Research

Evaluating determinants of social trust in water utilities: implications for building resilient water systems

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ABSTRACT. As global change increases the frequency and severity of drinking water threats, managers work toward building resilient water systems to adapt to these disturbances. A critical component of resilience is citizen trust in their water utilities. Trust in an institution is a function of individual's calculation of their water utility's capability and track record (rational determinants of trust), feeling that their utility shares values or has goodwill for them (affinitive determinants of trust), personal inclination to trust (dispositional determinants of trust), and belief that the utility is transparent and follows broader system regulations (procedural determinants of trust). Although trust also varies based on citizens' awareness of drinking water issues, it has rarely been studied in a low-salience context where less consideration is given to the trusting relationship. Using a four-stage drop-off pick-up method, we randomly sampled residents in Roanoke, Virginia, an area where drinking water quality is a low-salience issue, to explore the relationship between trust, determinants, and salience. The four determinants best explained the high trust residents had when considered together in the same model alongside salience factors. Procedural determinants were most positively related to overall trust while affinitive and rational determinants had positive relationships only when those beliefs were low. Once affinitive and rational beliefs passed a threshold of strength, their relationship with overall trust became more neutral. Our findings indicate that, for low salience issues, managers looking to increase trust in their institutions should consider focusing on enhancing public understanding of regulations and transparency governing their institution and on reducing potential negative beliefs about their utilities' capabilities, goodwill, and value alignment.

Key Words: *drinking water; governance; institutions; public water system; resilience; salience; trust; water; water security*

INTRODUCTION

Global deterioration of water quality as a result of anthropogenic climate and land-use change poses a considerable threat to drinking water security (Dunn et al. 2012, Pouget et al. 2012, Garrote 2017). These large-scale drivers are introducing increasingly frequent and unpredictable disturbances such as algal blooms, hypoxia, changing metal concentrations, and eutrophication that impact the water quality of the lakes and reservoirs (Olsen and Shindler 2010). Disturbance events can disrupt the water treatment process for many communities that depend on surface water sources for drinking water, resulting in foul odors or tastes. In more extreme cases, disturbances can cause toxin releases that directly threaten human health (Falconer 1999, Moore et al. 2008). For instance, when Lake Erie's water was contaminated by a cyanobacterial bloom in 2014, the water utility in Toledo, Ohio stopped delivery to half a million residents (Fitzsimmons 2014). As anthropogenic influence drives changes in the water quality of lakes and reservoirs, challenges to the security and availability of drinking water, like that in Toledo, continue to occur.

Resilience-based management offers promising strategies to respond to the types of challenges water systems face (Holling 1973, Carpenter et al. 2001, Cumming et al. 2005, Folke 2016). Rather than reacting to events like the Toledo algae bloom after they arise, resilience-based management embraces change as an essential part of a system and attempts to adapt with it to maintain essential functions (Longstaff and Yang 2008, Folke et al. 2009, Folke 2016). This quality makes resilient strategies well suited to address the disturbance events with which drinking-water systems contend.

Social trust is an essential component for resilience-based management because adaptive management often requires managers to reassess priorities and change course as knowledge about the system is gained (Holling 1978). Trust is an asset that helps citizens support management shifts, encourages cooperation (Davenport et al. 2007, Ross et al. 2014), and can improve the speed and effectiveness of management actions (Stern and Coleman 2015). This ultimately allows the public to focus their attention on other aspects of community well-being (Longstaff and Yang 2008, Zellner et al. 2012, Nelson et al. 2017, Song et al. 2019). Distrust can delay effective management by decreasing public receptiveness to communication, cooperation, or adoption of new programs (Leahy and Anderson 2008, Gray et al. 2012, Stern and Baird 2015). When trust is not present, it limits managers' ability to react quickly and effectively to change. As such, the success of management efforts to enhance resilience in drinking water systems and, by extension, protect the security of water resources, often depends on social trust in water management institutions.

Evaluations of trust in institutions like water utilities are likely moderated by the degree to which water security is at the forefront of people's minds (Higgins and Kruglanski 1996, Gray et al. 2012). Although there is high salience for water catastrophes such as those in Flint, Michigan and Toledo, Ohio (Tobin 2017), people are often less attentive to the quality of their tap water if they live in areas that have never or rarely experienced significant water quality issues (Attari et al. 2017, Quisto et al. 2017). When the salience of water quality is low, the decision to trust one's water utility may not reflect meaningful deliberation (Möllering 2006). Further, low salience combined with high trust may result in

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complacency, which could ultimately have negative impacts on institutional resilience (Stern and Baird 2015).

We examined social trust in a water utility to provide safe drinking water as a function of the attributes of the trustor, the trustor's perceived salience of water quality, and their judgements about the water utility supplying their drinking water. Using a sample of residents in Roanoke, a city in southwest Virginia, we expected increased trust to be related to the residents' personal dispositions to be trusting and their positive evaluations of the water utility and broader regulatory system. We considered salience of an issue to be a key scope condition that characterizes trust (Foschi 1997). Although trust and resilience have been widely explored in a natural resource context, previous research has not explicitly considered the role of salience in contextualizing that trust. We expected salience of drinking water as an "issue" to be low and baseline trust in drinking water quality to be relatively high in our target sample because of their water utility's history of providing consistently safe drinking water since its inception in 2004.

Trust ecology and the resilience of drinking water systems

Public drinking water utilities in the United States are a collective solution to the societal need for safe drinking water. These institutions are often imbued with the trust of the communities they serve to continually adapt to both changing demands for water and events, such as land use or climate related change. Change drivers introduce novel challenges, including increasingly frequent and severe algal blooms or the release of toxins into the water columns, that can undermine water treatment facilities' ability to treat and distribute safe drinking water. Their ability to adapt and innovate to these threats depends in part on public trust.

Trust ecology is a general theory of institutional resilience in which trust in institutions, like water treatment facilities, support that institution's ability to adapt to change in ways that preserve their general function even as the specific functions change (Stern and Baird 2015). Trust plays a key role in successful adaptation by, for example, enhancing opportunities for swift, effective cooperation and communication (Davenport et al. 2007, Stern and Coleman, 2015). Groups' inability to trust each other can severely constrain the learning, experimentation, and innovation needed for effective and timely adaptive management (Stern and Baird 2015).

The general function of a water treatment utility is to provide a continuous supply of safe drinking water for the communities it serves. Adaptive facilities are able to continually supply safe drinking water in the face of disturbance events, even if doing so entails shifting specific activities from, for example, water purification to purchasing water from other water treatment institutions. Public trust can provide water treatment facilities with the latitude to explore and experiment with such adaptation strategies.

Trust in institutions to supply safe drinking water represents the willingness of community members to accept the risk that they could lose access to safe drinking water. This willingness is based on the expectation that the utility will consistently provide an acceptable level of drinking water security (Mayer et al. 1995). Trust ecology recognizes that this trust can be exercised through

multiple intersecting channels, including individuals' pre-existing tendency to be a trusting person, their confidence in the capacity of the institution to deliver on outcomes, their feelings of connection to an institution (e.g., sharing similar goals), and their belief that a system of rules exists to provide a safety net to further prompt the institution to provide expected outputs (Stern and Coleman 2015).

Trust ecology reflects the intersection of these paths of trust including the number of channels present and the strength of trust derived from each channel. While some individuals may place more weight on consistent performance (e.g., achieving or exceeding standards for contaminants; Lima et al. 2019), others may place more weight on their positive experience with the institution's agents (e.g., customer service or perceptions of shared values; Perry et al. 2017). Understanding the nature of the trusting connection individuals have to an institution provides insight into the capacity that institution has to maintain trust in the face of events that may undermine it, such as alerts to boil water in the case of bacterial contamination.

Although the idea that increased trust is always related to increased resilience seems intuitive, it is possible that when individuals have high trust for an institution that is rarely at the forefront of their minds, the result is an uncritical confidence in the capacity of an institution to adapt (Stern and Baird 2015). Automatic acceptance can reduce the public's ability to perceive and react to unwanted changes. It can also reduce an institution's drive to experiment with innovative adaptive strategies. This results in complacency, an expectation of continued good outcomes without the active engagement that contributes to them.

Complacency of the public towards drinking water utilities could reduce the resiliency of those utilities. With some notable exceptions such as Flint, Michigan and Toledo, Ohio (Tobin 2017), water quality demands little day-to-day attention for most communities. Social awareness of water quality is not widespread, and the water treatment process itself is not well understood by the general public (Attari et al. 2017, Quisto et al. 2017). The psychological significance that people place on an issue, or an issue's salience, varies from person to person (Stewart 2009). Many people underestimate the amount of water they use, which can lead to further underestimating the impact water has on their lives (Attari et al. 2017). Salience provides a different context for understanding the relationship between trust and resilience, especially given that much of the literature on trust in natural resources focuses on situations where the salience of an issue is high (e.g., Perry et al. 2017, Lima et al. 2019, Song et al. 2019).

Generally, low salience can result in a less conscious form of trust, where an individual largely takes it for granted that the trustee will follow through on their commitments because the alternative is not at the forefront of their mind (Möllering 2006). This taken-for-granted brand of trust can be an asset to resilience-based management, allowing institutions to adapt more quickly while freeing citizens to focus their attention on other aspects of community well-being. However, it can also result in complacency that can reduce the development and integration of public input, diverse ideas, and experimentation and innovation, which may ultimately weaken adaptive capacity. Given the complex ways in which trust can support or undermine the performance of

institutions, there is a need to explore the ecology of trust across natural resource management contexts.

Our conceptual framework of social trust recognizes that it is an emergent property of individual judgements about an institution's capacity to provide expected outcomes (rational determinants), feelings of connection between the institution and community (affinitive determinants), the rules in place to protect community members from abuses of trust (procedural determinants), and an individual's propensity to be trusting (dispositional determinants; Stern and Coleman 2015). Further, these determinants interact with the salience of an issue to understand how trust relates to institutional resilience (Fig. 1). Salience is a multidimensional construct that includes, among other indicators, familiarity with, knowledge about, and attention paid to an issue (Stewart 2009).

Fig. 1. Trust in a water utility is a function of judgments about the utility, the utility's regulatory system, and personal propensity to trust, and the salience of the issue.
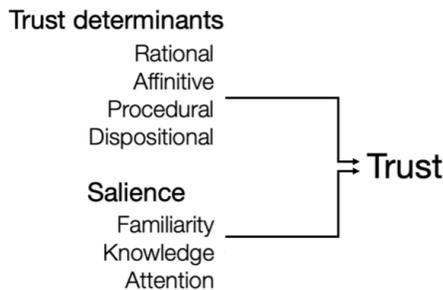
Our framework explores how trust in a water treatment utility is related to that institution's efforts to increase its capacity to provide consistently safe drinking water in the face of changing environmental conditions. The population we sampled in southwestern Virginia has not received any serious warnings in the 16 years of the utility's existence that would require them to change their drinking habits. Because of this, we expected that drinking water would be a low salience issue for our community, indicated by low familiarity, knowledge, and attention (Stewart 2009).

The trust ecology framework has been applied to many natural resource contexts, most often focusing on situations where relevance to stakeholders is high. For instance, Perry et al. (2017) found that trust between coastal residents and marine reserve managers was most strongly driven by affinitive determinants (shared values), which were higher in residents who lived closer to the marine reserves. Lima et al. (2019) examined trust between collaborating U.S.- and Mexico-based fishery organizations and found that, when procedural determinants was consistently low, members relied on rational determinants as a basis for their trust. Song et al. (2019) focused on a fishery management network in the Great Lakes region and found that rational and procedural determinants were important to mutual goal alignment between organizations, while affinitive determinants were critical to effective communication and decision making. Studies that considered dispositional determinants found weak or no

relationships with trust, suggesting that dispositional determinants may act more as a baseline for trust than a driver of it (Lima et al. 2019, Song et al. 2019).

We expected that higher degrees of any of the four determinants would be related to higher trust from residents (trustors) in the drinking water utility (trustee). In a context where concern about in-home water quality is not a salient issue and interactions with a water utility are limited, there could be a lack of interpersonal relationships that typically form the basis of rational and affinitive determinant assessments. In this case, we anticipated that procedural and dispositional determinants would be strongly related to an individual's overall trust in their water utility.

METHODS

Study area
The greater Roanoke area, in southwestern Virginia, includes the city of Roanoke and three surrounding counties: Franklin, Botetourt, and Roanoke. It is home to roughly 283,000 individuals and characterized by both urban and suburban neighborhoods (U.S. Census Bureau 2017a). The greater Roanoke area is populated by mostly white (81%) residents with a median income between $41,483 within the city of Roanoke to $64,733 within Botetourt County. The majority (89%) of residents have a high school education or higher (U.S. Census Bureau 2017a).

With the exception of one adjacent city that supplies its water to residents, all municipal water for the area comes from a single water utility. Since its inception in 2004, this utility has not experienced water safety problems severe enough to necessitate warning residents about water quality. Of the 130,000 households in the greater Roanoke area, approximately 48% receive drinking water from the utility. The utility's main water sources include two surface water reservoirs and one underground spring.

Sampling and data collection
Because our study was part of a larger investigation centered on the water quality of reservoirs that are sources for drinking water, we limited our population to residents whose households receive tap water from the water utility's two surface water reservoirs. We formed our sampling frame using publicly available data, cross-referenced entries with the water utility to ensure the sampling frame included only households who received water from the target reservoirs. We randomly selected 800 residents from this list to form our sample and collected data through a survey. Eight people were removed because of invalid addresses, leaving a final sample of 792. A response rate of 40% (n = 385) would provide ±5% sampling error for 95% confidence intervals (Dillman et al. 2014).

We employed a four-stage drop-off pick-up method based on Trentelman et al. (2016) for our survey distribution. We selected the drop-off pick-up approach because we anticipated that the lack of major water quality issues in the region over the past two decades would result in low salience of the topic and suppress participation in a mail survey. Drop-off pick-up methods emphasize social exchange and typically yield a 60–70% response rate, which is substantially higher than mail or phone survey modes (Steele et al. 2001, Jackson-Smith et al. 2016, Trentelman et al. 2016).

We began the data collection effort by sending letters to each resident in our sample one-week before the first in-person visit. This letter informed them of the study and our upcoming visit. Each house then received up to three in-person visits: the first to invite the resident to participate and drop off the survey, and, if the resident agreed, up to two follow-up visits as needed to retrieve it. Each member of the research team followed a script adapted from Dillman et al. (2014) and Trentelman et al. (2016) to enhance the uniformity of our interactions with residents. We visited addresses two days apart to give the resident enough time to complete the survey. If the resident had not completed the survey by the research team's third and final visit, we provided that resident with a postage-paid envelope allowing them to mail back the survey at their convenience. If a resident was not home when researchers visited, researchers made up to two additional attempts per visit to make contact on a different date and time. Each time we failed to contact a resident in these attempts to retrieve a questionnaire, researchers left a note on the participant's door saying, "Sorry we missed you, we will be back on [insert date]." If despite these efforts, we were not able to contact a resident to pick up their survey, we left a note on their doorstep explaining our retrieval attempts and provided a packet with a spare survey, cover letter, and a postage-paid envelope for the resident to return the survey in at their convenience. If we were unable to contact a resident for the initial visit after three attempts, we left a similar packet by their door with a longer note containing introductory details about the project and an invitation to participate.

We scheduled visits between 4 PM and 8 PM on weekdays and between 10 AM and 4 PM on weekends to maximize the likelihood that residents would be home. We began collecting data in September 2019 and suspended collection in November because of daylight savings time and safety concerns about working after dark. We intended to complete data collection in March 2020. However, our ability to continue data collection was precluded by the COVID-19 pandemic. This reduced our sample of 792 to 611. Although the sample selection was random, we distributed our survey based on geographic convenience. As a result, we were unable to sample 181 addresses clustered to the northeast of the City of Roanoke. Because race has been associated with water quality issues (Doria 2010, Fragkou and McEvoy 2016), we conducted a test on the equality of proportions comparing the proportion of respondents in each race category in our sample to 2017 data from the U.S. Census Bureau (2017b; Table A1.1). Although we are confident in our results, we do not generalize to all residents on municipal water in the greater Roanoke area because of potential systematic differences in socioeconomic status across neighborhoods.

Measurement
The survey instrument focused on residents' trust in their water utility to supply safe drinking water to their homes, the salience of in-home water quality, beliefs about and use of tap water in the home, and demographic information. We pretested the entire instrument (n = 60) on students at Virginia Tech and conducted a pilot study in Roanoke (n = 20) before implementing the survey.

Trust
The dependent variable of interest, trust, comprised two items based on Mayer et al.'s (1995) and Stern and Coleman's (2015)

conceptualizations of trust as a willingness to accept vulnerability (Fig. A1.1). According to this conceptualization, willingness to trust and willingness to accept vulnerability both represent trust. We first asked residents the extent to which they "trusted [their] local water utility to provide drinking water to [their] home that is safe to drink." Second, we were specifically interested in their willingness to accept vulnerability and asked respondents the extent to which they were "comfortable with [their] local water utility controlling the quality of water delivered to [their] home." We considered the resident to be the trustor, the water utility to be the trustee, and delivery of safe drinking water as the trusting behavior.

We were concerned about a potential lack of variation in responses because of high levels of trust resulting from a lack of major water quality issues over the previous 16 years. Prior to in-person pretesting, we used Amazon Turk to test a variety of trust indicators. For instance, we tested 5-point and 7-point agree-disagree Likert-type scales and found very little disagreement. Further, we were concerned that disagreement on the scale may reflect a lack of trust for some and distrust for others; however, distrust is a separate concept and not the focus of our study (Stern and Coleman 2015). We found that a unipolar scale resolved this concern and achieved better variation. We further pretested and refined the indicators-based feedback from the university community and from in-person pretesting in the field (n = 20). Our final scale measured trust on a scale from 1 = Do not trust at all to 9 = Completely trust, and vulnerability from 1 = Not comfortable at all to 9 = Completely comfortable. Because the distributions were similar and the items highly correlated (r = 0.92), we combined indicators into a single trust item using their means (Fig. A1.1).

Trust determinants
We used concepts from the trust ecology framework to develop indicators for the determinants of trust (Stern and Baird 2015, Stern and Coleman 2015; full question items found in Table A1.1). We operationalized rational determinants as a function of an individual's belief that their water utility has delivered and remains capable of delivering safe drinking water to their home. Affinitive determinants were measured as a function of an individual's general feelings of connection, goodwill, and value alignment with their utility. Dispositional determinants were based on the respondent's general tendency to be trusting, and procedural determinants were based on their belief that their water utility is regulated by larger governmental systems ensuring the delivery of safe water. Respondents rated their level of agreement for four rational determinant indicators, four affinitive determinant indicators, four procedural determinant indicators, and one dispositional determinant indicator. Rational, affinitive, and dispositional items were measured on a 7-point Likert-type scale from 1 = Strongly disagree to 7 = Strongly agree. Because the procedural determinants statements were designed to examine respondents' beliefs in the existence of systems that prevent their utility from delivering unsafe water, we used a 5-point scale from 1 = Definitely not true to 5 = Definitely true for procedural items. Our dispositional determinant indicator asked respondents to indicate the degree to which they "generally trust others," which is a well-validated indicator of generalized trust (Yamagishi and Yamagishi 1994, Yamagishi et al. 2015). We used exploratory

Table 1. Salience descriptive statistics.

Salience item	Obs.	Mean	Median	St. Dev.	Minimum	Maximum
Attention	348	1.68	1	0.74	1 = Never	4 = Often
Familiarity	341	2.07	1	1.01	1 = Not Familiar	5 = Extremely Familiar
Information Known	343	2.35	2	0.98	1 = No Information	5 = A Great Deal

factor analysis and Cronbach's alpha to assess the dimensionality and internal consistency of each determinant and created composite indicators of rational, affinitive, and procedural determinants (Table A1.1).

Salience
To measure salience, we adapted indicators from Stewart's (2009) framework for weather forecasting systems and focused on attention to the issue, impact on daily activities, emotional impact, and familiarity with one's drinking water system. We asked residents to respond to two questions about their knowledge about water quality and its delivery. The first question asked respondents to indicate the amount of information they could provide to a friend or family about their neighborhood's water quality (1 = No information to 5 = A great deal of information). The second question asked residents how familiar they were with what their water utility did to provide drinking water to their homes. (1 = Not familiar to 5 = Extremely familiar).

We measured attention using four questions asking how often respondents noticed unacceptable changes in their water in terms of taste, smell, appearance, and in general (1 = Never to 5 = Extremely often). We used Cronbach's alpha and exploratory factor analysis to assess the dimensionality of attention and combined the four items into a single index (Cronbach's alpha = 0.87, Table S1). We examined means and distributions to assess the degree of salience for tap water.

Data analysis
To understand the relationship between each determinant and overall trust, we visually inspected locally weighted regression lines over scatterplots. The rational and affinitive determinants exhibited non-linear relationships with the trust indicator. We used Akaike's information criterion (AIC) to identify the appropriate polynomial terms to include (Anderson et al. 2000). This approach protects against overfitting the model.

We employed two ordinary least squares regression models to examine the relationship between overall trust, trust determinants, and salience. Our first model examined the relationship between overall trust and rational, affinitive, procedural, and dispositional determinants. Our second model explored the potential moderating role of salience on overall trust. This final model explores how variation in salience relates to overall trust.

We conducted a commonality analysis of both models to identify the variance contribution that indicators explain in the models (Nimon et al. 2008, Sorice 2012). This analysis uses semi-partial correlations to partition the explained variance of overall trust for each variable into its unique contribution and its shared contribution, i.e., common to all possible combinations of variables.

Because this research was part of a larger study, the survey included an experimental design that involved three treatments addressing a separate research question. Although we found no effect related to the order of questions in the survey, best practices suggest including the treatment variable in the model (Tourangeau et al. 2000).

RESULTS
We contacted 538 residents out of the 611 addresses attempted between September and November 2019 for a 75% contact rate. Of those, 114 declined to participate, 57 did not return their survey, and 7 were deemed ineligible because of language barriers or illness. A total of 352 residents returned completed surveys for an 89% cooperation rate, a 59% response rate (AAPOR 2016), and a ±5.2% sampling error. According to a test of proportions, the race and gender demographics we measured in our sample did not differ significantly from the population's 2017 census measured demographics (U.S. Census Bureau 2017b, c; Table A1.2).

Salience
As expected, drinking water quality was a low-salience issue (Table 1). Most respondents (83%) reported that they "never" or "rarely" noticed changes in their water. Further, most (65%) were "not" or only "slightly" familiar with what their water utility did to provide tap water to their home, and only 7% "very" or "extremely" familiar. Knowledge about the general water quality in their neighborhood was also low with 60% indicating that they could provide no information or a little information and only 10% indicating they could provide "a lot" or "a great deal" of information.
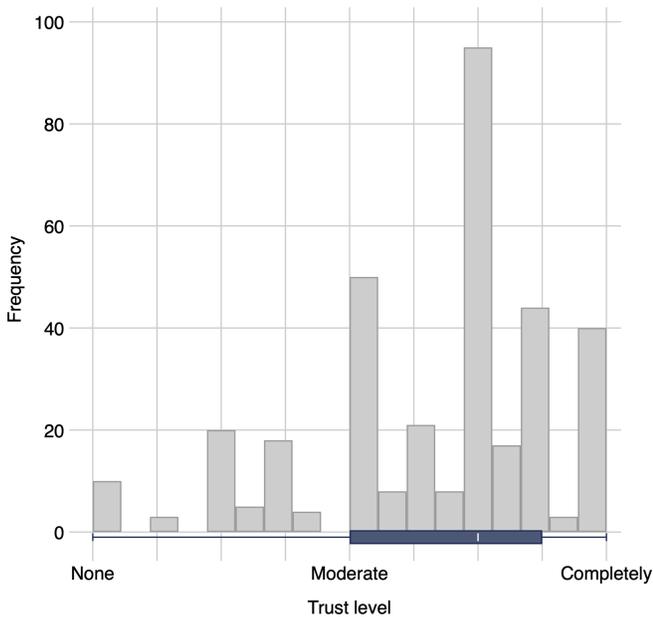
Trust
Overall, respondents trust their water utility (Mean = 6.3, Standard deviation = 1.9, Median = 7; Fig. 2). Although ~30% indicated that they mostly or completely trust the water utility, the distribution is left-skewed with 16% indicating less than a moderate level of trust.
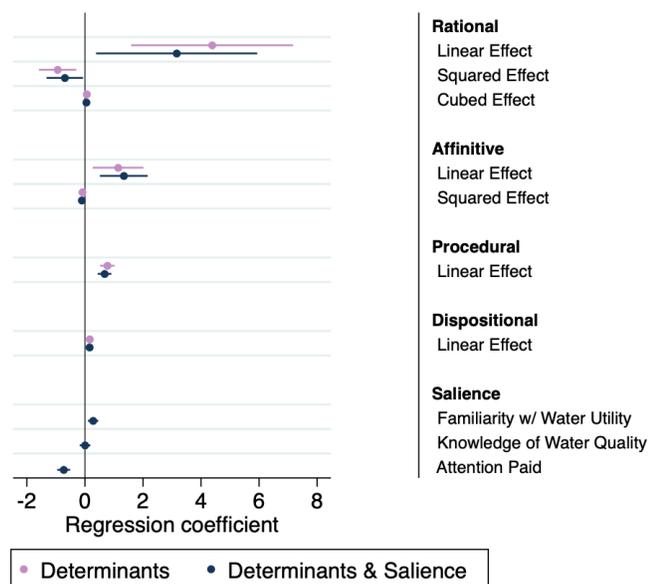
Determinants of trust
To examine the role determinants played in residents' trust, we employed an AIC model selection procedure, which indicated that the third-degree polynomial for the rational determinant and a second-degree polynomial for the affinitive determinant provided the best fit to the data. All four trust determinants were significantly related to the overall trust level ($F_{(9, 318)} = 23.70$, $p < 0.01$, $R^2 = 0.40$, $R^2_{adjusted} = 0.38$; Pink plot in Fig. 3; Table A1.3).

The relationship between expected trust and rational, affinitive, procedural, and dispositional determinants differed markedly (Fig. 4). At the lower end of the scale, from "strongly disagree" to "slightly disagree," there is a large positive association of

Fig. 2. Histogram with boxplot showing the distribution of overall trust in a water utility to provide safe drinking water.


Fig. 3. Coefficient plot with 95% confidence intervals for regression model of trust determinants only (pink plot) and a regression model that includes salience (blue plot). Table A1.3 contains the full regression output.

rational determinants with trust. However, once neutral levels are reached, the association disappears (Fig. 4A). Similarly, affinitive trust determinants were also nonlinear, demonstrating a positive association with trust when disagreement was present. This

relationship dampened as agreement on affinitive trust determinants increased (Fig. 4B). Taken together, these findings suggest that negative assessments of rational and affinitive determinants are more strongly associated with overall trust than positive assessments. Procedural and dispositional trust determinants exhibit linear positive relationships with overall trust (Figs. 4C and 4D)

Fig. 4. Relationship between rational (A), affinitive (B), procedural (C), and dispositional (D) determinants of trust and expected overall trust holding other determinants constant at their averages. Random noise was added to the scatterplot to perturb the location of markers of overlapping data and provide greater information about the number of observations at each point.
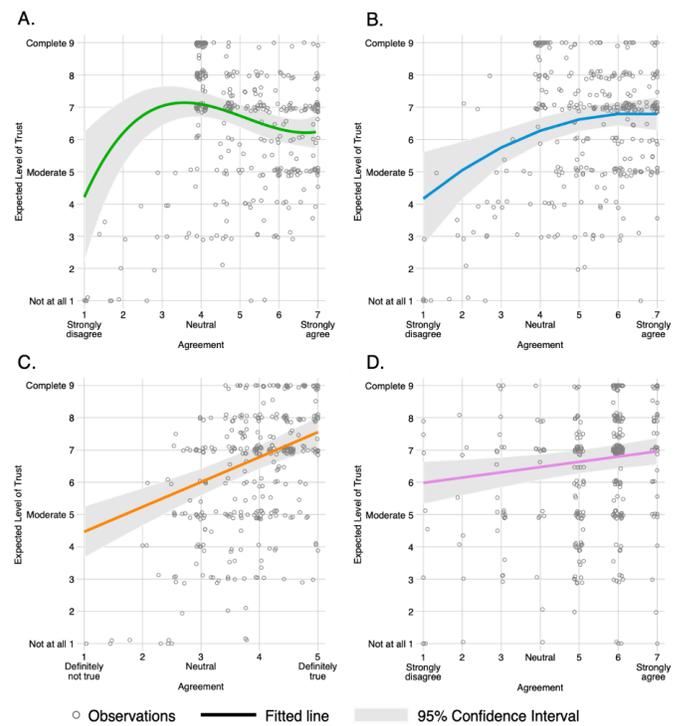
A commonality analysis indicates that, although determinants individually contribute to explaining variance, over half (59%) of the total variance explained by the model is shared by multiple determinants (Table 2). Individually, the procedural determinants uniquely contributed the most to explaining variation in overall trust (7%), more than twice as much as the rational and affinitive determinants.

Determinants of trust and salience
To determine the importance of considering salience when explaining trust variance, we compared the regression model of trust (Fig. 3, pink plot) to one that also included salience factors (Fig. 3, blue plot). Adding indicators of salience to the trust determinant model improved the fit (ΔAIC = -42.98) and increased the R^2 from 0.40 to 0.48 ($F_{(3, 315)}$ = 16.91 p < 0.01; Table A1.4). All trust determinants remained statistically significant, although the

Table 2. Commonality analysis showing the unique variance explained by the determinants of trust.

Determinant	R^2 Contribution
Unique to rational	0.02
Unique to rational squared	0.01
Unique to rational cubed	0.01
Common to rational, rational squared, and rational cubed	-0.01
Unique to affinitive	0.01
Unique to affinitive squared	0.01
Common to affinitive and affinitive squared	0.01
Unique to procedural	0.07
Unique to dispositional	0.01
All other common variance	0.24

Table 3. Commonality analysis showing the unique variance explained by the determinants of trust and salience.

Determinant	R^2 Contribution
Unique to rational	0.01
Unique to rational squared	-0.01
Unique to rational cubed	0.01
Common to rational, rational squared, and rational cubed	-0.02
Unique to affinitive	0.02
Unique to affinitive squared	0.01
Common to affinitive and affinitive squared	0.00
Unique to procedural	0.05
Unique to dispositional	0.01
Unique to familiarity	0.01
Unique to information	0.00
Unique to attention	0.07
Common to familiarity, information, and attention	0.00
All other common variance	0.32

coefficients for rational, procedural, and dispositional determinants were somewhat dampened. Familiarity with the water utility was positively related to trust ($b = 0.28$, $t = 3.06$, $p < 0.01$) while attention paid to changes in water quality was negatively related to trust ($b = -0.73$, $t = -6.46$ $p < 0.01$). The ability to inform others about one's water quality was not related to overall trust ($b = -0.00$, $t = 0.02$ $p = 0.98$). In sum, the more familiar residents were with their water utility's actions to provide tap water to their home, the higher the trust. Those who paid greater attention to water quality exhibited lower trust.

The commonality analysis indicates that two-thirds of the total variance explained by the salience model is common to multiple trust determinants (Table 3). The level of attention that residents pay to changes in water quality uniquely accounts for 7% of the variance in the model, making it the strongest unique contributor. Salience factors alone, or in combination with each other, contribute 8% of the variance explained by the model, indicating that the remaining variance can be attributed to trust determinants or the variance shared between trust determinants and salience.

DISCUSSION
Water utilities are tasked with the critical job of safeguarding the production of drinking water. People tend to pay little attention to and lack knowledge about water systems, especially when utilities consistently provided acceptable tap water that meets safety standards (Attari et al. 2017, Quisto et al. 2017). The nature of trust in these low salience conditions has not been explored and questions exist about how public trust in an institution interacts with salience to affect that institution's resilience. We found that trust is multi-dimensional, with contributions from rational, affinitive, procedural, and dispositional determinants. We also found that trust is related to the salience of the issue and that those with the lowest levels of trust pay more attention on average to changes in their drinking water quality.

Determinants of trust
Of the four trust determinants of the trust ecology framework, the procedural determinant exhibited the strongest unique contribution to overall trust variance, almost doubling the contribution of the next strongest contributing variable (Table 3). The affinitive and rational determinants contributed equally to trust; dispositional trust contributed the least.

In a low salience context, trustors generally have little information and experiences with trustees to form affinitive judgments, yet affinitive determinants of trust are significantly related to trust. Previous research has highlighted how important perceptions of shared values, goodwill, and emotional connections are to building effective relationships and overall trust. For example, Perry et al. (2017) determined that residents' trust in the organizations that managed their local coastal reserves increased the more residents felt they shared values with the institution. However, those were in high salience contexts. Stern and Coleman (2015) describe how affinitive judgments can be formed based on cognitive evaluation or subconscious judgments of a trustee's character. The latter can be an indicator of reliance on an affect heuristic, or automatic feeling-based associations with a topic (Slovic et al. 2007). Our findings suggest even when information to reinforce emotional or value-based connections is largely absent, affinitive determinants can play an important role in understanding trust.

Both affinitive and rational determinants exhibited nonlinear relationships with overall trust. These patterns indicate that the concept of distrust may be relevant to this low-salience issue. Distrust is specific to judgments where a trustor believes a trustee will negatively affect them (Stern and Coleman 2015). In such cases, a trustor rejects vulnerability rather than accepting it (Möllering 2006). Because trust and distrust are distinct concepts that relate to meaningful behavior relevant to institutional resilience (e.g., Stern 2008), future research could consider the role distrust plays on trust in low salience contexts.

The nonlinear relationships between affinitive and rational determinants and trust are reminiscent of satisficing theory, which posits that decisions can be made that either maximize optimum outcomes or satisfy a minimum threshold (Simon 1956). This suggests that gains in trust can be limited once individuals believe the utility performs up to a certain standard that encapsulates their interests (in the case of rational trust) or once it demonstrates its positive character or good intentions to the trustor (in the case of affinitive trust; Stern and Baird 2015). Consequently, efforts to improve social trust in similar low salience situations may be the most effective for individuals with

initially low levels of trust if those efforts target rational or affinitive determinants. Efforts to increase trust when trust is higher may be more successful if they attempt to increase confidence in procedural determinants.

Procedural determinants demonstrated a linear positive relationship with overall trust. Unlike rational and affinitive determinants, procedural determinants are not dependent on evaluations of the trustee per se, but rather the system within which the trustor and trustee co-exist (Stern and Coleman 2015). When there is little contact or communication between a trustor and trustee, as is true with water systems, the information about utilities needed for the trustor to form rational and affinitive judgments may be limited. However, in these same situations, the information needed about broader systems that trustors rely on to form procedural judgments is available. For instance, public water utilities in the United States are required to annually provide citizens with a water quality report about their drinking system. In place of judging a specific organization, trust may be enhanced by ensuring utilities are required to adhere to standards and that these requirements are reliably communicated and enforced.

Although the determinants provide insight into the individual components of trust, the ecology is defined by intersection of all four determinants. Notably, the commonality analysis indicates that two-thirds (66%) of the variance explained by the model is shared by two or more determinants. This indicates a presence of a diversity in "ways of trusting" and supports the existence of resilient relationship between the water utility and the public; trust ecology theory suggests that adequate stores of each type are necessary to support resilience. This trust diversity can serve a redundancy function that buffers the utility from the effects of a potential disturbance or loss of trust (Stern and Baird 2015).

Salience

As expected, residents indicated that their drinking water quality was a low-salience issue and had high trust in the water utility to deliver safe drinking water to their homes. We suggest that one mechanism for understanding why high trust under low salience occurs is the concept of cognitive frames. Although judgments of trust may be deliberative at first, the knowledge created and the initial decision to trust an entity guides future information processing and frees an individual from having to continuously reanalyze the decision to trust (Lewicki and Brinsfield 2011). Frames remain stable unless a new experience forces a trustor to reconsider their initial deliberation, and this can result in complacency. This idea complements Möllering's (2006) theory that in stable, low salience contexts, trust can be "taken for granted," where individuals continue to trust with little question. Taken-for-grantedness allows trustors to devote less cognitive effort to an issue as expectations for consistent outcomes of the relationship increase based on acceptable performance.

Contexts with high trust and low salience can provide institutions such as drinking water utilities with the social and political capital that allows them to experiment, innovate, and improve their adaptive capacity. Previous research on trust and resilience in high salience natural resource management suggested that an optimal level of trust tended to be high and diverse across determinants (e.g., Perry et al. 2017, Lima et al. 2019). Our findings reflected these characteristics. However, with issues of low salience, taken-for-grantedness can lead to a level of complacency that undermines adaptive capacity, especially when managers lose sight of the inevitability of disturbance and surprise in systems. Thus, an optimal level of trust includes an important role for both a lack of trust, i.e., wariness, and distrust, because they can stimulate stakeholder engagement that questions the traditions and assumptions under which institutions operate (Stern and Baird 2015).

The threshold at which trust becomes complacency is difficult to identify, and the relationship between complacency and institutional resilience is equally difficult to determine. However, preliminary indicators suggest that the water utility in our study has not fully captured the trust of the community and draws trust from multiple sources. Institutionally, the water utility continues to experiment and innovate, currently funding research to explore new avenues for adapting to change (Dhillon 2020). Although our findings suggest some degree of resilience may exist, longitudinal research on trust ecology is necessary to understand the relationships between trust, salience, and the system's actual resilience should meaningful disturbance occur.

CONCLUSION

Our research sheds new light on how trust ecology operates in low-salience situations. Prior studies of trust in natural resource management have more commonly focused on highly salient issues, such as the impacts of protected areas on communities (e.g., Stern 2008), outreach evaluations for conservation program participants (Lutter et al. 2018), or the attitudes of residents directly impacted by conservation actions (Perry et al. 2017). The contribution of each trust determinant may differ as changes in context require residents to reassess the trust relationship. Our findings suggest that incorporating salience as an explicit scope condition can enhance theory and understanding of the factors that influence trust judgments. Our findings support the trust ecology framework's emphasis that determinants of trust may operate differently from each other, yet all are necessary components for trust and the support of institutional resilience. Our findings support prior research regarding threshold effects of trust and suggest that, for rational and affinitive determinants, clearing a threshold of distrust (moving into at least neutral territory) may be more important than achieving fully positive evaluations of the trustee. Moreover, we found that building rational, affinitive, and procedural trust was important for influencing positive relationships with public entities.

As global change threatens the security of water systems, resilience-based management is a core strategy to protect water systems and to support the general function of water utilities to supply safe water. Community support for this capability allows managers to act with less resistance, frees residents from continual concern, and enables the community to focus on other aspects of well-being. Trust is an important component for building the social resilience of a system. In high-trust, low-salience contexts, trust-building or maintenance may come less from the flow of information and more from the ability of the water utility to adhere to water quality standards, provide consistent service, and invest in efforts to increase goodwill in the community. Careful attention to the amount of trust present can provide critical insights into the vulnerability of the system.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.
php/12833

Data Availability:

The data that support the findings of this study are not publicly available because of confidentiality restrictions with human subjects research. Ethical approval for this research study was granted by the Virginia Tech Institutional Review Board (IRB #19-023).

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Appendix 1: Supplemental materials

Trust and vulnerability

Although trust had a slightly higher mean than vulnerability, statistically the two indicators were not different from each other (t (344) =1.87, p = 0.06). In addition to a 0.92 correlation between the two items, a quantile-quantile plot (Figure A1.1A) and a comparison of distributions (Figure A1.1B) indicated that the distribution for trust and vulnerability are similar in spread and shape. Both variables have the same median (md = 8). Based on this, we combined trust and vulnerability into a single item we labeled "overall trust," using the mean score for each respondent. Overall trust in the water utility to deliver safe drinking water was generally high (Mean = 6.3, SD = 1.9, md = 7). We used this overall trust measure as this as our dependent variable throughout the analysis.
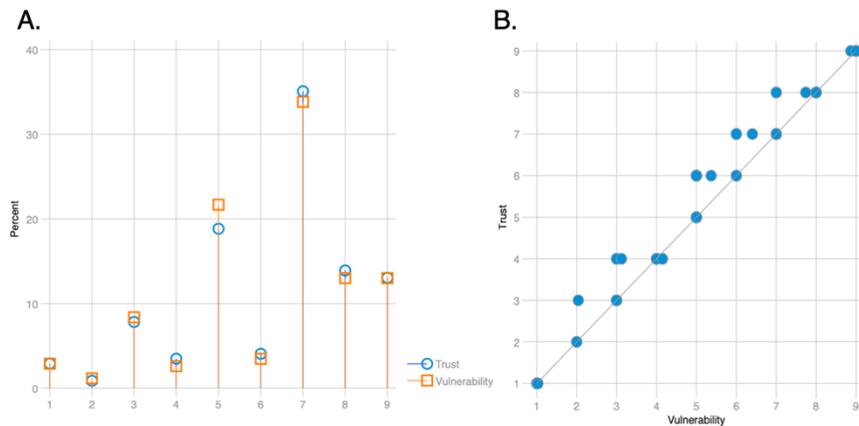
Figure A1.1 Visual inspection of trust and vulnerability indicators using a histogram (A) and a q-q plot (B) suggest a similar distribution across indicators.

Table A1.1: Indicators used to create composite variables.

Item	Observations	Mean	Standard Deviation	Median	Alpha
Rational Items[ab]					0.81
Capability: is capable of delivering safe drinking water to me	341	5.1	1.5	4	
Past performance: has consistently delivered safe drinking water to me	338	5.0	1.6	4	
Future expectations: will consistently meet my drinking water expectations	339	5.1	1.8	5	
Skill: is highly skilled at delivering safe drinking water to my home	339	5.2	1.6	5	
Affinitive Items[ab]					0.85
Interest alignment: cares about the quality of my drinking water at least as much as I do	341	5.4	1.7	6	
Encapsulated interests: has my best interests at heart	338	5.2	1.7	6	
Values similarity: shares values similar to mine	335	5.3	1.6	5	
Caring: cares about my well-being	340	5.2	1.7	6	
Procedural items[ac]					0.75
Public engagement: is required to listen to public input	344	4.4	0.8	5	
Compliance: is required to obey laws that ensure they distribute safe water	346	3.6	1.1	4	
External monitoring: would face consequences from the government if they failed to distribute safe water	345	4.0	1.1	4	
Conflict resolution: has procedures in place to resolve any problem I might bring to their attention	345	3.7	1	4	
Dispositional items[b]					N/A
I find it hard to trust others	338	5.3	1.4	6	
Salience attention items[d]					0.86
Notice changes in smell	347	1.7	0.8	1	
Notice changes in appearance	345	1.6	0.8	1	
Notice changes in taste	343	1.8	1.0	1	

[a]Items prefaced with: *My water utility…*
[b]7-point Likert-type scale: 1 = *Strongly disagree*, 4 = *Neutral*, 5 = *Strongly agree*
[c]5-point scale: 1 = *Definitely not true*, 3 = *Unsure*, 5 = *Definitely true*
[d]5-point scale: 1 = *Never*, 2 = *Rarely*, 3 = *Sometimes*, 4 = *Often*, 5 = *Extremely often*

Table A1.2: Nonresponse bias check for sample and population data by census block group based on 2017 data. There were insufficient observations for Native Americans/Native Alaskans and Native Hawaiians in our sample to perform a test of proportions.

Indicator	Population Total	Population Percent	Sample Total	Sample Percent	Mean Difference	St. Err. Difference	z	p
Black	19985	18.74%	47	13.43%	-0.05	0.05	-0.93	0.351
White	77781	72.93%	259	74.00%	0.01	0.03	0.39	0.699
Asian	4066	3.81%	12	3.43%	-0.00	0.05	-0.07	0.945
Hispanic	4514	4.23%	9	2.57%	-0.02	0.05	-0.25	0.805
Female	55560	52.10%	178	50.86%	-0.00	0.04	-0.06	0.949

Table A1.3. Regression results for trust ecology measures

Source	SS	df	MS	$F_{(9,324)}$	p
Model	515.6234	9	57.2915		
Residual	751.6221	324	2.3198		
Total	1267.245	333	3.805	24.70	<0.0001

Number of obs	R^2	$R^2_{adjusted}$	Root MSE
334	0.41	0.39	1.5231

Variable	b	Std Err	t	p	95% Confidence Interval	
Constant	-6.7219	1.4627	-4.60	0.000	-9.5994	-3.8443
Rational trust	4.3820	1.4184	3.09	0.002	1.5917	7.1724
Rational trust (squared term)	-0.9413	0.3281	-2.87	0.004	-1.5868	-0.2957
Rational trust (cubed term)	0.0611	0.0242	2.53	0.012	0.0135	0.1088
Affinitive trust	1.1418	0.4446	2.57	0.011	0.2672	2.0164
Affinitive trust (squared term)	-0.0881	0.0445	-1.98	0.048	-0.1756	-0.0006
Procedural trust	0.7725	0.1269	6.09	0.000	0.5228	1.0222
Dispositional trust	0.1631	0.0649	2.51	0.012	0.0354	0.2908
Treatment						
Control (Reference group)						
General information	-0.1395	0.2106	-0.66	0.508	-0.5539	0.2748
Technology-specific	-0.2807	0.2088	-1.34	0.18	-0.6915	0.1302

Table A1.4. Regression results for trust ecology measures including salience indicators

Source	SS	df	MS	$F_{(12,315)}$	p
Model	585.7846	12	48.8154	24.67	<0.0001
Residual	623.2398	315	1.9785		
Total	1209.0244	327	3.6973		

Number of obs	R^2	$R^2_{adjusted}$	Root MSE
328	0.48	0.46	1.4066

Variable	b	Std Err	t	p	95% Confidence Interval	
Constant	-4.3973	1.6397	-2.68	0.008	-7.6235	-1.1710
Rational trust	3.1600	1.4114	2.24	0.026	0.3831	5.9368
Rational trust (squared term)	-0.6950	0.3197	-2.17	0.030	-1.3240	-0.0659
Rational trust (cubed term)	0.0462	0.0233	1.99	0.048	0.0005	0.0920
Affinitive trust	1.3383	0.4191	3.19	0.002	0.5137	2.1629
Affinitive trust (squared term)	-0.1096	0.0418	-2.62	0.009	-0.1920	-0.0273
Procedural trust	0.6744	0.1195	5.64	0.000	0.4393	0.9095
Dispositional trust	0.1558	0.0614	2.54	0.012	0.0350	0.2765
Salience						
Familiarity	0.2796	0.0913	3.06	0.002	0.1000	0.4592
Informational	0.0020	0.0930	0.02	0.983	-0.1810	0.1849
Attention	-0.7338	0.1136	-6.46	0.000	-0.9574	-0.5103
Treatment						
Control (Reference group)						
General information	-0.0599	0.1981	-0.30	0.763	-0.4496	0.3299
Technology-specific	-0.0952	0.1969	-0.48	0.629	-0.4826	0.2923