

Creating a Collaboration Framework to Evaluate International University-led Water Research Partnerships

*Katy E. Mazer¹, Anna Erwin², Ruxandra Popovici², Edwin Bocardo-Delgado³, Laura C. Bowling¹, Zhao Ma², Linda S. Prokopy², and Carlos Zeballos-Velarde⁴

¹Department of Agronomy, Purdue University, West Lafayette, IN, USA; ²Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, USA; ³Department of Biology, Universidad Nacional de San Agustín de Arequipa, Arequipa, Peru; ⁴Department of Architecture, Universidad Nacional de San Agustín de Arequipa, Arequipa, Peru; *Corresponding Author

Abstract: In a globalized world, universities are forming partnerships to solve today's water-related challenges, such as increasing water scarcity and diminished water quality. Over the past 20 years, international university-led water research partnerships have been growing in number, including between the U.S. and countries in the Global South. While there are several examples of guidelines and best practices for executing collaborations, none focus on this type of partnership. Additionally, many international collaborations are formed between universities that have little previous experience in developing these types of partnerships. Often, critiques of partnerships happen after initiation and point to structural barriers and best practices for future collaborations, but few offer practical guidance on overcoming obstacles early on, amid an imperfect partnership. In this paper, we created a flexible collaboration framework which can be used as an evaluative tool. To model this, we conducted an internal evaluation of the Sustainable Water Management team of the Arequipa Nexus Institute, a collaboration designed to build research capacity at the Universidad Nacional de San Agustín to address local issues related to agriculture, natural resource management, and environmental change. Results highlighted project strengths and weaknesses and offered strategies to address challenges that many collaborations face. This strategy identification can serve as a guideline for improving the implementation of new or existing international university-led water research partnerships and help partners as they confront challenges at every stage of the partnership. The evaluation shows the effectiveness of using a collaboration framework as an assessment tool for international university-led water research partnerships.

Keywords: *collaboration principles, international university partnerships, water management, assessment, improvement strategies*

Environmental and socioeconomic issues around the globe are putting pressure on water resources. These stressors include climate change, pollution, and population growth (Bergstrom and Randall 2016). While many of these issues are global, they disproportionately affect the Global South for a multitude of reasons (Vörösmarty et al. 2000; Alcamo and Henrichs 2002). Threats to water security can require large investments and infrastructure-building for which many countries in the Global South do not have the resources (Vörösmarty et al. 2010).

Historically, countries in the Global North have intervened with foreign aid to alleviate some of these disparities. However, the benefits of this aid have been questioned, and researchers and practitioners have advocated for a more sustainable model (Bob 2017). In recent years, international research collaborations have been expanding rapidly (Kolesnikov et al. 2019). Such collaborations include formal partnerships, in which many universities in the U.S. have partnered with institutions abroad, including host country universities, government agencies, and medical

institutions (Kolesnikov et al. 2019). However, relationships between academic organizations are the most common type of educational collaboration (Ponds 2009; Kolesnikov et al. 2019). These partnerships, referred to here as international university-led research partnerships, are often mission-based and include the establishment of research centers in the host country (Kolesnikov et al. 2019). Many include other components, like education and entrepreneurship, but in this paper, we focus on the research aspect (Pfothenauer et al. 2016).

Though similar in principle, international university-led research partnerships vary from one another in their purpose and development method. The four most common formation mechanisms of these partnerships are 1) strategic planning by the visiting university, 2) a host country strategy aimed at capacity-building, 3) those developed over time from individual research partnerships, and 4) partnerships formed because of a specific need expressed by the host country (Kolesnikov et al. 2019). Though varied, main characteristics of a formal partnership over an informal collaboration include the presence of director(s), administrative support, and a multi-year commitment for research projects from both partners (Youtie et al. 2017). Pfothenauer et al. (2016) provided structural organizational methods and typologies for collaboration that can be applied across partnership types.

There have been criticisms of North/South research partnerships because scholars from the Global North often dominated the global agenda of collaborative research and have extracted data from research sites in the Global South. That model of research did not provide training for host country researchers or local resources for addressing research challenges (Wilmsen 2008; Kouritzin and Nakagawa 2018). Additionally, extractive research fails to adequately address local perspective and is dominated by external ideologies (Kouritzin and Nakagawa 2018). While there are still some power differences in university research partnerships between the Global North and Global South, some projects have placed value on research conducted by local people who understand cultural backgrounds, perceptions, and pertinent challenges (Mahuika 2008; Wilmsen

2008; Kouritzin and Nakagawa 2018). Locally-driven research can re-center the focus of research initiation, benefits, representation, legitimacy, and accountability on local interests (Bishop 2011). Consideration of ethics of international university-led research partnerships is an essential aspect of collaboration that can provide partners with more equal footing and define expectations of both groups (Morris 2015).

Part of the ethical considerations in developing these partnerships is the establishment of collaborative principles, which serve to enhance equity and collaborative success in a partnership. Several frameworks for collaboration principles have been published. Bryson et al. (2006, 44) created a set of 21 principles for cross-sector collaboration, which are those that involve “government, business, nonprofits and philanthropies, communities, and/or the public as a whole,” that highlight indicators of success. Similar principles and guidelines for collaboration have been developed for some other circumstances, including collaborative governance, transdisciplinary research in sustainability science, and collaborative ventures (Ariño and de la Torre 1998; Emerson et al. 2012; Lang et al. 2012). This literature, however, does not completely capture the necessary nuances of international university-led water research partnerships. The international component increases complexity, potentially involving different cultures, language challenges, and geographic distance between partners. Also, these partnerships are specifically between two universities, which include different participants and thus different considerations than cross-sector collaborations. Water-related research does, however, often involve considering policies or stakeholders involved in cross-sector collaborations, though the research collaboration is more limited both in its objectives and its interactions with outside groups. To increase likelihood of success of formal international research partnerships, a set of research principles is needed to guide collaboration formation and execution, especially when many partnerships do not have a strategic plan going into the partnership.

Many universities in the U.S. have formed partnerships with universities in the Global South to address water-related challenges, including water resources in Ethiopia (EIWR 2020),

research on ecosystems and environmental change in China (Gentry 2013), and agricultural water in Chile (UC Davis Chile 2020). However, few have provided details on the development of their partnerships, best practices, or challenges faced. Information on partnership success is limited, where a few instances report students educated and joint papers published, but these metrics lack consideration for broader impacts or project sustainability (Gentry 2013; Xiamen University and University of Delaware 2013; EIWR 2020). For example, Pfothenhauer et al. (2013) emphasized the importance of host country participants' ability to publish on their own or as first authors and increase their collaboration networks. However, few partnership websites discuss details of how capacity was increased or provide evidence that the university trained gained publication independence. The U.S.-Pakistan Centers for Advanced Studies in Water (USPCAS-W 2020) provided one of the few available self-critiques, and their lessons learned included the need to create and assess impacts of applicable solution-based research, the need for goal setting, and the importance of adaptive management.

While these takeaways are useful for other universities forming similar partnerships, a formal structure does not exist to guide which components to include, nor for how to evaluate and make adjustments when needed. Additionally, lessons learned provide insight on what should have been done, making them more applicable to the *next* collaboration rather than focusing on how problems can be addressed in the moment, or when it is most relevant (Bammer 2008; Spooner et al. 2016; Woldegiyorgis et al. 2018).

In this paper, we combine existing collaborative frameworks to identify and adapt a set of collaboration principles relevant to international university-led water research partnerships. To exemplify the use of these principles, we conduct an internal evaluation of a project focused on sustainable water management within an international university-led water research partnership between Purdue University in the U.S. and the Universidad de San Agustín de Arequipa (UNSA) in Peru using these collaboration principles. Results provide a rich description of the challenges and opportunities associated with

an international university-led water research partnership as an example using a collaboration framework as an evaluative tool. This process provides a model for scholars either interested in conducting a similar assessment or combining collaboration frameworks to study their unique collaborations. We conclude by suggesting strategies for overcoming challenges encountered in these types of partnerships to showcase opportunities for using a collaborative framework to improve ongoing partnerships.

Background and Methods

The Nexus Institute and the Sustainable Water Management Team

Purdue University's Discovery Park is a multidisciplinary research park formed to support the creation of solutions to today's problems. UNSA is a public university in Peru that has traditionally focused on teaching but has a four-part mission that also includes research and university in extension. In 2017, the two created a partnership to build research capacity at UNSA and address environmental sustainability challenges in the region. The Department of Arequipa, where UNSA is located, is a hyper-arid region with elevations ranging from 0 to 6400 meters, with water allocation and mining-related water quality concerns that dominate the political landscape. The two universities together formed the Arequipa Nexus Institute for Food, Water, Energy, and the Environment (the Nexus Institute), a collaboration that includes 21 research project teams and over 100 researchers from both Purdue and UNSA. The mission of the Nexus Institute is "to build capacity and collaborations needed to address key environmental, agronomic, and social challenges to support adaptive and sustainable growth in the Department of Arequipa (ANI 2020)." Of these 21 projects, there are at least nine teams conducting water-related research, including our project, the Sustainable Water Management (SWM) team. Topics addressed by water-related projects span water quality, improving data on water availability and water sources, and equitable water availability. The Nexus Institute, as well as individual project teams, have equivalent structures at both universities, with co-directors and co-principal

investigators (PIs) working together in leadership roles (Figure 1).

The SWM team is one of the largest groups within the Nexus Institute and is composed of 11 professors, five postdoctoral researchers, and a project coordinator, with a total of nine women and eight men. Several undergraduate students have also been involved from both UNSA and Purdue. Four project members are from UNSA and 13 are from Purdue University. Project member expertise spans agronomy, biology, agricultural and biological engineering, environmental engineering, landscape architecture, and natural resources social science. Because of the nature of the formation of the Nexus Institute, a formal evaluation framework was never created. The SWM team, in an effort to create an unbiased internal evaluation, utilized existing collaboration frameworks to create their own evaluation tool for project success.

Developing a Collaborative Framework for International University-led Water Research Partnerships

In order create a framework to examine the SWM project, we first conducted a literature review which mined scholarship on collaborative

frameworks, especially those relevant and applicable to international university-led water research partnerships. Because of the complexity and breadth of partnerships that involve water management, we studied frameworks spanning multilevel management and transboundary policies. Scholarship included cross-sector, collaborative governance, transdisciplinary research, and international collaborations (Winer and Ray 1994; Ariño and de la Torre 1998; Thomson and Perry 2006; Babiak and Thibault 2009; Emerson et al. 2012; de Jong et al. 2019).

After conducting the literature review, we created a framework that includes components from multiple cross-collaborative assessments. First, we chose Bryson’s et al. (2006) cross-sector collaborative framework because not only does water management research often involve cross-sector exchange, but the principles were easily adaptable and applied to many collaboration types. Second, we included principles from the transdisciplinary research in the sustainable science collaborative framework because it shared many aspects with our partnership, particularly in involving external actors, though it lacked an international perspective (Lang et al. 2012). Third, the broad guidelines provided by Archer and

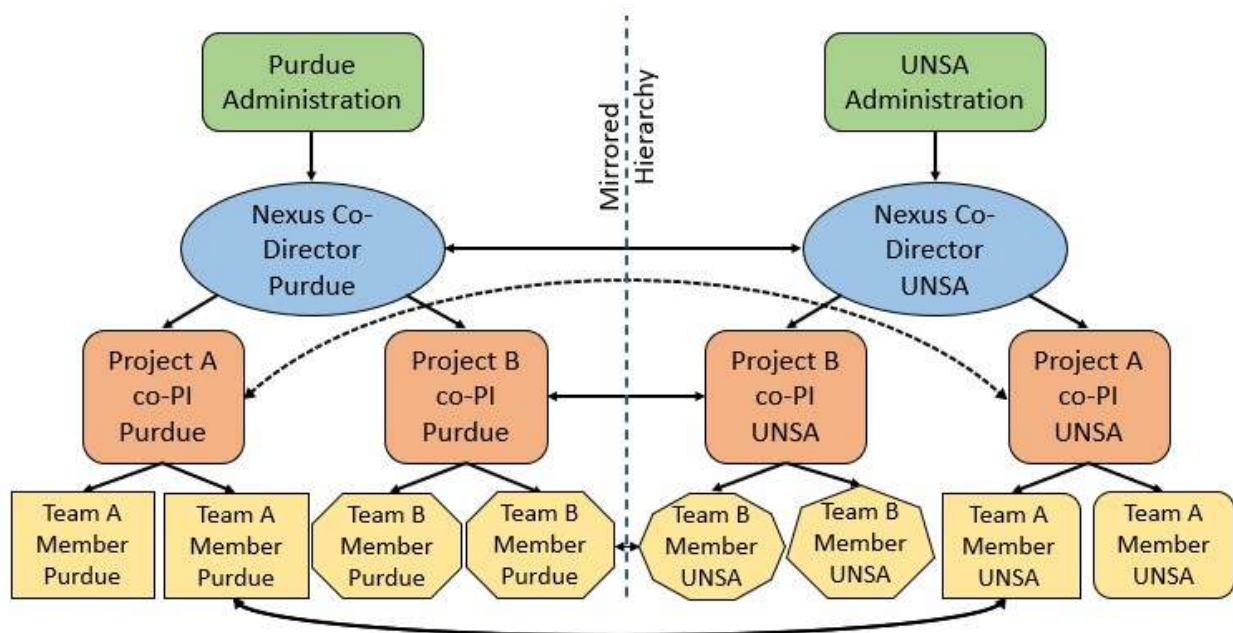


Figure 1. The Nexus Institute is structured with a parallel hierarchy on both sides of the collaboration, with shared leadership responsibilities for all levels of the partnership. Expertise among team members within groups was not always a perfect match. The SWM team was one of many projects within this structure.

Cameron (2009) were also useful when accounting for the flexibility needed when working with diverse partners. More detailed principles, showing collaboration competencies, were also useful for understanding relationships within the partnership and were applied for critical evaluation (Getha-Taylor 2008). Finally, we incorporated some principles from Ansell and Gash (2007) because they were useful in understanding the outward facing aspect of water research, which in our case included stakeholder engagement at multiple scales. Principles that were outside the scope of this partnership or that did not equate to actionable steps in a partnership were discarded.

The framework was next divided into categories, which reflect aspects of a project and considerations that are important for collaboration (Figure 2). The **initial structure** and **initial phases** are foundational to the collaboration development, and other phases of a partnership can be built upon them (Bryson et al. 2006; Lang et al. 2012). **Fostering growth** and **maintenance** are both dependent on previous stages of collaboration and coexist at equal importance (Archer and Cameron 2009; Lang et al. 2012). In water research, there is often **external involvement**, where some interaction with the public and governmental agencies is needed, but these interactions cannot be approached until there is a stable working relationship (and previous stages of the collaboration) between the two

partner institutions (Bryson et al. 2006). A sound relationship both improves the ability of the public to have a positive perspective and provides an adequate framework for outside organizations to participate (Lang et al. 2012).

Remaining principles were then placed into appropriate categories based on when in the collaboration process they were most applicable. Frequently occurring principles and those most applicable to the SWM team were selected as parts of the collaboration framework. While this paper is focused on a bilateral partnership, this model can be utilized for expanding the partnership, allowing the partnership to work with other entities, or duplicating the partnership at other universities.

This collaborative framework was used to conduct an internal evaluation of the Nexus Institute's SWM project. As the members of the SWM team were both authors and those that were sharing their experiences, we did not conduct formal interviews. However, because of the multidisciplinary and international nature of our team, our joint experiences created evidence to evaluate our progress. By applying our created framework as an evaluation, we recognize that we are the same entity creating and utilizing the assessment tool, and that because of this, inherent biases may exist in our evaluation. However, utilizing several existing frameworks and reconciling their many nuances makes this framework more robust and

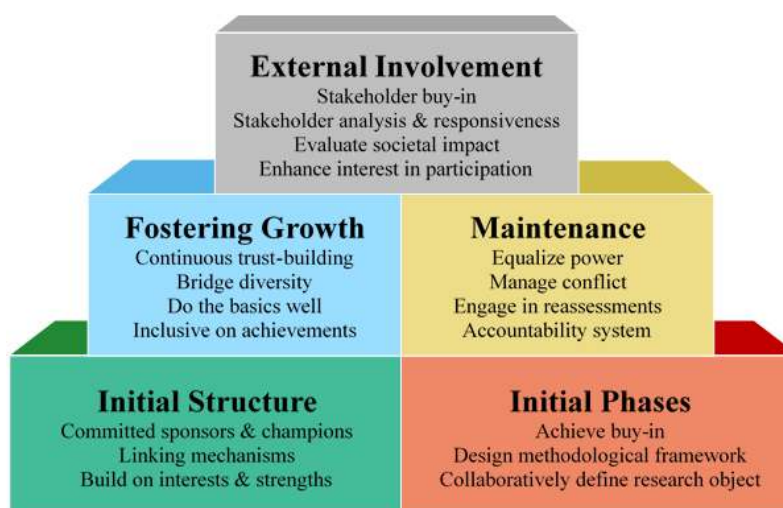


Figure 2. These five categories of collaboration - initial structure and phases, fostering growth, maintenance, and external involvement - are important aspects of international university-led research partnerships for water management that build on one another, and they can be used to better understand individual principles.

subject to self-reflexivity, where direct comparison with other frameworks would reveal gaps (Tracy 2010). Additionally, the internal evaluation assessed not only successes, but also weakness or challenges in this partnership. This suggests that this collaborative framework is functional and was created with sincerity, where the goal was to reveal areas of improvement rather than be boastful. We also recognize that as only one set of projects was assessed with this framework, there may be specific aspects to other projects that would not be addressed using these principles. To that end, the process we modeled in this paper can also be used to modify ours and other similar frameworks to include or exclude principles as necessary.

Results: Using the Collaborative Framework for an Internal Evaluation

In this section, we share the results of an internal evaluation of the SWM project of the Nexus Institute using these collaboration principles as an assessment tool. Factors affecting success came both from within the project team (internal) and from the entire Nexus Institute, the two universities, and from the two countries (external). We considered both internal and external influences and made suggestions to overcome encountered challenges, both from project experience and from the literature. The SWM team's experiences of the collaboration in relation to the principles, as well as strategies to address challenges that could be implemented during the project, are in Tables 1-5 and are discussed in the sections below.

Initial Structure

The initial structure of the SWM project was heavily influenced by the Nexus Institute (Table 1), which was largely based on existing conditions and ideals held by both universities, as well as the efforts of key individuals within the partnership. A key strength of the SWM team was that there were committed champions at many levels who were able to advocate for its creation and establishment. This has proved useful for the duration of the collaboration and will be useful as inevitable changes in the administration (particularly at UNSA) and in researchers occur. A large amount

of linking mechanisms existed at formation, including interests in addressing water resources issues and the desire for international recognition, which provided substantial motivations for each university to collaborate and provided a foundation for building a relationship (Bryson et al. 2006). The SWM partnership focused on building on self-interests and characteristic strengths, like cultivating local knowledge or insights about the Water Resources Law of 2009 (Popovici et al. 2020a), the guiding policy for water governance in Peru. This approach provided incentive for collaboration and a need for project involvement for both partners (Bryson et al. 2006). Research direction was tailored to the existing expertise of UNSA team members, which included investigating water availability for agriculture and the use of macroinvertebrates as water quality indicators (Bryson et al. 2006).

Initial Phases

The initial phases of collaboration allowed for more direct decision-making by the SWM team, though procedures were still heavily influenced by rules implemented on the level of the Nexus Institute (Table 2). The short project term (< 3 years) limited opportunities for the team members from both universities to collaboratively build a framework, which is important for setting expectations (Archer and Cameron 2009). However, the SWM team was one of few teams to include social scientists who gathered information on local perceptions and needs to inform project direction in water management decision-making. The social science data were invaluable in directing the research and producing locally relevant research products. The research object for the team, which is meant to provide guidance for putting a vision into action, was not initially defined collaboratively (Lang et al. 2012). Rather, it was outlined by Purdue researchers, with UNSA researchers adding to the team after project creation. This created confusion for both Purdue and UNSA project members because the initial research topic was established based on the Purdue team's limited knowledge of research needs and local circumstances affecting Arequipa. Being very aware of this limitation, building mutual understanding and bringing in the expertise and knowledge of UNSA colleagues

Table 1. Collaborative principles for initial structure.

Collaboration Principle	Nexus SWM Experience*	Strategies to Improve
Committed sponsors and effective champions (Bryson et al. 2006)	<ul style="list-style-type: none"> + UNSA and Purdue administrators, as well as many SWM project members, were committed to the partnership (Ex) + Committed postdocs and project coordinator, who were hired to work on Nexus projects only (In) – Frequent administration changes at multiple levels at UNSA (Ex) – Postdocs often hold a contracted (temporary) position (In) – PIs often split among various projects or responsibilities (In/Ex) – Hiring Purdue graduate students was not allowed (Ex) 	<ul style="list-style-type: none"> • Incorporate champions that can ensure stability during transitions as project develops (e.g., bring in a management specialist for implementation details and evaluation) (Ivery 2010) • Create space for sharing and negotiations among project teams (Morton 1983) • Formalize induction of new project members to follow specific norms (Morton 1983)
One or more linking mechanisms exist at formation (Bryson et al. 2006)	<ul style="list-style-type: none"> + Desire to solve problems + Desire to conduct cutting-edge research + Desire for international recognition (Ex) + Interest in water resources as an issue – Differences in annual calendars – Differences in language, culture, and location – Difference in views among administration of what aspect of writing papers is important (Ex) 	<ul style="list-style-type: none"> • Provide language classes or stricter language requirements for participation • Set up norms for how to deal with different calendars where the universities have different course schedules and vacation times
Build on individuals' and organizations' self-interest and each sector's characteristic strengths while minimizing, overcoming, and compensating for each sector's weaknesses (Bryson et al. 2006)	<ul style="list-style-type: none"> + UNSA – access to funding (Ex) + Purdue – R1 university seeking new research opportunities (Ex) + UNSA – knowledge of local needs and direction (In/Ex) + Purdue – publishing experience, ideas for techniques not yet used in Arequipa (In) + UNSA – proximity to study area (In/Ex) + UNSA – local connections (In) + Purdue – access to advanced equipment and software (In) + SWM team identified expertise of all members to utilize for research and project goals (In) – Lack of partner social scientists at UNSA (In/Ex) 	<ul style="list-style-type: none"> • Conduct a SWOT (strengths, weaknesses, opportunities, and threats) analysis • Ask each project member to outline their individual goals within the larger project (i.e., publish papers in peer-reviewed journals) • Ask each member to identify areas where they need resources or support from the PIs

*Factors considered for the Nexus SWM experience were both internal (In) and external (Ex) to the SWM team. The “+” refer to elements that contributed to a positive experience and the “–” refer to obstacles in the collaboration.

Table 2. Collaborative principles for initial phases.

Collaboration Principle	Nexus SWM Experience*	Strategies to Improve
Achieving “buy-in” (Ansell and Gash 2007)	<ul style="list-style-type: none"> + Project members interested in advancing research through partnership (In) + Many excited to work with international partner (In) + In-person meetings early on were critical (In) – Misunderstanding of project goals (In) – Frustration by many project members regarding the slow project pace (Ex) – Limitations for some faculty to participate (Ex) – Few incentives for UNSA faculty to participate, difficult time commitment (Ex) 	<ul style="list-style-type: none"> • Establish needs and identify rewards and motivations • Create clear expectations and process for dealing with success (Leider 1999) • Increase awareness and understanding of collaboration (Thomson et al. 1999) • Emphasize common values to find shared motivation (Morton 1983)
Building the framework (Archer and Cameron 2009)	<ul style="list-style-type: none"> + Included assessment of local perceptions (In) + Multidisciplinary team enhanced learning (In) + Ongoing in-person meetings (In) + Protocol for inviting co-authors and identifying research sub-teams (In) + Joint discussion on large project decisions (In) – Unrealistic time expectations (Ex) – Many overlapping projects and repeated content but disjointed communication (Ex) – No equivalent to postdocs at UNSA (Ex) 	<ul style="list-style-type: none"> • “It seems important to more carefully craft the project goals and to employ an adequate research methodology for evidence-based transfer and outreach.” (Wiek et al. 2012, 19) • Create line of sight for direction and purpose (Getha-Taylor 2008)
Collaboratively define research object, objectives and specific research questions, and success criteria (Lang et al. 2012)	<ul style="list-style-type: none"> + Re-evaluation of project goals and project member roles (In) + Initially vague research objectives (In) + Research pursued based on interest of project members (In) – Proposals were written only by Purdue (In/Ex) – Lack of consensus in understanding the term “environmental management” across languages – Isolation of proposal development (Ex) – UNSA project members were assigned (Ex) – Little vetting for project funding (Ex) – Lack of transparency for building (assigning) project teams (Ex) 	<ul style="list-style-type: none"> • Discuss project vision and mission and how they aligned with individual goals • Use a simple symbol/phrase as a reminder of the core (Heath and Heath 2007) • Create SMART (specific, measurable, achievable, relevant, time bound) goals for short and longer term within project timeframe

*Factors considered for the Nexus SWM experience were both internal (In) and external (Ex) to the SWM team. The “+” refer to elements that contributed to a positive experience and the “–” refer to obstacles in the collaboration.

was a priority when the project first started. Because objectives within the original proposal were general, the Purdue-UNSA team was able to discuss, identify, and focus on research aspects that were relevant and important to project members at both universities; for example, mapping of hazards related to flash floods in the city's ephemeral streams helped achieve buy-in from project members, which ensured commitment to the group (Ansell and Gash 2007).

Fostering Growth

In comparison to other collaborative phases, the SWM team had more control over meeting collaborative principles in the fostering growth phase (Table 3). One of their main successes was that trust-building activities, a key aspect for building relationships and preparing partnerships for challenges, were continuous between partners at the two universities (Bryson et al. 2006). Although, new, non-established relationships caused the project to progress very slowly at the beginning, and initial trust building that was unaccounted for in the proposed project timeframe led to misjudgment of a project timeline. Additionally, cultural differences, professional norms, languages, and research backgrounds created additional obstacles for bridging diversity that slowed progress. Bilingual project members and leaders on the SWM team were key in bridging diversity and building trust within the partnership. Specifically, a bilingual water scientist was recruited into the research team to serve as the overall project coordinator. This individual was invaluable in many ways, but her Spanish communication capacity (speaking and writing) and ability to translate all meetings and key project material was critical to promoting discussion among team members who did not have the language capacity, leading to increased trust and collaborative relationships among team members. Both trust-building and bridging diversity collaborative principles were thus vital steps in the project, which allowed the group to do the basics well by building a solid working rhythm. These foundational relationships acted as cornerstones when challenges were encountered (Archer and Cameron 2009). The SWM team valued transparency and allowed for an inclusive perspective on achievements, which acknowledges

all group members, by making requirements for inclusion in credit-giving, providing easy to follow guidelines to maintain motivation of efforts (Getha-Taylor 2008). For example, an authorship agreement was developed, discussed, and adapted to meet the fairness standard of different team members between universities and across disciplines.

Maintenance

Project maintenance was a stabilizing mechanism and allowed for consistent readjustment when the SWM team encountered difficulties (Table 4). However, the bulk of the maintenance challenges faced by the SWM team (and others) were external factors, imposed by the Nexus Institute. Internally, the SWM team was relatively deft in identifying and addressing problems, often translation miscommunications, as they arose. They utilized open communication to manage conflict early, as well as a central project coordinator to ensure accountability and maximize resiliency in the team. Equalizing power, which helps prevent mistrust, was one of the most consistently difficult challenges, where the UNSA also served as the funder and thus, made more rules and decisions (Huxham and Vangen 2005; Bryson et al. 2006). Within the project, funds were only directly available to Purdue, which created a power imbalance, though the decision to distribute funds to Purdue alone was made by UNSA. To mitigate this issue within the SWM team, project members were transparent about project costs and fund usage. The project team was also unique in their ability to have equal input and respect across genders, with equal distribution of male and female co-PIs, which was a more difficult challenge for other groups. The Nexus Institute as a whole also failed to include regular reassessments, which should be implemented to address issues early and make timely improvements (Bryson et al. 2006). This missing evaluation limited knowledge of progress and success of the collaboration as a whole, and the SWM team has compensated by conducting one informally via this internal evaluation. An accountability system, which provides guidance and expectations for participants, was limited to ensuring the successful completion of proposed deliverables, i.e., decision support tools for water

Table 3. Collaborative principles for fostering growth.

Collaboration Principle	Nexus SWM Experience*	Strategies to Improve
Trust-building activities are continuous (Bryson et al. 2006)	+ Transparency high priority (In) + Frequent virtual communication (In) + Periodic, but limited visits (In) + Inclusion of perspective of project members (In) + Periodic technical training available (In/Ex) + Process transparency (In) + Data sharing and division of work (In/Ex) + Annual workshop (In/Ex) – Some one-sided decision-making (In) – Connectivity issues (In) – Non-flexible rule changes mid-project (Ex)	<ul style="list-style-type: none"> • Build trust with vague goals and low expectations before clear goals with high expectations (Butler and Gill 1995; taken from Vangen and Huxham 2003) • Use small trust gained to build bigger trust and implement practices of sharing credit, balance of power, etc. (Vangen and Huxham 2003) • More frequent face-to-face interactions
Bridge diversity (Getha-Taylor 2008)	+ Some bilingual group members (In) + Cultural liaison (Ex) – Language challenges (In) – Lack of knowledge of other culture (In) – Difficulty in accommodating work norms for both groups (In) – Some one-sided procedures felt colonial (Ex)	<ul style="list-style-type: none"> • Cultural/diversity training • Recognize similarities, recognize and accept cultural limitations, utilize differences as strengths (Brodsky and Faryal 2006) • Get to know each other’s skills, weaknesses, and needs for support, and use them to your advantage (Archer and Cameron 2009) • Adopt a fusion model of collaboration (Janssens and Brett 2006)
Do the basics well (Archer and Cameron 2009)	+ Training for basic research topics (submitting papers, grant writing) (In) + Open communication through various platforms like email, video chat, and messaging (In) – Difficulty in consolidating multiple ideas and interests of all project members (In) – Leads to divided effort, lack of consensus (In)	<ul style="list-style-type: none"> • Collaboration training • Role clarity for each project member (Archer and Cameron 2009) • Commitment to a positive strategy of empowerment and representation of weaker or disadvantaged project members (Ansell and Gash 2007)
Inclusive perspective on achievements (Getha-Taylor 2008)	+ Transparent process for gaining authorship (In) + Inclusive authorship perspective (In)	<ul style="list-style-type: none"> • Acknowledgement of effort as deserved (Vangen and Huxham 2003) • One project member synthesizes group successes (Bammer 2008) • Expand measures of success that reflect and reward important work and collaborative nature (Goring et al. 2014)

*Factors considered for the Nexus SWM experience were both internal (In) and external (Ex) to the SWM team. The “+” refer to elements that contributed to a positive experience and the “–” refer to obstacles in the collaboration.

Table 4. Collaborative principles for collaboration maintenance.

Collaboration Principle	Nexus SWM Experience*	Strategies to Improve
Partners use resources and tactics to equalize power effectively (Bryson et al. 2006)	<ul style="list-style-type: none"> + Mirrored Nexus hierarchy and leadership structure (In/Ex) – Differences between university power structures (In) – One-sided distributor of project funds (Ex) – One-sided holder of project funds (In/Ex) – Bureaucracy both within UNSA and in Peruvian government (Ex) 	<ul style="list-style-type: none"> • Explore external funding options • Foster reciprocity for both collaboration and competition (Bammer 2008) • Altruistic perspective on resource sharing (Getha-Taylor 2008)
Partners use resources and tactics to manage conflict effectively (Bryson et al. 2006)	<ul style="list-style-type: none"> + Project coordinator to balance opinions/needs (In) + Open communication to foster trust for conflict ease (In) – Information distributed unequally to each university (Ex) 	<ul style="list-style-type: none"> • Collaborative conflict resolution (Getha-Taylor 2008) • Create a no-blame culture (Archer and Cameron 2009; Lloyd-walker et al. 2014) • Solve problems quickly, as they arise (Archer and Cameron 2009) • Be aware of limitations (funding, time, etc.) that will constrain boundaries (Bammer 2008) • Identify and understand organizational types (Archer and Cameron 2009)
Engage in regular reassessments (Bryson et al. 2006)	<ul style="list-style-type: none"> + Open communication (In) + Feedback from special events (In/Ex) + Biannual reports can include project challenges (Ex) + Collaborative principles assessment (In) – No formal feedback process (Ex) – No formal monitoring and evaluation program (Ex) 	<ul style="list-style-type: none"> • Start evaluation program • Conduct assessments at the level over which you have control • Build capacity in the importance and process of evaluation (Conlin and Stirrat 2008)
Accountability system that tracks inputs, processes, and outcomes (Bryson et al. 2006)	<ul style="list-style-type: none"> + Group research updates and tracking of progress (In) + Periodic deadlines for required checkpoints (In) + Accountability in progress in biannual reports (Ex) – Emphasis on deliverables, which can sacrifice the science (Ex) 	<ul style="list-style-type: none"> • Minimize ambiguity (Schwartz 2001) • Point person for compiling progress (Ryan and Walsh 2004)

*Factors considered for the Nexus SWM experience were both internal (In) and external (Ex) to the SWM team. The “+” refer to elements that contributed to a positive experience and the “–” refer to obstacles in the collaboration.

management, with inflexible guidelines and no consideration for less tangible, but equally valuable, outputs and outcomes (Bryson et al. 2006).

External Involvement

Because of the SWM team's focus on understanding local water-related institutions and their efforts in using stakeholder input to produce tools for decision-makers, their ability to navigate external involvement was largely positive (Table 5). UNSA project members were key in developing relationships with and achieving project buy-in, which improves likelihood of project impact, from agencies and individual stakeholders (Ansell and Gash 2007). Research and product development for water management support tools were heavily based on stakeholder analysis and feedback, both through interviews and focus groups (see Popovici et al. 2020b). By following cultural norms and ensuring responsiveness to key stakeholders, the SWM team enhanced capabilities for and interest in participation for partnerships in the future and assured that research outcomes would be useful to users (Bryson et al. 2006). The SWM team has also led coordination among other Nexus Institute projects to create a formal plan to reduce burden on external actors, like local water user associations. In other projects at the Nexus Institute, the process for creating new partnerships has already started, including Memorandums of Understanding (MOUs) signed with a partner water management agency in Peru. With good in-country press and project success among participating members, interest in collaboration has increased for other UNSA faculty, as well as faculty from other institutions, which allows for greater reach of the partnership for the future (Lang et al. 2012).

Discussion

The SWM internal evaluation provided a detailed example of a functioning international university-led water research partnership, as well as an example of implementation of this collaborative framework as an assessment tool for this partnership type. This method can be used by other similar partnerships to assess project success and provide guidance for project direction. The need for insight on collaboration

principles and project evaluation is increasing, as international university-led water research partnerships are rapidly growing (Kolesnikov et al. 2019). In this internal evaluation, many positive attributes of the partnership in the SWM project of the Nexus Institute were identified. Many of the challenges identified are associated with the opportunistic formation of this partnership, where early aspects were one-sided, as well as the lack of certain rules and structures. Because of the complexities of this partnership and the newness of the collaboration, this is expected because most collaborations are exceedingly difficult to execute successfully (Bryson et al. 2006). It is important that the issues identified be addressed, both by the SWM team itself, and by the Nexus Institute. Still, with similarities and many positive attributes of collaboration principles, this partnership has been viable, effective, and beneficial for both universities.

Assessing the SWM team within the Nexus Institute using a set of collaboration principles was an informative way for identifying challenges and providing insight on addressing these challenges. Strategies enacted in the project, as well as many suggested in the literature, created opportunities for improving the partnership as they occurred (Tables 1-5). Utilizing an attentive and proactive problem-solving approach, strategies can be implemented quickly and be effective. Because many of these partnerships are nascent (Kolesnikov et al. 2019), they must be careful to implement strategies to overcome differences, understand each other, and gain support (Bammer 2008). The evaluation of a project team within a larger partnership also provides a case example of how to make improvements inside an imperfect partnership, without having power to address all challenges. While this is limiting in some regards, it also empowers members of an already established project to learn to work within the space at which they can enact change.

When identifying challenges and considering improvement strategies, our collaboration framework is also useful in identifying a trajectory to overall project improvement. Because of its structure, implementation of principles farther along in the process may be dependent on successful implementation of principles from earlier stages

Table 5. Collaborative principles for including external involvement.

Collaboration Principle	Nexus SWM Experience*	Strategies to Improve
Achieve buy-in from outside stakeholders, other interested groups (adapted from Ansell and Gash 2007)	<ul style="list-style-type: none"> + Interactions with many groups through interviews and focus groups (In) + Development of relationships through previous contacts (In) – Disconnected message, overlapping asks to agencies among groups (In/Ex) – Slow to build stakeholder understanding of project and partnerships (In/Ex) 	<ul style="list-style-type: none"> • Hire on-the-ground research coordinator to maintain constant contact with stakeholders • Additional connections with groups outside of water management, like non-governmental organizations (NGOs), schools, and businesses • Create committee on community engagement to outline standard procedures • Clear strategy as to how participation benefits local stakeholders
Use stakeholder analysis, and emphasize responsiveness to key stakeholders (Bryson et al. 2006)	<ul style="list-style-type: none"> + Coproduction process to include stakeholder input (In) + Qualitative data collection from many stakeholders (In) + Extension efforts (In and Ex) – Lack of in-depth knowledge of community needs (Ex) – Ever-changing agency officials (Ex) 	<ul style="list-style-type: none"> • Add UNSA social scientists to work with the Purdue social scientists on the SWM team • Establish alternative strategies for receiving input from stakeholders (see Popovici et al. this issue)
Evaluate societal impact (Lang et al. 2012)	<ul style="list-style-type: none"> + Plans to create extension centers (In/Ex) + Creating consumer products based on research with user input (In) – No current plan for impact assessment (In) – Short project timeframe (In/Ex) 	<ul style="list-style-type: none"> • Incorporate narrative with qualitative and quantitative data (Donovan 2011) • Utilize document analysis and engage with decision-makers for feedback (Hanney et al. 2000) • Include a variety of impacts, including indirect, in assessment (van der Weijden et al. 2012)
Enhance capabilities for and interest in participation (Lang et al. 2012)	<ul style="list-style-type: none"> + MOUs signed with agencies (Ex) + Project progress attracted future potential partners (In) + Purdue faculty seminars at UNSA (In) + Used established organizations to engage community (Ex) + Many press releases for public engagement (Ex) + Active social media (In/Ex) + SWM has fostered some faculty partnerships beyond Nexus collaboration (In) – No unified message to stakeholders among projects (In) 	<ul style="list-style-type: none"> • Open call for participation at both universities

*Factors considered for the Nexus SWM experience were both internal (In) and external (Ex) to the SWM team. The “+” refer to elements that contributed to a positive experience and the “–” refer to obstacles in the collaboration.

and require that these more foundational principles be satisfied before addressing other principles. For example, some strategies for managing conflict, like collaborative conflict resolution, are much more challenging when trust-building activities are not continuous and a foundation of trust between groups has not been created (Kelmen 2005). Though there have been no large conflicts within the SWM team, continuous trust-building activities and relationships built among project members have enhanced communication and minimized misunderstandings that often lead to conflict (Kelly et al. 2002). These foundations have also been established to manage conflicts that could occur. Likewise, focusing on collaboration principles from earlier phases and reiterating them can lead to development or enhancement of other principles further along. For example, developing a joint understanding of the research goal can help keep the group's focus, provide motivation, serve for a measure of assessing progress, and is more likely to draw in outside interest when the message is unified (Christenson and Walker 2004; Heath and Heath 2007). Thus, in addressing challenges in a collaboration, it is important to work backwards in the framework of principles to identify the root cause of the problem (Vaaland 2004). Additionally, our assessment suggests that beginning with basic improvement measures can build foundations that will both address core issues and improve abilities to address more nuanced ones.

Conclusions

Based on our experience with and evaluation of an international university-led water research partnership, this type of collaboration is a viable option for developing sustainable research and can be beneficial for both universities. Developing these research partnerships can build research capacity at universities without those capabilities, provide important information to local populations, and contribute to the body of knowledge on global issues. Additionally, these opportunities can improve rankings and provide new sources of funding for universities in the U.S. (Kolesnikov et al. 2019).

This internal evaluation highlights how international university-led water research

partnerships can use collaborative frameworks as an assessment tool to ensure success. In this case study, the partnership vision is simple and clear and provides a permanent stable basis off which to build an institution with Purdue's Discovery Park and UNSA as partners. Stability is enhanced by a consistent funding source. After establishment of a solid foundation and achieving small successes that build both rapport and confidence between universities, there is an opportunity for growth within this partnership. Additionally, because of the nature of the research and the involvement of stakeholders throughout the research project, the SWM team and the Nexus Institute have provided a pathway to creating actionable research that can be applied to policy and have impacts on water management outside the confines of the two-university partnership.

While international university-led water research partnerships are a useful collaboration option, they should be approached thoughtfully, as there are many nuances that make them unique. The collaboration framework and the process to create it described in this paper can be used as guidance for structuring and building a partnership, from the initial structure and phases, to fostering growth and maintenance, and providing a solid foundation to extend research ideas and practices to include or impact local stakeholders. These characteristics and structures can then provide opportunities to replicate partnership within and across other institutions, especially in an international context. Even with already-established partnerships, these principles can serve as an assessment framework for finding weaknesses and making adjustments to improve them. Although evaluations are more effective if designed and monitored from the start, performing an evaluation at any point can provide some insight into partnership success.

Likewise, within existing partnerships, there is opportunity to make ongoing changes that can be implemented as soon as the need is identified. Using this framework, a simple process is in place for identifying challenges, and with this methodology, areas for improvement can be prioritized. Our findings suggest that there are many sources of strategies for improving during different phases of the partnership, and these can be implemented without having to wait for the next

iteration or funding opportunity. Acting quickly and being adaptable are important aspects of any international partnership, especially those recently created.

This was an internal evaluation of an international university-led water research partnership from one project within the collaboration, but there is need for a larger-scale evaluation of the entire partnership, including interactions among teams and at different leadership levels. Likewise, more studies of the collaboration success of these types of partnerships are needed.

Acknowledgments

Funds to support research in the Arequipa Nexus Institute for Food, Energy, Water, and the Environment were provided by the Universidad Nacional de San Agustín.

Author Bio and Contact Information

KATY MAZER (corresponding author) is coordinator of the Sustainable Water Management team of The Nexus Institute at Purdue University. She engages with stakeholder groups in Arequipa, Peru to coproduce water management decision-making tools. She can be contacted at kmazer@purdue.edu or 920 W State St., West Lafayette, IN 47907.

ANNA ERWIN is a Postdoctoral Research Associate in the Purdue University Department of Forestry and Natural Resources. Dr. Erwin is an interdisciplinary social scientist and environmental justice scholar who studies how people perceive and respond to social ecological change and investigates how organizations and policies respond to those changes. She can be contacted at erwin9@purdue.edu or through www.annaerwin.com.

RUXANDRA POPOVICI is a Postdoctoral Researcher in the Department of Forestry and Natural Resources at Purdue University. Her work focuses on environmental governance, where she researches the various rules and norms through which people on the ground manage their natural resources. She can be contacted at rpopovi@purdue.edu or 195 Marsteller St., West Lafayette IN 47907.

EDWIN BOCARDO-DELGADO is a principal professor in the Department of Biological Sciences and a graduate Environmental Science professor at the Universidad Nacional de San Agustín de Arequipa. He also works as an environmental consultant for several companies and a natural resource management specialist. He can

be contacted at ebocardo@unsa.edu.pe or Av. Sánchez Carreón s/n , Cercado Arequipa.

LAURA BOWLING is a Professor of hydrology in the Department of Agronomy at Purdue University. Her research investigates the water resources impact of environmental change across multiple scales, climate regimes, and ecosystems and communicates these findings to stakeholders. She can be contacted at bowling@purdue.edu or 915 W. State St., West Lafayette, IN 47907.

ZHAO MA is a Professor of Natural Resource Social Science in the Department of Forestry and Natural Resource at Purdue University. Her research examines how individuals and organizations make natural resource decisions in the context of social-ecological change. She can be contacted at zhaoma@purdue.edu or 195 Marsteller Street, West Lafayette, IN 47907-2033, USA.

LINDA PROKOPY is a Professor in the Department of Forestry and Natural Resources at Purdue University. She conducts research on the social dimensions of watershed management. She can be contacted at lprokopy@purdue.edu or 195 Marsteller St., West Lafayette IN 47907.

CARLOS ZEBALLOS-VELARDE is an architect, urban planner, and professor at the Faculty of Architecture and Urbanism at the Universidad Nacional de San Agustín in Arequipa, Peru. He conducts GIS analyses about various topics related to environmental urban planning and works in several research projects about participatory risk management with different communities. He can be contacted at czeballos@unsa.edu.pe or Urb. Las Begonias F-1, JLByR. Arequipa, Peru.

References

- Alcama, J. and T. Henrichs. 2002. Critical regions: A model-based estimation of world water resources sensitive to global changes. *Aquatic Sciences* 64: 352-362. Available at: <https://doi.org/10.1007/PL00012591>. Accessed March 13, 2020.
- Ansell, C. and A. Gash. 2007. Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory* 18(4): 543-571. Available at: <https://doi.org/10.1093/jopart/mum032>. Accessed December 10, 2019.
- Archer, D. and A. Cameron. 2009. *Collaborative Leadership: How to Succeed in an Interconnected World*. Butterworth-Heinemann, Jordan Hill, Oxford, UK.
- Arequipa Nexus Insitute (ANI). 2020. Arequipa Nexus Institute for Food, Energy, Water, and the

- Environment. Available at: <https://www.purdue.edu/discoverypark/arequipa-nexus/en/index.php>. Accessed November 6, 2020.
- Ariño, A. and J. de la Torre. 1998. Learning from failure: Towards an evolutionary model of collaborative ventures. *Organization Science* 9(3): 306-325. Available at: <https://www.jstor.org/stable/2640225>. Accessed December 6, 2019.
- Babiak, K. and L. Thibault. 2009. Challenges in multiple cross-sector partnerships. *Nonprofit and Voluntary Sector Quarterly* 38(1): 117-143.
- Bammer, G. 2008. Enhancing research collaborations: Three key management challenges. *Research Policy* 37(5): 875-887. Available at: <https://doi.org/10.1016/j.respol.2008.03.004>. Accessed January 3, 2020.
- Bergstrom, J.C. and A. Randall. 2016. *Resource Economics: An Economic Approach to Natural Resource and Environmental Policy*. 4th ed. Edward Elgar, Northampton, Massachusetts.
- Bishop, R. 2011. Freeing ourselves from neo-colonial domination in research. In: *Transgressions: Cultural Studies and Education* (Freeing Ourselves, Vol. 66), S. Steinberg and J.L. Kincheloe (Eds.). Sense Publishers, pp. 1-30.
- Bob C. 2017. Foreign government support for threatened civil societies: Helpful or harmful? In: *Partnerships in International Policy-Making: Civil Society and Public Institutions in European and Global Affairs* (International Series on Public Policy), R. Marchetti (Ed.). Palgrave Macmillan, London, pp. 257-273.
- Brodsky, A.E. and T. Faryal. 2006. No matter how hard you try, your feet still get wet: Insider and outsider perspectives on bridging diversity. *American Journal of Community Psychology* 37(3-4): 191-201. Available at: <https://doi.org/10.1007/s10464-006-9015-x>. Accessed February 14, 2020.
- Bryson, J.M., B.C. Crosby, and M.M. Stone. 2006. The design and implementation of cross-sector collaborations: Propositions from the literature. *Public Administration Review* 66(s1): 44-55. Available at: <https://doi.org/10.1111/j.1540-6210.2006.00665.x>. Accessed December 4, 2020.
- Butler, R. and J. Gill. 1995. Learning and knowledge in joint-ventures: The importance of trust. In: *paper presented to the British Academy of Management annual conference*. Sheffield, UK.
- Christenson, D. and D.H.T. Walker. 2004. Understanding the role of “vision” in project success. *Project Management Journal* 35(3): 39-52. Available at: <https://doi.org/10.1177/1056492604263036>. Accessed April 3, 2020.
- Conlin, S. and R.L. Stirrat. 2008. Current challenges in development evaluation. *Evaluation* 14(2): 193-208. Available at: <https://doi.org/10.1177/1356389007087539>. Accessed March 10, 2020.
- de Jong, K., U. Daellenbach, S. Davenport, J. Haar, and S. Leitch. 2019. Giving science innovation systems a ‘nudge’. *Technology Innovation Management Review* 9(10): 51-61. Available at: <http://doi.org/10.22215/timreview/1275>. Accessed January 3, 2020.
- Donovan, C. 2011. State of the art in assessing research impact: Introduction to a special issue. *Research Evaluation* 20(3): 175-179. Available at: <https://doi.org/10.3152/095820211X13118583635918>. Accessed March 10, 2020.
- Emerson, K., T. Nabatchi, and S. Balogh. 2012. An integrative framework for collaborative governance. *Journal of Public Administration Research and Theory* 22(1): 1-29. Available at: <https://doi.org/10.1093/jopart/mur011>. Accessed December 10, 2019.
- Ethiopian Institute of Water Resources (EIWR). 2020. Graduate Programs. Addis Ababa University, Ethiopia. Available at: <http://www.aau.edu.et/iewr/programs/>. Accessed October 28, 2020.
- Gentry, R. 2013. Special issue on impacts of land use and climate change on hydrological processes in China. *Journal of Hydrologic Engineering* 18(4): 377.
- Getha-Taylor, H. 2008. Identifying collaborative competencies. *Review of Public Personnel Administration* 28(2): 103-119. Available at: <https://doi.org/10.1177/0734371X08315434>. Accessed December 5, 2019.
- Goring, S.J., K.C. Weathers, W.K. Dodds, P.A. Soranno, L.C. Sweet, ... and R.M. Utz. 2014. Improving the culture of interdisciplinary collaboration in ecology by expanding measures of success. *Frontiers in Ecology and the Environment* 12(1): 39-47. Available at: <https://doi.org/10.1890/120370>. Accessed January 2, 2020.
- Hanney, S., T. Packwood, and M. Buxton. 2000. Evaluating the benefits from health research and development centres: A categorization, a model and examples of application. *Evaluation* 6(2): 137-160. Available at: <https://doi.org/10.1177/13563890022209181>. Accessed March 10, 2020.
- Heath, C. and D. Heath. 2007. *Made to Stick: Why Some Ideas Survive and Others Die*. Random House, New York.

- Huxham, C. and S. Vangen. 2005. *Managing to Collaborate: The Theory and Practice of Collaborative Advantage*. Routledge, New York.
- Ivery, J.M. 2010. Partnerships in transition: Managing organizational and collaborative change. *Journal of Human Behavior in the Social Environment* 20(1): 20-37. Available at: <https://doi.org/10.1080/10911350903256648>. Accessed December 12, 2019.
- Janssens, M. and J.M. Brett. 2006. Cultural intelligence in global teams: A fusion model of collaboration. *Group & Organization Management* 31(1): 124-153. Available at: <https://doi.org/10.1177/1059601105275268>. Accessed February 14, 2020.
- Kelly, M.J., J. Schaan, and H. Joncas. 2002. Managing alliance relationships: Key challenges in the early stages of collaboration. *R&D Management* 32(1): 11-22. Available at: <https://doi.org/10.1111/1467-9310.00235>. Accessed April 3, 2020.
- Kelman, H.C. 2005. Building trust among enemies: The central challenge for international conflict resolution. *International Journal of Intercultural Relations* 29(6): 639-650. Available at: <https://doi.org/10.1016/j.ijintrel.2005.07.011>. Accessed April 3, 2020.
- Kolesnikov, S., S. Woo, Y. Li, P. Shapira, and J. Youtie. 2019. Mapping the emergence of international university research ventures. *The Journal of Technology Transfer* 44: 1134-1162. Available at: <https://doi.org/10.1007/s10961-017-9640-6>. Accessed January 3, 2020.
- Kouritzin, S. and S. Nakagawa. 2018. Toward a non-extractive research ethics for transcultural, translanguingual research: Perspectives from the coloniser and the colonized. *Journal of Multilingual and Multicultural Development* 39(8): 675-687. DOI: 10.1080/01434632.2018.1427755.
- Lang, D.J., A. Wiek, M. Bergmann, M. Stauffacher, P. Martens, ... and C.J. Thomas. 2012. Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science* 7: 25-43. Available at: <https://doi.org/10.1007/s11625-011-0149-x>. Accessed January 28, 2020.
- Leider, H.L. 1999. Gaining physician buy-in for disease management initiatives. *Disease Management and Health Outcomes* 6: 327-332. Available at: <https://doi.org/10.2165/00115677-199906060-00003>. Accessed March 10, 2020.
- Lloyd-walker, B.M., A.J. Mills, and D.H.T. Walker. 2014. Enabling construction innovation: The role of a no-blame culture as a collaboration behavioural driver in project alliances. *Construction Management and Economics* 32(3): 229-245. Available at: <https://doi.org/10.1080/01446193.2014.892629>. Accessed February 17, 2020.
- Mahuika, R. 2008. Kaupapa Māori theory is critical and anti-colonial. *MAI Review* 3(4): 1-16. Available at: https://www.researchgate.net/publication/26569994_Kaupapa_Maori_theory_is_critical_and_anti-colonial. Accessed March 13, 2020.
- Morris, N. 2015. Providing ethical guidance for collaborative research in developing countries. *Research Ethics* 11(4): 211-235. Available at: <https://doi.org/10.1177/1747016115586759>. Accessed January 28, 2020.
- Morton, G.H.A. 1983. Become a project champion. *International Journal of Project Management* 1(4): 197-203. Available at: [https://doi.org/10.1016/0263-7863\(83\)90048-0](https://doi.org/10.1016/0263-7863(83)90048-0). Accessed March 10, 2020.
- Pfotenhauer, S.M., J.S. Jacobs, J.A. Pertuze, D.J. Newman, and D.T. Roos. 2013. Seeding change through international university partnerships: The MIT-Portugal Program as a driver of internationalization, networking, and innovation. *Higher Education Policy* 26(2): 217-242.
- Pfotenhauer, S.M., D. Wood, D. Roos, and D. Newman. 2016. Architecting complex international science, technology and innovation partnerships (CISTIPs): A study of four global MIT collaborations. *Technological Forecasting and Social Change* 104: 38-56. Available at: <https://doi.org/10.1016/j.techfore.2015.12.006>. Accessed January 3, 2020.
- Ponds, R. 2009. The limits to internationalization of scientific research collaboration. *Journal of Technology Transfer* 34: 76-94. Available at: <https://doi.org/10.1007/s10961-008-9083-1>. Accessed March 13, 2020.
- Popovici, R., A. Erwin, Z. Ma, L.S. Prokopy, L. Zanotti, E.F. Bocardo Delgado, ... and G.R. Arce Larrea. 2020a. Outsourcing governance in Peru's integrated water resources management. *Land Use Policy*. Available at: <https://doi.org/10.1016/j.landusepol.2020.105105>. Accessed November 4, 2020.
- Popovici, R., K.E. Mazer, A. Erwin, Z. Ma, J.P. Pinto Caceres, ... and L.S. Prokopy. 2020b. Coproduction challenges in the context of changing rural livelihoods. *Journal of Contemporary Water Research and Education* 171: 111-126. Available at: <https://onlinelibrary.wiley.com/journal/1936704x>. Accessed December 22, 2020.

- Ryan, C. and P. Walsh. 2004. Collaboration of public sector agencies: Reporting and accountability challenges. *International Journal of Public Sector Management* 17(7): 621-631. Available at: <https://doi.org/10.1108/09513550410562284>. Accessed April 3, 2020.
- Schwartz, R. 2001. Managing government-third sector collaboration: Accountability, ambiguity, and politics. *International Journal of Public Administration* 24(11): 1161-1188. Available at: <https://doi.org/10.1081/PAD-100105234>. Accessed March 10, 2020.
- Spooner, C., C. Lavey, C. Mukuka, and R. Eames-Brown. 2016. Multi-institution research centers: Planning and management challenges. *Journal of Research Administration* 47(2): 32-48.
- Thomson, A.M. and J.L. Perry. 2006. Collaboration processes: Inside the black box. *Public Administration Review* 66(s1): 20-32. Available at: <https://doi.org/10.1111/j.1540-6210.2006.00663.x>. Accessed December 10, 2019.
- Thomson, K., L. de Chernatony, L. Arganbright, and S. Khan. 1999. The buy-in benchmark: How staff understanding and commitment impact brand and business performance. *Journal of Marketing Management* 15(8): 819-835. Available at: <https://doi.org/10.1362/026725799784772684>. Accessed March 3, 2020.
- Tracy, S.J. 2010. Qualitative quality: Eight “big-ten” criteria for excellent qualitative research. *Qualitative Inquiry* 16(10): 837-851.
- UC Davis Chile. 2020. Research & Development. UC Davis Chile Life Sciences Innovation Center. Available at: <https://chile.ucdavis.edu/en/research-development>. Accessed October 27, 2020.
- U.S.-Pakistan Centers for Advanced Studies in Water MUET Jamshoro (USPCAS-W). 2020. Final Report: 12 Dec 2014 - 11 Dec 2019. Cooperative Agreement No. AID-391-A-15-00003. Available at: <http://water.mueta.edu.pk/wp-content/uploads/2020/05/Final-Report-USPCAS-W-MUET.pdf>. Accessed October 28, 2020.
- Vaaland, T.I. 2004. Improving project collaboration: Start with the conflicts. *International Journal of Project Management* 22(6): 447-454. Available at: <https://doi.org/10.1016/j.ijproman.2003.11.003>. Accessed April 3, 2020.
- van der Weijden, I., M. Verbree, and P. van den Besselaar. 2012. From bench to bedside: The societal orientation of research leaders: The case of biomedical and health research in the Netherlands. *Science and Public Policy* 39(3): 285-303. Available at: <https://doi.org/10.1093/scipol/scr003>. Accessed March 10, 2020.
- Vangen, S. and C. Huxham. 2003. Nurturing collaborative relations: Building trust in interorganizational collaboration. *The Journal of Applied Behavioral Science* 39(1): 5-31. Available at: <https://doi.org/10.1177/0021886303039001001>. Accessed December 12, 2020.
- Vörösmarty, C.J., P. Green, J. Salisbury, and R.B. Lammers. 2000. Global water resources: Vulnerability from climate change and population growth. *Science* 289(5477): 284-288. Available at: <https://doi.org/10.1126/science.289.5477.284>. Accessed April 3, 2020.
- Vörösmarty, C.J., P.B. McIntyre, M.O. Gessner, D. Dudgeon, A. Prusevich, ... and P.M. Davies. 2010. Global threats to human water security and river biodiversity. *Nature* 467: 555-561. Available at: <https://doi.org/10.1038/nature09440>. Accessed April 2, 2020.
- Wiek, A., B. Ness, P. Schweizer-Ries, F.S. Brand, and F. Farioli. 2012. From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science* 7(1): 5-24. Available at: <https://doi.org/10.1007/s11625-011-0148-y>. Accessed November 17, 2020.
- Wilmsen, C. 2008. Extraction, empowerment, and relationships in the practice of participatory research. In: *Towards Quality Improvement of Action Research: Developing Ethics and Standards*, B. Boog, J. Preece, M. Slager, and J. Zeelen (Eds.). Sense Publishers, Rotterdam, The Netherlands, pp. 135-146.
- Winer, M. and K. Ray. 1994. *Collaboration Handbook: Creating, Sustaining, and Enjoying the Journey*. Amherst H. Wilder Foundation, St. Paul, Minnesota.
- Woldegiyorgis, A.A., D. Proctor, and H. de Wit. 2018. Internationalization of research: Key considerations and concerns. *Journal of Studies in International Education* 22(2): 161-176. Available at: <https://doi.org/10.1177/1028315318762804>. Accessed January 3, 2020.
- Xiamen University and University of Delaware. 2013. *Collaboration Across the Seas*. Joint Institute for Coastal Research and Management. Available at: <https://www.joint-crm.org/>. Accessed October 28, 2020.
- Youtie, J., Y. Li, J. Rogers, and P. Shapira. 2017. Institutionalization of international university research ventures. *Research Policy* 46(9): 1692-1705. Available at: <https://doi.org/10.1016/j.respol.2017.08.006>. Accessed January 3, 2020.