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Management of Rural Water Services in Nicaragua: A Systematic Network Approach to Evaluating Stakeholder Alignment

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Water sector literature attributes a substantial cause of rural water system failure in developing countries to poor alignment between water service stakeholders. This study aimed to investigate a means for assessing stakeholder alignment by comparing the systemic interaction of stakeholder values, where the term 'stakeholder values' refers to aspects stakeholders believe are necessary to ensure rural water services are sustainable. The research held focus groups with key stakeholder groups involved in the management of rural water infrastructure in Terrabona, Nicaragua, to identify stakeholder values, and then used cross-impact analysis to evaluate how these values interacted to form stakeholder value networks (SVNs). Using normalized betweenness centrality measures, the structures of SVNs were compared to determine alignment. Results from this study showed high levels of stakeholder alignment on the topics of water resources and technology for the sustainability of rural water systems, while there was marked nonalignment regarding the involvement of local government and organizations in the management of water infrastructure. This study offers compelling evidence for future studies to assess stakeholder alignment by identifying and structurally analyzing SVNs.

Keywords: alignment; values; network; stakeholder; developing countries; rural water systems

Introduction

Significant progress has been made in improving access to potable water in developing countries over the past decade (JMP 2014); however, studies have shown that substantial issues with long-term sustainability exist in spite of these accomplishments (WASH Sustainability Charter 2013; JMP 2014; Davis et al. 2014). One important component for sustainable water services is the effective alignment between key stakeholder groups (Lockwood et al. 2003; RWSN 2010; Lockwood & Smits 2011). Unfortunately, water sector literature often points to incongruous alignment between donors, country-level organizations, and governments for confounding sustainability (Ferguson & Mulwafu 2001; Williamson et al. 2008; WaterAid 2011; International Research and Sanitation Centre 2012). For example, the International Research and Sanitation Centre (2012) tells of their experience with a 'vicious cycle' that results when the lack of stakeholder coordination causes nonalignment within sector policy, which, in turn, causes weakened stakeholder collaboration and unsustainable water services. Jansz (2011) mentions that, in spite of the many factors that can influence long-term sustainability of water infrastructure, it is paramount that stakeholders work together effectively with transparent coordination. Similarly, Pearce-Oroz et al. (2011) argue that 'inter-sector coordination contributes to sustainable water services, and closer alignment between local and national stakeholders' (p. 6) are critical for this end goal of sustainability.

Effective coordination and alignment between stakeholders, as a key element for water system sustainability, comes as no surprise. Project management literature indicates that stakeholder alignment is imperative for the long-term success of any project (Freeman 1984, 2001; Loucopoulos & Kavakli 1995; Vaidya & Mayer 2014). This literature mentions that alignment is fostered and realized through the agreement between stakeholder values, which drive and unify stakeholder actions that are beneficial to project success (Winn 2001; Luftman 2003). Thus, in accordance with the aforementioned literature, this research posits that the emergent outcomes from stakeholders' *values* – as they relate to the ideal management of rural water infrastructure – are their associated *actions*. Therefore, specifically evaluating certain aspects of stakeholder values would intuitively enable an improved ability to judge how stakeholders will align their actions towards the end goal of long-lasting water services (Rokeach 1973; Keely 1983; Zhang et al. 2008). As such, the aim of this research was to gain understanding on stakeholder alignment through the emergence and analysis of their respective values, and how these values interact.

This study proposes a method for comparing stakeholder values through the creation and analysis of stakeholder value networks (SVNs). We elected to use *stakeholder theory* and *network theory* to provide a theoretical basis for these proposed methods of data

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collection and analysis. Stakeholder theory suggests that mapping stakeholder values as they relate to a particular end goal (in this case, the long-term functionality of rural water infrastructure) can enable an improved understanding on their future actions (Rosenblueth et al. 1943; Wiener 1988; Winn 2001; Freeman 2001; Zhang et al. 2008; Mills et al. 2009). Similarly, network theory suggests the structural interaction of these stakeholder values – shown by drawing a network comprised of nodes (in our case, stakeholder values) and lines/edges that connect these nodes (to show the interaction between these values) – can provide insight into the type of stakeholders' actions that potentially manifest (Freeman 1977, 1978; Wasserman & Fraust 1994; Scott 2000; Borgatti & Everett 2006; Wossen et al. 2013).

As a proxy for stakeholder alignment, this research proposes to assess stakeholder action by comparing the structural interaction of their values networks. First, we propose using stakeholder theory for the illumination of stakeholder values based on their description of important aspects for sustainable water services. Second, we propose using network theory as a basis for the use of SVNs to display a meaningful interaction between stakeholder values. Lastly, we combine these three theories to develop a proxy for alignment based on stakeholder action inferred through the structural analysis of their value networks. Figure 1 summarizes the synthesis of these two theories that guided our research methods.

As a result, this research addresses the following questions within the context of rural water systems in Terrabona: *What are the values of stakeholder groups involved in the management of rural water infrastructure in Terrabona, Nicaragua? How are these values structurally connected as a network? How do each stakeholder group's value networks differ? What can these differences tell us about their alignment towards the end goal of long-lasting water services?* By using this approach, the interaction of stakeholder values within value networks is elucidated and compared to illuminate alignment.

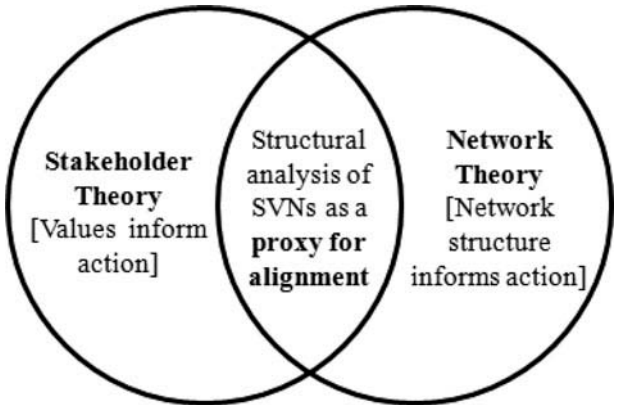

Figure 1. Theory synthesis.

Methods

The multiphase research approach employed for this study collected data from focus groups with four rural water stakeholder groups in the municipality of Terrabona, Nicaragua. These focus groups helped us explore, identify, and link stakeholder group values as they related to the idealized management of rural water services. These stakeholder values were qualitatively coded to identify recurring themes in stakeholders' language as a way to aggregate values into SVNs. We constructed SVNs for each of these stakeholder groups by performing a structural cross-impact analysis within each focus group. We then compared and contrasted the structural differences between SVNs using betweenness centrality scores to highlight stakeholder alignment (or nonalignment). The methodological phases, as they relate to data collection and data analysis, are explained below.

Data collection

Focus groups were conducted in Terrabona, Nicaragua. Terrabona was chosen as the research site due to the diverse spectrum of easily identifiable stakeholder groups involved in rural water infrastructure and the associated large number of water systems – many of which were functioning suboptimally (El Porvenir 2013). Terrabona is located 40 miles north of Managua, Nicaragua, the country capital, and has a population of 13,000, primarily located in 61 separate rural communities. Over the past 15 years, numerous water systems have been installed in Terrabona by the local government and nonprofit organizations, providing coverage of 77% (about 47 water systems); however, of these 47 water systems, only 54% are functioning properly (El Porvenir 2013).

We used focus groups to identify and map stakeholder values. Focus groups were used because of their ability to effectively surface stakeholder beliefs, perceptions, and language (Stewart 2014). These focus groups involved stakeholders within the municipal government (specifically government officials responsible for rural water infrastructure implementation and management in Terrabona), community water committees, a local nongovernmental organization (NGO), and students and faculty within a local academic institute. These stakeholder groups were chosen because of their direct and indirect involvement with rural water project implementation and water system management in Terrabona. Students and faculty chosen to participate in the focus groups were specifically those teaching or taking classes related to rural water management. While these students and faculty were not directly involved in water project implementation or water system management, we chose to include this group because many of these students would later be employed by the municipal government as government officials involved with water infrastructure planning in Terrabona.

Focus groups were conducted individually for each group of stakeholders to avoid conflicts or biases between

Table 1. Terrabona rural water project stakeholder focus group information.

Stakeholder group	Involvement with water services	No. of participants	Length (h)
Government	Implementation and management of water systems Community water committee training	5	2
Organization	Implementation and management of water systems Community water committee training	6	2.5
Water committees	Management of water systems	14	3
Academics	Future government-based water practitioners in Terrabona	16	3

different stakeholder groups. Audio was recorded for each focus group session to aid in the subsequent step of value aggregation and comparison. Table 1 displays some basic information regarding each focus group session and displays each stakeholder group's respective involvement with rural water infrastructure in Terrabona.

It may be seen in Table 1 that the water committees and academics stakeholder groups were considerably larger than the other two groups. For these larger focus groups, a significant effort by the focus group facilitator went into ensuring each stakeholder was involved in the discussion. The process of facilitating a discussion with a larger number of focus groups participants resulted in sessions that were approximately 1 h longer for both the water committees and academics stakeholder groups.

Focus group sessions began by asking stakeholders the open-ended question: 'What do you feel are the most important things that lead to the long-term functioning of a rural water system?' The wording of this question effectively asked stakeholders to provide 'things' (values) they thought might lead to the end goal of sustainable water services. Each stakeholder group was then given time to brainstorm, discuss, and reach consensus on the most important values.

Once these stakeholder values were identified and aggregated into subgroups, the next step was to ascertain the influence between values that would later be used to build each SVN. To do this, stakeholders were prompted to systematically identify 'the interaction between each value', through pairwise connections (i.e., good accounting on community participation, good accounting on proper system maintenance, community participation on good accounting, etc.). This method of pairwise interaction was considered a systematic, simple, and objective way to find the influence from one stakeholder value on the other (Cheung et al. 2001; Thurstone 1927; Bradley 1954; Linstone & Turoff 1975; Gregory & Wellman 2001; Saaty 2008). Practically, this process entailed eliciting and writing down all possible pairwise interactions. The focus group session ended after each pairwise influence was discussed, resulting in a synthesized list of pairwise comparisons between stakeholder values for each stakeholder group.

Data analysis

Each focus group session was recorded, transcribed in Spanish, and then imported and qualitatively analyzed in QSR NVivo 10 software to code similarities and differences between the stakeholders' language (QSR International Pty Ltd 2015). Transcriptions were intentionally kept in Spanish to preserve many of the contextual subtleties available only in the native tongue of focus group participants. Similar stakeholder value names that were described with similar language (wording) by stakeholders were then put into generalized categories, which enabled the comparison of these values between each of the stakeholder groups. Specifically, the recurring language used by stakeholders to describe the important values for long-term functionality of water infrastructure was used to create these means for stakeholder value generalization.

With the list of generalized stakeholder values, it was then possible to create a SVN for each stakeholder group. SVNs were built using the value interactions (the second part of each focus group session) indicated by the stakeholders. Interactions between the stakeholder values allowed us to analyze SVNs using R-Project for Statistical Computing (R-Project 2015), where each SVN represented the mapped interaction between stakeholder values. To structurally compare SVNs, this research used *betweenness centrality* as it allowed the research team to evaluate the position of key values within the network with respect to other values, and specifically the extent to which a stakeholder group's values connect other values and act as a 'bridge' within the system along the shortest path, known as the 'geodesic' (Borgatti 2005; Freeman 1977; Scott 2000; Hanneman 2001). An example illustrating betweenness is shown in Figure 2. In this figure, it can

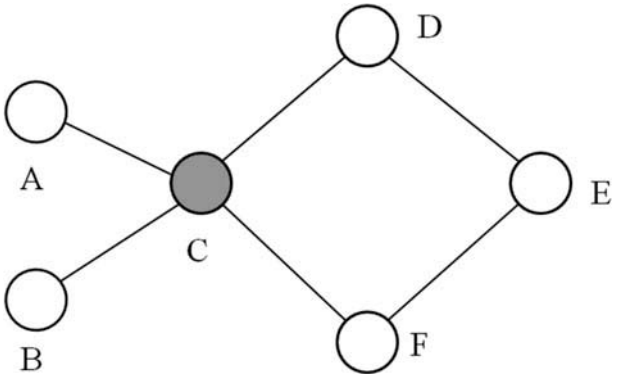

Figure 2. Betweenness illustration (the shaded node (C) has the highest betweenness score).

be seen that the node with the highest betweenness score would be C because it bridges the largest numbers of shortest paths between the other nodes in the network.

All centrality techniques implicitly measure the affect network structure (relationship between nodes) has on a particular outcome. An example affect could be how money is transferred, how people communicate, or how packages are delivered (Borgatti 2005). In this study, we assume the structural interaction between values affects stakeholders' decisions and subsequent actions, thereby affecting how they align their efforts.

Calculation of betweenness scores was accomplished by creating an SVN for each stakeholder group using the open source R-package 'statnet' (Acton & Jasney 2012). The betweenness scores for each SVN were then normalized to allow comparison between the four stakeholder groups. The equation we used to calculate these normalized betweenness scores is as follows:

$$g(v) = \frac{\sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}}{(N-1)(N-2)/2},$$

where $g(v)$ is the normalized betweenness centrality score for a particular value; v is the value of interest; σ_{st} is the total number of shortest paths that pass between value s and value t; $\sigma_{st}(v)$ is the number of those shortest paths that pass through value v; and N is the total number of values in the SVN.

Normalized betweenness scores were calculated for each value within each SVN. We assessed alignment between stakeholders by comparing the absolute difference between betweenness scores for stakeholder values using three different scoring metrics: *local, value-based*, and *stakeholder-based* alignment. These three scoring metrics were created to make important distinctions between different forms of stakeholder alignment. For example, local alignment describes alignment that exists between two stakeholder groups (i.e., academics with organization (Aca:Org)) over a single stakeholder value. A local alignment score is calculated as the absolute difference in normalized betweenness scores for a particular stakeholder value between two stakeholder groups. Value-based alignment shows the level of alignment that exists between all the stakeholders for a certain stakeholder value, considering all six possible paired stakeholder comparisons (i.e., academics with government (Aca:Gov), academics with organization (Aca:Org), water committees with academics (WC:Aca), etc.). As such, a value-based alignment score is calculated as the mathematical sum of all local alignment scores available for each individual stakeholder value. Lastly, stakeholder-based alignment describes alignment that exists for a particular pairing of stakeholder groups considering all stakeholder values. A stakeholder-based alignment score is calculated as the mathematical sum of all possible local alignment scores shared between two stakeholder groups for all the stakeholder values. Because in some cases local alignment scores could not be calculated, we normalize value-based and stakeholder-based alignment scores to allow comparison. In the next section, we present further examples for how these metrics were calculated.

Results and discussion

This section first presents the results from the focus groups and then the network analyses. Normalized betweenness scores for each stakeholder group and structural differences between each SVN are compared and discussed using the aforementioned alignment metrics in conjunction with quotes (translated from Spanish to English) from focus group participants and observations from the field. In this section, we highlight either alignment or nonalignment based on these findings and analysis methods.

Value generalization

The focus group activities yielded a spectrum of stakeholder values for each group. These values were aggregated into 11 values that, at minimum, 2 out of 4 stakeholder groups shared. Using these criteria, it was possible to cover the majority of values mentioned by the stakeholders while permitting comparison between at least two stakeholders. However, Table 2 shows that the majority of stakeholder values were shared between two and three stakeholder groups – a result that required us to normalize our scoring metrics. The stakeholder values that emerged through this selection process were technology (Tech), management (Man), communication (Com1), community (Com2), infrastructure (Infra), government and politics (G&P), water resources (WR), water system functionality (WSF), external support (Ext), finances (Fin), and training and education (T&E). Table 2 displays a description of each generalized stakeholder value, along with the language and context used by the stakeholder groups.

Network analysis

The resulting SVNs for each stakeholder group are shown in Figure 3 as a way to visualize the structural interaction of stakeholder values. In these network diagrams, each node is a stakeholder value, and each line is an interaction between these values. Arrows indicate the direction of influence of one value on the other. For example, T&E → WR means training and education affects, and thus informs decisions, related to water resources. The associated normalized betweenness scores are shown for each SVN in Table 3. Because our criteria for stakeholder value generalization allowed a minimum of two stakeholder group pairings, many of the stakeholder values were not comparable over all the stakeholder groups. In this case, stakeholder values that were not unanimously mentioned in a focus group session for a particular stakeholder group are designated with 'no data'. Normalized betweenness scores of zero denote stakeholder values that

Table 2. Value context by stakeholder.

Value	Stakeholder	Context referenced
Technology	Organization Academics	Quality of construction and materials so the system works properly
	Water committees	The type of system being implemented as it influences availability of electricity, materials; technologies that are too expensive may not be supported by the community
Management	Organization	Management would be organized, and all stakeholders would collaborate with effective leadership over the life of the project
	Water committees	Ownership is taken by the water committees who would organize effectively and frequently to assess and maintain the water system
	Government	Management of the water system should be provided by the water committees with support from the local government
Community	Organization	Necessity, demand, motivation, priority, drive community member interaction with the water system
	Academics	A willingness to pay, and a need for a culture of payment within the community; level of community education
Infrastructure	Organization Government Academics	Transportation infrastructure and reliable affordable energy (if applicable)
Government and politics	Organization Government Water committees	Government continuity, communication, law establishment, and reinforcement for water committees
	Academics	Tariff regulation Regulation of the water system technology
Water resources	Organization Water committees	Climate change, natural disasters, deforestation, land use, and source protection
	Government Academics	Water levels, conservation, availability of water resources
Water system functionality	Organization Water committees Government Academics	A functioning system (water quality, quantity, and continuity) is critical for the satisfaction of the community who ultimately pay for the service.
External support	Water committee	Visits from an organization
	Government	Organizational involvement, visitations, trainings
	Academics	The organization picks technology, and continually manages the system and educates the community on proper use of system, and on conflict resolution
Finances	Organization Government	Available funds saved to perform operation and maintenance of system available through the collection of monthly user tariffs
	Academics	Economic level of people
	Water committees	Financial reporting to community
Communication	Government Water committees	Communication related to information on water system functionality, issues, etc.
Training and education	Water committees	Trainings of users on proper and responsible use of the technology
	Academics Government	Training regarding water committee laws and the operation and maintenance of the system

are structurally unimportant; that is, they were not structurally necessary to bridge between other stakeholder values.

Alignment comparisons

Local, value-based, and stakeholder-based alignment scores were calculated using the normalized betweenness scores in Table 3 and are shown in Table 4. In Table 4, all cells (apart from cells on the far-right column and bottom row) display a local alignment score for a particular stakeholder value, calculated as the absolute difference in stakeholder value betweenness scores between two stakeholders. For example, the local alignment score for the finances stakeholder value compared between the water committees and organization (WC:Org) stakeholder groups is calculated as 0.2917 (WC) – 0.3373 (Org) = 0.0456. The cells in the far-right column named 'Norm. row sum' display the normalized value-based alignment scores, calculated by summing all local alignment scores available in each row and dividing by the number of alignment scores for a particular value. As mentioned previously, we chose to normalize this score because in some cases local alignment scores could not be calculated (denoted as 'no data' in Tables 3 and 4). In other words, normalizing the row enabled comparison of value-based alignment calculation for cases where localized alignment scores did not exist. For cases where only one local alignment score existed in a particular row, a value-based alignment score was deemed redundant and not calculated (i.e., for communication, training and

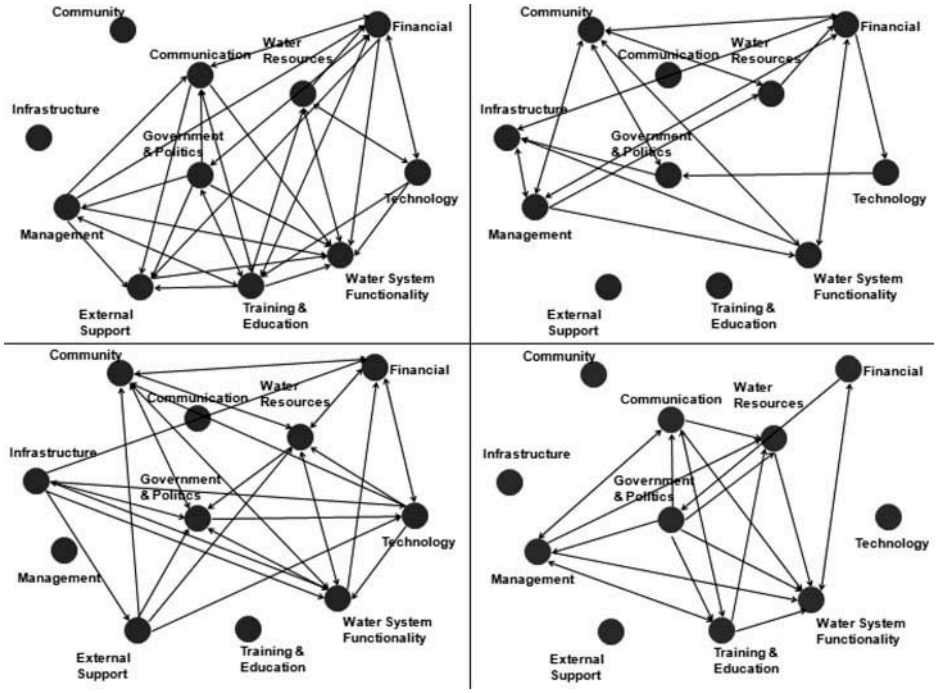

Figure 3. Stakeholder value networks (SVNs), water committees (top left), organization (top right), academics (bottom left), and government (bottom right).

Table 3. Normalized betweenness scores for each stakeholder group ordered from highest to lowest.

Water committees		Organization		Government		Academics	
T&E	0.3170	Fin	0.3373	WSF	0.4000	G&P	0.2937
Fin	0.2917	Com2	0.2103	Fin	0.4000	Fin	0.1258
WSF	0.2277	Tech	0.1429	G&P	0.3667	WR	0.1190
Tech	0.0714	G&P	0.1429	Man	0	WSF	0.0722
Man	0.0104	Man	0.1032	WR	0	Tech	0.0425
G&P	0.0104	Infra	0.0675	Com1	0	Com2	0.0425
WR	0	WSF	0.0198	T&E	0	Ext	0.0107
Com1	0	WR	0.0000	Tech	No data	Infra	0.0079
Ext	0	Com1	No data	Com2	No data	Man	No data
Infra	No data	T&E	No data	Infra	No data	Com1	No data
Com2	No data	Ext	No data	Ext.	No data	T&E	No data

Note: Stakeholder values are abbreviated as follows: G&P, government and politics; Man, management; T&E, training and education; Com1, communication; WSF, water system functionality; WR, water resources; Fin, finances; Ext, external support; Tech, technology; Infra, infrastructure; Com2, community.

Table 4. Alignment scores for the three alignment metrics (lower numbers denote alignment).

Value	WC:Org Org:WC	WC:Gov Gov:WC	WC:Aca Aca:WC	Org:Gov Gov:Org	Org:Aca Aca:Org	Gov:Aca Aca:Gov	Norm. Row Sum	
Finances	0.0456	0.1083	0.1659	0.0627	0.2115	0.2742	0.1447	Value-based alignment
Government and politics	0.1325	0.3563	0.2833	0.2238	0.1508	0.0730	0.2033	
Management	0.0928	0.0104	No data	0.1032	No data	No data	0.0688	
Water resources	0	0	0.1190	0	0.1190	0.119	0.0595	
Water system functionality	0.2079	0.1723	0.1555	0.3802	0.0524	0.3278	0.2160	
Technology	0.0715	No data	0.0289	No data	0.1004	No data	0.0669	
Communication	No data	0	No data	No data	No data	No data	–	
Training and education	No data	0.317	No data	No data	No data	No data	–	
Community	No data	No data	No data	No data	0.1678	No data	–	
Infrastructure	No data	No data	No data	No data	0.0596	No data	–	
External support	No data	No data	0.0107	No data	No data	No data	–	
Norm. column sum	0.0917	0.1378	0.15052	0.1540	0.1231	0.1985		
			Stakeholder-based alignment					

education, and community stakeholder values). A similar normalizing process took place for stakeholder-based alignment, where in this case summing was of cells in a particular column (Norm. column sum).

Comparing local, value-based, and stakeholder-based alignment scores highlights interesting findings on stakeholder alignment in Terrabona. Low scores for each of these metrics imply alignment, and conversely, high scores imply nonalignment. We now present the results from these quantitative analyses for alignment and nonalignment in conjunction with quotes from participants and contextual support from our observations in the field.

Alignment. The water resources stakeholder value appeared to have the lowest value-based alignment score (0.0595), meaning consistently low local alignment scores for each stakeholder pairing, and good alignment for the value overall. Interestingly, the only SVN that yielded a normalized betweenness score over null for water resources was for the academics stakeholder group. The academics local alignment score of 0.119 for water resources (as opposed to 0 for the other stakeholders) is supported by a quote from an academics stakeholder who stated: 'If water resources are not managed well, the water system will not be sustainable'. While the other stakeholders mentioned the importance of water resources for water system sustainability, this importance did not emerge based on their SVNs.

Additionally, both management and technology stakeholder values received low value-based alignment scores (0.0688 and 0.0669, respectively). Within each focus group session, the majority of stakeholders agreed on the value of management as the responsibility of the water committees (a management scheme known as 'community-based management'). However, the details on how management was to be executed within water committees varied substantially between stakeholder groups. As is shown in Table 1, the water committees stakeholders believed they were in charge of the water system; however, organization stakeholders believed the water committee was the primary maintainer of the system, but that all stakeholders should be involved; and government stakeholders believed the community should be in charge of managing the system, with the help of the government. These apparent disparities in perception of the ideal management schemes are reinforced further in the network diagram (Figure 3, top left), which shows a high level of influence from management on other stakeholder values, yet a low level of influence from the other stakeholder values towards management. This shows that management has a greater effect on other stakeholder values than vice versa; and thus the low betweenness scores for management overall.

The technology stakeholder value had a moderately high normalized betweenness score between the stakeholder groups and was referenced primarily in terms of issues related to electricity costs, shown by a quote from one organization stakeholder: 'The type of system is important, because there are systems that pump by gravity and some systems that pump by electricity. The water committee needs to be careful with water systems that pump by electricity, because they need to understand the costs associated with this type of technology, and know that if they don't pay their electricity bills, the electricity will be cut-off, and water will stop flowing.' The network diagrams in Figure 3 support this quote for all three stakeholder groups who mention technology (WC, Aca, and Org), where the structural interaction between these stakeholder values implies that finances affects technology, indicating that finances for operation and maintenance must be considered before choosing a technology. This is representative of the high level of alignment between these three stakeholder groups regarding the technology stakeholder value.

Finances, despite receiving a moderately high value-based alignment score of 0.1447, consistently earned the top 2 normalized betweenness scores for all stakeholder groups (Table 3), meaning finances was a hub for connection to other stakeholder values. Evidence of the influence of finances on other stakeholder values was seen in conversation between stakeholders during the focus groups as they discuss about how finances affects other aspects of water system management, thereby supporting the consistently high betweenness scores seen for finances. The language used by water committee stakeholder groups presents a telling example of this connectivity for finances to management, technology, government, and water resources stakeholder values, summarized in Table 5.

Of the six potential stakeholder-based alignment comparisons (considering all stakeholder values), the lowest scoring comparison was Com:Org (0.0917). That alignment appears to exist between this stakeholder pairing agrees with what we observed in Terrabona. The organization stakeholder group was observed to be closely involved in education and training programs of the water committees, and stated that an important aspect for a successful water project was the motivation and empowerment of water committee members to properly manage

Table 5. Connectivity of the finances stakeholder value stated by the water committees stakeholder group.

Linked value	Quote
Management	*If the finances are managed well, people have faith in their water committees and then they'll pay* [monthly tariffs].
Technology	*The type of technology used affects the amount users have to pay.*
Government	*If we have lots of money, we don't have to depend on the government,[and] if we're sustainable, we wouldn't depend on them . . . well at least not 100%.*
Water resources	*If there was more funds* [in the community overall], *there could be more reforestation . . . and if there was more money, than less people would be cutting down trees* [for fires], *which would affect the environment.*

Table 6. Connectivity of the community stakeholder value stated by the organization stakeholder group.

Linked value	Quote
Maintenance	[water committees] *Will do the maintenance, if they are motivated*.
Finances	*If a culture is made around gathering funds and saving, this will affect the ability to have funds for maintenance. If there isn't a culture of paying, the people won't pay.*
External support	*If the community is motivated, they will search out donors*.
Community	*Without empowerment and motivation, you can't have a sustainable project*.

their water system. This alignment is demonstrated quantitatively by their local alignment score (WC:Org) of 0.0928 for management, and a relatively high normalized betweenness score of 0.2103 for the community stakeholder value. This high betweenness score is further supported by various organization stakeholder quotes that mention the importance of the community for the sustainability of the water project, outlined in Table 6.

Nonalignment. Government and politics and water system functionality stakeholder values appeared to have the highest local (0.3563 and 0.3802, respectively) and value-based alignment scores (0.2033 and 0.2160, respectively), thus signifying an apparent lack of alignment with these two stakeholder values. Government and politics is an easy target since the majority of stakeholders had strong opinions regarding how the government should be involved with rural water supply. This is illustrated well by the quote from a water committees stakeholder about not wanting to depend on the government, shown in Table 5: 'If we have lots of money, we don't have to depend on the government, [and] if we're sustainable, we wouldn't depend on them … well at least not 100%.' This stands in obvious contrast with how the government stakeholder group desires to interact with community water committees by offering them incentives if they agreed to be officially legalized by the government, a process that takes some water committee years to complete: 'So the community will have a water system that works well, the community needs to organize a water committee. We organize the meetings, and we explain the water rights, and we help them do the paper work to become officially recognized so they may have energy subsidies and bank accounts. The government helps improve the capacity of the water committees to support the water system.'

The academics stakeholder group SVN indicated the high importance of government involvement for sustainable rural water services, receiving a normalized betweenness score of 0.2937 for government and politics. This high normalized betweenness score for government and politics indicates a high connectivity between government and politics and the other stakeholder values, as supported by the one academics stakeholder's quote: 'Whether the water system is functioning isn't based on the government, the government isn't involved much in the maintenance. They influence everything else.' Strangely, the government and academics stakeholder groups (Gov:Aca) appeared to be the most poorly aligned, with the highest stakeholder-based alignment score of 0.1985, largely driven by their high local alignment scores for finances (0.2742) and water system functionality (0.3278). Similarly, the organization and government stakeholder groups (Org:Gov) also appear out of alignment, receiving the second highest stakeholder-based alignment score of 0.1540.

Study implications and limitations

The findings from the structural analyses of SVNs showed alignment existed between the water committee and organization stakeholder groups – likely due to how these two stakeholder groups work together and communicate. Alignment between stakeholder groups regarding each individual stakeholder value existed for the values: management, technology, and finances. For the stakeholder value, management, this related to the importance of a viable community-based management scheme; for the technology stakeholder value, this related to the importance of selecting an appropriate technology that could be feasibly maintained by the water committee; and for finances, this related to the importance of available funds for the operation and maintenance of the water system. That alignment exists based on the structural interaction of these stakeholder values implies similar decisions would be made by stakeholders related to a project's finances, management, and technology. This connection between stakeholder value interaction and alignment is supported by the observed management decisions made in Terrabona regarding appropriate technology based on regional finances and the costs of operation and maintenance.

The largest discrepancy of stakeholder-based alignment was found between the academics, organization, and government stakeholder groups. Alignment could be bolstered through improved communication between these stakeholder groups to enable an alignment of their respective water management plans. Improved alignment between these stakeholder groups might then lead to improvements in how community-based water system management schemes are successfully planned, implemented, and managed in Terrabona with the help of external support from the government and local organizations – a strategy that is in line with current best practices in the water sector (Lockwood et al. 2003; Pushpangadan & Gangadhara 2008; Prokopy et al. 2008; Davis et al. 2008; Montgomery et al. 2009; Smits et al. 2012; International Research and Sanitation Centre 2013).

The presentation of qualitative examples gathered from the focus groups allowed us to support the quantitative findings on stakeholder alignment based on the structural analysis of SVNs. As such, this study demonstrates a novel and useful way to quantitatively evaluate

stakeholder alignment. However, it remains to be seen whether comparing stakeholder value interaction accurately predicts future stakeholder alignment, as well as the resulting impact varying levels of alignment may have on water service sustainability. Thus, further research will be needed to validate these and any subsequent findings by investigating whether stakeholder alignment or nonalignment truly manifests in the way inferred by their value networks, and whether this improved alignment truly leads to sustainable water services.

Finally, it is important to note that a stakeholder group representing water users was not included in this study because of our limited research resources. As a result of these constraints, we deemed it infeasible to obtain a representative sample of water user opinions within a single focus group while maintaining the focus group size used for the other four focus groups (i.e., less than 16 participants). Although most of the water committees stakeholders in this study were water users themselves, future studies would certainly benefit from the emergence and analysis of stakeholder values from water users, potentially through a series of focus groups conducted within multiple communities.

Conclusions

This study demonstrates a way to evaluate stakeholder alignment through the analysis of SVNs. SVNs were created using data gathered in focus groups with four different stakeholder groups (government, water committees, academics, and organization) involved in rural water infrastructure implementation and management in Terrabona, Nicaragua. Using data gathered in these focus groups in conjunction with qualitative coding, we identified 11 stakeholder values that could be compared between at least two of the four stakeholder groups. By comparing pairwise interaction between stakeholder values within focus groups, we then created and structurally analyzed SVNs using betweenness centrality as a means to judge stakeholder alignment.

The methods employed in this study allowed for insightful stakeholder alignment comparisons to emerge. From these insights, it was possible to highlight alignment (and nonalignment) of stakeholders based on the structural interaction of their values, which thereby aided in developing recommendations for ways to improve stakeholder alignment in Terrabona. For example, the apparent lack of alignment between government and organization stakeholder groups informed our recommendation for the improved communication between the government and organization stakeholders to better support existing community-based management schemes in Terrabona. This same level of insight on stakeholder alignment in Terrabona could likely be gained by applying this method in other areas and contexts by water practitioners (local organizations, NGOs, etc.) and academic researchers interested in making recommendations for improved stakeholder alignment. Thus, this study provides ample motivation for future research that continues to grow understanding on stakeholder alignment by comparing true stakeholder alignment outcomes with the alignment assessments found by the structural analysis of SVNs.

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