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Top picture: SWAN work meetings, Spring 2013, Tucson
Photo: Hoshin Gupta

Bottom picture: SWAN Workshop, April 2013, Tucson, Tucson
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1. INTRODUCTION – THE SWAN PROJECT AND THE FEASIBILITY STUDY

SWAN is an international cooperation project granted by the European Commission under the FP7, as INCOLAB Action. The SWAN project involves five European Union Member States (Bulgaria, France, Netherlands, Spain and United Kingdom) and the USA. The European teams are The National Institute of Geophysics, Geodesy & Geography-Bulgarian Academy of Sciences (NIGGG-BAS; Bulgaria), Centre National de la Recherche Scientifique (CNRS, France), UNESCO-IHE Institute for Water Education (Netherlands), Universidad de Sevilla (USE; Spain), and University of the West of England (UWE; United Kingdom). The USA team is The University of Arizona. The SWAN project is coordinated by the French CNRS (Centre National de la Recherche Scientifique) that created a Joint International Research Unit (UMI 3157) in collaboration with the University of Arizona in 2008.

The principal objective of SWAN project is to reinforce collaboration between EU and US research in the field of sustainable water action. Since the beginning of the project, the original idea of a “Sustainable Water Center” has been defined and developed as an Organization for a Transatlantic Dialogue on Water (TDW). The TDW might constitute a platform that will bring together multidisciplinary research, education and knowledge exchange at both national and international level. Working towards understanding/solving water issues, physical/natural sciences will tightly collaborate with social sciences with the close collaboration of the institutional figure throughout the involvement of stakeholders. The work of the future TDW will be articulated around the integration of skills, policy, experts and different disciplinary perspectives into the project. This articulation will require the involvement and commitment of stakeholders to SWAN's work at different levels through the development of effective modes of participation. A strategy for effective stakeholder involvement will be developed building from the experience of SWAN's work.

The forms and modalities of the TDW have to be defined from scientific, legal and financial points of view. In this context, one of the main outputs of the SWAN project is a Feasibility Study into the establishment of an enduring institutional structure as a framework to develop this international collaboration. The aims of this feasibility study are to determine the steps for building a lasting cooperation between US and European institutions, organisms but also industries, to open the activities of the joint research unit iGLOBES (“International and Global

Environmental Studies", UMI 3157 CNRS/University of Arizona) to researchers from European countries as well as increase the scientific cooperation in ongoing research activities in preparing new joint projects, organizing of joint seminars, summer schools and similar activities, giving access to data bases or methodologies in the field.

Giving the close collaboration of stakeholders as a bridge between academia and institutions, and their important role as experts in different water management issues, their input in the constitution of the TWD is very valuable. During 2014, one of the main outcomes of the first period of SWAN project was the differentiation of stakeholders in three levels of action and collaboration (Figure 1):

- Level 1: *International Stakeholders Advisory Board* for the SWAN feasibility study in order to organize a transatlantic water dialogue network. Its role is to provide advice and insights on how academia and managers can work together to better inform management challenges and relevant research. The identification of this level of stakeholders is one of the main challenges of the feasibility study coordinated by the CNRS team: they do not necessarily come from national stakeholders groups but from international institutions (research, governance) that might have a specific view on a new research network.
- Level 2: *National Stakeholders* that regularly collaborate with the corresponding participating teams in the SWAN project, collaborating in their ordinary activities of research and dissemination, even outside of SWAN.
- Level 3: *Local Stakeholders* that are involved in each case study and work together with the researchers. The list of stakeholders involved in each case study can be very extensive, with stakeholders engaged at different levels.

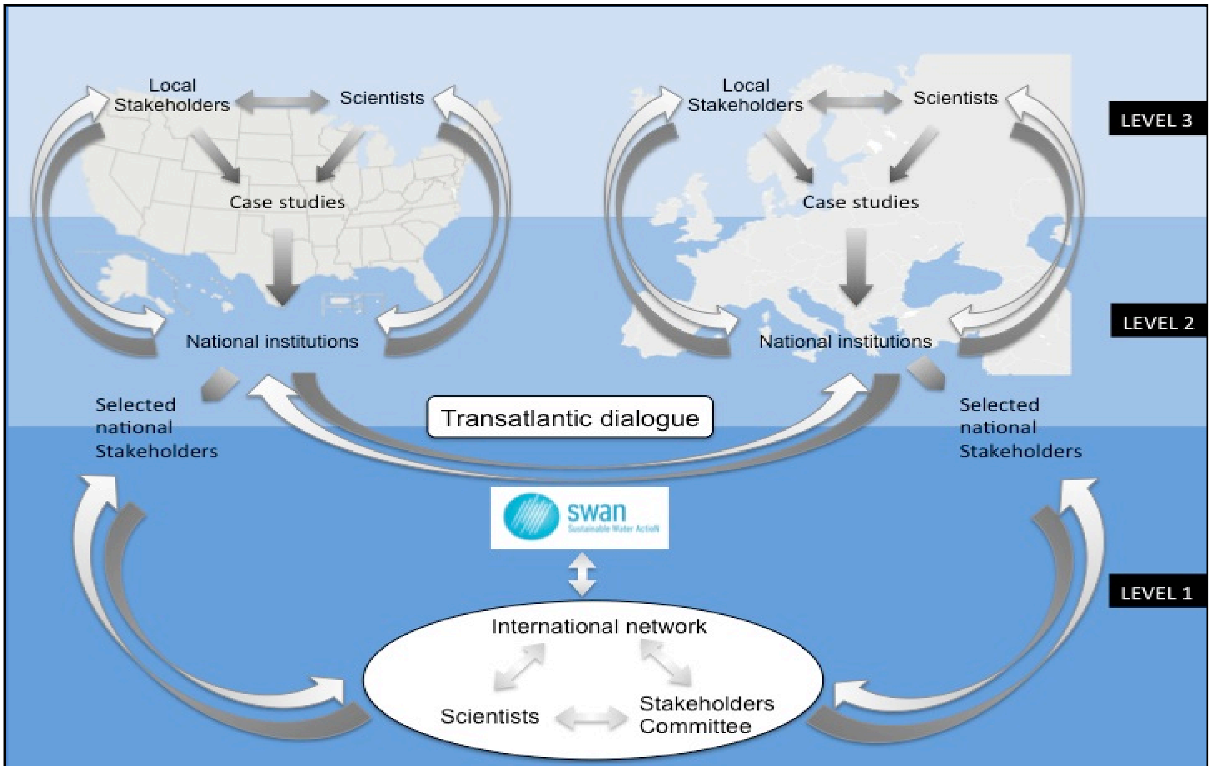

Figure 1. Articulation of the 3 levels of stakeholders

In the framework of the Feasibility Study, during the spring of 2014, a survey was sent to *International Stakeholders Advisory Board* in order to receive their recommendations for the organization of the future TDW. This deliverable will analyze the results of this survey.

2. STAKEHOLDER INVOLVEMENT AND PUBLIC PARTICIPATION**

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2.1. Why Should Stakeholders be Included in Scientific Research Projects?

The study and implementation of solutions to address complex water problems requires cooperation between physical and social scientists and the people, organizations, businesses and political institutions that must cope with the problem. The non-scientists provide insight into, and practical knowledge about, various aspects of the problem, and thereby help to establish a better perspective of the problem to be solved. In the literature and practice, the groups from whom such input should be sought are known as the "stakeholders".

The importance of involving stakeholders in scientific investigation is well documented. Increasingly, the literature reports a growing number of areas in which 'lay' individuals are either working with scientists, or for scientists, as part of the effort to resolve complex issues (Marshall and Picou 2008). The inclusion of stakeholder participation in planning and development of a research project has been shown to offer multiple benefits; including, increased legitimacy of the research, potentially greater opportunity for implementation of research recommendations, and an expanded range of solution options (Mauser, 2013; Enengal, 2012). Their inclusion can also help to diffuse contested situations and to rebuild citizen trust of science and government (Ravetz 2008). These benefits can, in turn, lead to public support for funding and the tapping of community resources to enable the project results to be implemented.

Stakeholders can bolster the legitimacy of a research project because they provide a different viewpoint than scientists (Pohl 2005, Welp et al. 2006), and the ideas they provide about the issue can prompt new lines of investigation and analysis (Pickett and Cadenasso, 2002) by the investigators who are, in turn, more qualified to evaluate and design the research project (Kramer, 2005). Stakeholders are also likely to have local knowledge of the social, political and physical details of a situation that may be overlooked by, or are unknown to, investigators. Absent such lack of local knowledge, wrong assumptions may be made and significant waste of resources can occur. For example, knowledge communicated by stakeholders that a local urban area does not rely on a particular stream as a source of water will prevent a researcher from undertaking the unnecessary work to determine whether the stream can provide a sustainable supply of the water to the urban area. On the administrative or institutional side, stakeholders can provide researchers with information about which institutions make water policy and which institutions implement the regulations to enforce the policy, thereby allowing researchers to better allocate their time to the institution which provides the most relevant information for the investigation. Similarly stakeholders can identify relevant social and political influences that affect not only the accurate identification of the problem but also the merits and efficacy of proposed solutions (Alexandrescu, 2014). This particular benefit of stakeholder involvement can help researchers from having their work undervalued or dismissed due to faulty initial assumptions, unforeseen political or social barriers, or the perception of arrogance or ignorance on the part of the research team. Thus, research conducted with stakeholder involvement can have a greater impact on society (Enengal, 2012) than will occur without this input, because research recommendations developed with stakeholder participation may receive greater political support (Krellenberg, 2014) and social acceptance. Importantly, as decision makers gain more understanding about the nature and methodology of the research, they are better able to comprehend what academic research can provide, communicate their needs, and are more likely to accept and make use of the results (Kramer, 2005).

On the negative side, the failure to achieve stakeholder involvement may threaten the continuation or implementation of a research project. Natural science teams have suffered actual loss of experimental equipment from sabotage when the local citizens have not been sufficiently informed and engaged in setting up experiments (Gorg, 2014). Expensive research projects have come to naught and projects have been left to collect dust in the absence of stakeholder acceptance, such as when Australian stakeholders rejected a comprehensively analyzed research project that would have generated potable water, in favor of more expensive treated water transported from an outside source (Fishman, 2011).

Although stakeholder participation can provide significant benefits, investigators should be cognizant that they can create new challenges that the investigators must be prepared to address. Stakeholders may not be a uniform, homogenous group; instead, they may be divided by their values, cultures and identities and unable to resolve their disputes with respect to particular water issues (Fuller, 2011). Their ability to provide different perspective to the research may well arise from the fact that the stakeholders have not just different interests, but conflicting interests. Such conflict can arise between all types of stakeholders. States may dispute rights to a river (Wyoming v. Colorado, 259 U.S. 419, 465 (1922)); farmers and utilities may clash over the use of treated effluent (Arizona Public Service, Co. v. Long, 160 Ariz. 429, 773 P.2d 988 (1989)); environmentalists and military bases may perceive the need for very different uses for groundwater (Center for Biological Diversity v. Rumsfeld, 198 F. Supp. 2d 1139 (D. Ariz. 2002); Indian Tribes and industry may have conflicting needs from a water source (Fuller, 2011). A particular water issue may be so divisive and mistrust among the stakeholder so pervasive that difficulties may arise in even bringing the parties together to discuss possible resolutions. Where, however, there is sufficient incentive for the parties to work together toward a common overall purpose, scientists can work with stakeholders to put together a politically supportable and scientifically legitimate plan (Fuller, 2011).

2.2. Who are the Stakeholders?

Given the importance of including stakeholders in research projects commissioned to tackle complex problems, all necessary stakeholders and their respective interests should be identified at the beginning of the project (PMI, 2013). Importantly, the need to identify stakeholders is a continuous process, so as to avoid the fallacy of confirmation bias that can threaten the need for objectivity, which may be lost if the public perceives that the purpose of the research is to reach a predetermined conclusion. As a result, researchers must remain vigilant to avoid being seen as closed-minded and unwilling to work with the objects of the study. While not acting as advocates for a particular outcome, researchers must be continuously willing to identify those people who have a recognizable interest in the research.

Accordingly, the physical scientists and social scientists, with their knowledge and methodology in the fields of sociology, political science and economics, must work together to produce a comprehensive and accurate analysis of the stakeholders needs and reactions both at the initial stages at the project and then as the project continues. When viewed in this light, stakeholder analysis enhances the researcher’s goal of systematically gathering and analyzing quantitative and qualitative information about the problem and “exploiting” input from potential stakeholders to determine which interests should be taken into account throughout the project. The stakeholder analysis process improves the effort to identify the interests, expectations, and influence of particular stakeholders and relates them to the purpose of the project. It also helps to identify stakeholder relationships (with the project and with the other stakeholders) that can be leveraged to build coalitions and potential partnerships to enhance the project’s chance of success, along with stakeholder relationships that need to be influenced differently at distinct stages of the project (PMI, p.395). It focuses on the personalities, positions and capabilities of participants from the decision making community because those participants will be the key players in determining whether a research project will be implemented through the political process (Kramer, 2005).

The potential stakeholders in water projects can include elected officials, environmentalists, utilities, developers, industry, agriculture support groups, and other organizations (Rousseau, 2005). The stakeholders for similar, but different projects – both in terms of geography and time – may not be the same, because different parts of the world will have different stakeholders, and interests given little weight in one case may become more important due to changing economic or environmental considerations as times change. Those who dominate water issues and the relative impact of stakeholder’s activities should be expected to change over time as domestic and industrial needs increase and agricultural needs decrease (Sivakumar, 2011). Accordingly, because the anticipated future impact of a given project will differ from other projects, these differences must be taken into account when determining the appropriate stakeholders.

One method to create a comprehensive group of stakeholders involves compiling an initial set of stakeholders whom the researchers believe will have relevant information, or whose livelihoods will be affected by the particular project. When the stakeholders have been preliminarily identified, a process to interview those stakeholders must be planned and executed to obtain their input regarding additional people, groups, and organizations with the potential to impact or be impacted by the particular project – including the use of the interview process to identify other stakeholders – so that all potential stakeholders have the opportunity to participate in the research process (PMI, 2013).

Another method to determine potential stakeholders in a water research project focuses on the identification of the relevant ecosystem affected by the water project or problem. Researchers then identify the different societal benefits provided by the ecosystem, known as “ecosystem services” to determine the relevant stakeholders. Ecosystem services, according to the UN Millennium Ecosystem Assessment (2005a), consist of “provisioning services” (extractable resources), “regulatory services” (processes that regulate the natural environment), “cultural services” (culturally valued benefits) and “supporting services” (processes essential to maintenance of the integrity, resilience, and functioning of ecosystems) (Everard, 2012). These different services give rise to diverse stakeholders whose interests, as discussed above, may potentially conflict with respect to a particular project. While it may be difficult to engage stakeholders with conflicting interests, well-reasoned solutions are more likely to result from a project that engages stakeholders in productive negotiation based on sound research. For example, the appropriate management of the Florida Everglades was finally resolved by the collaboration of stakeholders and scientists after more than a decade of negotiation and litigation among the Seminole and Miccosukee tribes, environmental groups and private industry (Fuller, 2011).

Numerous situations exist in which comprehensive negotiations, undertaken on a foundation of sound research and data, have not been attempted or conducted with significant adverse consequences. For example, the Aral Sea suffers from water shortages because policymakers approved the upstream diversion of its river water supply for cotton-fields without fully considering the impact of massive diversions on the Aral Sea; Apalachicola Bay in Florida lost substantial amounts of it estuarine habitats where oysters and other marine life thrived due to water management practices that consumed excess amounts of ground water and depleted the available fresh water for the bay; and South East Asia has lost large stands of mangrove forests which threatens the surrounding ecosystem due to the conversion of “swamp land” into fish and shrimp cultivation ponds (Turner and Jones, 1991; Ruitenbeek, 1994; Tri et al., 1998).

From these examples, it can be seen that investigators must fully evaluate, in addition to the benefits that may be created by a project, any other changes that may be triggered by the project. Ecosystems involving bodies of water can have a wide variety of stakeholders; examples range from hydroelectric plants, to fisheries to recreational fishing. Thus, stakeholders in a particular ecosystem may include:

1. Direct extensive users of the ecosystem, who use it in a fashion that is not inconsistent with rapid ecosystem recovery but yet whose livelihood depends upon the existence of a stable ecosystem. The types of users falling into this category could include harvesters of timber, available plants and fish.

2. Direct intensive users with access to new technology that allows more intensive harvesting which may prevent rapid recovery of the ecosystem or even cause damage to the resilience of the system. The interests of this group will be in conflict with the first group. The users in this category may range from fishermen that overfish an area, to sand and gravel operators that dredge a river beyond its ability to recover.

3. Agricultural producers that change a particular ecosystem from its particular state (such as a desert) to agricultural land and who may import water or convert the use of water inconsistent with the interests of other groups. An example of such uses would be agricultural pumping of groundwater that threatens a riparian habitat (Glennon, 2004).

4. Industries or municipalities that rely on the ecosystem for operations or for sources of potable water. Withdrawal of water by these users may impact the water table and cause a loss of riparian habitat, and adversely impact other groups who rely upon the existence of the water table at a certain depth, whether for domestic or agricultural use.

5. Indirect users who benefit from indirect ecosystem services such as storm abatement, flood mitigation, hydrological stabilization and water purification.

6. People who live close to a particular ecosystem in a transition zone between established urban or suburban areas and the water and whose property derives value from the proximity of the ecosystem. For example, homeowners who live near a riparian area (Browning-Aiken, 2003).

7. Nature conservation and amenity groups who combine nature conservation objectives with an enjoyment of the presence of plant and animal species and a desire to use the ecosystem for its recreational potential, such as river rafters on the Rio Grande River in New Mexico.

8. Nonusers who may, geographical distance notwithstanding, attribute nonuse value to riparian habitats in arid zones, possibly due to their recognition of intrinsic value of such riparian habitats recognized by the non-market economic value of conservation usually quantified by two methodologies: a revealed preference model using travel costs and a stated preference model using contingent valuations (Turner, 2000).

Creating the list of stakeholders by identifying the ecosystem requires an examination of the fundamental components of the specific ecosystem at issue. First, all ecosystems must have specific physical boundaries that identify the space encompassed in the particular ecosystem (Pickett and Cardenasso, 2002). Second, ecosystems have a biotic complex, which are the living organisms ranging from microbes to humans. Third, ecosystems have an abiotic complex, which are the physical elements such as the atmosphere, soil and water. Fourth, the ecosystem structure inherently recognizes that there is an interaction between the biotic complex and the abiotic complex in the defined physical space (Pickett and Cardenasso, 2002). The more completely the various aspects of the ecosystem are recognized and taken into account in the stakeholder analysis process, the better the facts about the ecosystem can be used to identify all stakeholders who may be involved in a project or problem. As physical and social scientists interact more effectively, ecosystem models can incorporate the full range of human institutions, account for human capital and social capital (community, political, formal, and informal institutions) (Costanza et al 1993).

In order for stakeholder identification to be successful, the researchers must fully engage with one another in working toward a common goal (Ramirez Andriotta). If the ecosystem(s) are to be used to identify the appropriate stakeholders, each member of the team must focus on defining the appropriate ecosystem or set of ecosystems relevant to a full analysis of the research project. This task may pose significant difficulties among researchers from different disciplines, in part because social scientists and physical scientists may use different geographical parameters in their respective research. The social scientist often looks to political subdivisions such as cities, counties, states, which do not necessarily have boundaries that correspond to the physical boundaries of watersheds. As a result, the investigators must engage in meaningful discussion to agree upon the geographical boundaries of the study. The failure to properly identify relevant stakeholders can result either in an incomplete list, or to a too-extensive list of "stakeholders" who (except in the broadest sense) have no recognizable interest in the project and whose inclusion/participation in the stakeholder process may serve to alienate true stakeholders who feel that their participation has been undercut by the involvement of people with no interest or stake in the outcome of the study.

2.3. How should stakeholders be engaged?

Once the stakeholders are identified, the investigators need to ensure that the stakeholders are fully aware of the project and its potential impact. Efforts must be devoted to providing information regarding knowledge already acquired, the research to be undertaken and the expected impacts from that research (Krellenberg, 2014). The investigators must next determine the purpose and manner of the desired engagement. For example, researchers may desire simply to acquire information from stakeholders, a less intense form of participation (Alexandrescu 2012). Engagement at this level typically involves interaction in the form of interviews, online newsletters, and training events, and the distribution of information (Enengel, 2012). Alternatively, researchers may want to fully include stakeholders in the implementation of the research project. The stakeholder's willingness to engage in a research project, however, may not coincide with the investigator's desired level of involvement.

Clearly, the commitment of time and effort requested of a stakeholder to participate in a research project can be significant and could present a barrier to the desired level of involvement. The commitment to a particular investigation could also include adopting a new practice that could adversely affect the stakeholder. Not surprising, therefore, the literature reveals that stakeholder involvement and willingness to be involved in a research project can vary over an entire spectrum (PMI, 2013). At one end, stakeholders may be resistant to a project due to an actual or perceived threat to their economic livelihood or physical well-being (Krellenberg 2014). The level of resistance may be so great that the stakeholders could even actively seek to defeat the project through political means or by sabotaging research equipment. Lesser levels of stakeholder resistance may require a legal mandate or actual payment to stakeholders. In one reported case study, the approach taken by the governing authority to overcome stakeholder resistance to a proposed program was to loosen the standards so that the stakeholder participation in the study did not impose an additional cost on the stakeholder (Wright and Jacobson, 2010). In contrast, the stakeholders may be so willing to participate that the stakeholders may seek to take the lead in the project. For example, individuals living in contaminated communities often are the first to identify adverse outcomes associated with toxic exposure (Ramirez Andreotta, 2014).

In the context of complex water issues, the methodologies of post-normal science and transdisciplinarity contemplate a much more engaged stakeholder than one who is neutral to the investigation or simply provides information. Viewed from the context of these methodologies, stakeholder engagement must begin at the inception of the project in a supportive or even leading role and work with the investigators to define the problem, to identify potential solutions, and (in the process) to establish a common understanding of the research goals. The inclusion of stakeholders thus requires more intensive framing and articulation or explanation of the relevant issues to allow for in-depth analysis and to encourage rather than inhibit focused research and analysis (Peterson 2011, 379; Mayumi and Giampietro 2005).

Important issues in the design planning, undertaken in consultation with the stakeholders, are the spatial and temporal scales of the required research. The research questions need to be apportioned into manageable research tasks (Stauffacher et al., 2008). In addition, during this co-design phase, stakeholders and academic participants need to work in a coordinated manner to identify the relevant disciplines, participants and the scientific integration steps necessary to approach the topic and to agree on the roles different groups will fill in advancing toward the research goals (Mauser, 2013). The identification of the different interests represents an important step because resource management and policy decisions can produce “winners” and “losers”. The closer the research activity is to an actual, important decision, the more critically the analytical framework will be scrutinized by potential losers (Kramer, 2005).

The next step in the project in which stakeholder involvement may occur is in the coordinated collection and analysis of the data, also known as the “co-production of the research” (Krellenberg, 2014). At this stage, the scientist working on a particular topic could present a briefing paper at a public forum in order to provide those in attendance with the most current information about the purpose of the research and the progress that has been made. The stakeholder’s co-production responsibilities call for the stakeholder’s engagement and participation in the discussion of the information presented, the identification of the information deemed necessary to take action, and the development and articulation of priorities to attach to the different research undertakings (Krellenberg, 2014). Routine dialogue between stakeholders and researchers throughout the project thus serves to enable the ongoing exchange and interaction of the parties’ respective knowledge and to ensure the societal relevance – and acceptance – of the research (Mauser, 2013). Typically, stakeholder participation appears be more prominent in the initial and final phases of a research project, while the middle phases of data analysis are mostly performed by the researchers (Enengel, 2012). In more contentious situations, investigators may find that stakeholders are unwilling to accept solutions unless they have participated in and vetted the scientific process that produces the data (Fuller, 2011). As a consequence, while normally stakeholder participation declines in this middle phase, in appropriate circumstances, additional effort should be made to fully retain stakeholder involvement.

The final step in the research process is the “co-assessment and co-dissemination” phase during which development of results and recommendations are jointly agreed upon by the extended peer community, in terms of its contribution to the adoption of solutions to address societal problems (Funtowicz and Ravetz 1994; Jahnet al. 2012). Thereafter, the researchers have the opportunity, influenced by the input from the stakeholder team, to publish the acquired knowledge in accessible form, to translate the results into comprehensible and usable information for the different stakeholders and to foster an open discussion on the valuation, applicability and relevance of the results among groups of conflicting interests (Mauser, 2013). At this juncture, models may be developed to provide a useful means to communicate with the public and decision makers, especially when the stakeholders have engaged in the actual construction of the model (Costanza and Folke 1997).

2.4. How to Manage the Stakeholder Interactions?

While it is perhaps a statement of the obvious, at the most basic level, stakeholders are also people. They may participate in the investigation due to job responsibilities, a particular passion or interest in the subject matter, or because their economic livelihood, property rights or physical well-being may be at stake. They will have completing demands on their time and energies. Accordingly, during the design of a project the researchers must recognize, as discussed above, that the level of stakeholder participation will typically vary over the lifetime of a project (Alexandrescu, 2014) and that each group should be expected to make different contributions at different stages of the research process (Enengel, 2012). Thus, once the stakeholders are identified and engaged at the desired level in the project, measures must be taken to maintain their continued support, avoid stakeholder fatigue and minimize resistance – thereby significantly increasing the likelihood of achieving project success. (PMI, 2013).

Good management of stakeholder interaction requires engaging stakeholders at appropriate project stages to obtain or confirm their continued commitment to the success of the project. This means that investigators must be committed to dedicating enough time to build and maintain relationships with each stakeholder group. The relationships will develop only through repeated interactions that create mutual respect and trust (Kramer, 2005). Specifically, building the necessary relationships requires continued communication with the stakeholders (Mauser, 2013; Kramer, 2005; Eden, 2011). One way to develop and maintain trust is to readily provide all material information about the project, conduct meeting open to all participants about the projects, with rules known in advance and consistently applied.

Although the literature in the area questions which concepts and processes are the most suitable to support communication (Mauser, 2013), the growing field of citizen science offers valuable guidance in this area. Citizen scientist projects are those projects in which scientists employed by nongovernmental organizations, universities, and community organizations engage in research efforts requiring nonscientists to collect significant amounts of observational data for scientists. These lay volunteers, known as “citizen scientists,” obtain large amounts of data representing repeated observations over a large geographic area or a long period of time, or both. In these types of projects, the scientists design the project by identifying precise and narrowly drawn research topics and establish the protocols for the data collection and recording operations. Successful citizen science projects implement continual communication and interaction between the project coordinator and the participants. A well-designed project includes the following characteristics: (1) a clear scientific question; (2) developed and refined project materials including clear protocols; (3) good data management; (4) timely disseminated results; and (5) measured impacts (Dickinson and Bonney 2012).

Based on these projects, a good working relationship requires a clear understanding by all parties of the research undertaken; the process by which the research will be conducted; the use of reliable means to collect and record data; the results based on the data; and the import of the results. This information can be disseminated in the course of stakeholder meetings, newsletters, monthly or quarterly reports. The precise timing of communications is not important, provided that the contacts occur regularly, consistently and timely with respect to the research gathered and in advance of the date of any required decisions. Communication also requires the investigators to address potential concerns that have yet to become issues, such as resistance to change, to anticipate future problems that may be raised by stakeholders, and to be aware of the potential need to broaden the group of involved stakeholders (PMI, p. 405).

Good management also includes recognizing that stakeholder expectations and goals may not be the same as the expectations and goals of the investigators. Stakeholders that are organizations such as non-profit organizations may be interested in collaborating in a research process to gain knowledge for lobbying purposes. Private industries may be willing to participate because they perceive the investigation as a method to obtain necessary information without long term funding of a team of researcher. Incentives for farmers include discovering methods to improve yields. Investigators’ interests may be focused on tackling an important problem through a rigorous and exhaustive research process that will then be the subject of a peer-reviewed article. (Harris 2013) If these different goals are not clearly recognized, conflict could arise during the course of the investigation. For example, a conflict could arise where stakeholders may want completed research made public immediately and put into use while scientific researchers may envision publication in peer reviewed journals (Harris, 2013).

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3. SURVEY ANALYSIS

During the spring of 2014 a survey was distributed among the stakeholders of each team (n=20), defined as belonging to the level 1. This survey was designed to get stakeholders' recommendations for the feasibility study and retrieve information about what will be the potential of a new organization on water issues such as TDW (Annex 1).

The institutions of the participants of the survey have specific areas of action: Management, Utilities/Services and, Education, Research and Debate. Most of the institutions were linked with academic, non-profit organizations, government institutions. There were also institutions link to private consulting, municipality, university and private companies. They mainly interact with partners/stakeholders during the research process: mainly in public events, dissemination, publications, less in governing boards and research process (Figures 2 and 3).

Figure 2. Question 2: Are your organization's aims developed with partner organizations?

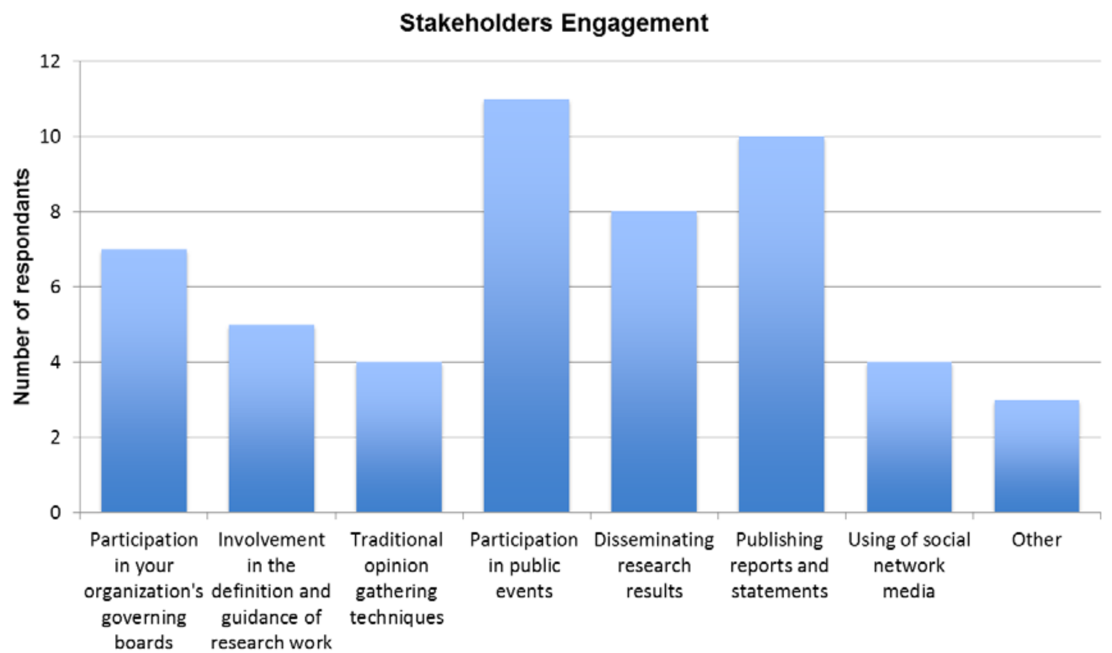

Figure 3. Question 3: How do you engage your partners and stakeholders in carrying out your mission?

The goal of the questions regarding the Potential of the Transatlantic Dialogue was to gather information about what kind of niches are not occupied for the existing centers, and what kind of structure should have this center/network in order to accomplish its mission.

The results showed that there was little interest in a center focused on water engineering and conflict resolution and transparency, or development of economic tools. Nevertheless, there was an expression of interest on topics such as *water quality, water ecosystems, water data, information generation and management technologies*. The participants also expressed their interest in a better connection between areas of research, areas of action, research and decision making through access to research by workshops, internet platform, network, exchange program, information hub. This platform of collaboration should be a scientific network, minimal and open. It should have a legal structure that allows allocation of international funds, submit proposals, and get agreements with other partners (Figures 4 and 5). This organization would benefit the institutions by offering expertise and workshops, partnership for projects, training, and new areas of knowledge.

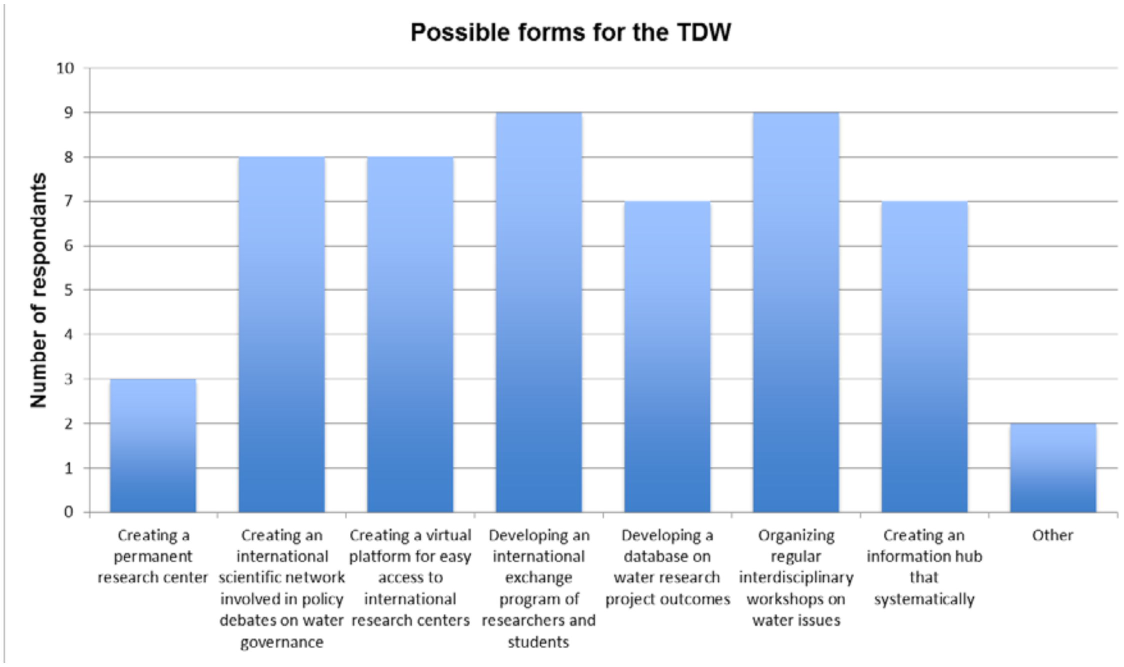

Figure 4. Question 6: Given the wide array of international water related research centers that exist today, how could a new scientific organization for a Transatlantic Dialog between Europe and the USA help improve water-related research?

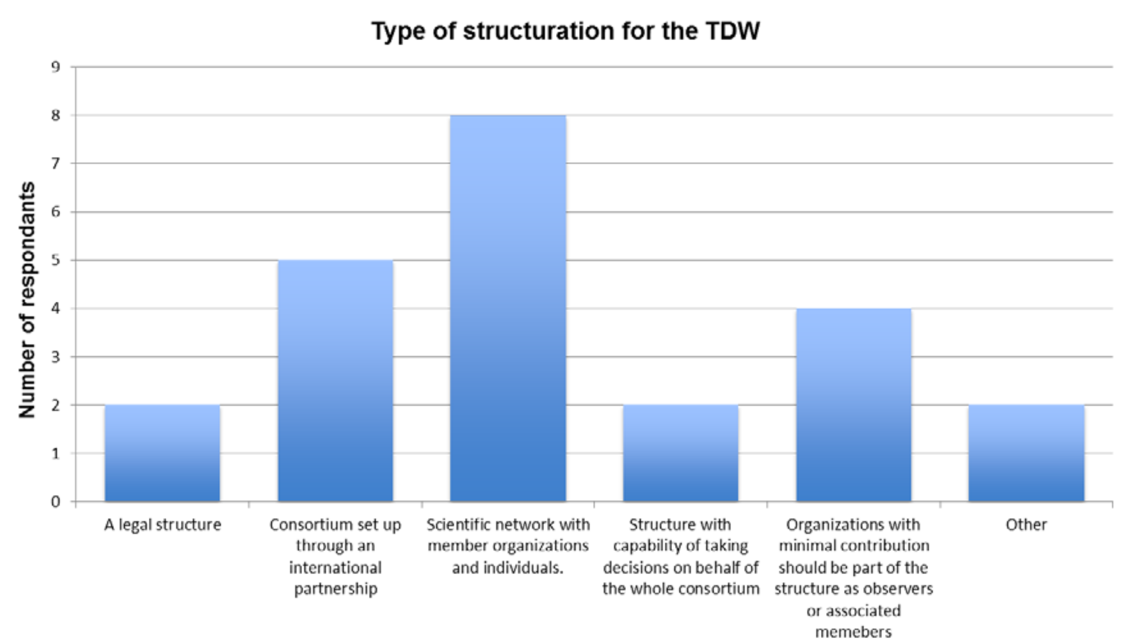

Figure 5. Question 9: What type of structure should a new scientific organization for a transatlantic dialog have?

The participants were very positive under the possibility to create this new network, since it could impact the international and national water policies by producing cutting-hedge publications and workshops, harmonizing legislations, exchanging of good practices and information at international level, developing collaborative actions with existing international centers, education, developing system-theory based approaches for improving communication of knowledge, showing independent viewpoints on water issues (data, technologies, etc.), counterbalancing the corporation agenda (scientific and politic), linking research-decision making, inventing new regulations for water use and management (not only center for science and qualification), innovative methodologies.

The next step of the research is to develop a scientific and organizational proposal for the Feasibility study in the context of the academic offer of the University of Arizona, which is the institution that was proposed in the DOW as the headquarters of the organization for a transatlantic dialog on water.

4. THE SCOPE OF ACADEMIC TRAINING AND DEGREES AT THE UNIVERSITY OF ARIZONA: IS THERE AN OPPORTUNITY FOR AN INSTITUTE FOR OPEN KNOWLEDGE AND CITIZEN SCIENCE?**

***By Simone Rambotti, School of Sociology. The University of Arizona*

4.1. Introduction

Following the recommendations of the stakeholders, the goal of this chapter is to explore the opportunity, even the necessity, to implement an academic offer on environmental and water issues that is compatible with the SWAN mission. SWAN attempts to create a research center that is able to enhance the collaboration between European Union and United States, emphasizing relationships between researchers, industry, policy-makers, and general public. SWAN values interdisciplinary communication between fields, countries, and ideas. Consistent with this mission, the establishment of a new academic offer should be (a) positioned at the intersection of multiple disciplines, (b) strongly focused on applied training, and (c) oriented towards community and stakeholders. Given these three points, it would be particular strategic to establish an offer that draws attention to the ideas and practices of open knowledge, and more specifically citizen science. Finally, SWAN also values novelty, thus it should propose an academic offer that is different from already existing opportunities. In order to assess the feasibility of this project, this report will review and analyze the current academic offer at the University of Arizona. Before moving to the empirical section of the report, a brief analysis of the concept of citizen science, its opportunities, and its issues follows.

4.2. Citizen science: growing and timely

In June 2014 the Oxford English Dictionary revised the entry for citizen, adding the expression citizen science, defined as “scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions” (1). The apparent democratization potential intrinsic to new technologies drove a renewed interest in scientific openness, and similar definitions arose: crowd science, crowd-sourced science, civic science, networked science, and Science 2.0. It is possible to have an intuitive grasp of such interest looking at patterns found using two services offered by Google. The first one, Google Ngram Viewer, shows the frequency of words or short phrases in printed sources during the time period 1800-2008. It is available in eight languages. The chart for English is shown in Figure 6.

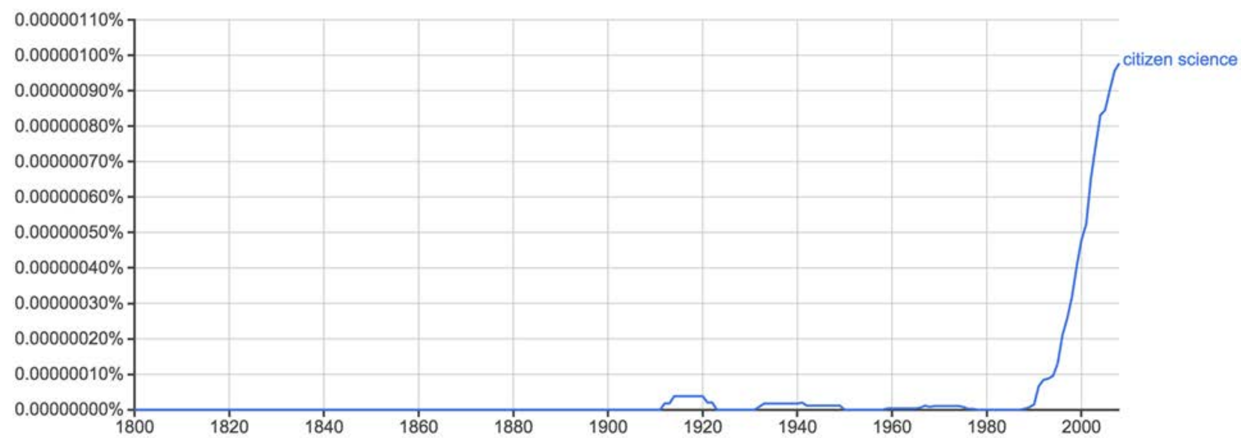

Figure 6. Citizen science: frequency in printed sources, 1800-2008

The horizontal axis shows time; the vertical axis shows the percentage of "citizen science" out of all the bigrams (contiguous sequences of 2 words) that can be found in the books sampled by Google (5 million books), written in English and published in the United States from 1800 to 2008. The data show a steady increase in the presence of "citizen science" in printed sources from the 1990s. Figure 7 shows the same data restricted to the time period 1990-2008, and confirms the pattern.

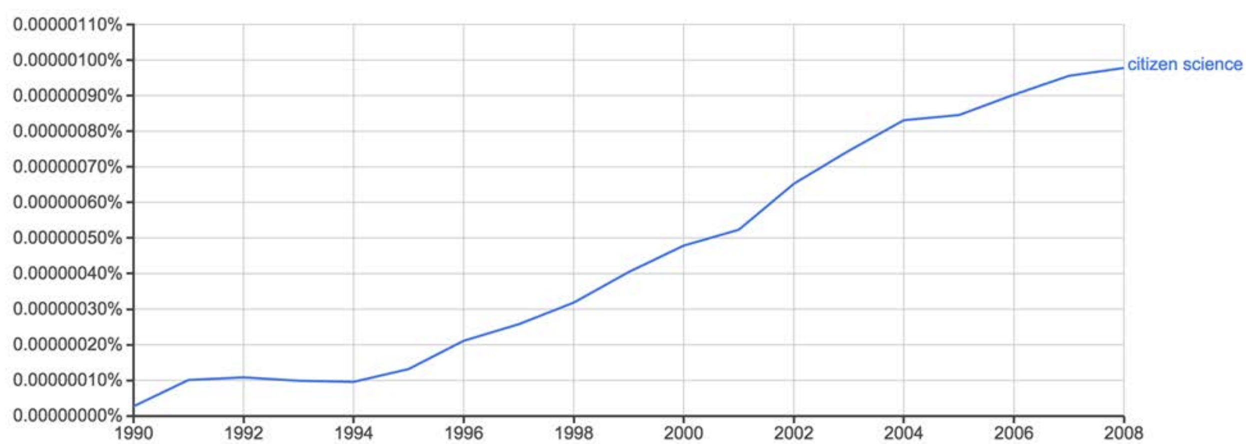

Figure 7. Citizen science: frequency in printed sources, 1990-

The second service, Google Trends, shows the frequency of search-terms over time, across different regions, and in different languages. The data start from 2004. Here, we limit the analysis to English, and we focus on change over time (Figure 8).

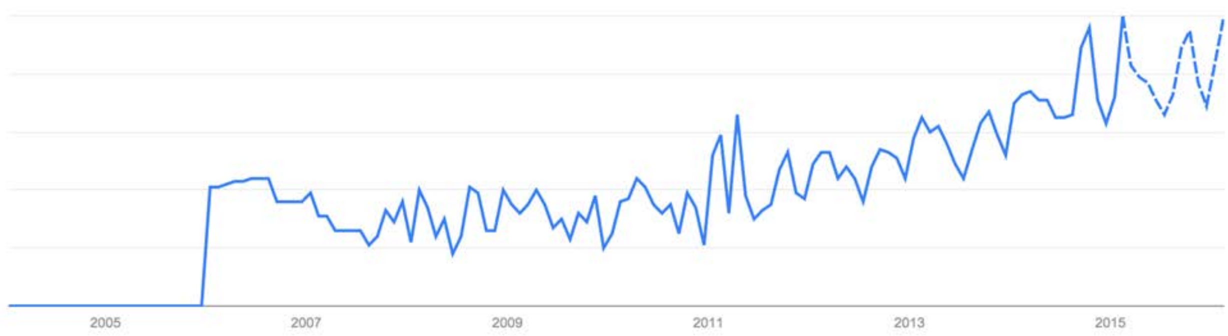

Figure 8. Citizen science: search-term frequency 2004-2016

The horizontal axis represents time; the vertical axis represents how often the term is searched: the peak, just reached in February 2015 (partial data) is equated to 100. The first value above 0 appears in January 2006, and it is equal to 41. The dashed portion of the line represents a forecast calculated by Google and based on previous search: its limit is February 2016, whose predicted value is 99. Analyzed together, these patterns suggest that attention and interest towards citizen science are (a) increasing, and (b) timely, suggesting that it may be appropriate for the SWAN to invest in this direction.

4.3. New term, old practice, new challenges

Although the expression citizen science is new, and trends are growing, the practice might very well be old. In fact, scientific research, before being institutionalized and embedded in public and private universities and research centers, employing professional researchers that produce and circulate their work globally (big science), was often voluntary and self-financed, operated by informal networks of nonprofessional science enthusiasts who communicated privately within their small circle (little science): indeed, it is has been argued that this new public wave of scientific participation might mean a return to little science (2, 3). While the extent of this return might be questionable, because as mentioned above, the participation of general public to scientific endeavor often occurs under the direction of professional scientists affiliated to institutions like universities and private or public research centers, the participation itself of citizens represents a drastic change, which carries opportunities, issues, and implications worth considering. The tech revolution, started in the 1990s with the diffusion of the Internet and culminated in the affirmation of social media and the Web 2.0, enhances the first opportunity: the immediacy of scientific communication, and its relative discussion (2). It has been suggested that this might raise questions such as contested knowledge, fugitive evidence, reliability, and ultimately blurry the distinction between professional scientists and informed public (2). It might also imply a shift towards a more provisional, epistolary form of journal publishing, defines as Scientific Publications 3.0 (2). The diffuse activity of observation might raise also ethical issues of privacy and surveillance (4). It is another type of immediacy, however, that might represents the most appealing opportunity of citizen science for the research institutions: the enormous potential of data collection. For instance, the crowd-sourced astronomy project Galaxy Zoo, part of the larger project Zooniverse, whose headquarters are at Oxford University and the Adler Planetarium, greatly benefited from the participation of general public: “in its first six months Galaxy Zoo provided the same number of classifications as would a graduate student working round the clock for 3.5 years” (5). With a productivity ratio of 7 to 1, it is not surprising that research institutions look at citizen science with vivid interest. However, as much as the integration of these two frameworks (big science and little science) is certainly promising, especially with regard to the enhanced capability of data collection, caution must be used in assessing the validity of the scientific process. A key element indubitably lies in the evaluation of findings obtained with the participation of general public. Such evaluations seem to be encouraging: in fact, most of studies suggest that, if proper training is administered, the data collected by participating volunteers are comparable to those collected by professional scientists (6–10). Furthermore, evidence suggests that quantitative measurement produced by citizen scientists is more reliable than their qualitative assessment (6, 11). Hence, in order to benefit from the collaboration and employment of general public, research institutions must provide properly designed protocols, rigorous training materials, and close professional assistance (6, 12, 13). This emphasis on training matches the interest of SWAN with regard to the creation of an applied curriculum that is in line with its interdisciplinary and community-oriented mission. Furthermore, it is worth noting that this training, which can result in a certification released by the SWAN, may be available not only to nonprofessional volunteers, but also to scholars and researchers (e.g., undergraduate and graduate students, junior researchers, researchers who are new to interdisciplinary work for which they are not fully equipped, and so forth) that need to develop specific applied skills that, for a variety of reasons, they lack. Let us hypothesize a scenario: an interdisciplinary project requires the integration of social and natural sciences; professional researchers in one field lack expertise in the other field; the SWAN offers an applied curriculum that lies in the middle ground of the two fields, and prepares researchers on both sides to establish a rewarding collaboration, and to work effectively towards a successful research. By this point, it is clear that the attempt to establish an interdisciplinary, applied curriculum focused on training is valuable. The remaining part of the report will show whether the University of Arizona already provides a similar offer.

4.4. Review of courses offered at the University of Arizona

In reviewing the courses offered at the University of Arizona, one question immediately arises: how many course are exactly offered? The answer is surprisingly unclear, but the number is undoubtedly extremely high. In fact, the Office of Admissions of the University states: “The University of Arizona offers a wide variety of academic programs, many of which are among the nation’s best. Students can choose from more than 300 undergraduate and graduate degrees through 20 colleges and 11 schools on three campuses” (14). The source of our data is the description of the UA courses for credits, which can be found online at the 2014-15 General Catalog webpage. The catalog represents “the University’s primary, comprehensive single source of departmental, college and university-wide information related to academic programs” (15). The course catalog lists all the active curricula, regardless of the fact that they are currently offered or not: i.e., one course could be active but not offered because no instructor has requested to teach it, or because no student enrolled in the course. The course catalog is organized by alphabetic order: one must click a letter, and a list of majors appears; once one selects a major, all the course active in that major are listed. To give an idea of the breadth of the offer, one can consider that only for the letter “a” there are 2324 courses available, and only for the major in Anthropology there are 411 courses. There is some redundancy to take into account: for instance, all the majors that offer doctoral degrees provide a course #920 (e.g., ANTH 920) that allows PhD candidates to enroll for dissertation credits. Another source of redundancy is that many majors propose 400-level and 500-level courses that are essentially the same, and are open to both undergraduate (who can enroll at 400-level) and graduate students (500-level), with the latter being expected to fulfill additional requirements, e.g., a final research proposal. Even considering this redundancy, the number of courses offered is striking.

In order to review this offer, we proceeded with a systematic reading of the course descriptions. Inevitably, some majors (e.g., Environmental Science) are more likely than others (i.e., Japanese Studies) to list curricula of interests for the SWAN project. Nevertheless, no major was discarded a priori. Particular attention was dedicated to the presence of buzzwords such as water, environ—, hydr—, and so forth. Consistent with the points raised above, and the mission of the SWAN project, the courses were coded considering the following four variables:

1. Presence [1] or absence [0] of emphasis on water (W);
2. Presence [1] or absence [0] of emphasis on practical, hands-on, applied training (T);
3. Presence [1] or absence [0] of emphasis on community, stakeholders, nonprofessional scientists (C);
4. Whether the disciplines could be categorized as humanities (H), social and behavioral sciences (SBS), or natural sciences (NS).

The assumptions of the review is that (a) the presence of the first three elements is best, given that the substantive interest of the SWAN project is water, that the SWAN promotes training in order to produce quality research, and that the SWAN values participation of the local community, and (b) that an interdisciplinary approach is desired, given that the SWAN adopts a multi-faceted philosophy that combines contributions from physical, natural, and social sciences.

4.5. Findings

Despite the number of courses listed in the catalog is, as said, extremely high, the analysis yields a surprisingly low number of relevant curricula: 82. However, the surprise should be perhaps reconsidered. In fact, taking into account the specificity of the variables of interest, it is reasonable that only a small portion of cases meets the criteria. Table 1 shows the frequency distribution of the courses with regard to the type of discipline:

Table 1. Discipline type

	N	%
Natural Sciences	63	76.83
Humanities	4	4.88
Social Behavioral Sciences	15	18.29
Total	82	100

Not unexpectedly, given the focus on water issues, natural sciences offer the vast majority of the courses of interest. Table 2 shows how the courses are distributed on the first three variables that guided the coding: presence [1] or absence [0] of emphasis on water, training, and community. The percent column is calculated relatively to n=82; however, the categories are not mutually exclusive, thus the sum of the percent column is larger than 100.

Table 2. Emphasis on water, training, and community

	N	**%**
Water	47	57.32
Training	41	50.00
Community	46	56.10
Water + Training	17	20.73
Water + Community	13	15.85
Training + Community	20	24.39
Water + Training + Community	1	1.22

No less than half of the courses present emphasis on at least one element; approximately one fourth to one sixth of the courses emphasize two elements; very interestingly, only one course meets all the three criteria. Given the assumptions of the analysis, the results are comforting: indeed, table 1 shows that natural sciences are prevalent, so interdisciplinary can be increased by giving more representation to social sciences or humanities; table 2, instead, shows that the University of Arizona offers virtually no curriculum that lies at the intersection of the interests and mission of the SWAN project. In order to provide a relational analysis of the information included in tables 1 and 2, we operated a disjunctive coding of the variable discipline, and treated the resulting course-by-variable (82x6) matrix as a 2-mode network (*16*). The result is shown in figure 9.

The courses are presented in red, while the variables are presented in blue. The sharp contrast between the centrality of natural sciences and the marginality of humanities and social and behavioral sciences is immediately visible. It is also possible to identify some clusters of courses, which are conveniently highlighted in Figure 10.

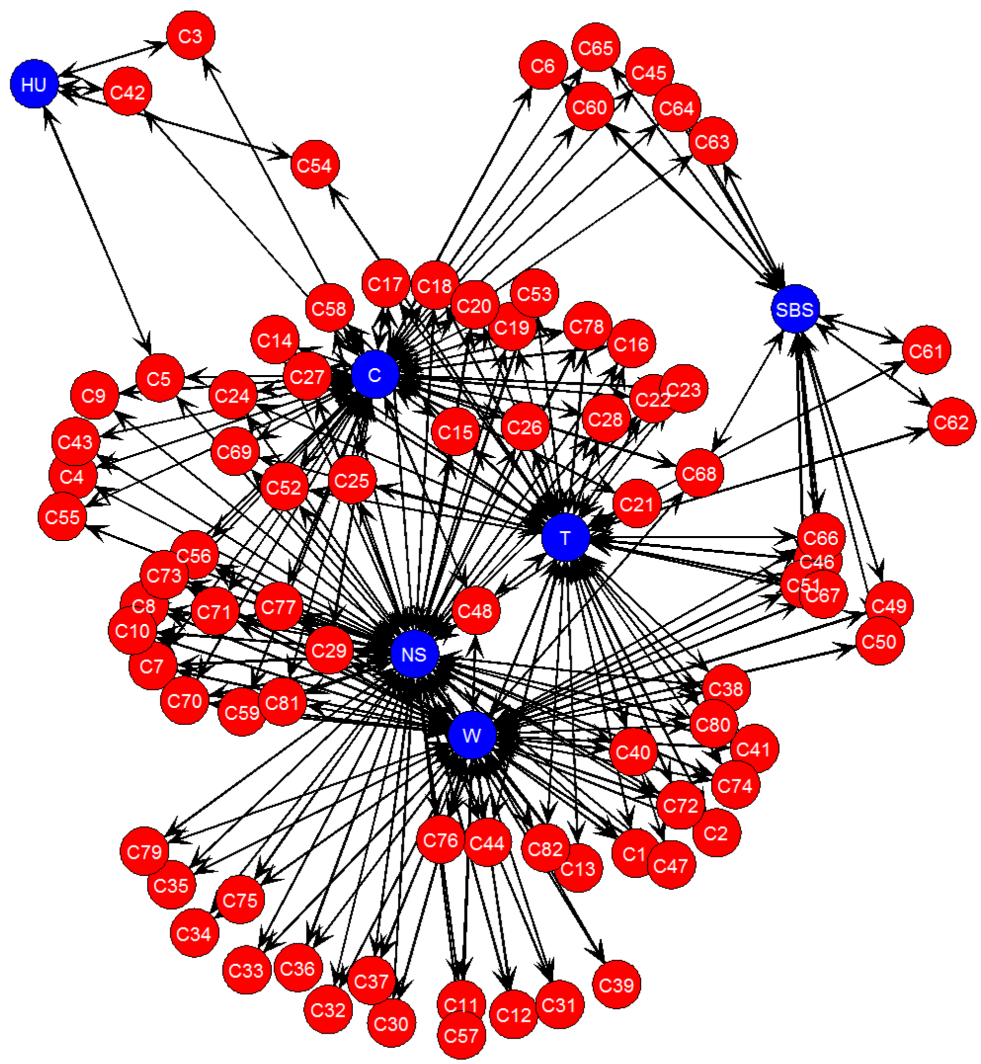

Figure 9. Course-by-variable 2-mode network

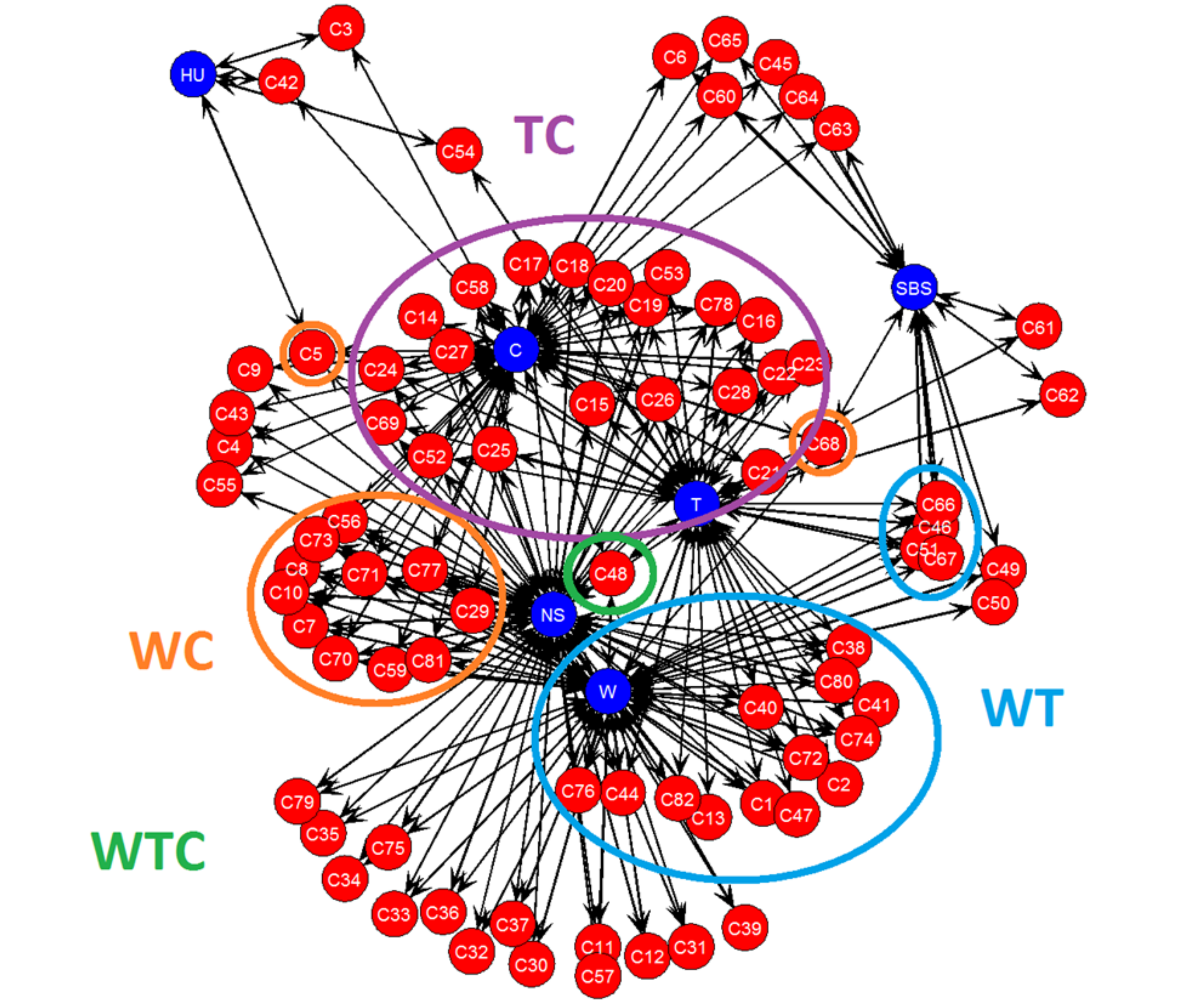

Figure 10. Course-by-variable 2-mode network: clusters

We provide one example of course per cluster, starting from the group WT (water and training), in light blue. Out of 17 courses, 13 are offered by natural sciences; the remaining 4 are offered by social and behavioral sciences. An example of this cluster is the course "HWRS 249A – Principles of Hydrology", part of the Hydrology and Water Resource major. Its description is the following:

> *Introduction to the hydrologic cycle and review of main processes, such as precipitation, evaporation and transpiration, runoff, infiltration and ground water* ***[emphasis on water]****.*

> *Some concepts and tools for water resources management are discussed. Laboratory techniques* ***[emphasis on training]*** *complement lecture topics.*

The second cluster (WC), in orange, is composed by 13 courses that stress water and community, 11 of which offered by natural sciences. An instance of this group is the course "ENVS 195C – Water Resources in the Tucson Basin: Natural Resources", part of the Environmental Science major, which is described as follows:

> *In the Western U.S.* ***[emphasis on community]*** *it is said, "Whiskey is for drinking and water* ***[emphasis on water]*** *is for fighting." History has proved this to be all too true. Here's a chance to see what all the fighting is about, while developing library and presentation skills. The semester's results will be posted on class web page. Join us!*

The third cluster (TC), in purple, focuses on training and community, and is made up by 20 courses, all offered by natural sciences; 15 are offered by the Biochemistry major, and are part of a series of curricula designed for teachers of secondary school. One example is "BIOC 471 – Ecological Principles for Teachers":

> *Principles of ecology with a focus on applications* ***[emphasis on training]*** *and current research appropriate for teachers of secondary school* ***[emphasis on community]*** *biology. This course is designed for prospective and in-service science teachers* ***[emphasis on community]*** *who wish to develop a deeper understanding of ecology. Basic themes include how organisms interact with other organisms and their environment, factors that influence the size and stability of populations, how geography affects biodiversity and the application of these principles to current ecological issues including global warming and invasive species. This course is designed to be on-line. In-service science teachers* ***[emphasis on community]*** *may take the course for graduate credit by completing additional graduate-level course work.*

This curriculum is particularly interesting because it is exclusively designed to be fully on-line. This option is actually quite frequently available: many courses usually offered in a traditional classroom environment now are available in a hybrid in-person/on-line or fully on-line format. An alternative example of the TC cluster is represented by the course "ENVS 497F – Community and School Garden Workshop" (Environmental Science major), which reveals a deep involvement with the community (signaled also by the sponsorship of a stakeholder) and a strong applied nature:

> *This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools **[emphasis on community]** helping students and teachers **[emphasis on community]** to undertake the design, construction, planting, harvesting and preparation of foods **[emphasis on training]** from a local school garden **[emphasis on community]**. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank **[emphasis on community]**. In addition to attending that workshop, students are also expected to attend at least one fieldtrip **[emphasis on training]** among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school **[emphasis on community]** and its teachers and students supporting the development and maintenance of school garden and attendant curriculum **[emphasis on training]**.*

Finally, highlighted in green, there is the only course that emphasizes water, training, and community (WTC). Offered by the Ecology & Evolutionary Biology major, the course “ECOL 454 – Water Harvesting” is described as follows:

> *Course focuses on water **[emphasis on water]** harvesting principles and techniques. Students will learn how to apply **[emphasis on training]** concepts at their own residences **[emphasis on community]** and participate in applying **[emphasis on training]** them on the UA campus **[emphasis on community]**.*

While the nature and goal of the course might be quite different from what the SWAN would be proposing, the focus on the three elements of interest is clear: water is the substantive topic; directly applied training is the leitmotif; local community is the context.

4.6. Conclusions

The goal of this report was to assess the opportunity to create an academic curriculum consistent with the SWAN interests and mission, and able to meet the following criteria:

- Interdisciplinary approach;
- Scientific openness;
- Research on water;
- Focus on applied training;
- Community/stake-holder orientation;
- Novelty.

To accomplish this goal, we thoroughly reviewed the undergraduate and graduate courses already available at the University of Arizona. The results make a strong case in favor of the creation of the new academic offer. In fact, interdisciplinary is underachieved: among the cases that we examined, more than three quarters are offered by natural sciences. Humanities and social and behavioral sciences are very peripheral: simply making their presence more central will result in increasing interdisciplinarity. As for the scientific openness, we saw how the interest towards public participation to scientific activity is growing and timely. This endeavor can take advantage of the technologies now available not only in the Web 2.0 (e.g., social media), but more specifically in the education industry (e.g., D2L, an eLearning platform already available at the University of Arizona). Finally, while the focus on water, training, and community is already moderately represented at the University of Arizona (50 courses lie at the intersection of two of these three characteristics), the focus on all these three elements is virtually unrepresented. Filling this gap would guarantee a status of originality to the curriculum designed by the SWAN. All things considered, implementing an academic offer on environmental and water issues compatible with the SWAN mission is not only possible, but also desirable.

4.7. References

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5. ANNEX 1: SURVEY FOR THE INTERNATIONAL STAKEHOLDERS ADVISORY COMMITEE

Objectives

We are currently working on a Strategic Report to define the vision, scope and structure of the Transatlantic Dialog Network, based on our experience in collaborative research within the framework of the SWAN project. Our report will include a short list of potential new partners, define criteria to enhance the process of scientific and institutional integration, and propose a strategy to expand the UMI iGLOBES (CNRS / University of Arizona) collaboration into a multi-partner scientific and training European platform in the USA that develops new ideas, methods and research projects at a worldwide scale. From an organizational standpoint the Network hopes to develop:

- A mechanism for students and staff mobility between partners; particularly with arrangements for student exchange and study.
- A multi-institutional collaborative training program on water management.
- A Secretariat, based at the UMI iGLOBES at the University of Arizona, to provide the necessary support for the work of NTWD.
- A vehicle for organization, management and dissemination of cutting edge collaborative research.

Accordingly, this survey is a preliminary step towards developing our Strategic Report, and aims to solicit expert input regarding the development of the NTDW. We thank you for your time and ideas.

Name of Respondent: ______________________________

Name of Organization: ______________________________

I. ABOUT YOUR ORGANIZATION

1. **What is the primary aim of your organization (and specific unit)?**

____

____

____

2. **Are your organization's aims developed with partner organizations? Yes ☐ No ☐**
If yes, please tick the appropriate box below

☐ Universities and research centers
☐ Philanthropic institution and water foundations
☐ Non-profit organizations
☐ Governmental institutions
☐ Private consulting
☐ Private companies
☐ Other (please, specify): ______________________________

____

____

3. **How do you engage your partners and stakeholders in carrying out your mission? Please check the appropriate answers.**

☐ Through participation in your organization's governing boards
☐ Through involvement in the definition and guidance of research work
☐ Through traditional opinion gathering techniques (surveys, focus groups, etc.)
☐ Through participation in public events (workshops, meetings, etc
☐ By disseminating research results (website, etc.)
☐ By publishing reports and statements (internet, books, magazines, etc.)
☐ Through the use of social network media
☐ Other (please, specify): ______________________________

____

____

II. ABOUT THE NETWORK FOR A TRANSATLANTIC WATER DIALOGUE

4. Which water-related research topics require a multidisciplinary approach that could be the focus for a Transatlantic Water Dialogue?

- ☐ Water quality
- ☐ Water ecosystems (ecosystem services, ecological health, etc.)
- ☐ Risk management (climate change, droughts, floods)
- ☐ Water engineering
- ☐ Integrated assessment tools for water socio-ecosystems
- ☐ Water data and information generation and management technologies
- ☐ Economic instruments for water management (prices, connection fees, etc.)
- ☐ Water governance (laws, institutions, administration)
- ☐ Conflict resolution
- ☐ Democratization and transparency of decision making processes
- ☐ Other (please, specify): ____

____

____

5. Where does your organization get the information from regarding cutting edge work?

____

____

____

6. Given the wide array of international water related research-centers that exist today, how could a new scientific organization for a Transatlantic Dialog between Europe and the USA help improve water-related research?

- ☐ By creating a permanent research center
- ☐ By creating an international scientific network involved in policy debates on water governance
- ☐ By creating a virtual platform for easy access to international research centers
- ☐ By developing an international exchange program of researchers and students
- ☐ By developing a database on water research project outcomes
- ☐ By organizing regular interdisciplinary workshops on water issues
- ☐ By creating an information hub that systematically organizes information and links to the work of already existing centers and initiatives.
- ☐ Other (please, specify): ____

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7. How do you think that a new research organization might impact international and national water policies?

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8. How could such a scientific collaboration benefit your organization (and specific unit)?

- ☐ By providing a hub of expertise and a meeting point for researchers
- ☐ By exploring new areas of knowledge and expertise
- ☐ By providing academic training for members of your organization
- ☐ By participating in workshops and meetings with stakeholders and decision makers
- ☐ By promoting partnerships for international research projects
- ☐ Other (please, specify): ____

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9. What type of structure should a new scientific organization for a transatlantic dialog have?

- ☐ A legal structure
- ☐ A consortium set up through an international partnership
- ☐ A scientific network with member organizations and individuals.
- ☐ A structure with capability of taking decisions on behalf of the whole consortium
- ☐ Organizations with minimal contribution should be part of the structure as observers or associated members
- ☐ Other (please, specify): ____

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10. This organization should be capable of:

- ☐ Receiving contributions in general (grants, fees, cash contribution, in-kind contributions) and managing its own budget?
- ☐ Purchasing and owning goods and services (Building new place or equipment for example)?
- ☐ Submit proposal to open calls and entering into agreements with third parties?
- ☐ Employing and paying staff?
- ☐ Other (please, specify): ____

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11. Please share any relevant suggestions or thoughts.

Thank You.

The SWAN Coordination Team.