship section.

Guston, et al., 2003; Jacobs, 2002; White, Wutich, Larson, Gober, Lant, & Senneville, in press); reconciling the supply of and demand for scientific information (Sarewitz & Pielke, 2007); and stakeholder engagement (e.g. for natural resource management see Sabatier, Focht, Lubell, Trachtenberg, Vedlitz, & Matlock 2005; Jacobs, Garfin, & Lenart, 2005) – this thesis creates a new conceptual framework with two specific objectives: first, to operationalize what it means for an organization to effectively manage the science-policy interface, and, second, to create an analytic approach with which to evaluate boundary organizations engaged in this type of work. Key elements of this framework include: (1) governance and ownership: how boundary organizations are situated within the broader political landscape – including their accountability to knowledge producers, users, and other stakeholders; (2) reconfiguration: the capacity of boundary organizations to bring about significant modifications within both science and decision-making, so as to create better connections across the two domains; and (3) management of dynamic processes: the extent to which boundary organizations have the capacity to be adaptive and reflexive in responding to new scientific research and changes in decision contexts.

The thesis applies this framework to a case study of the Arizona Water Institute (AWI). AWI is an example of an organization established to support interaction among communities involved primarily in knowledge and information (e.g. university scientists), and communities involved in action (e.g. practitioners). Officially initiated by then-Governor Janet Napolitano as a consortium of the three state universities, in partnership with the State Departments of Water Resources (ADWR), Environmental Quality (ADEQ), and Commerce (ADOC), AWI was a mechanism by which to bring together, organize, and help manage water expertise and water decision-making in Arizona. The Governor and other advocates for AWI expected the organization to ultimately transform water research, management, and policy. AWI was to be Arizona's institutional leader for sustainability-oriented water resource technology and research (particularly in the context of rapidly urbanizing, water-scarce, drought-prone, semi-arid environments) and to be globally recognized as a model for trans-disciplinary and multi-sectoral collaboration, stakeholder engagement, and successful integration of environmental resource management and economic development. This study explores how well AWI achieved these goals of improving the production, packaging, dissemination, and application of scientific information in policy and management contexts. Accordingly, the thesis poses the following question: was AWI effective at facilitating meaningful and productive exchanges among water managers and water experts in Arizona's three universities, the private and public sectors, and relevant state agencies in Arizona?

The thesis first presents an overview of scholarship in science policy and social studies of science focused on the science-policy interface. Based on this work, the thesis presents a conceptual framework for analyzing institutions involved in science-policy integration work. Subsequently, it presents the case study of AWI, beginning with research design, and following with a detailed introduction of AWI's history and organization, and findings. Third, it describes the Arizona Water Institute in detail, as an illustrative case study of an institution working at the interfaces of research, policy, and management communities for sustainability-oriented objectives. Fourth, it presents data

and findings from applying the conceptual framework to AWI. Finally, the last section offers generalizable lessons, conclusions, and reflections for future research and management.

#### Current Theory

Scholarship in a wide range of disciplines and sectors is increasingly concerned with the pervasive and important disconnect among communities involved in producing, processing, legitimizing, and using knowledges across many action arenas, e.g. climate forecasting (Agrawala, Broad, & Guston, 2001; Buizer, Jacobs, & Cash, Forthcoming); agricultural extension (Cash, 2001; Carr & Wilkinson, 2005); and water resources (Jacobs & Pulwarty, 2003). The questions that follow help frame the array of current theory related to integrating knowledges and action, relevant to the ensuing analysis. From the perspective of a sustainability-oriented agenda, why does the structure and function of relationships among information, decision-making, and planning matter? How do we know when the "right" questions are being asked, the "right" information is being produced and disseminated, and/or the "right" decisions are being made? What constitutes "right;" who decides; and how do we assess our proximity to it, vis-à-vis knowledge-action integration efforts? In what ways do answers to these questions shape and get shaped by institutions and the configuration of governance regimes that institutions comprise (e.g. Anderies, Janssen, & Ostrom, 2004)? How can governance regimes be reorganized to support research and practice aimed at better connecting science and policy to create more socially-beneficial and sustainability-oriented outcomes (however defined)?

Intervening in and transforming the institutional configurations that characterize science policy, in favor of more meaningful relationships and integration of knowledge and action, has become one of the foremost issues in the sustainability and sustainable development agenda. For example, the United States National Research Council (NRC) established the *Roundtable on Science and Technology for Sustainability* in 2004. The NRC website identifies better linking of science to outcomes is an important goal of the Roundtable:

...through its activities, the Roundtable identifies new ways in which science and technology can contribute to sustainability....The goal for the Roundtable is to mobilize, encourage, and use scientific knowledge and technology to help achieve sustainability goals and to support the implementation of sustainability practices.<sup>2</sup>
To help achieve this goal, the Roundtable organized a workshop in 2006 on this topic:
"Linking Knowledge with Action for Sustainable Development: The Role of Program Management – Summary of a Workshop" (2006). This workshop specifically identified the knowledge-action disjuncture as a subject of high priority for the United States science policy community.

This thesis adopts a "sustainability perspective." For the purposes of this project, a sustainability perspective indicates integrativeness and inclusivity; a whole-systems, multiscalar, and long-term-oriented approach; and the recognition of complexity, uncertainty, interconnectedness, and the inevitability of tradeoffs associated with all choices (Anderies, 2002; Tainter, 2003; Jacobs & Morehouse, 2005). Various conceptual approaches have emerged to address enhancing the efficacy of exchanges among diverse types of actors, stakeholders, and producers in order to advance sustainability goals. By

<sup>&</sup>lt;sup>2</sup> <u>http://sustainability.nationalacademies.org/roundtable.shtml</u>

and large, these approaches identify the relative independence of science and policy as communities that face each other across a sharp "boundary" (Agrawala, Broad, & Guston, 2001; Cash, 2001; Guston, 2001), "frontier," (Bush, 1945) "nexus" (Hoppe, 2005), "intersection" (Star & Griesemer, 1989), or "interface" (Jones & Fischhoff, 1999; White, Corley, & White, 2008), as a critical part of the problem. The broad consensus is that knowledge and action often fail to come together as needed for addressing the complexities and tradeoffs of sustainability problems (e.g. Braun, 2008).

This problem has been addressed from a wide range of perspectives, yielding diverse theories and approaches designed to explain and/or improve the ties between knowledges and actions. Stated very broadly, examples include: stakeholder engagement (e.g., Sabatier, Focht, Lubell, Trachtenberg, 2005); transdisciplinarity (Kinzig, 2001; Klein & Scholz, 2001; Hirsch, 2006); creating mechanisms (e.g. boundary objects) and/or institutional infrastructures (e.g. boundary organizations) for negotiating across the divides (e.g. Guston, 2001; Star & Griesemer, 1989); the role of the boundary manager, highlighting the potential power of a charismatic leader (e.g. in fostering constituent participation, involvement, and joint-fact-finding activities); and qualities of the knowledge-action relationship, in the context of sustainability issues (e.g. Cash et al, 2003; Jacobs, 2002; Miller, 2001).

Some scholars, most notably Guston (2001), emphasize the significance of organizations at the figurative "boundary" between science and policy. Others characterize the interaction of these domains as being highly complex and argue for a broader and more nuanced understanding– and ultimately reconceptualization– of how

knowledges and actions come together for, e.g. sustainability objectives (Adger et al., 2003), global environmental governance (Miller, 2001), and public management (Feldman, Khademian, Ingram, & Schneider, 2006). This thesis seeks to bring these two literatures into productive dialogues, building upon the theory of boundary organizations. It centers on the institutional role of facilitating the integration and negotiation of diverse types and sources of information with a range of relevant levels and scales of decisionmaking. At the same time, the thesis observes that this work necessarily involves boundary organizations in engagements with a much broader landscape of actors. The purpose of this section is to provide a sketch of the conceptual, theoretical, and analytical underpinnings of this study, framing and justifying the focus on institutions, their role at the boundary, and their relationships to the dynamics of the broader landscape. It begins with efforts to manage knowledge-action boundaries, focusing specifically on organizations situated at these boundaries and the particular challenges they face, drawing primarily upon Guston's work (1999; 2000; 2001). Next, it describes scholarship concentrating on the attributes and configurations of institutional landscapes and, especially, putting forth arguments for change within one or more aspects of or across the boundary (Jacobs, 2002; Cash et al., 2003; Sarewitz & Pielke, 2007). Finally it explores relevant theory that recognizes and embraces systemic factors, such as complexity, uncertainty, and change, with respect to managing the relationships between knowledge and action, e.g., hybrid management (Miller, 2001), adaptive management and governance (Folke et al., 2004), and institutional learning (Senge, 2006).

Efforts to Manage Knowledge-Action Boundary – Organizations

Scholarship on "boundary work" generally

...highlights the prevalence of different norms and expectations in the two communities regarding such crucial concepts as what constitutes reliable evidence, convincing argument, procedural fairness, and appropriate characterization of uncertainty. It points out the difficulty in effective communication between the communities that results from these differences, and stresses the importance for effective advising of explicit development of boundary-spanning institutions or procedures (Cash et al., 2003).

Guston's theory of boundary organizations (2001) provides crucial insights into the importance of institutional infrastructure to "manage" the boundary between science and policy. "Boundary organizations" simultaneously (a) help to construct and maintain the appropriate boundaries between science and decision-making, and (b) negotiate with all sides for mutually-beneficial outcomes (Guston, 2001; Guston, et al., 2000). They also help identify and build relationships with relevant, appropriate players in the broader institutional landscape, so as to negotiate the disparate informational and functional capacities, cultures, and political agendas to help decision-making better align with knowledge and societal needs (Guston, 2001). The value of boundary organizations in practice, so the argument goes, is that they provide scientists and policymakers with "an opportunity to construct the boundary between their enterprises," to achieve outcomes that they determine to be desirable. At the same time, the organizations are engaged in "assuring proper participation [among politicians, researchers, and technology-transfer

specialists], balancing of interests, and [democratic] accountability structures around newly collaborative tasks" (Guston, 1999, p. 106).

In other words, Guston explains the role of organizations in developing more effective science-policy exchanges and describes an entity that facilitates (a) the manufacture of manipulatable boundaries within each domain to suit the worldview and comfort of each; and (b) meaningful cross-domain interaction that allows for the maintenance of these boundaries, to protect the distinct identities for which they were erected, but in important ways also to transcend them to develop productive relationships that enhance the societal benefit of scientific research and policy-making.<sup>3</sup> In order for this to work in practice, according to Guston, boundary organizations have "dual agency" (2001): "they exist on the frontier of two relatively distinct social worlds with definite lines of responsibility and accountability to each" (1999, p. 93).<sup>4</sup>

Activities of a boundary organization include the development of "boundary objects," which may include decision-support devices or other mechanisms to facilitate productive exchanges across these domains. According to Star and Griesemer's foundational study on making meaningful cooperation possible among science experts,

<sup>&</sup>lt;sup>3</sup> Guston provides the following criteria for "identifying the boundary organization:" ...the creation of a space for the creation and use of boundary objects or standardized packages, or a combined 'scientific and social order'; the collaborative participation of principals and agents, or scientists and non-scientists; and the mooring to mutual interests and distinct lines of accountability (1999, p. 105-106).

<sup>&</sup>lt;sup>4</sup> "The boundary organization draws its stability not from isolating itself from external political authority, but precisely by making itself accountable and responsive to opposing external authorities" (Guston, 1999, p. 111 note 60).

"amateurs," and university and zoo administrators, "two major activities are central for translating between viewpoints: standardization of methods, and the development of 'boundary objects.' Boundary objects are both adaptable to different viewpoints and robust enough to maintain identity across them" (1989, p. 387). In addition to "objects," boundary organizations also work to produce "standardized packages," referring to a "translation" process resulting in a mutually useful articulation of important issues and information available (Guston, 1999, p. 105-106). All of this refers to the "stabilization" aspect of boundary organization's work, indicating its "[successful performance] as an agent for both politicians and scientists" (Guston, 1999, p. 87).

#### Modifications within Each Side of & Across the Boundary

Other scholarly approaches for identifying the sources and conceptualizing the problems occurring between knowledge and action domains include those calling for investigation and transformation of how knowledge gets produced and/or how decisions get made. Surprisingly few authors have called for something similar to a whole reconfiguration of institutional landscapes, to be more supportive of sustainability goals or socially-beneficial outcomes (e.g. White, Corley, & White, 2008). More common are discussions of the constructs of one side or another warranting the primary focus on knowledge-action disparities and potentially unintended, unfavorable, and unevenly distributed implications. A sampling of these is outlined below, beginning with an assessment of the production of science as being out of touch with user demands (Logar & Conant, 2007; Sarewitz & Pielke, 2007); moving to the attributes and functions of sciencial knowledges that render them useful for stakeholders (Cash et al,

2003); and closing with processes for building mutual understanding, trust, equitable relationships, and capacity, as well as, the potential impact of these activities on decision-making (e.g. Herman, Susskind, & Wallace, 2007; Jacobs, 2002; Jacobs & Pulwarty, 2003; Lemos & Morehouse, 2005; Moss, Medd, Guy, & Marvin, 2009; Ingram & Feldman, unpublished manuscript, October 2008).

Ineffectual interfaces among the practices and products of science and policy (as illustrated in the Katrina example) may be derivative in part of science communities' insufficient engagement with society (e.g. Cash et al., 2003; McNie, 2007; Rayner, Ingram, & Lach, 2005). Analysts who make this argument generally highlight how reconfiguration could (and, presumably, should) occur within knowledge-production. In a 2007 special issue of the *Environmental Science and Policy* Journal, Sarewitz and Pielke consider this and

... how one might approach the problem of rigorously assessing the relationship between a research portfolio (or a set of alternative portfolios) and the societal outcomes that the portfolio is supposed to advance (p. 6).

To these authors, this is the "neglected heart of science policy," calling attention to "how little attention is paid to understanding the relationship between alternative possible research portfolios and stipulated societal outcomes" (2007, p. 6). Sarewitz and Pielke characterize the science-policy relationship in the traditionally economic terms of "supply" and "demand," and indicate that the needs of information users poorly correspond with the subjects of scientific research. They show that "better" science portfolios would contribute to the achievement of "an ideal reconciliation of supply and

demand [that] would match the capabilities of science with the needs of those who could most benefit from it" (p, 9). Advancing the needs and desires of a society is predicated partly on the focus and outcomes of science research agendas, Sarewitz and Pielke explain. They characterize "better" in this context as reflecting "an understanding of the supply of science, the demand for science, and the complex, dynamic relationship between the two" (p. 6). They develop a conceptual framework (from here on referred to as "RSD"), diagramed as a two-by-two matrix. It positions the production of scientific research (supply side) counter to the need for scientific information (demand side), providing a visual tool to demonstrate how to identify "missed opportunities" (p. 12), for connecting science and decision-making. Sarewitz and Pielke explain that these are characterized by (a) "inappropriate" research portfolios, determined by an overlay of feasible scientific work and poorly aligned incentives provided by funding agencies that neglect the needs of users; and (b) circumstances where information is available that would benefit decision-making but is not applied. The latter, Sarewitz and Pielke acknowledge may be reflective of users' lack of sophistication or marginalization from the science process, or other impediments within the governing institutional arrangement (2007, pp. 12-13).

The RSD framework was recently applied to *DCDC WaterSim*, a decision support device developed by ASU's Decision Center for a Desert City.<sup>5</sup> Nearly seventy water experts across Central Arizona (including water managers, consultants, and policy-

<sup>&</sup>lt;sup>5</sup> Wutich, A. & Gartin, M. (2006). *WaterSim codebook*.

makers) participated in a demonstration and facilitated discussion of the first iteration of *WaterSim*. Stakeholder participants were questioned about the utility of the model with respect to their own work.<sup>6</sup> Stakeholder responses were coded using four RSD-related categories to perform a "comparative overlay" (Sarewitz & Pielke, 2007, pp. 12-14) of stakeholders' perceptions of the type and format of delivery of the information *WaterSim* provided and how well it met their expectations and needs.<sup>7</sup> (Each code represented a side of the "missed opportunity matrix," which served as an analytical device through which to map data and construct supply-demand relationships.) The findings of this work yielded valuable insights into the ways in which the model, as well as the experience of participating in the use of it, could be modified to be more useful for end-users (White, Corley, & White, 2008; White, et al. , Forthcoming; unpublished work, DCDC, 2007-8).

This example demonstrates an attempt to answer precisely the question Sarewitz and Pielke pose: "how do we know if we are doing the right science?" (p. 14). The first iteration of the *DCDC WaterSim* model revealed that the university research community– the "supplier" of the information – was to an extent disconnected with the decision-

<sup>&</sup>lt;sup>6</sup> Specifically: "(1) How relevant is the model to your needs as a decision-maker (or the needs of decision-makers in your workplace? (2) What is your opinion of the scientific adequacy and the technical information presented in this model? (3) Do you think that the information presented here is fair, unbiased, and respectful of stakeholder values?" (Gartin et al., 2007)

<sup>&</sup>lt;sup>7</sup> The original seven substantive codes within the reconciling supply of and demand for scientific information category are: Unsupplied information, Supplied information, Undemanded information, Demanded information, (Subcode) Externally demanded information, (Subcode) Internally demanded information, Boundary-demanded information (Codebook, 2006).

making stakeholder groups that participated – constituents comprising the "demand" for information. It is difficult to comment on "missed opportunities" in this instance, as developed by Sarewitz and Pielke – largely because the study focused on perceived needs, i.e. stakeholders' stated information demands, as opposed to assessing actual societal outcomes, available information, and the capabilities of the users and scientists. However, it is clear that there were missed opportunities related to time and resources lost for building the kinds of trust relationships boundary organizations need to thrive.

Another example of scholarship on reconfiguring science and policy for more effective integration comes from the interdisciplinary Knowledge Systems for Sustainable Development Working Group, initially supported by the National Oceanic and Atmospheric Administration (NOAA) (Cash et al., 2003; also, Cash et al., 2002). This work, which focuses on whole knowledge systems and their dynamics posits that "effectiveness of knowledge systems" can be described in terms of "boundary management" or bringing science and technology to bear on decision-making, and that this is predicated on three characteristics: (1) stakeholders must perceive that those involved in producing science and the science itself are *credible* – in short, the "supply" (applying RSD terminology) or science "side" does work that is scientifically valid, accurate, and generally of high quality; (2) science must also be *salient* or relevant to the social, economic, and political circumstances of users; and (3) the process by which information is gathered, processed, produced, and disseminated must be perceived of as *legitimate*, including fair and trustworthy (Cash et al., 2003, pp. 8088-8089).

The group developed several empirical cases and characterized the extent to which these attributes applied to the ability or quality of efforts to use science and technology for sustainable development. They determined that successful boundary management (wherein credibility, saliency, and legitimacy apply) is attributable to several so-called "functions" and "institutional features." These include communication, described as dynamic, multi-directional, and non-exclusive to stakeholders; translation, which offers "mutual understanding" as an imperative, requiring effort beyond communication; and mediation (Cash et al., 2003, pp. 8087-8090).

An essential aspect of this approach is the configuration of a knowledge system – the characteristics of knowledge production and the institutional functions that participate in boundary-spanning – and therefore the reconfiguration that may be necessary to orient the system better toward sustainable development. The need for reconfiguration is also identified as important in *Connecting Science, Policy, and Decision-making: A Handbook for Researchers and Science Agencies*, which provides a set of critical issues for consideration and functional "steps" toward the execution of successful research-practice integration (Jacobs, 2002). The handbook suggests, for example, that researchers must develop a comprehensive "understanding of the context" and of the "users/clients [and their] perspectives" before defining research questions if the outcomes are to be expected to be used and useful. Taking care to identify and then intimately understand their audience helps guide scientists toward products that are meaningful, in terms of the temporal and spatial scales, the skill and knowledge-level, and the particularities of uncertainty likely to concern users, i.e. salient (for discussion about targeting stakeholder

populations and the socio-political implications, see Schneider & Ingram, 1993; and see Shackley & Wynne, 1996, for framing uncertainty at the boundary in global climate change science and policy; and for a discussion of engaged universities, see Lawson, 2002).

#### Addressing Complexity & Change Across & Beyond the Boundary

The third way in which extant scholarship helps frame the exploration of knowledge-action integration processes focuses on the complexity, uncertainty, and dynamism of human-environment systems and articulates ways to think about these processes in nuanced and integrated ways. Important to this theme are concepts and theories of institutional learning, adaptive management and governance, reflexivity, and hybrid management. Specific aspects include openness and responsiveness, flexibility and nimbleness, experimentation, constructing and deconstructing (as described by the hybrid management approach), and mechanisms for self-evaluation and gathering user demand and feedback.

An organization that is truly working for its stakeholder community to enable the integration of available knowledges, expertise, and resources for decision-making must be accessible and receptive to users (Ingram & Bradley, 2006; Lemos & Morehouse, 2005; Taylor, 1997). Mechanisms that institutionalize a degree of self-reflection in an organization toward its own practices, facilitates learning and adaptation in response to changing stakeholder demands and environmental conditions and also contribute to an organization's ability to act reflexively – an integral dimension of the knowledge-action integration effort. Apparent openness to input from actors at the boundary and reflexivity

demonstrates to users a commitment to serving their interests and that of the relevant larger (and longer-term, as requisite of addressing sustainability) objectives. The notion of legitimacy discussed in the prior section is similar (Cash et al., 2003). Jacobs offers specific themes and strategies for achieving this kind of dynamic reflexivity in natural resource management. These include elements of effective communication (frequently characterized as two-way engagement, particularly in the form of dialogue), collaboration, the importance of opportunities for users to participate (and their capacity to participate, including, education and equity considerations), and an adaptive approach informed and provoked by user-input (e.g., Jacobs, Garfin, & Lenart, 2005; Jacobs, Colby, de Kok, Woodard, Maguire, & Megdal, 2004). Adaptive management and adaptive governance offer important ideas for the philosophical and institutional underpinnings of the sustainability agenda. As theories, they recognize, even embrace, uncertainty, change, and the absence of "stability." Adaptability, in this way, emphasizes processes, iterativity, and learning by doing wherein decisions are made (i.e. policies are implemented) as experiments. In theory, it is important to empower stakeholders across scales through direct involvement, facilitate collaboration with a broad range of interests, and recognize multiple types and sources of knowledges as valuable for decision-making (e.g. Lee, 1999; Resilience Alliance, 2009; Folke, Hahn, Olsson, & Norberg, 2005). Further, this type of management conceptualizes a thoroughly integrated institutional regime establishing meaningful "cross-scale" linkages that overcomes typical challenges of mismatches among management institutions, scales, and the particularities of the problems themselves (e.g. Folke, Pritchard, Berkes, Colding, & Svedin, 2007; Miller and

Erickson, 2006; Cash et al, 2006; Anderies, 2002).<sup>8</sup> All of this points to the role of institutions that act to confront head-on the manufactured barriers of the variety of actors invested in a particular issue area in order to negotiate their perceptual differences and help create effective boundary management and boundary objects.

Institutionalized internal reflection and self-evaluation are essential to the execution of an adaptive approach. This is also true of consistent and continual efforts to identify and understand the (potentially changing) needs and interests of the constituent population, i.e. demand-gathering. Part of the latter offers insights into the utility of the organization's work, which can, in turn, be useful for rigorous scrutiny of the organization's work, with respect to stakeholder concerns. Different types of questionnaires, surveys, workshops, and stakeholder meetings might be a part of eliciting feedback. Developing a clear way to receive and integrate input from broad sources into regular practice, and then making this approach readily available, demonstrates that the organization's priorities are supportive of constituents. Jacobs's *Handbook* provides mechanisms for soliciting and ensuring feedback, evaluating one's work, and measuring "success in collaboration" (2002).

Adaptation and reflexivity are essential characteristics, in terms of an organization's ability to do work that is useful, relevant, and important. They are also a

<sup>&</sup>lt;sup>8</sup> Miller and Erickson suggest essentially this in their discussion of strategies "for bridging scales and epistemologies in global environmental assessments." They express this as, "orchestrating cross-scale epistemic jurisdiction—strengthening dialogue and exchange, as well as appropriately delegating authority, across scales of assessment and governance" (2006, p.298).

critical aspect of developing trust, support, and the perception of the organization's genuine commitment to working in the interests of stakeholders. Adaptability arises in much of the literature that acknowledges the value and necessity of bringing diverse viewpoints and expertise to bear on governance for sustainability. Jacobs and Morehouse agree that adaptive management principles are useful within sustainability discourse, and declare:

We need to learn how to integrate our constantly improving understanding of natural [and human] systems with our decision-making processes, improve our monitoring systems and analyze the implications of what we observe over multiple time and space scales, learn from our mistakes, and avoid making consequential decisions that are irreversible. It's worth a try. (2005, p. 26)

Much of Jacobs's work deals with procedural aspects of the knowledge-action integration in a very practical way – arguably more so than other models described above– but clearly works with similar issues. While not neglecting the importance of "outcomes," her work implicitly emphasizes the process. Efforts to address divergences among actors with particular information and decision-making capacities are likely to have important long-term impacts, e.g., the development of functional cross-domain relationships, trust, capacity-building, knowledge-sharing and education. Likewise, Miller observes that "finding institutional arrangements that can command credibility, legitimacy, and authority among the many, diverse publics, officials, and experts around the world with a stake in global decision making is an exceedingly complex and difficult task" (2001, p. 479). Concurring with this conceptual orientation, Lach, Rayner, & Ingram (2005), show how it is possible (if not likely) to have organizations that seem to possess these characteristics but do not act in a way that is supportive of any or all sides of an issue.

Miller, also interested in the ways knowledge systems and boundary organizations function, advocates for an approach that offers greater nuance through an "emphasis on the social arrangements and practices internal to boundary organizations and the dynamics of their relationship with a diverse array of other organizations" and recognizes that boundary organizations are not the only players (2001, p. 287). Specifically, the approach he puts forth – hybrid management – points to the importance of looking at "processes by which [hybrids] are constructed, taken apart, and ordered in relation to one another," i.e. hybrid management.<sup>9</sup>

Hybrids are social constructs that contain both scientific and political elements, often sufficiently intertwined to render separation a practical impossibility. They can include conceptual or material artifacts... techniques or practices...or organizations (Miller, 2001, p. 480).

According to the hybrid management approach, "'boundary organizations' [refers] to those social arrangements, networks, and institutions that increasingly mediate between

<sup>&</sup>lt;sup>9</sup> Miller notes that his use of the term "hybrid" is an adaptation of French philosopher Bruno Latour's application of the concept. Miller explains that Latour (1993) "explicitly theorizes modernity as the 'proliferation of hybrids,' by which he means the mixing up of facts and values, knowledge and identity, nature and culture, science and politics in our conceptual frameworks, material technologies, and social networks and institutions ... [and that] the basic drive of modernity has been to purify hybrids into science or politics, facts or values" (Miller, 2001, p. 486-487).

the institutions of 'science' and the institutions of 'politics'-understood as labels for distinct forms of life in modern society" (p. 482). Concurrently, they help "to manage hybrids ... [and thereby] contribute ... to the maintenance of a productive tension between science and politics" (2001, p. 495). There are four components to this model, which offer insight into managing dynamic processes in the context of bringing together knowledge and action through institutions (Miller, 2001, p. 287). "Hybridization" describes the intentional bringing together of diverse components of scientific and political domains. This process involves "both normative and technical judgments" to yield, e.g., "standards and measures" reasonable from the perspective of scientific expertise and meaningful and of value to policy-makers (p. 489-490). Taking apart various components of scientific and political domains - "the opening up of hybrids" describes the "deconstruction" function. While the capacity "to deconstruct scientific knowledge claims rests significantly on [the] ability to mobilize competing interpretations of scientific evidence and theories," Miller explains that this process "[renders] tacit and value-laden assumptions visible to participants in policy debates...[and] can help increase the transparency of the policy process and [even] enhance policy effectiveness" (2001, p. 491). The third function, also mentioned above, describes efforts to make each domain appear distinct from each other, i.e. boundary work. Through boundary work, the legitimacy of both domains gains within society as a whole (p. 492-3). Finally, hybrid management includes "cross-domain orchestration". This denotes the coordination of actors and interests within different domains, while

maintaining perceptions that participating domains are discrete "for purposes of legitimacy" (p. 493-4).

Managing dynamic processes for sustainability-oriented objectives emphasizes that "ways need to be found for institutions, networks, and even cultures that put together order and knowledge in very different ways to each successfully sustain its own internal processes while forming productive relationships with one another" (Miller, 2001, p. 287). Miller and Erickson (2006) put forward strategies that are applicable and useful this conversation:<sup>10</sup> (a) "building critical [citizen] capacity for policy reasoning;" (b) "promoting epistemic tolerance and pluralism...i.e., recognizing and facilitating the expression of divergent styles of reasoning;" (c) "enhancing epistemic dialogue and exchange...as well as crosscutting reflection and evaluation;" and (d) "orchestrating cross-scale epistemic jurisdiction" (Miller & Erickson, 2006, p. 298). These strategies are not far removed from hybrid management – expressed "as the glue that links scientific, political, and other institutions together in modern political economies" (Miller, 2001, p. 488) – and are useful for thinking about the precise institutional role of at knowledge-action interfaces.

Some of the most useful aspects of the approaches introduced above include: the importance of process and approaching complex problems with an awareness of the whole context and a willingness to proactively ascertain influential dynamics, and actors

<sup>&</sup>lt;sup>10</sup> While the focus of that work is on "bridging scales and epistemologies" within a context democratization of international governance and drafting global environmental assessments, these strategies are clearly framed for more general applicability.

and needs involved – whether the focus be on, e.g., knowledge systems (e.g., Cash et al., 2003) or scientist-practitioner cooperative interactions (e.g. Jacobs, 2002). The system, inclusive of not only boundary organizations, but also the broader institutional arrangements that comprise particular problem areas, may contribute to, e.g. the marginalization or empowerment of certain actors, to the funding of certain science portfolios and not others, to the potentially detrimental "siloing" of particular discipline-and sector-specific sectoral knowledges (e.g. Taylor, 1997), and to creating decisions making institutions that either fail to or are incapable of appropriately using scientific knowledge. Better understanding of the intricacies of human-environment systems broadly may help to identify, explain, and ultimately address inefficiencies and inequities of knowledge-action relationships affecting sustainability efforts globally.

The work presented here concentrates on the role of institutions in terms of the integration of diverse knowledges and actions for addressing complex problems and how those institutions relate the broader political landscape. Efforts to analyze and evaluate how these relationships impact the production of information and its consumption and application are crucially needed:

In the public sector, science policy decision-making is mostly about how to allocate marginal increases in funding among existing research programs. At the same time, such allocation decisions are usually justified in terms of their value in pursuing societal outcomes extrinsic to science itself. In a world of limited science resources, then, it would seem more than sensible to bolster such justifications with better understanding of the implications of science policy decisions for societal outcomes. Nevertheless, consideration of how alternative research portfolios might better achieve stipulated societal outcomes is not a regular part of science policy discourse or decision processes (Sarewitz and Pielke, 2007, p. 14).

To reiterate, the narrative that follows seeks to provide a useful addition to sustainability studies and science policy scholarship through a further and more focused exploration of institutions performing knowledge-action integration activities. To accomplish this, the thesis turns next to the design of the research project, followed by the case study of the Arizona Water Institute.

### **Research and Application**

### Research Design

This project applies the above conceptual framework to a case study of the Arizona Water Institute. Data collection for this study involved one-on-one confidential semi-structured interviews, <sup>11</sup> document review, and participant observation of AWI. The interview sampling frame consisted of twenty-seven individuals who were directly involved with AWI and/or were immediately affiliated to the organization and its work. Interviewees included Executive Committee members, the Executive Director, three of the four Campus Coordinators, two of the three Associate Directors, a representative sample of the stakeholder External Advisory Board (with respondents representing, e.g. the business, private water provisioning, federal and local government, land use, rural and American Indian groups), several AWI-sponsored research project Principal Investigators, as well as two individuals who played instrumental roles in the initiation of the concept for the AWI and its implementation.<sup>12</sup>

The document review component of data collection included comprehensive study of materials produced by, in the name of, or through funding from the AWI. Such materials included the AWI website, newsletters, email updates, meeting minutes, testimonies and testimonials, as well as project and workshop reports and other

<sup>&</sup>lt;sup>11</sup> Refer to the Appendix for: (a) the Arizona State University Institutional Review Board (IRB) Human Subjects Research approval of this project, and (b) the IRB-approved confidentiality agreement between researcher and interviewee.

<sup>&</sup>lt;sup>12</sup> See Appendix B for specific information about AWI stakeholders, per AWI's Needs Assessment in 2006.

outcomes.<sup>13</sup> Participant observation was used to experience and analyze additional outreach, translational, and collaborative work relevant to improving the information production and application relationship. The author participated in a sampling of activities AWI supported and/or hosted during the period the research was conducted. These included the Water Panel of the Binational Arizona-Mexico Commission meeting (Phoenix, June 20, 2008); the Water Resources Research Center (WRRC) Conference entitled "The Importance of the Colorado River for Arizona's Future" (Phoenix, June 24, 2008); an External Advisory Board Meeting (ADWR, October 2008); a workshop cosponsored by the AWPCA (Arizona Water & Pollution Control Association) entitled "Focusing Arizona's Water Research: A One Day Workshop" (Tempe, October 29, 2008); an informational meeting for ASU faculty discussing opportunities and support AWI offers (ASU, September 2008); a Farmers' "Listening Session" as part of the AWI project focused on understanding farmers' concerns and the perceptual landscape of agriculture, economic development, water resources, and the future in Arizona (Buckeye, August 2008);<sup>14</sup> and the WRRC and AWI conference entitled "Best Practices for Stakeholder Engagement in Water Resources Planning" (Tucson, March 2009).

<sup>&</sup>lt;sup>13</sup> AWI's home page is located online at <u>www.azwaterinstitute.org</u>; publications including newsletters and brochures are available at <u>http://azwaterinstitute.org/publications.html</u>.

<sup>&</sup>lt;sup>14</sup> This project continues through FY2009 and in collaboration with the Agri-business Council of Arizona (ABC), entitled "Arizona's Agricultural Economy: Future Scenarios and Water Management Implications." So-called listening sessions took place across the state, and were loosely facilitated conversations with a "we want to hear from you" theme with farmers and others involved in agribusiness.
To analyze these data, the study adopted a three-pronged perspective. The first aspect of the perspective may be considered "internal" to the organization, and examines AWI's own practices and outcomes. This perspective assesses the extent to which AWI's actions aligned with its own mission and objectives, as well as to the expectations of its stakeholders. The second is theoretical and asks how AWI and its activities can be used to inform the science policy literature. The third emphasizes the organization's role in science-policy integration for governance and sustainability in Arizona. It asks if AWI made unique and valuable contributions to the institutional landscape of water research, policy, and management in Arizona.

#### Arizona Water Institute

The Arizona Water Institute (AWI) was explicitly designed as a "boundary organization," of the sort the scholarship surveyed above describes. The organization was established to serve as a focal point for research-to-action related to water resource sustainability (both water quality and water quantity) in the State of Arizona. A brief overview of the Institute is presented here, describing how and why AWI came into being, the organizational landscape within which it emerged, how it characterized itself and its own goals, as well as its contributions to water expertise and decision-making.

The environment of the State of Arizona, particularly the central and southern regions, is semi-arid, drought-prone, and rapidly urbanizing. The majority of Central Arizona's water arrives for consumption through surface water transfer from the Colorado River, claiming the most junior rights among a seven-state agreement, as well as from groundwater overdraft. While water expertise is extensive across state university and practitioner domains, the pace and scale of growth and increasingly apparent impacts of climate change have made water resource sustainability acute (Jacobs & Holway, 2004). Onlookers of Arizona's water situation emphatically declare water quality infrastructure, long-term access, and supply concerns urgent. Many warn of an impending crisis. In July 2008, for example, *Arizona Republic* columnist Shaun McKinnon cited a U.S. Environmental Protection Agency report on climate change "foresees a hotter, drier future...[and the disruption of] the critical runoff cycle that provides water to millions of people"<sup>15</sup>.

## Beginnings

In this context, the Arizona Water Institute emerged, in large part, from considerations of the latent value of enhanced coordination among the universities, state agencies, and others with a particular stake in water resources. Among researchers in Arizona, ideas of "transdisciplinarity" and collaboration, "social embeddedness" and "hands-on learning," as well as "access and impact" had become widespread.<sup>16</sup> Then-Governor Janet Napolitano faced increasing pressure to prioritize water issues, given the fast pace of development and concerns about drought, availability, and access. An example of such criticism came from the general manager of the Central Arizona Project

<sup>&</sup>lt;sup>15</sup> <u>http://www.azcentral.com/news/green/articles/2008/07/18/20080718climate-risks0718.html</u>

<sup>&</sup>lt;sup>16</sup> E.g. <u>http://ui.asu.edu/newamu/, http://www.arizona.edu/home/aboutua.php, http://home.nau.edu/academics/default.asp.</u>

(Arizona's largest wholesale water provider), Sid Wilson, who especially focused on the need for Arizona to be more proactive. The *Arizona Republic* quoted him:

This is a critical time. We're living off the legacy of the past, of leaders who are no longer there. If someone doesn't step in and show some leadership, the cupboard's going to be bare. We live in a desert. Without water, we're nothing (Sid Wilson quoted, April 2, 2004).<sup>17</sup>

In 2005, Northern Arizona University Professor Rand Decker led the drafting of a white paper recommending and describing the implementation of an "Arizona Water College," to function as a hub for water experts across the state. He explained that what he was trying to describe was modeled after the Nevada Higher Education System's Desert Research Institute, which "is independent of any one campus, while collaborating and utilizing talent from all of them" (personal communication, March 2009). Figure 1 is the corresponding flyer to these ideas.

<sup>&</sup>lt;sup>17</sup> "Napolitano slammed by CAP chief over desalter," received from http://www.sdcwa.org/clips/2004/04april/040204/040204napolitanoslammed.html.



Figure 1. Arizona Water College one-page concept flyer. This document was drafted by

Dr. Rand Decker soon after his arrival at the Northern Arizona University in 2005 outlining his vision for an entity that would bring the universities into collaboration and service roles with practitioner communities and the broader public. This idea contributed to the development and shape of the Arizona Water Institute (received through personal communication, March 2009). This work presented the vision of an organization that would provide "the Governor, the Legislature, State Agencies and Public/Private Constituencies with timely water resource advisory capabilities and decision support, while generating new capital resources for the State System of Higher Education [sic]" through "instruction," "research," and "service" (Arizona Water College One-Page Concept Flyer, 2005).

## AWI's Purpose

Governor Napolitano announced the formation of the "Virtual Water University" at a Town Hall meeting at the Grand Canyon in November of 2004. One of the rationales for funding this initiative was to build economic opportunities associated with broad investment in water across the three Arizona state universities – more than 400 faculty and staff with water related expertise and arguably one of the largest groups of water experts in the United States. With little support from the mostly-conservative Republican legislature, the Arizona Water Institute became a funded mandate of Napolitano's in 2006. Its "core group," which included people who had extensive experience in government, private sector, water management, and university research, laid out a vision of AWI as a convener of an extensive array of water-relevant experts and stakeholders. It was self-consciously a boundary organization, "deliberately designed to be at the 'boundary' or interface between entities that don't normally interact, and to provide them with the mechanisms, expertise, capacities, etc. that allow them to interact....We have designed AWI deliberately to bridge across the university-practice interface and the university-policy interface" ("core group" member, personal communication, July 2009). AWI put its attention from the beginning on helping to facilitate shared problem-solving

endeavors and the development of functional relationships, mutual understanding, and respect across government, university researcher, and practitioner communities. It operated to instigate and provide funding for collaborative research projects, sponsor and coordinate outreach and educational events, and to contribute to the "translation" of science for myriad uses.<sup>18</sup> The focal areas of its research program were: "Building the Arizona Hydrologic Information System;" Climate change/drought/adaptation;" "Energy/water sustainability;" "Capacity building/watershed research and support;" "Salinity management & technologies;" and "Emerging contaminants and treatment technologies" (AWI 2007 Annual Report). Project and event topics ran this gamut, for example: "Assessment of Navajo Nation Hydroclimate Network" (Garfin et al, 2007); "The Water Costs of Energy in Arizona" (Pasqualetti, 2007); "Salinity Management and Desalination Technology for Brackish Water Resources in the Arid West" (Workshop, 2007); and "Climate Change Adaptation for Water Managers" (Workshop, February 4-5 2008). AWI, by the nature of its construction as a boundary organization and through targeted efforts, provided and consolidated information important to water resources. This included an unofficial "who's who" of water experts (particularly across the Arizona

universities and water decision-making communities) and the Arizona Hydrologic

<sup>&</sup>lt;sup>18</sup> For example, Sarewitz and Pielke (2007) refer to philosopher Philip Kitcher's ideal wherein there is an "optimal" match of the needs of science users and the productions of scientific information. This ideal labeled "well-ordered science" is "achieved through an ideal process of representative deliberation" (Sarewitz and Pielke, 2007, pg 8 (paraphrasing Kitcher)). The "institutions governing the practice of inquiry within society" engage, among other things, in translation, which is resultant of "inquiry into applications, the policy followed is just the one that would be recommended by ideal deliberators. . ." (2001, pp. 122–123).

*Information System* (AHIS), an extensive "state-wide, collaborative [and open-source] effort" that, according to the AWI website introducing this portal, "provides a comprehensive framework for knowledge management and information discovery using data related to physiographic surveys, hydrologic observations, and water resources monitoring and assessment throughout the State of Arizona."<sup>19</sup>

# Organizational Approach

AWI is a consortium of the three universities in the state – Northern Arizona University, Arizona State University, and the University of Arizona – "focused on water sustainability through research, technical assistance, education, and technology."<sup>20</sup> Notably, AWI also included partnerships with the Arizona Departments of Water Resources, Environmental Quality, and Commerce; a representative from each holds an Associate Directorship within the organization. The Executive Director and staff – including faculty members from each of the universities, serving as Campus Coordinators – were overseen by its Executive Committee, comprised of the Vice Presidents for Research at each university, a representative from the Governor's Office, a representative of its thirty-six member External Advisory Board (EAB), and the director of the Arizona Department of Water Resources, representing the three state agency partners. EAB members represented the AWI "stakeholder population," which included federal and state

<sup>&</sup>lt;sup>19</sup> E.g. AHIS was one of four initial research projects officially begun in 2006, and has funding to continue past FY2009. More information can be found at <u>http://azwaterinstitute.org/ahis.html</u>, or it can be accessed at <u>http://chubasco.hwr.arizona.edu/ahis-drupal/</u>.

<sup>&</sup>lt;sup>20</sup> <u>http://azwaterinstitute.org</u>

agencies; Indian tribes; local, municipal, and regional water providers; watershed groups; the private sector; professional associations and consultants; the agricultural community; and the environmental community (AWI Needs Assessment Report<sup>21</sup>).<sup>22</sup> For the remainder of this work, the ambiguous term "stakeholder" is used in the context of AWI to refer to these groups.

<sup>&</sup>lt;sup>21</sup> Gerlak, 2006; located at <u>http://www.azwaterinstitute.org/media/AWI\_public-document-FINAL.pdf</u>. See Appendix B for details on stakeholder categorizations that emerged from this report.

<sup>&</sup>lt;sup>22</sup> Stakeholder groups were originally articulated as: "Arizona Department of Water Resources (ADWR), Arizona Department of Environmental Quality (ADEQ), Arizona Department of Commerce, Cities/Municipalities, Native American Tribes, Developers/Builders/Realtors, Manufacturers, High Tech/Biotech Industry, Water-Related Product Companies, Environmental Engineers/Consultants, Agriculture/Food Industry, Electric Power Utilities, and Water Utilities, including Municipal Water Utilities" (Arizona Water University Business Plan Draft v.2 for comments, August 14, 2005).



Figure 2a: Official Organizational Structure Diagram of the Arizona Water Institute.

(Originally located on the webpage, "About Arizona Water Institute"

http://azwaterinstitute.org/about.html.)



*Figure 2b*: Unofficial Organizational Structure Diagram of the Arizona Water Institute. This diagram (an author rendition) provides somewhat more detail than the official diagram shown in Figure 2a. A more interpretive version of this diagram is used for the ensuing analysis.

AWI staff meetings were held weekly; the Campus Coordinators and Associate Directors employed a democratic, roundtable approach, where each attendee voiced particular concerns or points of interest in a "round" as the meeting commenced. The EAB met biannually, ostensibly to receive updates on AWI's work, provide input, and have an opportunity to touch base with one another and the organization. The structure of AWI was deliberate, motivated by the idea that inclusion, focused collaboration, and integration are vital ingredients of natural resource sustainability work.<sup>23</sup>

To help identify specific stakeholders and their needs, AWI performed an extensive "Needs Assessment" in 2006. The survey reached individuals in each of the communities listed as party to the "stakeholder population" represented on the EAB and asked not only for specific issues that concerned different groups but also how they preferred to receive communications and services AWI might be able to provide (e.g. online access, meeting formats, and communication delivery mechanisms). This helped staff and other initial actors formulate a series of "themes," for which leaders emerged, and around which the research program and outreach efforts ultimately revolved. The organization has a variety of communication materials available on its website, in addition to the aforementioned online hydrological information database it sponsored. It includes announcements, a calendar of water-relevant events, its self-description, mission, and work foci. The interface is simple with numerous hyperlinks to other areas

<sup>&</sup>lt;sup>23</sup> See, for example, the exchange of memoranda preceding the establishment of AWI involving the Arizona Department of Water Resources and the original actors of the concept of AWI: "State Agency Memorandas [sic] on Arizona-Specific Water-Related Needs" <u>http://azwaterinstitute.org/publicationsmisc.html</u>.

of the website, e.g. to the reports from research projects funded by AWI. The full-length reports, overall, are fairly academic, though all are suitable for the interested professional/practitioner. Accompanying nearly all of these are two-page overview documents; these are simpler and quicker to read. Information about and updates on all of the projects are written up in monthly electronic newsletters (and also available in paper form, averaging three pages), as well as other highlights of AWI activity or points of interest. A color brochure provides a straightforward explanation of the organization and its work, its partners, and contact information. The mailing list receiving AWI's broad-based updates comprised over two-thousand individuals from across the spectrum of local and national groups, well beyond the "stakeholders," e.g., the World Bank, Joint Global Change Research Institute, and the National Council for Science and the Environment in Washington, D.C.

The drafting of AWI's Business Plan was driven by the Battelle Corporation, in correspondence with the representative of the Arizona Department of Commerce and instated with the mandate of appropriations from the Governor's Office. It described how the organization would arrive at financial sustainability within five years and thrive over the long-term self-sufficiently, by accruing revenues from intellectual property rights expected to result from its collaborative research projects. The initial mandate allocated legislative and other funding and other resources to AWI, with the same level of support to be directed to each of the universities. Though this was controversial because the University of Arizona had substantially more resources in the water arena than NAU or ASU, the AWI concept was to treat the three universities as equals. The Business Plan

assumed that the organization would, in addition to other sources, accrue revenue from intellectual property rights, and that it would be fully self-sufficient within its first five years. Much of the fund-raising support promised by the Governor's Office never materialized, though the Board of Regents did provide support to the main office staff for the first three years. The branding and promotion of the organization was largely done by the Executive Director, with some assistance from the Department of Commerce and SAHRA, the NSF Center for Sustainability of Semi-Arid Region Hydrology and Riparian Areas at the UA.

#### Findings and Analysis: AWI as a "Boundary Organization"

Implicit within the work presented here is the argument that missing from discourse on knowledge-action is an approach by which to conceptualize and assess the "effectiveness" of institutions that operate at the boundary between different types of knowledge- and decision-making (which, as already explained, operate differently from other institutions). The three themes that together frame the analytical framework employed here to assess AWI in this way are derived from the theoretical frameworks of existing scholarship described above: (1) governance and ownership: boundary organizations' position within the broader political landscape – including their accountability to knowledge producers, users, and other stakeholders; (2) reconfiguration: the work of organizations at the boundary that contributes meaningfully to changes within both science and decision-making, in ways that enhances the relationships across the two domains; and (3) management of dynamic processes: boundary organizations'

adaptive capacity and reflexivity, relative to changing circumstances in science and decision contexts.

At the surface, it is clear that AWI is a good case study of what is involved in an organizational endeavor aiming to tackle an undeniably complex and vital aspect of the modern human-environment system - in this case, distribution of water resource supply, quality, and access for the long term, at the confluence of rapid urbanization, resultant land conversions, and existing water scarcity. As executed by AWI, this work involved a sustainability approach, adaptive management concepts, and the ideas of "boundary management." AWI's efforts also involve: bringing together of a wide range of actors and stakeholders for the practices, processes, and outcomes associated with scale- and theme-specific problem identification and articulation; the development of targeted and collaborative integrated action plans; and the dissemination and implementation of these objectives for the use and ultimate benefit of appropriate stakeholder communities. The brief description of the Arizona Water Institute in the preceding section serves as the foundation upon which to now investigate what "effectiveness" might mean of such an entity – having emerged with the implicit intent to change the ways scientific information and decision-making are brought to bear on issues that inevitably and non-trivially disparately affect certain groups and regions – from the perspective of the three-pronged perspective of this thesis.

A number of important questions underpin this assessment. Many scientists do not appear to have thought deeply about how they determined their research priorities. Does the work of AWI address or contribute to greater integrativeness or reflectiveness of priority setting and consequent funding allocations? How about for policy-makers: is there evidence that AWI has enabled greater introspection and reflexivity on the part of various levels of decision-making? To what extent was the AWI performing as an "effective boundary organization," as an institution established to facilitate the meaningful integration of a wide range of information, knowledges, ways of understanding and operating? How prominent and fruitful was the stakeholder engagement aspect of AWI's work, and how competent was the organization in communicating, translating, producing, and marketing relevant and credible work? Within the context of Arizona water sustainability and governance, did AWI offer unique opportunities, practices, and capacities? Was it viewed and valued as doing so? With respect to the ideas that led to to the organization's inception, official mandate, vision, and stakeholder expectations, how "successful" an organization was AWI?

#### Governance and Ownership

This section analyzes the organizational make-up of the organization and perceptions among its key stakeholders and staff to understand (a) the degree to which AWI was able to establish a place for itself at the boundary and within the broader institutional governance regime, and (b) was able to get key actors at the boundary to take ownership of the organization and its activities. A boundary organization, this analytical framework posits, must be not only unique in terms of what it offers but also to demonstrate this to prospective users and to cultivate a role for itself within its broader context. Governance and ownership together serve a central theme of this analysis to indicate issues and perceptions associated with financial viability, accountability, authority, identity, and values. Questions for this aspect of the analysis include: In what ways do particular aspects of the organization's internal structure and how it fits within the broader governance regime contribute to (or impede) the cultivation of a sense of shared responsibility? Has the presence (or absence) of ownership among AWI's partners affected its boundary management activities? In what ways did AWI represent itself to the public, potential users? How useful were these efforts in making clear what AWI was as an institution; its purpose; and what it could and intended to offer in the way of services related to water resource sustainability?

# Establishing authority at the boundary and a role within the broader landscape

To be successful – to thrive, even survive – the boundary organization must not only fit itself into the boundary, where other actors may feel they already occupy relevant niches, it must also be able to express what services it offers that are valuable and different from what is already available. Accomplishing these tasks are likely to take time, an issue that came up innumerable times in discussions related to the perceived "value-added" of AWI within Arizona's water governance context and to its ability to persuade people to take ownership of its activities.

Elements of competition (e.g. competing organizations, attention for research, and for time with key water-related actors), misunderstanding (e.g. regarding expectations of the organization and for those involved), and an image of its financial approach that provoked discomfort, worked to the disadvantage of AWI, which took great pains to encourage ownership. AWI was established in a state with an impressive array of researchers and practitioners with extensive knowledge of the water situation. Competition across the universities has always been fierce, and the ramifications of this, several interviewees explained, spilled over into AWI's early efforts to make a place for itself in Arizona. Key actors in university leadership who held the survival and success of AWI within their power viewed AWI as a threat and failed to give the organization their full support. Concerns were expressed that AWI would "step on the toes" of or at least not add values to boundary-spanning (or science-based) efforts that the universities were already pursuing.

The main office of AWI was housed at the University of Arizona, which lays claim to over three-hundred faculty with expertise relevant to water, as well as the well-establish Water Sustainability Program (WSP). WSP is financed under the Technology and Research Initiative Fund (TRIF); the five institutes that comprise the Program were "established to leverage the University's strengths in hydrology, water-related research and policy, and environmental technology industries to create several outcomes, including" practical water-related education, "internationally-recognized research and technology transfer initiatives," and greater intra-university multi-disciplinary work focused on deriving "solutions to real-world problems in the state."<sup>24</sup> The similarities between the missions of WSP and AWI are evident.

<sup>&</sup>lt;sup>24</sup> Two of the WSP institutions are noteworthy, relative to the objectives of AWI. The Arizona Water Resources Research Center (WRRC) "promotes understanding of critical state and regional water management and policy issues through research, community outreach and public education." And, Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA) is an NSF Science and Technology Center that "focuses on developing and integrating, multidisciplinary understanding of the hydrology of semi-arid regions" (http://www.uawater.arizona.edu/).

Despite these claims from some university actors, however, observing AWI for the purposes of this analysis revealed that the organization was fundamentally different in several ways. State agencies held influential roles within the structure of AWI, which was novel to Arizona, if not beyond. It institutionalized a functional partnership across the three universities, to an extent that was yet untried in the state. University employees were collocated with state agencies and the highly-experienced central staff who were positioned there for the explicit purpose of engaging in boundary-spanning activities (and help ensure that projects fit within what the Arizona Water Institute identified as priorities for Arizona's water). AWI's commitment to real-world applicability – choosing topics based upon what is deemed relevant to and timely for stakeholder groups – was also unique, particularly given the organization's broad and diverse reach across the State and beyond.

Other stakeholders admitted confusion as to the qualities of AWI that were distinct to the organizational landscape of water sustainability and governance. Three interviewees involved in the AWI concept and implementation from the beginning stages expressed moderate difficulty in explaining the distinction between the work of, for example, the Water Resources Research Center (WRRC) and AWI. WRRC was established in 1964 and has been increasingly focused on policy-relevant dilemmas (personal communication, February, 2009). WRRC also produces two periodicals commonly described as very "readable" and useful (multiple interviews).<sup>25</sup> The WSP, being at UA and well-funded and reputed, did seem to have an impact on AWI's ability

<sup>&</sup>lt;sup>25</sup> These are Arroyo and Water Resources Research Journal.

to engage UA researchers. A significant amount of funding and attention was already directed at water-related issues there; many UA researchers wondered what the purpose of AWI was generally or why they would seek its funding.

#### Challenges of a Democratic Approach, Lines of Accountability

AWI's architects, including the state Governor's Office and leaders were fully dedicated to constructing a type of boundary organization. This made for very complex structures and procedures – including most especially the manifold lines of accountability - which were both limiting and useful. That the institutional infrastructure was positioned at all sides of the "boundary" was very useful to executing boundary management activities. (I.e., the boundary represented a point of intersection facilitated by AWI for universities, practitioners, and policy-makers; activities to facilitate their interaction in meaningful ways included collaborative research projects and real world, issue-specific, multi-stakeholder workshops.) It was limiting in the sense that all of AWI's actions involved a convoluted array of steps, actors, and lines of authority. AWI's complex structure resulted from an effort to develop something that would be – and appear to be – highly inclusive and well-connected, to the biggest players in Arizona's water. This was demonstrated by AWI's posts in state agencies, universities, and its large stakeholder board. While AWI was physically located within the University of Arizona, everything else about its mission and institutional construct was oriented toward trans-university and multi-sectoral relationships and targeted collaboration.

AWI's Executive Director was immediately accountable to at least six "bosses" at any given time (university Vice Presidents of Research on the Executive Committee, the Arizona Department Water of Resources Director, the chair of the EAB, and the Governor's Office representative). It seems reasonable to assume that having such an array of esteemed and influential figures, within the context of university research and government, would automate the process of establishing a foundation of "owners." Yet, AWI struggled very much with this, and the implications were extensive.

One example of this struggle involved accountability to the universities. An interviewee offered a familial analogy, declaring that "a boundary organization has to have real parents – not just foster parents, like the universities were." This person went on to say that universities could "pick and choose" what they thought was important to support, including AWI, it turned out. Even though funds for AWI did not come from the universities, but from the Governor's office through the universities, the latter ultimately had the power to pressure the organization out of viability. Another interviewee, also in a high administrative position at the same university as the former, alleged that his university was already doing the type of work AWI was established to do, including in water resources. This individual was unable to think of a specific example of boundary-spanning, boundary management, or extensively stakeholder engagement oriented projects or outcomes in water resources that were useful to actors in the university and in decision-making sectors that was occurring within his institution. Although there were several forces at work contributing to AWI's eventual closure, the reason most often noted points to AWI's direct accountability to the universities.

Another key challenge for complex boundary organizations is to be fair and representative of the full range of stakeholders (Albin, 2001; 2002). An example of

AWI's struggle between being fair and representative and having a difficult array of factors to manage was with the research proposal process. The research program was originally created with three distinct layers of review, in order to filter proposals through multiple bodies of experts before making funding determinations. While this practice was ultimately reduced to one collaborative and democratic review process among lead staff, the intent was to rigorously ensure fairness and representativeness with respect to stakeholder groups and identified needs.

A third illustration of how AWI's structural complexity affected its boundary management work was with the size of the External Advisory Board. A preponderance of respondents noted that the EAB was too large (36) to be of much use in the ways that were perhaps hoped, e.g. eliciting feedback on specific issues the organization wanted advising. According to the Governor's Office which dictated its approach, the purpose of the stakeholder board, was to create a mechanism to develop a broad base of support for AWI immediately. The intention was that if all of the key stakeholder groups were given a post on the Board, by way of at least one figure who would ostensibly represent their interests, stakeholders would have a sense of participating in a collective endeavor, for which responsibility was shared. The leadership understood that engaging with key stakeholders in personal, if not one-on-one, ways was vital to the success of any or all part of its mission. However, the size of the Board presented a significant constraining factor. AWI leadership was perhaps as confounded by the size of the Board as its members, especially with its highly limited personnel and therefore limited capacity to engage broad numbers individually.

## Setting Expectations

In establishing an institutional presence within a large landscape, representation is crucial. An organization must be understood to be valued, and that means that doubts about the organization's value must be addressed. According to interviewees, this was a problem for AWI. AWI's problem was rooted, at least in part, in uncertainty or confusion about what AWI was, as well as its purpose, expected modes of operation, financial sustainability, and the ability to meet users' needs. One distinguished interviewee expressed his own inability - and that of the public, according to him - to fully understand AWI and its value to water research and policy in Arizona. This uncertainty impacted his willingness to support AWI with time and money. His critique regarding emphasized confusion about where money would go when given to AWI, and to what kind of projects. To this individual, AWI was not clearly distinct from the state government or universities, raising questions as to whether financial support would simply contribute to the coffers of governmental agencies or to big university budgets. He believed this confusion stymied AWI's fiscal growth. This sentiment was echoed by at least five other interviewees, each from slightly different perspectives.

Many AWI stakeholders emphasized that for an unconventional organization, it is imperative to express clearly what type of an organization it is, how it runs, and who its allegiances are to, if one hope to secure stakeholders' attention and confidence. That AWI fell short in this regard was clear in interviews. When asked for their perceptions about what AWI was or could be, their answers ranged from a seed grant provider for small research projects to an entrepreneurial endeavor. Some Board members also disagreed about what the organization was, how it would operate, and what it expected to do in its tenure. At least three interviewees stated that they believed - citing their understanding of Governor Napolitano's original mandate for the organization – that AWI was meant to be a vehicle through which the State of Arizona would attract global attention for its extensive expertise in water resources, and urban and arid landscapes. Developing, packaging, commercializing, and marketing products related to water management and related issues -e.g. methods of conservation - was the expected focus for these individuals, as was the reason they understood for why they were asked to be on the EAB. Once on the Board, they recognized that AWI was choosing projects and activities that did not support this agenda. They continued to participate in meetings, in hopes of swaying the direction toward higher-profile activities with a greater potential for longer term (financial) returns to the organization. By contrast, other stakeholders, such as project principal investigators and immediate participants and beneficiaries of various research projects, mostly lauded their endeavors. Rather, it illustrates the wide disparities among stakeholders' conceptions of what AWI was, in addition to their often divergent opinions and visions for the organization. This divergence impacted AWI's efforts to cultivate a base of "owners" and establish an authoritative role in the context of Arizona's water sustainability and governance.

At its root, fashioning a clear vision for a boundary organization includes developing and articulating a mission and specific objectives, as well as what it anticipates from its users. Communicating what can be expected of it and what it expects in return, in order to function and evolve optimally is crucial. But, this must be done in a nuanced fashion. As AWI understood well, different types of stakeholders are comfortable in different venues, have different goals, and frame and reason about problems differently. This means developing targeted communications to stakeholders, at least at some level. While the former notion – conveying a clear, specific description of what it is, what it will do, and why it is relevant and important may seem obvious, AWI's experiences suggest otherwise. A predominant perception among interviewees echoed this point, and (at least three) put forth the idea that a staff position devoted to the many facets of self-representation would have served the organization well.

One way this could have been achieved is by using EAB members as "ambassadors," as was proposed in an interview with one stakeholder with extensive experience with high-level state agencies and running and participating on institutional boards. This person indicated that she was already acting as such, but thought it would be useful strategy to make clearer the role and value of EAB members, individually and as a collective.

## Helping users Identify with Boundary Organization

AWI leadership made clear in interviews that the organization would have benefitted from a greater level of responsibility-sharing, in developing ownership of AWI. Leaders highlighted not only the enormity of the workload is described but also a recognition of the importance of involving diverse stakeholders, in order to enhance political and financial support and sustainability. However, they also made little effort to conceal the frustration they felt toward the failure of their attempts to delegate, in order to disseminate the responsibility and take full advantage of the wide range of expertise

available to AWI. AWI had a large number of stakeholder groups represented in a variety of positions in order to empower people within the organization, encourage them to take ownership of projects and initiative, and of the institution itself in broader networks. Private consulting firms, engineers, state agency officials, and tribal nation administrators, among others, sat on the EAB, led research projects, and participated in conferences, workshops, and collaborative meetings. Given the array of opportunities to become involved and the number of constituents who became involved, it seems reasonable to expect that a sense of "ownership" and care for the success of the organization would follow. Some interviewees indicated, for example, that the relationship between a boundary organization (AWI) and its stakeholders should be manifested as "it is us" and "we are it," and at least three interviewees indicated that AWI had achieved this goal for them. These individuals felt their own identity had come to correspond to AWI; they understood that the "umbrella" that AWI symbolized or the network that it acted as a hub for was created for and made meaningful by those who engaged in it. This sentiment was not the majority, however. In fact, the larger the number of constituents and the greater the diversity, at least in the case of AWI, seemed to make the task of cultivating ownership more challenging, given the greater complication and energy required to explain and cater to the perceptions of such a wide target audience (Schneider & Ingram, 1993).

The failure to delegate was compounded by other problems. The Executive Director, by her own characterization and mentioned by nearly all twenty-five stakeholder interviewees, was and felt in a position to carry out at least some aspect of all of the organization's functions. The majority of these individuals indicated that the Director "was the organization and it was she." Jacobs, who respondents consistently characterized as "incredibly hard-working" and "focused," was clearly viewed as intent upon making the knowledge-action integration happen through AWI. Many interviewees saw Jacobs as a huge strength for AWI; others expressed concern about its long-term sustainability. Reasons given included the risk that the Director would "burn-out" and/or move away from the post, for which no leadership succession plan was in place. Further, that stakeholders often claimed to know primarily of the organization and its work by one individual – its leader – coupled with the fact that the organization lacked conventional "bricks and mortar," it was likely especially difficult to work with stakeholders to help them understand how the boundary organization might provide useful, if not ultimately necessary, services and resources. On the other hand, many pointed out that the organization's credibility vis-à-vis stakeholders was immediately positive, since Jacobs – and the rest of the AWI staff – had very favorable reputations in water resource research and decision-making communities. This was a very important aspect of AWI's efforts to find and effectively express its role within the broader landscape of actors in Arizona's water.

Management of the External Advisory Board was also a problem. AWI's communication with the Board and AWI's facilitation of meetings was not particularly conducive to providing unfiltered feedback. The predominant commentary among EAB member interviewees was on the lack of or minimal discussion time for each meeting. Meetings were dominated by presentations on what AWI had been working on. One interviewee summed up the way he felt that EAB meetings were structured with the statement "we're going to tell you what we're doing and we're going to get your feedback," and that there was "a lot of reporting to us." Members interviewed expressed that they had originally believed that their role as an EAB member was to provide advice and an opportunity to work through whatever challenges or thinking the organization may be doing on "next steps". All of this suggests that EAB meetings may not have been conducted in a way that some stakeholders felt comfortable contributing; those who did voice concerns during limited discussion times, felt unwelcome to do so. AWI staff – four of those interviewed – also indicated their dissatisfaction with the way the functionality of the Board and its meetings. When asked about what meetings were hoped or intended to be like among AWI staff, responses varied across the continuum from, e.g., "basically reporting on what AWI was doing and then get some discussion," to "get some help thinking through different challenges facing the organization, to "use the group to have institutional mechanism by which to be in constant multi-way dialogue with key stakeholders." While AWI staff recognized that the amount of time and opportunity for productive discussion was limited, a few also expressed that they felt it was important to update members on AWI activities, and to use it as a mechanism by which to maintain and enhance stakeholder support. These individuals all cited examples of explicit attempts to change meeting formats and, importantly, to spread the responsibility among the participants. These efforts were ultimately unsuccessful, however.

#### Financial Sustainability

As explained above, funds came from the Governor's Office, through the universities, to AWI for its boundary-spanning activities. Because the expectation (held mutually by AWI leaders, the Governor's Office, and the university VPRs) was that these funds would not continue indefinitely (and it was a relatively small sum to begin with, given the ambitions of the organization or that of research centers participating in funding similar work), AWI leadership was preoccupied with seeking and securing financial partners. This was heightened as AWI's support in the State's executive branch became threatened, with key advocate Governor Napolitano's transfer looming. AWI was successful at finding financial partners for particular projects and sponsors for its events, however; several of these received funds from other agencies for future iterations of their work. In addition to AWI's options being constrained by their financial status and time and energy spent seeking funds, the organization's image was affected – in particular, perceptions increasingly grew among three key university administrators and a handful of stakeholders with private sector experience that the organization would not survive on the financial path it was on. These factors worked against its efforts to develop with stakeholder groups understandings of the organization and ways each could identify with and use it.

The Business Plan, as originally conceived, was intended to guide AWI in the direction of financial self-sufficiency and security within five years, through intellectual property rights awards. This view expected collaborative projects to aim at generating "products," of various types, intended for commercialization. Collaboration with industry and the private sector was seen as essential to conceiving commercializable

ideas, design, implementation, and marketing. The Business Plan was perceived by many as ambitious to an unrealistic degree; others saw it as overly narrow in its heavy focus on global-scale market viability and stature. Yet, the lessons that it offered were hailed by most, particularly the emphasis on an aggressive search for self-financing and making a strong business case for utility of AWI – at least in the nascent years. Some stakeholders were particularly put off, however, by the lack of market-driven work of AWI. These individuals claimed, with some frustration, that they began working with AWI under the presumption that the organization was interested in and could use their commercial expertise and partnership to enhance the marketability of knowledges and methods, as well as technological innovations generated through AWI support.

Obviously, individuals, firms, and other entities desire not to waste their money. Evidence of an organization's clear and reasonable approach to managing and strengthening its financial capacity – and commitment to following it, toward fiscal security – is both an attractive and necessary condition for prospective financial partners. Additionally, a fundamental component of a boundary organization's pursuit of its stakeholders' support is its understanding of the importance of shared branding and implementation. Among businesses, the choice to financially contribute to an organization is often determined as much by expected returns and other benefits the partnership yields from advertising and marketing its own services (e.g. through displaying business logos along with AWI's in distributed communication materials), as it is by the impact its support expects on the recipient organization. Several important players in the private sector and positions of leadership across the organizational landscape expressed frustration with AWI, in this regard.<sup>26</sup>

# Reconfiguration

Cash et al. (2003) contend that the ability of a boundary organization to effectively "mobilize" science and technology to address sustainability problems is contingent upon successful knowledge-action "boundary management" – i.e. "in ways that simultaneously enhance the salience, credibility, and legitimacy of the information they produce" – by way of the necessary system "functions" communication, translation, and mediation. This work and others emphasize the importance of a boundary organization's capacity not just to do and promote work that is topical and of high quality, but to help target and provide it to the appropriate actors in a way that is comprehensible, readily accessible, and overall useful (Jacobs, 2002; Schneider & Ingram 1993). The following analysis concentrates on AWI's role as a force for reconfiguration. This includes AWI's work communicating with and engaging stakeholders; initiating and facilitating collaboration among diverse actors; and translating existing science and actively contributing to the integration of various processes of science and decision-making, for more socially-beneficial and -meaningful outcomes. This section explores AWI as an instigator, provider, facilitator, and mediator, in an attempt to understand the sort of impact AWI had on Arizona's water resource sustainability and governance. As part of this broader question, it considers whether it

58

<sup>&</sup>lt;sup>26</sup> Due to confidentiality agreements and the smallness of the community subject, allusions to specific examples may only be made here.

engaged effectively with and among the diverse landscape of interests. AWI was created to be part of, party to, and composed of water management actors with some kind of a "stake" in Arizona's resources. Their responsibility was, admittedly, distributed across an expansive spectrum of expertise, mental models, institutional designs, and administrative modus operandi. Was AWI able to negotiate successfully across these variegated jurisdictions and influence the perspectives and possibly also the operations of these actors? The analysis moves forward with the assumption that there is an integral connection among an organization's relationships with its stakeholders, the perceived worth of the science it generates, and the ability of an organization to produce, package, and disseminate information (e.g. Lach, List, Steel, & Shindler, 2003; Guston, 2000; Star & Griesemer, 1989). It finds that AWI was a catalyst for reconfiguring that landscape in some ways, and in other ways it had less impact, and was perceived as an agent of the status quo.

Further, it explores *perceptions* of AWI as a force for change force – to varying degrees – in the knowledge-action dynamics of Arizona's water sustainability and governance context. The central question of this aspect of the analysis is as follows: has AWI helped to reconfigure the way scientific information is produced, decisions are made, and the ways in which the science- and decision-making communities interact? Key to this is the question: Was AWI (perceived as) asking the "right" questions; choosing the "right" projects; seeking out the "right" people and expertise; and developing the "right" partnerships, vis-à-vis the needs of Arizona's water sustainability? Findings are derived primarily from interview responses on how satisfying the

experiences and outcomes of AWI research projects, workshops and conferences, and communication materials were to the work of stakeholders, and what this meant for their acceptance of the organization vis-à-vis their work (i.e. whether stakeholders were inclined to return to AWI to fulfill their water-related informational needs). *Structure and functions for reconfiguration* 

As addressed in the governance and ownership piece of this analysis, because they occupy a likely unfamiliar role and a little-observed space within "normal" governance regimes, boundary organizations must work especially hard to situate themselves within this space of already existing political and scientific institutions, and explain and justify itself within the landscape. Necessary for participating in the transformation of the knowledge-action landscape is establishing trust. Developing mutually-beneficial and -accountable relationships that leads to trust and the capacity to catalyze reconfiguration is one of the biggest challenges and most critical tasks of a boundary organization. Trust is integral to the boundary organization's viability and efforts as a catalyst of reconfiguration to convince potential users of their trustworthiness, understanding of the needs of the relevant context, legitimacy (Jacobs, 2002). AWI made important strides in achieving trust among important stakeholder groups and developing these kinds of relationships, but not without struggle or criticism.

Building trust is highly time-consuming and resource-intensive for new organizations with little or no name recognition, e.g. AWI. This reinforces the importance of institutional partnerships and the role of individuals involved with the boundary organization with primary allegiances to a particular stakeholder group. If well-conducted, these relationships can yield many benefits: far-reaching representation of stakeholder demand within the organization; representation of the organization throughout a broad cross-section of stakeholder constituencies; cultivation of trust and understanding; and ultimately a catalytic role in the dynamics of knowledges and actions in the relevant context. The role of regular, active, multi-stakeholder involvement and collaboration is indispensable in this regard, as is problem-framing, capacity building among constituencies, and seizing every opportunity to expand networks of support.

AWI arguably was designed out of a mélange of approaches and lessons from literatures introduced in the current theory section: each aspect of the institutional construct claimed an integral function in the broader boundary management schema. This statement is according to four interviewees who were involved with the AWI concept early on – who independently admitted to consciously applying lessons from knowledge-action theoretical and empirical literature - as well as to a deliberative "mapping" of the parts of the AWI. Figure 3 is an imperfect sketch of the structure of the organization, and the lines of engagement and authority that are inherent to its design. It attempts to illustrate how deliberate the organizational construct was in terms of promoting viable and regular cross-boundary interactions. Note especially that the arrows represent the inter-institutional and cross-domain exchanges the organization facilitated by way of its research program and other outreach and translational activities. They are demonstrative of the range of efforts involved in AWI's reconfiguration efforts, and, further, potentially indicate evidence of the extent to which AWI reconfigured the landscape. It is difficult, if not impossible, to make specific verifiable claims as to the

impact AWI had on the way the knowledge-action landscape functions. However, the lines of engagement illustrate interactions that were instigated by AWI and imply relationships that may well persist after AWI's closure.



# LEGEND

	Outline of the Arizona Water Institute; rough diagram of the organization's functions
	AWI staff and primary players; the external advisory board represents each of the stakeholder groups, and consults in various formats with the Exec. Comm. frequently
	3 major state agencies with individuals who serve as associate directors of AWI, and key employees in the agency
•	AZ's 3 state universities, which comprise the consortium that is AWI
$\diamond$	Self-identified stakeholder classifications, all represented in the 2006 "Needs Assessment" AWI conducted, prior to fully formulating its objectives & approach
Э	Abstractly illustrates the regular interactions facilitated by AWI, including flows of information & perspectives
٢	Indicates AWI's efforts to engage with a wide array of stakeholders, & to act as a convener of their interests, with the intent of providing an opportunity for collaboratively considering more sustainability-oriented decision-making options
\$	Funding: Appropriations came through the Governor's office (mandate for AWI), & went equally to the 3 universities. This was not meant to last indefinitely, & AWI constantly sought external funding (including often successful financial partners for research projects).
Figure 3. An interpretive institutional diagram of the Arizona Water Institute. This	

illustration is the author's conceptualization of the organizational construct of AWI and

directions of different types of information exchanges, within the information and

decision-making context.
# **Operations**

The "Assessment of Navajo Nation Hydroclimate Network" project, spearheaded by UA professor Gregg Garfin, is widely hailed as a success, on multiple levels of AWI's mission. As described by one of AWI's staff, it was a "great marriage of talent and expertise....The resources came through AWI," and then "key talent" came from UA, the Navajo Nation, and NAU. Conversations with stakeholders involved in this project were very positive – and appreciative – about their interactions with AWI and project leaders and the outcomes the project yielded. The Navajo Nation Department of Water Resources (NNDWR) requested the assistance of AWI to help put together interested individuals in the universities and elsewhere who would contribute expertise to its attempt to respond to a Technical Memorandum issued in 2003 outlining the Nation's hydroclimate needs.

In consultation with the NNDWR, the AWI project team visited data collection stations, interviewed staff, analyzed the NNDWR hydroclimate data, evaluated instrumentation and data communication needs, identified potential improvements, and determined options for reducing overall network size – while filling in key data gaps. At the NNDWR's request, the AWI project team convened a workshop to explore possibilities for the NNDWR to achieve its goals through collaboration and exchange of data with outside agencies.<sup>27</sup>

<sup>&</sup>lt;sup>27</sup> From the "Assessment of the Navajo Nation Hydroclimate Network: Executive Summary;" full report available at <u>http://azwaterinstitute.org/media/AWI721garfin.pdf</u>.

This project can be conceptualized as a success in terms of Guston's boundary objects (e.g., Guston, 2001),<sup>28</sup> and the result of the project – a hydroclimate assessment – can be understood as a hybrid in terms of Miller's hybrid management approach (Miller, 2001).<sup>29</sup>

Interestingly, however, the same stakeholders involved in the NNDWR and hydroclimate assessment project felt dissatisfaction (as expressed in interviews with two individuals associated or familiar with this project and another non-university stakeholder) with the constraint on project development that Principal Investigators had to be university employees (faculty or staff). According to the sentiment of these interviewees, this was a reinforcement of the status quo: specifically, it meant that those who felt they had a reasonable claim to propose support from AWI, but were not associated with the university research community, had to endure what felt to them to be quite challenging level of rigmarole to identify and establish contact with university researchers who might take on their cause and propose/lead the project (implying that the power base would remain in the universities). Counter to this perspective, one interviewee from the private sector expressed complete comfort with this model, stating

<sup>&</sup>lt;sup>28</sup> Guston explains that "boundary objects sit between two different social worlds, such as science and nonscience, and they can be used by individuals within each for specific purposes without losing their own identity (Star and Griesemer 1989)" (2001).

<sup>&</sup>lt;sup>29</sup> Recall that: "hybrids are social constructs that contain both scientific and political elements, often sufficiently intertwined to render separation a practical impossibility. They can include conceptual or material artifacts (e.g., the climate system or a nuclear power plant), techniques or practices (e.g., methods for attributing greenhouse gas emissions to particular countries), or organizations (e.g., the SBSTA or the Intergovernmental Panel on Climate Change)" (Miller, 2001, p. 480).

that this part of AWI– however collaborative, engaged, and real-world-oriented – had to do with research. And, this person rightly implied, universities know how to do research. Given that the funds to operate AWI came from the legislature directly to the universities and the driving objective of the organization to build connections with the university, this was a reasonable approach.

Boundary organizations seem to be highly susceptible to these kinds of problems. Their attempt to develop boundary objects, hybrids, and/or standardized packages, however well-deliberated, may sometimes fail at being accepted mutually in scientific and nonscientific domains, in part because of the complexity of landscape and the responsibilities they take on. As Miller (2001) acknowledges, science has "increasingly [been] accorded...a central role" in policy making, but

...the mobilization of science to serve the ... public good is neither simple nor straightforward...[F]inding institutional arrangements that can command credibility, legitimacy, and authority among the many, diverse publics, officials, and experts [relevant to the science-policy context of interest]...is an exceedingly complex and difficult task. (Miller, 2001, pp. 478-479).

AWI attempted with all of its collaborative research projects to instigate processes and outcomes that were meaningful and useful for all actors in the university, practitioner, and policy domains. In this case, AWI sought to operate a research program that would engage actors across this spectrum of actors, but evidently did not overcome reticence from a set of actors about where its allegiances lay. Adding to this, several interviewees indicated that the research projects and their outcomes took fairly academic forms, to the exclusion of a collaborative trans-sectoral effort. All of this points to moderately unsuccessful boundary object construction as well as a failure of complete reconfiguration. Again, this seemed to result largely from poor communication: AWI strongly encouraged all stakeholders (university and non-university alike) to propose projects and would help them find the appropriate researchers to work with, to the extent that such persons existed. Until the 2009 research program, discussed in greater detail in the following section, this may not have been as clear as it could have been, and the perception persisted among some that the organization was a program of the universities (vs. an entity working to make exchanges from and to the universities).

Another project that is often cited by staff as exemplary of the kind of collaboration and merging of expertise that the organization strove for received funding for FY2007 and 2008: "Verde River Ecological Flow Science – A Collaborative Approach." The process and outcomes of this project are demonstrative of successful boundary object production. Investigators for this project came from each of the three state universities; in addition to AWI, financial support or "External Partners-Investigators" came from The Nature Conservancy (TNC), Water Resources Research Center, and NAU, the Museum for Northern Arizona, and Arizona Geological Survey. Two interviewees took part in this project and spoke very positively about the experience, including the science findings and the interaction with local actors, such as the Verde River Basin Partnership (VRBP). The impetus for the Verde River project, as explained in the Executive Summary of the final report, is that the "science-based water resource planning partnership," VRBP, needed to develop a "plan that identifies long-term water supply management options for communities in the Verde River Basin," in accordance with the directive with which it was created.<sup>30</sup> This plan needed to include an analysis of the implications of human activity for the ecosystem, relevant to the river. The purpose of the project was to "develop the science to describe those consequences" and thereby contribute to the objectives of the locality to protect and provide for the sustainability of the river for ecological and social needs over the long-term. Several newspaper and newsletter articles were written about the study, during and after, indicating the usefulness of the focus and results. For example, the Water Advisory Committee of the county of the Verde Watershed is said to have deemed this project as "one of the first and most important steps in developing an overall water management plan," and others point out that the benefits from this study will reach well beyond the county.<sup>31</sup>

A particularly important AWI-initiated and -funded project, aforementioned briefly, is the Arizona Hydrologic Information System (AHIS). This has been a priority of AWI since its inception, and was one of the projects that was able to keep its funding allocation for FY2009 after AWI's closure. The AHIS initiative was to "bring together the information held and provided by" Arizona's primary water stakeholder groups for

<sup>31</sup> For example, see "River study helping irrigation companies," Steve Ayers, Staff Reporter for the Camp Verde Bugle, December 11, 2008 (http://campverdebugleonline.com/main.asp?SectionID=1&subsectionID=1&articleID=2 1757); "New Verde study hopes to quantify riparian needs," Joanna Nellans for The Daily Courier, December 23, 2007 (http://www.azwaterinstitute.org/media/122607% 20Daily% 20Courier% 20-%20Verde% 20River% 20study.pdf).

<sup>&</sup>lt;sup>30</sup> Final report for this project is located at: <u>http://www.azwaterinstitute.org/media/AWI714springer.pdf</u>.

their mutual benefit for now and into the future.<sup>32</sup> The effort to collect, aggregate, make useful and available water-related information was (and continues to be, according to interviewees involved in this process) a great challenge of navigating and negotiating with myriad and often fundamentally incompatible administrative and institutional cultures, ways of operating (including timeliness), and data output and storage types. This project was a boundary object in its design; the following statement is taken from the front page of the AHIS portal on the AWI website.

The approach to AHIS development remains inherently multi-disciplinary and addresses the needs of data collectors, providers and consumers in numerous water-related fields from both scientific and engineering perspectives. It is intended that the data clearinghouse and analytical tools made available in AHIS will provide invaluable support to governmental agencies and affiliated policymakers, tribal organizations and groups, private firms and consulting services, and academic research and technology development for hydrology- and

<sup>&</sup>lt;sup>32</sup> "The development of AHIS is a state-wide, collaborative effort led by the Arizona Water Institute (AWI) and involving three state universities (the University of Arizona, Arizona State University, and Northern Arizona University), three state administrative departments (the Arizona Departments of Water Resources, Environmental Quality, and Commerce), numerous federal agencies (e.g., the USGS, the Bureau of Reclamation, the Bureau of Land Management, and the National Weather Service), regional water and power providers (e.g., the Central Arizona Project, the Salt River Project, and local water utilities), county and municipal organizations throughout the state, tribal authorities, nongovernmental organizations, and volunteer observer networks" (http://azwaterinstitute.org/ahis.html).

water-related planning, education and outreach within Arizona and throughout the arid and semi-arid Southwest.<sup>33</sup>

The language used here speaks explicitly to the concept of constructing a boundary object: developed with the information and involvement of its users, with the intent to be useful to those same users, in whatever ways meet their particular needs and capacities. AHIS is a working device that was designed to change along with changing information and informational needs across the stakeholder community.

These examples speak to the wide range of topics AWI was involved in, and, despite some criticism, the majority sentiment regarding the organization's research program was generally quite positive. Their ability to hone in on topics important to stakeholder groups and become fully integrated and involved in each particular context for the purposes of the project, communicate effectively during project processes, and to initiate the collaborative production of science products and needed science translation work, attests to the important role they played as a change agent at the boundary. *Scope* 

Another aspect of the analytical theme of reconfiguration as it relates to the scope, mission, and objectives of a boundary organization is the capacity of the organization. AWI had such a broad spread of stakeholders that it was reasonable to expect it to have a similarly broad mission, and the scope of AWI's mission was undeniably ambitious. Their broad mission was reflective of their democratic approach and commitment to the

<sup>&</sup>lt;sup>33</sup> http://azwaterinstitute.org/ahis.html

needs of very diverse constituencies. Yet, their capacity was strongest for pursuing small, targeted projects. The criticisms they received for the path taken included: focus should be on addressing the "big" issues in Arizona like water, growth, and where we should go from here; research project topics were too narrow and academic – could or would have been done at one of the universities; should have done more projects with less staff, or should have done less projects with greater funding allocations for each; needed a more viable financial plan, as the work being done would not accrue revenue to sustain operations over the longer term; or, needed to invest attention and funding allocations directly at developing, packaging, and commercializing water-related products – largely, to draw attention to it as a global model and Arizona for hosting it, to prove to potential financiers that it had a viable long-term business plan, as well as to sustain itself.

It is easy to say that for the short term – as some interviewees suggested, particularly those representing private sector interests – the organization would have benefited from choosing to 'do less with more,' i.e. expended its relatively small resource allocations on fewer, higher-profile projects that may have both attracted more attention and had a greater immediate overall return. This recommendation assumes that the choice to pursue many research projects in a year – most with fairly specific topics, scales, and scopes – in addition to a few more prominent and interactive endeavors – with broader foci – is somehow ineffective. Further, it is predicated on the belief that highprofile projects, bigger investment opportunities, and a more expansive thematic concentration leads to "success." However, there is no guarantee (in AWI's case) that focusing on fewer topics would have yielded more or different results, nor what the reaction would have been had AWI chosen to focus thematically very narrowly in the immediate term of its inception. Moreover, it is worth noting that the transaction costs and other business-related aspects of AWI's collaboration were enormously challenging: AWI leadership was constantly overwhelmed with the negotiations they were forced to do across the different administrations involved in collaborative work. Administrative efficiency was a major impediment to AWI's boundary management efforts, including its ability to affect perspectives, cultures, and ways of operating within and across the agencies involved in knowledge and action.

AWI's approach, including in terms of topic selection, was to do what it saw as necessary to build its constituency/community, which it defined as all water researchers and manager. This broad-based strategy meant a large number of beneficiaries, and consequently a similar foundation of trust and involvement. AWI planned to proceed this way early on to see where those investments led, orienting them to larger projects where the greatest demand emerged. The projects that were allocated funding for fiscal year 2009 were notably larger in funding allocation and scope. Inferring from conversations with AWI stakeholders, it was not this approach itself that was problematic. Rather, they seemed either unaware of or to misunderstand the organization's strategic trajectory. What is striking about the aforementioned criticisms is not necessarily their breadth per se, but that they imply an absence of clear visions within different constituencies for the organization (however disparate these visions would have been across the range of stakeholder groups). This seems to confirm the weakness in communication that was described in the previous theme of governance and ownership.

# Legacy as a catalyst

A staff member for AWI, as well as a Principal Investigator for multiple AWIfunded projects, explained that the state universities have each been trying to expand their reach beyond themselves. Though, he admits, universities are likely to still be better at collaborating with each other (which, AWI's experiences suggest, is marginal at best, at least in the context AWI worked within), than with stakeholders. However, NAU has always worked with non-university groups, e.g. in rural watershed areas and the tribes. This individual explained that AWI offered a way for the universities to more easily "tap into the stakeholder engagement" opportunities that exist outside of themselves. The funding that is available through AWI was a "mechanism to facilitate collaboration," whether it be through research projects or workshops or other ways. He stated that AWI had been helpful in finding the talent within the universities and across the researchpractice spectrum, and facilitating collaboration. Another high-level stakeholder proclaimed that AWI "definitely" was leaving a "legacy." This individual described AWI as a catalyst for, even an agent of, reconfiguring the ways in which scientific knowledges are produced, decisions are made, and broadly the institutional arrangements affecting information-decision relationships. This staff member's articulation of AWI's purpose in the landscape obviously skewed positively, due to his post in the organization's leadership, but that this rhetoric was emblematic of the discourse

throughout AWI leadership and active participants of their own roles and of the orientation of the organization, is by no means trivial.

These ideas emerged even in interviews with individuals wanting to have lessfavorable to negative conversations about the organization; for example, an interviewee in a high-level university administration position who denigrated the role of AWI, citing his university's own work in boundary-spanning activities, ultimately acknowledged that those efforts were yet quite weak. Two other conversations with individuals of similar roles in the broader landscape within which AWI existed, went in a similar direction – following this interviewer's pursuit of specific examples of those individuals' institutions' instigation or facilitation of water resource- and sustainability-related endeavors involving community engagement, and multi-disciplinary and multi-sectoral collaborative problem-framing and development of products useful to research and decision-making communities (i.e. boundary objects). Each individual foremost described the capacity of their research and boundary-spanning entities to do such work, and – though such efforts have been done and do exist – his/her expectation of greater effort in the future.

The finding that this analysis derives, then, is that AWI affected those who engaged with it in some way, e.g., through workshops, conferences, and funded collaborative research projects that were funded in part or in full by the organization. Even those who spoke cynically of the organization in interviews and informal conversation ended up admitting that there was some aspect of what they were doing with AWI that was different from what they had done before. These were the individuals, most often, who already had sufficient political capacity and networks to do the kind of work they thought needed to be done. Nevertheless, the concept and execution of AWI seemed to broaden some perspectives, particularly to what was now plausible to tackle Arizona's most important issues (according to stakeholder testimony): water, growth, and economic development. Moreover, several non-university researcher participants – irrespective of some of their complaints about proposal submission restrictions – spoke positively of their experience with AWI, in terms of the connections made to the university, government, and the private sector that were not as plausible prior to AWI. AWI did not reconfigure the whole landscape of water science and decision-making in Arizona for sustainability – and cause universities to operate in new and more collaborative ways, for example – nor could it have been expected to. It certainly had significant impacts upon some individuals and their stakeholder constituencies of those who were able to take full advantage of its services,<sup>34</sup> and arguably rattled the status quo by offering alternative ways of producing and consuming science – integrated approaches.

#### Managing Dynamic Processes

<sup>&</sup>lt;sup>34</sup> Examples include: the Navajo Nation as a result of the Hydroclimate Assessment project; the Verde River Partnership, for the collaborative data collection and analysis done in partnership with The Nature Conservancy to support riparian area protection efforts; the work led by Dr. Mariella with the InterTribal Council of Arizona, entitled "Approach to Water Management by Tribes in Arizona," significant for the strides made in terms of trust- and capacity-building; and the AHIS, about which no interviewee has spoke pessimistically, with most bringing it up unprompted as a useful tool for more easily and expeditiously accessing and managing water-related information.

The third analytical category interrogates institutions engaged in boundaryspanning work for their ability to manage dynamic processes. This aspect of the analysis acknowledges the immense challenges associated with boundary management work, particularly in terms of the inherent complexity, persistent flux, and uncertainty characteristic of social-ecological systems. Relevant questions include:<sup>35</sup> What sorts of mechanisms for identifying and understanding stakeholder informational demands and for communication did the organization employ? With what level of frequency did the organization employ these, what types of information did the organization garner, and was this perceived as enough, too little, or satisfactory by stakeholders? Does the boundary organization learn from other boundary management endeavors, or does it use mechanisms internally to reflect upon and evaluate past actions and current practices? Is there any evidence that, in response, the boundary organization modified its behavior or practices? The aspect of the analytical model presented here is concerned with the capacity of boundary organizations to learn and to be self-reflective, open, inclusive, and appropriately flexible. This section explores AWI in these terms, assuming that a necessary feature of a successful organization attempting to link knowledges and actions is its responsiveness to ever-changing political and human-environment dynamics.

One of the most fundamental and yet least cited aspects of becoming an entity that embodies these characteristics of adaptability is having the initial capacity to experiment

<sup>&</sup>lt;sup>35</sup> Again, these questions are written in the past tense to reflect the analysis of AWI which became retrospective, once it closed. The analytical framework developed in this thesis is intended to be useful for organizations established in between knowledge and action domains.

with different initiatives, be available and attentive to stakeholders, to learn, and to change practices.<sup>36</sup> Capacity, in this use, refers especially to: sufficient, consistent, and secure (which may imply diverse) sources of financial support; engaged and dedicated actors/participants, i.e. owners, in the sense used in this present work; and time – the understanding<sup>37</sup> that several years are likely required to begin operating consistent with its vision.<sup>38</sup> Having the ability to take risks and experiment with an approach or program for a particular period of time requires a level of financial security and support that is likely to be difficult for many new organizations to achieve. For an organization that, by its nature, occupies an unconventional role in local socio-institutional regimes, it may be

<sup>&</sup>lt;sup>36</sup> Adaptive management and adaptive governance have well-developed literatures, which were only cursorily surveyed in the theory section of this thesis. See for a general but tidy introduction to the subject of adaptive management Lee (1999).

<sup>&</sup>lt;sup>37</sup> Understanding among stakeholders, financiers, and other entities party to the organization's functioning.

<sup>&</sup>lt;sup>38</sup> There is very useful scholarship on "adaptive capacity," particularly as it relates to the concept of resilience theory. The analysis of this thesis adopts a somewhat broader perspective, but is educated by this literature. See, for example, the work of the Resilience Alliance (<u>http://www.resalliance.org/</u>); they conceptualize adaptive capacity partly in this way:

Adaptive capacity in ecological systems is related to genetic diversity, biological diversity, and the heterogeneity of landscape mosaics (Carpenter et al. 2001a, Peterson et al. 1998, Bengtsson et al. 2002). In social systems, the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups play an important role in adaptive capacity (Scheffer et al. 2000, Berkes et al. 2002)....Resilience is key to enhancing adaptive capacity ("Adaptive Capacity" http://www.resalliance.org/565.php).

Key features of developing adaptive capacity, according to this group, include: "learning to live with change and uncertainty; nurturing diversity for resilience; combining different types of knowledge for learning; and creating opportunity for self-organization towards social-ecological sustainability."

particularly challenging to obtain the types of resources needed to enable the opportunity to learn and apply its lessons to modify current practices. AWI exemplifies the importance of this point. Even though AWI was established through a funded mandate from the State's executive branch, along with appropriations from the legislature, it was not protected from partisan politics, budget cuts, and the pursuit of self-serving agendas among leaders in participating entities. All this said, however, AWI displayed immense adaptive capacity in certain respects.

# Adaptive management approach

AWI's research program exemplified its adaptive management approach. Its focus evolved from a large number of small projects to a small number of large projects, for example. This was demonstrative, in part, of its response to user demands that it should take up broader and higher-profile topics – ultimately, this meant addressing big issues and implications associated with water resources, population growth, land use, and economic development in Arizona. The organization transformed the entire approach to its research program for fiscal year (FY) 2009. While it was unable to execute the plan as intended, due to its closure, the 2009 approach for eliciting, reviewing, and funding research project proposals was significantly different from the previous years. It was demonstrative of the organization's commitment to be representative of a broad range of stakeholder interests and capacities, and to ensure its connectedness with appropriate water-related actors in the State of Arizona.

While AWI was not a grant-funding agency of the traditional sort, much of the way its research program operated appeared to the uninformed observer to be quite

similar. For fiscal years (FY) 2007 and 2008, AWI put out requests for proposals (RFPs) explaining what AWI was, its funding allocation opportunity, areas of research interest it looked for in proposals that year, the proposal review process, and how to apply, including the recommendation/requirement that applicants apply as a multi-institutional and -stakeholder team. For example, the RFP for FY2008 includes this passage:

Faculty members and staff at ASU, NAU and UA are eligible to submit proposals, but it is strongly recommended that they build partnerships with communities, tribes, local, regional and state agencies and the private sector. Researchers in any of the social, biological, physical, and engineering sciences and fields such as water management, water law, business, economics and health sciences are invited to apply. It is STRONGLY recommended that proposals involve researchers from more than one university and collaborations with partners from outside the universities.<sup>39</sup>

- Scientific/technical/intellectual excellence and innovation;
- Collaborative approach: involving a minimum of two of the three universities (although exceptional projects involving only one university may be considered IF there are counterbalancing collaborations with agencies or public-private partnerships; note, though, that AWI has a strong preference for cross-university collaborations);
- Qualifications of investigators;

<sup>&</sup>lt;sup>39</sup> Original emphasis. Document header: "ARIZONA WATER INSTITUTE REQUEST FOR PROPOSALS FOR COLLABORATIVE RESEARCH ON ARIZONA WATER ISSUES. Revised: August 14, 2007 by tlh." Specific "Criteria [for funding] (in general order of importance)" for this RFP were:

<sup>•</sup> Evidence of need for project (clear benefits to stakeholders, partnerships with stakeholders);

<sup>•</sup> Strategic importance to water management, economic development and building the research and technical assistance capacity of the universities and the Arizona Water Institute;

Proposal requirements were relatively standard for an academic-style project, in terms of

format, submission process, and other logistics.<sup>40</sup> FY2009 was a quite different in

- Availability of matching funds and other contributions that are essential to the project (unless a compelling case is made that no alternative funding is currently available or likely in the near future); if matching funds are not yet available but have been applied for from another source, identify the source and date that funding decision is anticipated.
- Commercialization, economic development and technology transfer opportunities;
- Interdisciplinary and boundary-spanning opportunities;
- Transferability of results to other applications;
- Educational and training opportunities/innovations in water-related education and capacity building;
- Ensuring balance among education/assistance, research, technology development and economic opportunities across the three campuses.

<sup>40</sup> From AWI's FY2008 Request for Proposals on submission requirements:

"The proposals shall consist of a 2 page Letter of Intent with the following sections:

- 1. Short Description of Proposed Project
- 2. Statement of Need
- Evidence of need for project (clear benefits to stakeholders, partnerships with stakeholders);
  - Strategic importance to water management, economic development and building research, applications, and technical assistance capacity; and
  - Potential impacts of project.
  - 3. Project Approach

• Demonstration of a collaborative approach with synergistic activity being conducted by researchers on different campuses and involvement of practitioners/stakeholders

• Identify how project will provide educational and training opportunities

- 4. Research Team and Qualifications (attach a maximum two-page résumé for each investigator, including partners if they are proposing to receive funding through this RFP)
- 5. Commercialization, Economic Development and Technology Transfer Opportunities (if applicable)
- 6. Budget & Schedule (attachment to the two-page Letter of Intent)

Availability of matching funds, including separate identification of sources and amounts of in-kind and direct financial contributions that are essential to the project (unless a compelling case is made that no alternative funding is currently available or likely in the near future)

For the budget, you must use the Excel file template found with the RFP announcement on the AWI website under "Funding" – "AWI RFP's."

approach, though not particularly in its core priorities. Instead of requesting that stakeholders match themselves up with other interested individuals and parties who might have complementary expertise, and instead of requiring respondents to collectively embark on the fairly laborious endeavor required of such an RFP, respondents were asked to submit a maximum three-hundred word "Concept Proposal." The email statement from AWI's Executive Director with this announcement to "Arizona Water Institute participants and other interested parties"<sup>41</sup> explained that the funding approach, and proposal and management mechanisms had changed:

We will be funding a smaller number of larger projects....AWI staff will help build the final proposals and budgets – but there is an expectation of a higher proportion of external matching for projects that are selected. Even if you have only a preliminary idea, please contact AWI staff to discuss them. This includes partnerships with private and public sector entities. AWI staff may be able to help with external funding ideas as well.

This brief articulation of a concept was the only requirement for submission (including budget proposal).

- 7. Letters of support/collaboration
- 8. Name of AWI coordinator, theme leader or associate director with whom you discussed your project prior to submittal.
- 9. Identify which of the six focal areas you believe your project is most closely related to.

<sup>41</sup> This email, with subject "Arizona Water Institute Project Funding Announcement," was sent from the Arizona Water Institute on behalf of AWI assistant Stephanie Polm, Friday, September 05, 2008 2:56 PM.

While the example from FY2008 pointed towards the kind of highlycollaborative, engaged, and real-world orientation AWI claimed characterized its approach, FY2009 emphasized these features even more. The earlier modes of its research proposal solicitation and funding allocation were intended not only to help develop a broad support base, but also to, the extent possible, be involved extensively in the activities and agendas of its expansive stakeholder constituency. By fall of 2008, the organization had funded dozens of research projects across the State – universities, agencies, tribes, public and private entities, environmental groups, etc. – and was better positioned to embark on projects tackling broader issues, with likely even longer-term outlooks and returns. Importantly, the way the FY2009 RFP process was structured offered inarguably greater access and empowerment. Immensely important was AWI's explicitly stating to users to contribute barely-formed ideas for collaborative research, inviting conversation about these ideas with staff, offering staff time, knowledge, and capacity to help frame and develop a viable project, and to further assist in seeking collaborators and financiers. While AWI was available and prepared to provide these services prior to this announcement, the decision to change its approach and reiterate or plainly put forward how it could be used and valued by stakeholders is very clearly illustrative of AWI's awareness of user demand and capacity to adapt and attempt to meet those demands.

The "AWI Project Funding Announcement and Solicitation of Conceptual Project Proposals, Faculty Incentive Grants, and Student Internship Grants" sent out in September 2008 for FY2009 explained the new process for collaborative research projects, in this way:<sup>42</sup>

Unlike the two previous years, we are not soliciting complete proposals this time. We are only asking for concept proposals. However, as with previous funding cycles, each project should contain cross university collaboration to the maximum extent feasible. Project **concepts** should be structured to maximize opportunities for creative collaboration and to minimize the needs for extensive coordination across different units. Engagement with water managers, community stakeholders and decision makers will be emphasized even more than for AWI's 2007 and 2008 projects.<sup>43</sup>

The call for these went out earlier than RFPs had for FY2007 and 2008 and had a quick turn-around time of about one month. The RFP was preceded about a month by intensive informational meetings at all three campuses and elsewhere to explain this new approach to prospective applicants and other potentially interested parties. The author attended one at ASU, facilitated by Dr. Jim Holway.<sup>44</sup> The room was full (of more than thirty faculty

<sup>&</sup>lt;sup>42</sup> According to this announcement, there were "two basic funding sources: 1) the large projects portfolio for collaborative research projects and 2) faculty incentive grants/student internship opportunities on all three campuses."

<sup>&</sup>lt;sup>43</sup> Original emphasis.

<sup>&</sup>lt;sup>44</sup> The meeting was titled "'Arizona Water Institute at ASU' Faculty & Staff Lunch," held at the Global Institute of Sustainability on September 29, 2008. The (tentative) agenda, as it was sent out to announce the event, comprised: Welcome & Introductions; "AZ Water Institute – 2008 Funding for Projects & Update;" Project Results – Water & Energy Brief Presentations (Paul Westerhoff – Fuel Cells for Water Production; Mike Pasqualetti – Water use to produce electricity in AZ; Chris Harto – Life Cycle Water

and staff), and, counter to the criticism that AWI's EAB meetings were presentationheavy and lacked sufficient opportunity for discussion, the bulk of this meeting was question and answer with Holway, attendees, and other participants of AWI-funded projects or activities.

### *Gathering demand*

A critical component of a boundary organization's efforts to "manage dynamic processes" is staying abreast of the makeup of the stakeholder population and their informational and technical demand. This is important for several reasons. How the organization serves its various stakeholder groups is dependent on its understanding of the landscape of needs, including each group's preferred ways of having them addressed. With a changing environment, stakeholder needs may also change, meaning that the entity must have a systematic approach to identifying and understanding the context of stakeholders and issues important to them (e.g. Jacobs, 2002).<sup>45</sup> Upon its inception, AWI performed a very thorough needs assessment for which it continues to receive praise. It is widely viewed as having been helpful in orienting AWI, as well as introducing themselves to the public. According to interviewees from AWI's leadership, the priority research areas and the ways in which stakeholders were addressed and communicated with were informed by and, in fact, derived from this needs assessment.

Costs of Alternative Transportation Fuels); Recommendations for AWI Activities & Funding Suggestions.

<sup>45</sup> This may beg the question "Do water managers and providers really know what they need to make better decisions?" but, the judgment of practitioners and water stakeholder contingents is not a concern of this research.

There were no specific mechanisms within AWI's institutional structure that enabled regular identification of emerging stakeholders or needs, e.g. semi-annual confidential user surveys. However, the organization implemented other approaches, such as sporadic questionnaires eliciting participant input following a workshop or other events. The best example of AWI's efforts to gather stakeholders informational demands is "Focusing Arizona's Water Research: A One Day Workshop," held October 29, 2008 in partnership with the Arizona Water Pollution and Control Association (now called Arizona Water). The purpose of the workshop was to provide an opportunity for water researchers, decision-makers, and water stakeholders to brainstorm collaboratively priority areas for water-related research in Arizona. The agenda was structured to create effectively a very fun, lively, and open conversation.<sup>46</sup>

Other responses to interview questions about how AWI made sure that it was "asking the right questions" "to the right people" "in the right way," referred to the impressive expertise, strong and broad water-related networks, as well as extensive multidisciplinary and -sectoral collaborative work experience of its staff. These claims are easily supported by a review of available resumes, biographical sketches, and, quite significantly, the affirmative collective testimonies of stakeholder interviewees and external actors. The AWI "core group" was very well-connected to and entrenched in the water resource research and decision-making in Arizona. Examples of some of their

<sup>&</sup>lt;sup>46</sup> Basic information about this workshop is posted on AWI's "Workshops" page at <u>http://azwaterinstitute.org/workshops.html</u>. The agenda for this workshop is located at <u>http://www.awpca.org/calendar/Research%20Workshop%20Registration.pdf</u>, and the list of attendees is at <u>http://azwaterinstitute.org/media/102908%20attendance</u>.

credentials include: AWI's Executive Director was Tucson Active Management Area Director for more than a decade, and Deputy Director of the NSF Center for Sustainability of Arid Region Hydrology and Riparian Areas (SAHRA) at the University of Arizona;<sup>47</sup> the Associate Director at ADWR was the Santa Cruz AMA Director for ten years before becoming ADEQ's Arizona-Mexico Border Environmental Manager for the same length of time, both experiences that put him in positions to translate and mediate water resource challenges intrastate and internationally;<sup>48</sup> the Associate Director at ADEQ was that agency's Water Quality Division Deputy Director;<sup>49</sup> one of the Campus Coordinators was a long-time Assistant Director of the ADWR;<sup>50</sup> and another had much experience in program management, involving outreach and collaboration with diverse stakeholder groups.<sup>51</sup> The regular and intimate involvement of the AWI leadership across the stakeholder spectrum was important for the organization to collect user demand and address preferences for how they could respond effectively.

<sup>&</sup>lt;sup>47</sup> Kathy Jacobs, who was also Professor and Specialist at the Department of Soil, Water and Environmental Science and Water Resources Research Center, and most recently was appointed chair of the study on Adapting to the Impacts of Climate Change at the National Academies of Sciences.

<sup>&</sup>lt;sup>48</sup> Placido dos Santos.

<sup>&</sup>lt;sup>49</sup> Charles (Chuck) G. Graf, who held other posts at ADEQ prior, as well as at ADWR, the Arizona State Land Department, and the National Forest Service.

<sup>&</sup>lt;sup>50</sup> Jim Holway, who most recently was the director of the Sustainability Partnership at ASU's Global Institute of Sustainability, where he also held a post as professor of practice at the School of Sustainability and the Department of Civil, Environmental, and Sustainable Engineering, where water resources was central to all of his work.

<sup>&</sup>lt;sup>51</sup> Anna Spitz, who is currently Program Manager for the UA College of Science Center for Astrobiology.

The structure of AWI was such that each main stakeholder group (broadly construed) was represented by an individual, who held some title role in the organization. For example, the role of the Campus Coordinator was very important to AWI as a boundary organization; it was a direct connection to the universities. These individuals were expected to be available to users generally and to provide updates pertaining to the work of AWI, relevant opportunities and news, as well as to actively seek out and be in contact with potential stakeholders. The perceptions of university researchers interviewed regarding Campus Coordinators were extremely mixed. A subset of Principal Investigators for AWI-funded projects was completely indifferent about the Campus Coordinators and not especially aware of their presence. At least two interviewees felt very strongly about the lack of communication, engagement, and help from these individuals, while the rest felt indifferent, were basically satisfied, and/or expressed the ease with which they communicated with them. The outreach and demandgathering activities of AWI ostensibly were the particular responsibility of Campus Coordinators (according to communication with AWI staff). Upon reflection, these individuals themselves, as well as three researchers interviewed, admitted that they could have been more active in this way. They cited how they could have been more active promoting the organization across their respective campuses and elsewhere, and in helping to find and secure funding and stakeholders. Another example of how its structure was important for AWI's ability to manage dynamic processes was highlighted in a remark made by one interviewee pointing how the organization missed important opportunities to enhance relationships, develop institutional partnerships and extend

networks. This individual described his research project as having initiated contact and relationships with a multitude of actors (including individuals and institutions, from non-profit user groups to federal agencies) across the stakeholder spectrum, and how, since this was also the case for AWI projects generally, the organization would have benefitted substantially from an approach to absorb those relationships and the lessons learned (not reflected in projects' final reports or presentations). The point of this idea was for the organization to develop institutional knowledge and memory that would be rooted in the foundation built by an effective aggregation of the experiences of each time AWI was represented in and engaged with the broader community.

### Conclusions and Further Research

This section begins by reflecting upon the conclusions that can be drawn about AWI as a boundary organization, with respect to the three-pronged analytical framework developed and applied here. A broader discussion overlaps, including specific implications derived from the analytical and empirical work of this thesis. Additional thoughts that arose during and as a result of this research, that may be useful going forward in practice and in theory of integrating knowledge and action, conclude.

The preceding analysis of the Arizona Water Institute presents a mixed and nuanced picture of the organization, in terms of integrating knowledge and action. For each of the three themes used to explore AWI, the organization's position and role in the dynamics of the broader political landscape (of water sustainability and governance in Arizona), main challenges, areas of support, choices of action, and outcomes have been assessed.

In terms of the features of the analytical category "governance and ownership," AWI struggled significantly. Its efforts to develop authority within the governance regime of water resources in Arizona and to develop owners out of key actors and stakeholders were impeded by several interrelated factors. The most evident of were: confusion among stakeholders as to its identity and role at the boundary; too-widely dispersed lines of accountability; an inadequate base of "owners" among stakeholder constituencies; modest and insecure operating funds; and tough competition in institutional landscape for a boundary management reputation. AWI was a catalyst for reconfiguration of the landscape in that it provided and facilitated important opportunities for actors in different domains throughout the landscape to interact – in many cases fostering mutual understanding, knowledge sharing, and long-term trusting relationships – and emphasized stakeholder engagement, real-world orientation, and collaboration within the university research model. In other ways it was less effective. It was only marginally successful at engaging the private sector; it missed important opportunities to expand networks and develop its base of institutional partnerships; and it somewhat ineffectively communicated the varied ways in which actors within and outside the university could actively participate in AWI's research program.

Finally, AWI demonstrated a strong commitment to adaptability and reflexivity: it implemented a very thorough needs assessment to shape its thematic foci; it effectively managed the seemingly constant changes of administrative personnel and institutional memory across the landscape; and it responded to stakeholder interests for broader research topics and greater opportunities to voice interests and partake. On the other hand, it lacked mechanisms for institutional learning and reflection and was heavily criticized for not offering sufficient opportunities for open dialogue among stakeholders, especially in ways that were neutrally facilitated.

Boundary organizations attempt to be accountable to multiple and diverse actors, while at the same time assiduously working to "stabilize" the boundary where actors intersect. As a result, they can become susceptible to skepticism, administrative and cultural mismatches, and resistance of long-held ways of conducting research or making decisions. Vulnerability is characteristic of boundary organizations, since the perceptions of actors on all sides of the figurative boundary are key determinants of their strength and survival (as evident in AWI's efforts to demonstrate their value to stakeholders). It is not the objective, nor the desire, of a boundary organization to strive for a common understanding, vision, or identity for its stakeholders at all sides of the boundary. Instead, articulating, framing, and (however subtly or blatantly) conveying specifically how it is of value to the agendas and interests of particular stakeholder groups is imperative.

Organizations at knowledge-action nexuses ultimately are or strive to become participants in and agents of the governance regime within which they emerge. Generally, however, their credibility and value must be achieved. The boundary organization is responsible for identifying stakeholders and persuading (current and prospective) users to interact with, support, and "own" it. They are affected by changing political and economic circumstances, as conventional institutions are, but are especially vulnerable. Because they straddle at least two socially-distinct domains, these entities must work to establish a role (and consequent political capacity) for themselves within the broader institutional landscape, in order to thrive. To be an authority at the "boundary," an organization must be able to demonstrate and convince users that it is capably accountable to the relevant actors at all sides, and therefore able to be relatively allegiance-neutral, embodying an identity that is broad, even ambiguous. Simultaneously, this type of entity must work to develop a representative distribution of "owners," who will each develop particular understandings of the organization and ways to identify with it. Stakeholders who take ownership of the organization, recognizing its work (e.g. production of boundary objects or standardized packages) as important and useful to their own work will contribute to its political capacity and support its claims as a mutually-interested player.

The correlation between perception of utility and potential success vis-à-vis actual success is high. Organizations with the intent to operate in the convoluted space where the fundamentally divergent cultures of research, government, resource management, and the private sector come together must prioritize cultivating a position of authority and meaningful stakeholder-specific identities at the boundary and within the broader political landscape. People need to understand why a boundary organization is established, i.e. what it offers that would or could not have been provided by the existing institutional regime. With respect to common cynicism, people also need to understand its relationship to other institutions that they ascribe important values to, e.g., a state government agency, a university program, a private consulting firm, etc. Is it one of these entities – or none of the above? If none, what is it?

The case study of AWI illustrates this, as confidence of AWI among the key stakeholders interviewed was not strong across the board. This proved to be due primarily to confusion: lack of clarity and understanding of why AWI existed, how it would benefit them, and how it fit within Arizona's water governance and sustainability landscape. To this end, several interviewees for the AWI case study, including staff, suggested devoting resources explicitly to informational, promotional, and public relations-oriented efforts. The relevancy and reach (i.e. ability to establish an authoritative role in political context and subsequently relate and be useful to appropriate stakeholders) as well as its financial sustainability and even survival, were impacted in significant ways. This was, in part, because the organization was unable to generate an effective support base, or owners. It must not be understated how difficult and time-consuming it is for any boundary organization – particularly when funds are limited and name recognition has yet been well-developed – to prioritize effectively. In other words, in order to best address all of the demands of it, and to weigh the very real tradeoffs of investing monetary and other resources in informational campaigns about itself and services (relative to, e.g., specific boundary-spanning activities) is a monumental task.<sup>52</sup>

From the perspective of this present work, the lesson is not to secure revenue streams or of fundraising capacity (necessarily), but of the importance of helping users identify with and become empowered through using the boundary organization. This is vital to a boundary organization's efforts to establish a boundary management role and build up the interest, confidence, and ultimately identification and ownership among key actors. The AWI case study demonstrated the importance of – more than how limited funds can constrain choices and opportunities –convincing key stakeholders of the organization's cleverness and capacity not only to acquire and retain funds, but also to maintain its accountability with the diverse actors occupying the boundary.

<sup>&</sup>lt;sup>52</sup> Moreover, the focus on public relations and marketing may seem frivolous, superficial, or even a distraction from what a boundary organization is presumably foremost interested in, which includes: deciding upon, defining, developing, and then supporting boundary management activities, like the collaborative research projects of AWI.

The Board of the boundary organization, e.g. AWI's External Advisory Board and Executive Committee, or other advisory-oriented actors or bodies the institution creates for itself, is one of its – if not its most – important assets. The institution must take seriously the capacity and role of the Board. This is most especially true in AWI's case, whose Board was made up essentially of its key stakeholder constituents. It represents a vital mechanism for the appearance and actualization of authority and accountability. It is both a tool to create the perception of strong and varied oversight and to ensure a steady multi-directional exchange of information, knowledge, and informational demands. As part of the institution, Board members should (be able and desire to) embody an explicit role; this should be expressed as mutually useful for the organization's mission and objectives and for the members themselves. Individuals serve on a stakeholder board – as was the case with AWI – because they represent key stakeholder constituencies and their needs and because they have specific skills, connections, or other resources that are supportive of the organization's agenda. Just as stakeholder constituencies require the boundary organization's help guiding them to an understanding of how it is valuable to their work and interests, stakeholders seem also to require almost an invitation to take an active role in and use the organization. Recall from above, for example, that the almost unanimous sentiment from EAB members interviewed, besides general confusion, was confusion as to what they were expected to do for and with the organization, and how that would benefit them (and fit within their busy schedules and not somehow deter attention or business from their current work, in, for example, consulting or in other ostensibly boundary-spanning venues).

In terms of "managing dynamic processes," the utility of the organization-board relationship is likely to be more effectively exploited if this potential reciprocity is continually and consistently explored, explicated, and cultivated. This is partly done through one-on-one conversations between the organization's administration and board members (as time-consuming and practically difficult as this surely is) and maximizing opportunities for both task-specific and open-ended dialogue. Some kind of "neutral" party may be helpful in facilitating and mediating these conversations, particularly when the actions of the organization are on the agenda. For example, a professional facilitator may be recommended in instances that the organization seeks relatively uninhibited feedback on current practices, approach, and input for future directions.

Striving in part to participate in the reconfiguration of the knowledge-action landscape, it is prudent also for an organization to develop an agenda that is highly focused (since, particularly in nascent periods as discussed above, [financial, human, and other types of] resources are often slim). This point speaks to the penchant of ambitious people with broad, impressive ideas, who, however unwittingly, may move an organization to taking on more issues than may align with its vision of catalyzing a knowledge-action system reconfiguration and/or than it may ultimately have the capacity to do well. In AWI's case, a few stakeholders indicated in interviews that the organization was "trying to take on the world" and that it seemed unlikely to succeed being as spread out as the impression they had of it was. AWI made the strategic choice to be spread out thematically and across a large swath of stakeholder communities in the attempt to develop its stakeholder base during its early years. Its intent to slowly focus its funds on fewer and higher profile projects evidently was not communicated effectively to onlookers.

Hence, *time* seems to be one of the most critical issues for boundary organizations. It is fair to say that nearly all of efforts of the AWI took significant amounts of time, as is necessarily true of any worthwhile attempt to be inclusive of and manage the variety of knowledges, capacities, and agendas with a stake in an issue as complex as water resources. Supporters of AWI's efforts spoke of how at the time of its closure, it was just "coming of age." Four interviewees – individuals intimately familiar with organization and program development and management and also familiar with boundary-spanning challenges – used a version of precisely this term. In many ways, boundary organizations are experiments and would be administered best from this perspective (Ingram & Bradley, 2006; Jacobs, 2002; Jacobs & Pulwarty, 2003; Lach & Steel, 2007). In the most basic sense, this requires enough time – and, importantly, the fortune or the capacity to possess the resources necessary to provide for enough time – for the organization to experience reasonable tribulations, to learn, adjust, and move ahead as an even more effectual entity. For AWI, this in large part meant time to demonstrate its utility within the context in which it was operating. Extensive amounts of time and energy are required for the necessary development of meaningful working relationships and trust with and among stakeholders (Jacobs & Morehouse, 2005; Lach, Rayner, & Ingram, 2005). Further, these resources are required in order to cultivate a deep functional understanding of information demands and establish a collectively agreeable and understandable plan of action that has a higher likelihood of working over

the longer-term. The lesson that might be derived from this for the future is the need for sufficient commitment and capacity to persistently and continually expend time building and maintaining positive, productive, and mutually empowering and beneficial reciprocal relationships.

It is the *process(es)* of boundary management work that must be better recognized and valued within knowledge-action discourse and practice – of cultivating a credible, legitimate brand, and identifying and developing meaningful relationships. Quantifiable, tangible, "outcomes" are more easily valued and lauded in the contemporary capitalist society, but are only a part of the boundary organization's portfolio. For this reason, boundary managers must consciously value (and help enable the broader political context to value) the "intangibles" of boundary management work, like cultivating long-lasting mutually-beneficial partnerships across "the boundary."

#### Further Research

This work included a consideration of existing scholarship on relationships among different types of knowledges and actions generally (and more specifically, this includes science-policy, information-decision-making, or research-practice). The fundamentals of relevant theories – mainly, core themes pertaining to knowledge-action integration – have been conceptually amalgamated here, and used to develop a different conceptual model. The analytical framework derived from this exercise attempts to integrate these to offer an approach that is at the same time broader and more nuanced than what currently dominates the discourse. Its focus is on institutions and their role in and the extent to which they bring knowledges and actions to bear on one another in more their immediate

context, as well as the broader settings political landscape. Primarily through the presentation of the Arizona Water Institute case study and the application of this framework, the lessons and efficacy of the current theory and the framework as an analytical device has been explored. This approach is oriented towards argument for an articulation of knowledge on "boundary management" type approaches, in terms of assessing the quality, effectiveness, success, and/or impact of the practices, processes, and outcomes of a "boundary organization," or related institutional construct.

Meaningful, equitable, and efficient relationships and methods, across knowledge- and action-oriented jurisdictions are more important in the context of increasingly challenging factors of the human-environment system – such as climate change, urbanization and land conversions, deforestation and desertification, and changing precipitation patterns and water scarcity. The disconnect that often (instead) describes interaction between these arenas is a powerful problem that has the potential to engender unintended and undesirable affects, e.g., on the natural environment, already marginalized social groups, and economic development. The work of this thesis has been exploratory, in the sense that the approach put forth was new and applied for the first time. Unsurprisingly, issues and additional areas of inquiry, outside of the scope of the present work but interesting for further research, arose developing, applying, and reflecting upon the theory and practice of integrating knowledges and actions. Some of these ideas for further consideration in research and practice domains along the vein of the analysis presented here follow. The elements of the analytical framework developed here are useful, but, for the purposes of better contributing to the quality and focus of the discourse, how can we better specify these terms? Further, how can the ideas these terms express be developed for greater methodological robustness, as well as be representative of an even broader spread of literature, e.g. to include more prominently aspects of scholarship on sustainability and governance (Norton, 2005), learning and reflexivity (Senge, 2006; Grunwald, 2004), fairness (Rawls, 2001; Dobson, 1999; Albin, 2001), and institutional analysis (Ostrom, 2005))?

In this present work, institutions and their landscapes are the focus on the analysis. What other classifications may be relevant and important to understanding knowledge-action integration, particularly the role of institutions? Relatedly, what is the relationship between organizations operating within their landscapes and their abilities to enhance sustainability outcomes? For example, organizations operating within their landscapes may turn out to be a constraint, in terms of their abilities to contribute to or broader implications for, sustainability agendas. Better understanding of the issues these questions raise may be useful for sustainability-oriented policy, e.g. providing recommendations for how institutions might navigate these constraints to be more capable actors for the relevant sustainability agenda. Or, they may raise unsettling questions about whether whole landscapes need to be remade.

Regarding "reconfiguration" put forth here as integral to assessing knowledgeaction integration, how do we measure it? How can we evaluate efforts to make modifications within knowledge-focused or decision-oriented domains? How do we
know whether or not, or to what extent, the ways in which an organization has contributed to reconfiguration are "good"? For analytical clarity, how do we parse out the important, but often subtle, distinction between changes that occur internal to the organization and those that the organization contributed to in the broader landscape? Given the unbounded variability of real-world contexts within which this concept of reconfiguration would be useful, what generalizable mechanisms can we create to enable the recognition, understanding, and analysis of evidence of reconfiguration, with respect to knowledge-action integration work by institutions? How can we inform and make this conversation and the implementation of measurement tools accountable to ethical and sustainability-oriented considerations? Would it be useful to develop the capacity and tools to envisage alternative system scenarios to help guide boundary organizations' reconfiguration efforts?

What types of institutional arrangements seem to support boundary management activities and allow them to thrive? Can or should universities have/host boundary organizations, or more generally institutions that intend to function as intermediaries or wholly uninterested, unbiased actors? What are the benefits and limitations of being a completely independent institution?

Additional real-world case studies that offer detailed descriptions of the distinct cultures and areas of functional overlap of knowledge and action domains will be increasingly valuable. Particularly useful will be case studies developed and analyzed using consciously sustainability-oriented perspectives. What the concept of sustainability can offer the knowledge-action integration conversations prevalent throughout science policy and social studies of science includes a long-term outlook, particularly intergenerational equity considerations, an intentionally broad, integrative, inclusive approach, involving multiple ways of knowing, sets of values, and expertise, and the acceptance of uncertainty, complexity, and persistent systemic change. The present work has dealt with and emphasized the enormous complexity of boundary management efforts; that financial capital, and political and social identities and interests are likely to always present challenges to truly integrative, collaborative work; and that innovativeness and creativity require time and ownership of the kind that can and will support cross-jurisdictional orchestration efforts. Disconnects between knowledge and action are common and problematic in contemporary societies. This thesis has argued that efforts to analyze why knowledge and action often suffer disconnects – and to improve these relationships – must focus on the institutions that attempt to link knowledge and action and the dynamics of the broader context.

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# APPENDIX A

ASU INSTITUTIONAL REVIEW BOARD (IRB) HUMAN SUBJECTS RESEARCH MATERIALS



Phone (480) 965-6788 Facsimile (480) 965-7772

То:	Clark Miller SS
From:	Mark Roosa, Chair Soc Beh IRB
Date:	09/05/2008
Committee Action:	Exemption Granted
IRB Action Date:	09/05/2008
IRB Protocol #:	0808003164
Study Title:	Addressing the Challenges Facing Arizona's Water Resources, and Institutional Perspective: a Cas Water Institute

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2).

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

### INTERVIEW CONSENT FORM

# "Addressing the sustainability challenges facing Arizona's water resources, an institutional perspective: a case study of the Arizona Water Institute"

### INTRODUCTION

The purposes of this form are to provide you (as a prospective research study participant) information that may affect your decision as to whether or not to participate in this research and to record the consent of those who agree to be involved in the study.

### RESEARCHERS

Clea Senneville, a Graduate Student in the School of Sustainability at Arizona State University and academic advisor Dr. Clark Miller has invited your participation in a research study.

### STUDY PURPOSE

The purpose of the research is to examine the activities and decisions of AWI, and assess them relative to its own expectations. Study findings are intended to contribute positively to AWI's pursuit to provide services and support for stakeholders of Arizona's water resources.

### DESCRIPTION OF RESEARCH STUDY

If you decide to participate, then you will join a study involving research of the Arizona Water Institute and its role in the sustainability of water resources in Arizona to the long-term future.

This study is undertaken with the knowledge and support of AWI, and findings are intended to contribute positively to AWI's pursuit to provide services and support for stakeholders of Arizona's water resources. During the interview, you will be asked to reflect on your perceptions of AWI, with particular consideration of its commitment to stakeholder engagement and addressing Arizona's diverse water resource concerns. Participation in this study is completely voluntary. You have the right not to respond at any point during the discussion, and to withdraw from the study at any time. Your decision will not affect in any way your relationship with AWI or ASU. There is no payment for your participation in the study.

If you say YES to a face-to-face or telephone interview with Clea Senneville, then your participation will last for approximately one hour, at a mutually agreed-upon location. You will be asked to reflect on your experience and perceptions of the Arizona Water Institute, with particular consideration of its commitment to stakeholder engagement and addressing the concerns relevant to water resource sustainability in Arizona. As a participant, you have the right to skip any question and withdraw from the study, at anytime. Approximately 80 subjects will be participating in this study state-wide.

### RISKS

There are no known risks from taking part in this study, but in any research, there is some possibility that you may be subject to risks that have not yet been identified. There are no known risks from taking part in this study; all information obtained from you is strictly confidential.

### BENEFITS

The possible/main benefits of your participation in the research are that the Arizona Water Institute may better understand and be more effectively positioned to address the needs of your stakeholder group and the concerns of your locality. With a deeper awareness of the priority issues of your particular situation, the AWI will also be more capable of providing services that contribute to the long term sustainability of water in Arizona.

### CONFIDENTIALITY

The interview will be audio recorded, and notes will be taken. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you, and no

information will ever be released that would allow anyone to identify you or anyone else in your family. Any identifying information about you will be separated immediately from the data, and placed in an encrypted folder on a server that is password-protected at the Arizona State University. Clea and Dr. Miller are the only individuals who will have access to this. All data will be coded to protect confidentiality; all identifying information will be destroyed upon completion of the study (expected summer 2009).

### WITHDRAWAL PRIVILEGE

Participation in this study is completely voluntary. It is ok for you to say no. Even if you say yes now, you are free to say no later, and withdraw from the study at any time. If applicable, your decision will not affect your relationship with the Arizona Water Institute or Arizona State University.

### COSTS AND PAYMENTS

The researchers want your decision about participating in the study to be absolutely voluntary. Yet they recognize that your participation may pose some inconvenience for you or consume some of your time. However, there is no payment for your participation in the study.

### VOLUNTARY CONSENT

Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Clea Senneville at <u>Clea.Senneville@asu.edu</u> or (480) 329-2783. Mail may be sent to School of Sustainability at Arizona State University: PO Box 875502 Tempe, AZ 85287-5502.

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk; you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Research Compliance Office, at 480-965 6788.

This form explains the nature, demands, benefits and any risk of the project. By signing this form you agree knowingly to assume any risks involved. Remember, your participation is voluntary. You may choose not to participate or to withdraw your consent and discontinue participation at any time without penalty or loss of benefit. In signing this consent form, you are not waiving any legal claims, rights, or remedies. A copy of this consent form will be given (offered) to you.

Your signature below indicates that you consent to participate in the above study.

Subject's Signature

Printed Name

Date

Legal Authorized Representative (if applicable) Printed Name

Date

### INVESTIGATOR'S STATEMENT

"I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. These elements of Informed Consent conform to the Assurance given by Arizona State University to the Office for Human Research Protections to protect the rights of human subjects. I have provided (offered) the subject/participant a copy of this signed consent document."

Signature of Investigator	Date
S S	

# APPENDIX B

# ARIZONA WATER INSTITUTE STAKEHOLDERS

AWI's 2006 Needs Assessment Participants provides a useful picture of the stakeholder population for the organization, as a whole. The table below is "Table 1" from the Assessment; immediately following is a comprehensive list of the specific stakeholder groups who participated in the Assessment and potentially also in future AWI activities:

Participating Stakeholders in Arizona Water Institute Needs Assessment				
Stakeholder Group	Number of Participating Stakeholders			
Federal agencies	8			
Indian tribes	9			
State agencies	4			
Local and regional entities	10			
Watershed groups	12			
Regional and municipal providers	17			
Private sector	6			
Professional associations and consultants	7			
Agricultural community	5			
Environmental community	7			
TOTAL	85			

# **Participating Stakeholder Groups**

# **Federal Agencies**

- Bureau of Reclamation (2)
- Bureau of Land Management
- US Geologic Survey
- National Park Service
- US Fish and Wildlife Service
- US Forest Service
- Department of Agriculture, Agricultural Research Service

# **Indian Tribes**

- Ak-Chin Indian Community
- Colorado River Indian Tribe
- Havasupai Indian Reservation
- Hualapai Tribe
- Navajo Nation
- Salt River Pima-Maricopa Indian Community
- Tohono O'odham Nation
- White Mountain Apache Tribe
- Yavapai-Prescott Indian Tribe

# **State Agencies**

- Arizona State Land Department
- Arizona Game and Fish Department
- Arizona Corporation Commission
- Arizona Department of Real Estate

# Local and Regional Entities

- Arizona Municipal Water Users
- Arizona Rural Water Association
- Arizona Water and Pollution Control Association
- Yuma County Water Users' Association
- Pima Association of Governments
- Central Arizona Association of Governments
- Pima County Department of Transportation
- Pima County Department of Environmental Quality
- Town of Prescott Valley (2)

# Watershed Groups

- Coconino Plateau Regional Water Study
- Little Colorado River Watershed Coordinating Committee
- Lower San Pedro Watershed Group
- Middle San Pedro Watershed Group
- Mogollon Rim Water Resources Management Study
- Northwest Arizona Watershed Council
- Gila Watershed Partnership
- Show Low Creek Watershed Enhancement Partnership
- Upper Agua Fria Watershed Group
- Upper Bill Williams Watershed Group
- Upper San Pedro Partnership
- Wilcox Partnership

# **Regional and Municipal Providers**

- Salt River Project (2)
- City of Tucson Water Department
- City of Phoenix Water Services Department
- City of Mesa
- City of Glendale
- City of Scottsdale
- City of Chandler
- Tempe Water Utilities Department
- Town of Gilbert
- City of Peoria

- City of Yuma
- City of Flagstaff
- Bella Vista Water
- Metropolitan Domestic Water Improvement District
- Arizona Water Company
- Arizona American Water Company

## **Private Sector Community**

- Tucson Electric Power
- Pinnacle West Capital Corporation
- Southwest Gas Company
- Northern Arizona Pump Company, Inc.
- Flagstaff Well and Supply Company, Inc.
- Private attorney

# **Professional Associations and Consultants**

- Arizona Hydrological Society-Flagstaff Chapter
- Haley and Aldrich
- Arizona Cattlemen's Association
- Arizona Nursery Association
- Arizona Water Well Association
- Homebuilders Association of Central Arizona
- Water Utilities Association of Arizona

# **Agricultural Community**

- BKW Farms
- Maricopa-Stanfield Irrigation and Drainage District
- Individual Farmer
- Sundance Farms
- Arizona Farm Bureau Association

# **Environmental Community**

- National Audubon Society of Arizona
- Arizona Open Land Trust
- The Nature Conservancy of Arizona
- Sierra Club of Arizona
- Sonoran Institute
- Friends of the Santa Cruz River
- Verde Watershed Association

# APPENDIX C

# DEVELOPING MECHANISMS FOR ELICITING FEEDBACK: AN EXAMPLE OF A STAKEHOLDER QUESTIONNAIRE FOR AWI

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#### Arizona State University

### Arizona Water Institute Survey

### AWI Web Site

The research includes an assessment of the effectiveness of the Arizona Water Institute (http://azwaterinstitute.org, or click on the button above) in relation to its own mission and objectives, its approach to addressing primary concerns of water resource sustainability, and to meeting the needs and interests of identified stakeholders.

Participation in this study is completely voluntary. As a participant, you have the right to skip any question and withdraw from the study, at anytime. Your decision will not affect your relationship with the Arizona Water Institute or Arizona State University. There are no known risks from taking part in this study, but in any research, there is some possibility that you may be subject to risks that have not yet been identified.

This questionnaire is expected to take no longer than twenty minutes. The researchers want your decision about participating in the study to be absolutely voluntary. There is no payment for your participation in the study.

Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Clea Senneville at Clea.Senneville@asu.edu or  $\blacksquare_{\pi}$  (480) 329-2783 . Mail may be sent to School of Sustainability at Arizona State University: PO Box 875502 Tempe, AZ 85287-5502.

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk; you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Research Compliance Office, at 🔤 + 480-965 6788

**Confidentiality Statement:** The list of people invited to complete this survey was compiled from mailing lists maintained by the Arizona Water Institute. Your responses will be confidential. The research team will not have access to any information that would personally identify you or connect you to your survey responses. Once the project is completed, all potentially identifying information will be discarded. The results of this study may be used in reports, presentations, and publications, but results will only be reported in the aggregate.

Completion of the questionnaire will be considered your consent to participate.

Next

### AWI - Stakeholder Survey

### How to enable Java Scripts

Several of the "other" response categories have pop-up boxes that allow you to elaborate on your answer. In order for these to work, you will need to have Java enabled in your browser. If you are uncertain how to do this, we have instructions available. Click the "Java" button above for details. Please contact Bill Edwards if you have questions or concerns: bill.edwards@asu.edu.

- 1. Which of the following do you most closely associate with: (check all that apply)
  - Federal agencies
  - Indian tribes
  - State agencies
  - Local and regional entities
  - Watershed groups
  - Regional and municipal water providers
  - Private sector
  - Professional associations and consultants
  - Agricultural community
  - Researchers
  - Collaborators
  - Students
  - Other (Please specify)

The following questions are intended to get a sense of your familiarity with the Arizona Water Institute and the extent to which it factors into your work in Arizona's water resources.

2. How do you primarily get information about or interact with AWI?

- Brochures and information pamphlets or postings
- Newsletter
- Listserv
- Direct email contact with AWI staff members
- Phone contact
- Presentations
- Conferences
- Meetings
- Other (please specify at prompt)
- 3. How familiar are you with AWI's research efforts?
  - Very familiar
  - Somewhat familiar
  - Not very familiar
  - Not familiar at all
- 4. Have you ever responded to an AWI Request for Proposals (RFP)?

Yes 🔍 No

5. Have you been involved in a project funded by AWI?

119

http://129.219.249.41/cgi-bin/ezs.exe

Yes	No
Previous	Next

9/29/2008 1:51 PM

120

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### AWI - Stakeholder Survey

### 5a. How many AWI-funded research projects have you been involved in?

5b. What was your role in your **most recent** project? (Check all that apply, if you identify with more than one below)

- Principal or Co-investigator
- Researcher or Research Participant
- Student
- Collaborator
- Sponsor
- Research Subject
- AWI Project Manager
- Other

If you checked "other" above, What was your role?

5d. Please indicate the research theme you have been primarily involved in:

- Web-based access to water information
- Capacity building/watershed research and support
- Climate change/drought/adaptation
- Emerging contaminants and treatment technologies
- Energy/water stability
- Salinity management and technologies
- Other not listed here. (Please specify at prompt)

5f. Please indicate your primary reason for choosing AWI to work with on this theme (i.e. what did you feel might be different about AWI than another organizations). Some possible reasons are listed below; please elaborate in the space provided, if "other."

- Opportunity to connect with people I might not have otherwise
- Ability to do stakeholder-driven or research in collaboration with stakeholders
- Prestige
- The Request for Proposals applied to my interest
- I was invited to by a collaborator who knew AWI
- I respect the objectives of AWI, and was interested in being a part of their mission
- Other (Please specify why you chose to work with AWI at prompt)

5g. Other reason

121

### AWI - Stakeholder Survey

6. Please let us know if you have recommendations specifically regarding AWI's RFPs or funding opportunity postings.

7. Are you interested in being involved in an AWI project in the future, as, for example, a participant, sponsor, or researcher?

Yes

No

Maybe

7a. (If "Yes") In what capacity are you interested in being involved with AWI, in the future?

- Principal Investigator
- Participant
- Sponsor
- Researcher
- Project Manager
- Other (Please indicate how you imagine being involved in the future)
- Not applicable

Please elaborate:

Previous	Next

### AWI - Stakeholder Survey

8. Approximately how many of the events (e.g. presentations, workshops, conferences) that AWI has supported or been involved in, since its inception, have you attended?

0 1-2

0 3-5 5 or more

None that I recall

Previous	Next

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### AWI - Stakeholder Survey

9. From your perspective, where does most of AWI's effort seem to go?

(Please choose all that apply)

- Hydrologic Information Management
- Water Quality and Treatment
- Ecosystems, Restoration, and Management
- Conservation Technology and Consumer Behavior
- Aquifer Management & Sustainability
- Watershed and Regional Technical Assistance and Facilitation
- Educational Opportunities and Innovations
- Capacity-building
- Tribal Support
- Climate Variability and Change
- International Applications and Research
- Commercialization, Economic Development, and Technology Transfer
- Other (please specify at prompt)

11. Is AWI focused on the "right" issues for the State of Arizona's water resources? In other words, are the issues AWI has prioritized, in your view, the most pressing issues for water resource sustainability in Arizona?

- Yes
- For the most part
- No
- In some ways
- I'm not sure

12. Please elaborate:

Previous	Next

### AWI - Stakeholder Survey

Please indicate your perception of AWI's progress (recognizing that it is starting its third year), with regards to each of the following:

13. AWI serves as the hub of research, community assistance and analytical support to ensure clean and sustainable water resources

- Excellent
- Very good
- Good
- Needs work
- Poor
- Undecided or unsure

14. AWI provides education, training, and professional capacity building to citizens and state, local, and tribal government decision makers about conserving and managing water in arid/semi-arid environments

- Excellent
- Very good
- Good
- Needs work
- Poor
- Undecided or unsure

15. AWI serves as a driver of economic opportunity by developing water products and services

- Excellent
- Very good
- Good
- Needs work
- Poor
- Undecided or unsure

Previous Next

### AWI - Stakeholder Survey

16. As you may know, AWI provides services to stakeholders, industry, agencies, and communities. How satisfied are you with AWI's efforts in each of the following areas? A space is provided below if you wish to comment.

	Very satisfied	Somewhat satisfied	Neutral	Somewhat dissatisfied	Very dissatisfied	Undecided/Unsure
Water-related data access and retrieval	0	0	0	0	-	•
Projects focused on real world solutions	-	0		-	1 m 1	1 <del>-</del> 1
Presentations for groups and events	•		0	•	, • ·	, - ,
Planning support & meeting facilitation	-		-	-		-
for water-related applications						
Planning support & meeting facilitation	0	0	0	0	•	•
for water-related applications						
Technology development & commercialization			0	ø		.0

17. Comments:

Previous	Next

126

### AWI - Stakeholder Survey

18. How has AWI's performance, since its inception in 2006, compared to your expectations?

- Exceeded my expectations
- Met my expectations
- Met some of my expectations
- Not met my expectations

18a. Elaborate if desired

19. Does AWI provide added value, other than providing research funding, to your work in Arizona's water resources?

- Ves, definitely
- Ø Yes, somwhat
- Not really
- No
- Not sure

Previous	Next

### AWI - Stakeholder Survey

21. Have you attempted to contact AWI staff (e.g. for information about AWI or to participate in AWI's work)?

Yes

No

22. How do you regard your experience contacting AWI? Please consider the responsiveness of AWI staff to your efforts to communicate with them, in terms of timeliness getting back to you, general helpfulness, etc.

- Very good
- Good
- Fair
- Poor
- Not good at all
- Not applicable (e.g. I have no experience in this matter.)

22a. Please elaborate

23.In your experience, is AWI as an organization open and responsive to new ideas, constructive criticism, or general suggestions regarding how it operates?

- Yes, very much so
- Yes
- Not particularly
- No
- Not applicable (e.g. I have no experience in this matter.)

23a. Please elaborate

24. Do you believe that AWI has been doing an effective job of identifying and connecting with the primary stakeholders of Arizona's water resources?

- Ves, definitely
- Yes
- Not really
- No

128

### Undecided

24a. Please explain

25. In your view, has AWI been fair (relatively unpoliticized or unbiased) in its choice of partner organizations, project themes, and stakeholder relationships?

- Ves, definitely
- Yes
- Not really
- No
- Undecided

25a. Comment (In what way? Or why not? Please elaborate especially if you believe AWI has not been fair in some way, and, if desired, make recommendations):

26. Have you shared AWI's Requests for Proposals, activities, or projects to anyone?

- Yes
- No
- No, but I am open to doing so in the future

27. Are there any drawbacks or limitations to being associated with AWI? (Please explain)

Previous	Next

129

http://129.219.249.41/cgi-bin/ezs.exe

### AWI - Stakeholder Survey

28. Do you think AWI will be of valuable to you in the future?

- Ves, definitely
- Yes
- Not really
- No
- Undecided

28a. In what way? Or, why not?

29. Do you believe that you or your organization will maintain a relationship with AWI and its services for the foreseeable future?

- Yes
- Probably
- Onlikely
- No
- Our Unsure

30. What, if anything, do you feel AWI could do differently to better serve your interests? Please consider the mission of AWI, and if there is something you believe AWI could do to be of more use to you, please explain what this is and suggest how it could be done.

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Previous	Next

# 130

http://129.219.249.41/cgi-bin/ezs.exe

AWI - Stakeholder Survey

Is there anything else you would like to tell us?

Thank you for you cooperation. We appreciate your willingness to participate in this important project.

Previous	Finish

AWI Study 2007 Thank you

http://dcdcsurvey.asu.edu/Sthanks.htm



# Arizona Water Institute Survey

Your responses have been submitted.

Thank you very much for your participation. If you would like to provide additional feedback or information, please do not hesitate to contact me at Clea.Senneville@asu.edu