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Attitudes toward water resilience and potential for improvement

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Research Article

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Abstract

Non-technical summary. There is a global water crisis, brought on by human actions. The ways we make decisions about water must transform to solve it. We focused on the attitudes that people in society hold toward water to understand how close or far away we are from a broadly accepted worldview that supports this transformation (what we call 'water resilience'). We found that, across six countries in the Global South and North, attitudes showed moderate support for water resilience. Many people also showed potential to increase their support.

Technical summary. Water in the Anthropocene is threatened. Water governance aligned with the complex, dynamic, and uncertain nature of social–ecological systems (a 'water resilience' paradigm) is needed, and requires transformative change. We queried the potential for transformative change from the perspective that societal worldviews/paradigms offer an important leverage point for system change. Our study aimed to identify attitudes about water resilience and the extent to which there was potential for greater endorsement of water resilience. We surveyed individuals in six countries using vignettes to determine their level of water resilience endorsement ($n = 2649$). Overall water resilience endorsement was moderate ($M = 2.86$ out of 4). In some countries, a vignette related to a personally relevant water issue resulted in higher water resilience endorsement. More than half of the respondents held the potential for greater water resilience endorsement. Those with the greatest potential were younger, had children, considered religion more important, were more likely to live in urban areas, and lived in the same area for 10+ years. These findings provide guidance how to engage with the public (e.g. age-specific or parent-focused framing) to potentially increase societal water resilience endorsement.

Social media summary. General public in six countries moderately supports water resilience to address the water crisis, with room to improve.

1. Introduction

Water, the 'bloodstream of the biosphere' (Ripl, 2003), is increasingly in crisis, both in terms of quality and availability for ecological and human well-being. The human activities that continue and increase in the Anthropocene are wreaking havoc on natural and social systems and for water in particular (Rockström et al., 2014). Our global systems are dependent on water and its regulatory and supporting functions, as well as its direct necessity for humans and other living entities to survive (Falkenmark et al., 2019), and there is increasing recognition of the interconnectedness between water and many other issues (e.g. biodiversity loss, extreme weather events, and human health and livelihoods) (IPBES, 2019; IPCC, 2018; Sköld, 2022; WEF, 2021; WHO, 2018). In the 2021 World Economic Forum *Global Risks Report* the top two risks in terms of likelihood are both closely linked to water (Sköld, 2022; WEF, 2021). The approaches we used in the past and continue to use to govern water (i.e. decision-making and direction setting for on-the-ground actions) are not sufficient in this era of complexity, uncertainty, and change (Baird & Plummer, 2021).

It is now more apparent than ever that to survive this escalating crisis, we need to increase the resilience of our water resources and governance. One important way in which water resilience can be built is through water governance that is aligned with a social–ecological resilience perspective (Folke, 2006; Folke et al., 2016; Lebel et al., 2006). We use Folke et al.'s (2016) definition of social–ecological resilience and apply it to water systems in particular: 'the capacity to adapt or transform in the face of change in social–ecological systems, particularly unexpected change, in ways that …support human well-being' where well-being is considered a 'good quality of life'. Several definitions of water resilience exist (see, e.g. Rodina, 2019) and there are critiques of how resilience is defined in systems where water is a focus (e.g. Dewulf et al., 2019). We use Folke et al.'s (2016) definition as this study approaches water as a focal point but considers the broader social–ecological system resilience around it in

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general terms that allow for elaboration along multiple dimensions – in our case by using resilience 'principles' set out by Biggs et al. (2012).

Seven principles for building social–ecological resilience that are relevant to governance have been identified by Biggs et al. (2012, 2015) (see Supplementary Table S1 for more information about each principle). The principles identify important considerations with regard to (1) the social–ecological system (i.e. intertwined social and ecological systems): maintaining diversity and redundancy (P1), managing connectivity (P2), and monitoring slow variables and feedbacks (P3); and; (2) governance in particular: broadening participation (P5), encouraging learning and experimentation (P6), and promoting polycentric governance (P7). The final principle is 'fostering an understanding of social–ecological systems as complex adaptive systems' (P4), and this principle acts as the connection between the two sets of principles (i.e. principles 1–3 focused on the social–ecological system and principles 5–7 focused on the governance system) described in Biggs et al.'s (2012) work.

Water resilience represents a paradigm, or a set of ideas and beliefs about the nature of the system (Baird et al., 2020b; Schoeman et al., 2014). Paradigms and associated personal mindsets or worldviews – as a foundation from which a system arises – feature as an important leverage point for system change (Abson et al., 2017; Meadows, 1999). Our conceptualization of mindset is consistent with definitions from positive psychology that align mindset and worldview (French, 2016). In the leverage points literature, paradigms, worldviews, and mindsets have been used interchangeably (e.g. Meadows, 1999; O'Brien, 2019). We believe it is worthwhile to acknowledge how these terms have been treated and apply the term 'worldview' throughout the paper hereafter for simplicity. Shifts in paradigms/worldviews/mindsets fall within the 'personal (or individual) sphere' of system transformation (O'Brien, 2019). We approach the question of how to build water resilience from this perspective of personal/individual alignment with the water resilience worldview, recognizing that improved alignment offers a potentially powerful leverage point for system change.

To undertake this exploratory work, we focused on attitudes (i.e. evaluations of the 'degree of favorableness of unfavorableness with respect to a psychological object') (Ajzen & Fishbein, 2000, p. 2) toward water resilience. This focus reflects scholarship that identifies attitudes as strongly influenced by worldviews (Ballew et al., 2019; Hedlund-de Witt et al., 2014) and provided us with an approach to assess the status quo of a broader societal water resilience worldview and potential for shifts toward a more fulsome water resilience worldview. Accordingly, our aim was to understand the attitudes of individuals across multiple countries in the Global South and North about the governance of water resilience – drawing from Biggs et al.'s (2012, 2015) social–ecological resilience principles. Further, we aimed to understand the extent to which there is potential for these attitudes to be shifted.

2. Literature review

There is increasing acknowledgment of the role that individuals and their 'inner worlds' play in fostering broader system change and transformation, both in relation to water resilience specifically (Baird et al., 2020a) and social–ecological systems more broadly (e.g. Ives et al., 2020; O'Brien, 2019). How we think about the system of which we are a part, our worldviews and related attitudes about these systems, influence the governance options that we see as feasible and desirable (Ballew et al., 2019; Bohensky et al., 2015). Various bodies of literature have approached this topic differently and deserve some elaboration. As authors, we approach the promise of the individual and their attitudes for realizing water resilience as a dominant paradigm from training and experience in psychology and sustainability science. Sustainability scientists – specifically the subset who have worked with the concept of leverage points – have described the worldview, paradigm, or mindset as part of the 'inner worlds' of individuals (Ives et al., 2020), the personal sphere (O'Brien, 2019), and the 'intent' of the system, that is, 'the underpinning values, goals, and world view of actors that shape the emergent direction to which a system is oriented' (Abson et al., 2017, p. 32), among others. A statement by Ives et al. (2020, p. 211) about a sustainability science orientation describes the broad approach taken to the study of individual internal factors: 'the term is broad and inclusive, so as to invite exchange of ideas and insights from across academic disciplines'.

While we appreciate a broad and inclusive approach, we seek a middle ground between precision and inclusivity in this study. Accordingly, we have accepted the broader use of the term 'worldview' as a way to describe the water resilience paradigm. However, we are precise about our use and measurement of attitudes in this study – defined as, evaluations of the 'degree of favourableness of unfavourableness with respect to an [attitudinal] object' (Ajzen & Fishbein, 2000, p. 2; Henderson et al., 2008). Thus, we consider our work on attitudes as aligned with sustainability science understandings of, and discussions about, worldviews and individual (or personal) leverage points. We acknowledge that the leverage points literature describes the specific leverage point of interest here as 'the shared idea in the minds of society…constitute that society's paradigm' (Meadows, 1999) and our aim in expanding this study to multiple countries is to begin to understand societal trends in water resilience endorsement. Further, in measuring attitudes, we acknowledge that attitudes encompass properties of both content and strength. Here, we focus on content of attitudes – the overall evaluation of an object – and not strength (the persistence and influence on behavior that the attitude exerts) (Henderson et al., 2008).

2.1 Relationship between individual and societal worldviews

We focus our attention on individual attitudes and how they manifest or affect changes at broader, societal levels. This is a complex relationship, mediated by many potential variables that influence system change. Transformation to sustainable water governance (e.g. through water resilience) requires a whole-of-society approach (Bennett et al., 2019; Frantzeskaki et al., 2016; Naito et al., 2022). Individuals offer opportunities and demand radical innovations including calling for new ways of governing (e.g. through changed regulation/political change), can have major impacts when in positions of power, and build internal momentum that has cascading implications for broader society and governance (Adger et al., 2005; Bamberg et al., 2021; Geels & Schot, 2010; Meadows, 1999; O'Brien, 2015).

A first step to engaging the lever of attitudes (as representations of worldviews) for broader system transformation is to understand to what extent they already align with endorsement (i.e. a positive, supportive attitude) for the water resilience paradigm, and whether there is room to shift attitudes toward greater endorsement. We build on foundational work in Canada and the

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United States by Baird et al. (2020a) that found water resilience endorsement was relatively high, but varied based on several individual factors. In our study (Baird et al., 2020a) we identified specific individual factors that predicted lower water resilience endorsement. However, we did not collect data to assess the potential for greater water resilience endorsement. This study aims to assess water resilience endorsement and potential greater endorsement in an international study of six countries, using a sample of individuals from each.

3. Methods

Data collection occurred in July 2020 using an online questionnaire developed and presented via the Qualtrics platform and administered via a third-party data provider, Dynata. Respondents were members of the Dynata research pool, and were compensated for their time with Dynata credits that could be exchanged for gift cards. The questionnaire was administered in six countries where English was a main language for communication: Australia, Canada, India, South Africa, United Kingdom, and the United States. We aimed to represent countries in both the Global North and South. Each of the six countries experiences a range of water issues, from droughts/water scarcity to infrastructure to pollution issues (Boretti & Rosa, 2019; UNESCO, 2012; United Nations, 2023). We collected at least 350 responses per country, and oversampled to try and achieve this target. Responses that took less than 5 minutes to complete (cut-off based on the minimum time to complete estimated during pilot testing of the questionnaire) or for which <70% of the vignette questions were completed were removed, leaving 2649 retained for analysis (Australia: 452; Canada: 447; India: 380; South Africa: 344; United Kingdom: 474, the United States: 470). Questionnaires were subjected to localization by a Dynata expert for India and South Africa to ensure that the language and references (e.g. education levels, income ranges, spelling of certain words) were consistent with the context in those countries. Prior to completing the study, participants were required to provide written, informed consent. The study was approved by the Human Research Ethics Board at Brock University and conducted in accordance with Canadian Tri-Council guidelines.

3.1 Questionnaire

We adapted an instrument to measure the extent to which individuals endorse the seven principles of social–ecological resilience (Baird et al., 2020a; Biggs et al., 2012, 2015), using vignettes as a tool to accommodate the complexity of the principles (Finch, 1987; Obasi et al., 2023). A total of three vignettes were developed, each of which contained a short text-based description of a situated water issue: flooding, drought, or overfishing focused on surface and irrigation water (source not identified) (see Table 1 for the vignettes). Each vignette was followed by a series of 10 associated multiple-choice questions. The 10 questions were associated with the seven resilience principles identified above. As each of the first three water resilience principles (maintaining diversity and redundancy, managing connectivity, and slow variables and feedbacks) have both an ecological and a social dimension, we developed two questions for each of these principles. While social–ecological systems are indeed intertwined, there are more specific ecological or social dimensions within them. We decided to combine them at the analysis stage to recognize that the principles were not 'just' ecological or social, but represented both.

There were four options possible for each multiple-choice question. The four options corresponded to different 'levels' of resilience endorsement, from none to full endorsement. Respondents could choose as many options as they agreed with, and were asked to rank the options they selected, if multiple, for each question in terms of their preference for them (see Box 1). For example, if a respondent selected two options of the four possible, those two options would be ranked in terms of the most preferred (first) and least preferred (last). In situations where respondents selected only one option response for a question, no ranking was needed. An example of a vignette and question is provided in Box 1. Vignettes received by respondents were randomized so that 1/3 of respondents received a vignette that aligned with a water issue that they had personally experienced (determined as described below), while the other 2/3 of respondents received a randomly assigned vignette. At the end of the questionnaire section focused on the vignettes, respondents were asked to rate the difficulty in responding to them (1 = extremely difficult; 5 = extremely easy).

Individuals were asked to identify up to three water-related crises from within a list of five (rising water temperatures, demand [i.e. availability of water], drought, flooding, waterborne diseases/parasites, and pollution/contamination) that had affected their local waterways, and to rank their selections based on their impact (1 = greatest impact on local water source). This allowed us both to assign either a relevant (1/3rd) or less relevant (2/3rd) vignette, which in turn allowed us to examine whether the

Table 1. Vignettes presented to respondents

Vignette 1: Water from a local river is used for commercial fishing and irrigated agriculture (using water from the river for commercial farming). The river is managed by a regional government agency. There has been a rapid reduction in the number of fish in the river over time, and some fish species are in danger of disappearing completely. Overfishing is one cause of the reduction in fish populations. An increase in water use and chemical pollution from agriculture has led to deterioration in suitable fish habitat. This has resulted in disagreements between the fishers and farmers who use the water, and the government agency that manages the river.	**Vignette 2:** Recently, severe rainstorms and high water levels in the nearby lake caused serious flooding and damage to the city's waterfront, shoreline, and nearby roads. The city had to evacuate many residents, and will have to spend a lot of money to fix the damage. The floods destroyed fish habitats as well, and large numbers of fish in the lake died. Reports indicate that flooding will continue to be an issue along the shore and the impacts are likely to become increasingly worse over the next 100 years.	**Vignette 3:** A record-breaking dry year caused by an extended period of below-normal rainfall has occurred. The drought was represented by intense heat, as well as low levels of soil moisture, surface water, and water for irrigation (supplemental water provided to crops). The drought significantly affected local agricultural crop production. Even farmers who had access to irrigation to maintain crop quality had difficulty keeping up with demand. Researchers suggest that continued extreme weather may result in less rain and more drought in the coming years. Many farmer organizations are working in collaboration with the government to reduce the impacts of drought on their crops.

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Box 1. Example vignette and response schematic (text in *italics* not shown to participants)

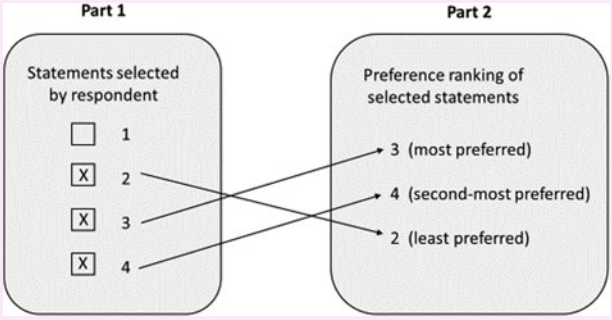
Vignette presented to respondent:

A record-breaking dry year caused by an extended period of below-normal rainfall has occurred. The drought was represented by intense heat, as well as low levels of soil moisture, surface water, and water for irrigation (supplemental water provided to crops). The drought significantly affected local agricultural crop production. Even farmers who had access to irrigation to maintain crop quality had difficulty keeping up with demand. Researchers suggest that continued extreme weather may result in less rain and more drought in the coming years. Many farmer organizations are working in collaboration with the government to reduce the impacts of drought on their crops.

Question presented to respondent in relation to the vignette (selected question focuses on the 'Broaden Participation' Principle (P6):
Given the predictions that droughts will last longer and be more severe over time, a drought task force is suggested as a way to create a plan for the future. Who should be involved in the task force, and to what extent? (Select all statements that you agree with)

- ☐ Include representatives of government agencies who have a focus on agriculture and water. The task force should ask for information from different groups (e.g. farmer associations, businesses). However, final decisions on a plan would be made solely by the government representatives. *(1 = no resilience endorsement)*
- ☐ Include representatives of government agencies who have a focus on agriculture and water. The task force should ask for information from different groups (e.g. farmer associations, businesses) and should invite them to participate in some aspects of plan development, but final decisions on the plan would be made solely by the government representatives. *(2 = low resilience endorsement)*
- ☐ Include representatives of government agencies who have a focus on agriculture and water. Other groups (e.g. farmer associations, businesses) should participate in all parts of plan development. Final decisions on the plan would be made by the entire task force. *(3 = moderate resilience endorsement)*
- ☐ Include representatives of government agencies who have a focus on agriculture and water and other groups (e.g. farmer associations, businesses). All participants should be provided with what they need (e.g. training, other support) to actively participate. Final decisions on the plan would be made by the entire task force. *(4 = full resilience endorsement)*

For those who chose more than one statement they agreed with (see part 1 in schematic below), respondents were asked to rank them in terms of preference (part 2 in schematic below). For example, if a respondent chose statements 2, 3, and 4 above, they were provided with those same statements in the next question and asked to put them in order from most preferred (moved to the top of the list) to least preferred (moved to the bottom of the list) (see schematic below). The most preferred option was used as their individual 'score' for that principle. So, if statement 3 was ranked as their most preferred as in our example, that respondent's score for that principle was '3'.



underlying importance placed on water impacted their resilience endorsement (i.e. if the vignette was personally salient, did that affect endorsement?).

Respondents were asked a series of additional questions. Demographic questions included age (in years), sex (female, male, or other), political affiliation (rated on a seven-point scale from 'very left wing' to 'very right wing') (note that this was revised as needed to account for different understandings within countries of 'left' and 'right' in politics), area (urban, suburban, or rural), years residing in area (increments of 5 years), highest level of education (from no high school diploma to a master's degree or higher), whether or not they had children, and religious importance (on a seven-point scale from not at all important to extremely important). Participants also responded to a series of questions to assess a number of psychological traits, including locus of control, self-efficacy, empathy, and resistance to change; however, these data are part of a different study and thus are not presented here. These questions were asked after the vignettes, and before the demographic questions in the questionnaire. See the questionnaire in the Supplementary Material for the specific order.

The decision to include questions of political affiliation and religious importance was based on findings from previous studies in water resilience attitudes that identified these variables as significant predictors of water resilience endorsement in Canada and the United States (Baird et al., 2020a). This previous study did not assess potential for attitude shifts, used a different measure of water resilience endorsement, and was more narrowly geographically scoped. Here, we extend and expand that work.

3.2 Analysis

Water resilience principles scores were subjected to a confirmatory factor analysis to evaluate the extent to which the data adhered to a two-factor solution (see Supplementary Table S2 and Figure S1). Principles 1–4 formed the first factor (the focus on the social–ecological system) and principles 5–7 formed the second factor (focus on governance).

The quantitative data were analyzed in IBM® SPSS. One-way analysis of variance (ANOVA) with Scheffe post-hoc tests or independent-samples *t*-tests with Bonferroni corrections (as

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appropriate) were used for comparisons that included continuous variables (i.e. resilience endorsement, age, religious importance, and political affiliation). We also use a hierarchical regression analysis to determine whether demographic differences predicted potential for improvement in resilience endorsement scores. For any analysis based on sex, only those who identified as female or male were included as the number of respondents identifying otherwise was very small ($n = 3$). For analyses based on age, participants who indicated either no age or an impossible age (e.g. 234) were not included. Finally, only those participants who completed at least 7/10 questions on the vignette measure were included in the overall analyses.

4. Results

4.1 Respondent demographics and water issues

There were 2643 respondents who completed a sufficient proportion of the vignette questions to be included in the analysis. The attributes of the respondents are provided in Table 2, both overall ($n = 2649$) and as a function of country. Note that the number of respondents who completed each demographic question varied and thus the totals for each attribute differ.

Respondents identified similar problems affecting local water bodies, and ranked them similarly, when provided with a list of options. Assessed by country, respondents in all countries except Australia ranked pollution as the most impactful (while Australians ranked 'drought' most impactful and 'pollution' second). 'Demand' was ranked second most impactful in most countries, except in Australia as noted and Canada, where 'disease' was ranked second.

4.2 Water resilience endorsement

Figure 1 shows the mean responses and response distribution for each of the seven resilience principles (combining the responses to the two questions [ecological and social] for each of the first three principles into a single principle value). The mean water resilience endorsement overall (for all six countries combined) was 2.87 (SD = 0.51) on a scale of 1 (no endorsement) to 4 (full endorsement). When calculated by country (Figure 2), a one-way ANOVA with a Scheffe post-hoc showed that there was a significant difference in mean resilience endorsement among countries, $F(5, 2643) = 4.88$, $p < 0.001$, $\eta^2 = 0.01$, such that resilience scores from India were marginally, but statistically, lower than South Africa and the United Kingdom ($M_{diff} = -0.17$ and -0.13 for South Africa and the United Kingdom, respectively). To understand what principles contributed to these differences, the individual principle scores were examined and compared for each country (see Supplementary Table S3). Principle descriptions are provided in the Supplementary material for reference (see Supplementary Table S1). Principles (P) 1 and 4 showed significant between-country differences in endorsement, such that South Africa endorsed P1 more than Australia and the United States, $F(5, 2623) = 4.46$, $p < 0.001$, $\eta^2 = 0.01$ ($M_{diff} = 0.26$ and 0.23 for Australia and the United States, respectively), and the United States endorsed P4 more than India, $F(5, 2514) = 3.37$, $p = 0.005$, $\eta^2 = 0.01$ ($M_{diff} = 0.24$). In addition, both P3, $F(5, 2632) = 2.50$, $p = 0.03$, $\eta^2 = 0.01$, and P7, $F(5, 2475) = 3.31$, $p = 0.006$, $\eta^2 = 0.01$, differed as a function of country; however, there were no significant differences in the post-hoc analysis.

4.3 Relationships between resilience endorsement scores and other variables

Respondents rated the difficulty of responding to the vignettes as 2.91 out of 5 (SD = 1.13; where 5 is 'extremely easy'), which roughly corresponds to the rating of 'neither easy nor difficult'. There was a relationship between respondents' overall resilience endorsement scores and their difficulty rating for the vignettes, such that as difficulty scores increased, resilience scores also increased, $F(4, 2624) = 17.95$, $p < 0.001$, $\eta^2 = 0.03$; a relationship that was consistent across all countries except South Africa, $F(4, 347) = 1.95$, $p = 0.102$, $\eta^2 = 0.02$. There was no relationship between the number of vignette questions completed and the difficulty rating of the task (all p's >0.06).

There was an effect of receiving a vignette that illustrated a water issue that individuals had personally experienced, $t(2647) = 3.58$, $p < 0.001$, $d = 0.15$, such that individuals who received a personally salient vignette ($M = 2.91$, SD = 0.50; $N = 974$) had a slightly higher overall resilience score than those who were randomly assigned a vignette ($M = 2.84$, SD = 0.51; $N = 1675$). However, a series of Bonferroni-corrected (new $\alpha = 0.008$) independent samples t-tests showed that the difference in resilience scores as a function of whether participants received a personally salient vignette was significant only for participants from India, $t(392) = 2.85$, $p = 0.005$, $d = 0.29$, and the United States, $t(467) = 3.05$, $p = 0.002$, $d = 0.31$, although Canada approached significance, $t(474) = 2.44$, $p = 0.015$, $d = 0.23$. No other countries showed a difference in resilience score as a function of whether the vignette was personally salient (all t's <1.8, all p's >0.07).

Finally, resilience endorsement was associated with a few demographic variables, although these findings were inconsistent across countries. For instance, Canadian females had higher resilience scores than did Canadian males, $F(1, 445) = 5.62$, $p = 0.018$, $\eta^2 = 0.01$, but this difference was not found in any other country. There was also a small effect of the type of area in which South African participants lived, $F(2, 345) = 4.07$, $p = 0.018$, $\eta^2 = 0.02$, such that participants who lived in suburban areas had higher resilience scores than did participants who lived in urban areas. Finally, whether or not participants had completed a university degree was associated with resilience scores in both India, $F(1, 380) = 4.80$, $p = 0.03$, $\eta^2 = 0.013$, and the United States, $F(1, 459) = 11.43$, $p < 0.001$, $\eta^2 = 0.024$, but whereas higher education was associated with *higher* resilience scores in India, it was associated with *lower* resilience scores in the United States. No other demographics were associated with resilience endorsement. Note that for the purposes of these analyses, the 'years in area' and 'highest education' variables were recoded as binary variables ['less than 10 years' *vs.* '10+ years' for years in area; 'no university' *vs.* 'university' for highest education]. Country was coded using dummy variables such that Australia = 1, Canada = 2, India = 3, South Africa = 4, United Kingdom = 5, and United States = 6.

4.4 Preference rankings and potential for improvement

For those vignette questions where respondents chose multiple statements with which they agreed, they ranked those statements in terms of preference. The preference rankings provide rich data with which to understand the *demonstrated* potential of respondents for greater resilience endorsement. We focus here on those respondents who selected more than one statement for at least three of the 10 principle questions and, when ranking the statements, ranked lower resilience endorsement statements as

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Table 2. Respondent demographics (proportions, means, and standard deviations) both overall and by country

	Overall	Australia	Canada	India	South Africa	United Kingdom	United States
Sex							
Male	50.1%	49.6%	48.5%	52.4%	50.3%	50.4%	49.6%
Female	49.8%	50.4%	51.2%	47.4%	49.7%	49.4%	50.4%
Other	0.1%	0.0%	0.2%	0.3%	0.0%	0.2%	0.0%
Age in years				Mean (SD)			
	46 (17)	50 (16)	47 (15)	32 (8)	34 (12)	47 (15)	61 (13)
Area							
Urban	41.0%	27.1%	48.9%	79.6%	39.6%	35.5%	21.8%
Suburban	45.0%	61.8%	34.2%	14.8%	50.6%	48.0%	56.9%
Rural	14.0%	11.1%	17.0%	5.6%	9.8%	16.5%	21.4%
Years in area							
Less than 1	4.3%	5.6%	4.9%	1.9%	4.6%	4.0%	4.8%
1–5	22.5%	25.3%	25.7%	15.3%	28.3%	20.7%	22.1%
6–9	13.5%	15.3%	14.1%	14.0%	14.5%	13.1%	11.2%
10–19	23.6%	21.6%	24.3%	28.6%	21.4%	23.3%	24.8%
20+	36.2%	32.2%	31.0%	40.2%	31.2%	38.9%	37.1%
Highest education							
No high school	3.3%	6.4%	2.2%	0.5%	2.9%	6.3%	0.7%
High school	20.0%	22.3%	18.3%	6.0%	29.3%	22.9%	21.1%
Apprenticeship/trade	8.8%	14.6%	6.9%	0.5%	6.1%	9.7%	12.8%
College diploma	16.0%	16.4%	20.7%	2.9%	22.9%	18.7%	13.9%
Bachelor's degree	31.3%	26.3%	37.4%	40.7%	33.9%	28.2%	23.5%
Master's or higher	20.6%	13.9%	14.5%	49.3%	4.9%	14.1%	28.0%
Children							
Yes	59.6%	62.9%	54.2%	63.0%	57.5%	55.4%	64.7%
No	40.4%	37.1%	45.8%	37.0%	42.5%	44.6%	35.3%
Religious importance[a]				Mean (SD)			
	4.1 (2.4)	3.4 (2.3)	3.4 (2.4)	5.3 (2.1)	5.6 (2.0)	3.2 (2.3)	4.2 (2.3)
Political affiliation[b]				Mean (SD)			
	4.1 (1.9)	3.9 (1.8)	3.7 (1.9)	4.5 (2.0)	4.4 (1.7)	3.9 (1.7)	4.3 (1.8)

[a]Religious importance ranges from 1 (not at all important) to 7 (extremely important).
[b]Political affiliation spans from 1 (very left-wing) to 7 (very right-wing).

more preferred than higher resilience endorsement statements. For example, if a respondent selected statements 2, 3, and 4 (as in Box 1) and ranked the statements in the following order: statement 3 as their most preferred, statement 4 as their next most preferred, and statement 2 as their least preferred, they were included in the analysis because statement 4 (full resilience endorsement) was ranked *lower* than 3 (moderate resilience endorsement). We will refer to this situation as 'potential for greater resilience endorsement' hereafter.

We found that 1642 respondents (62%) indicated in at least one of those questions (i.e. for one of the resilience principles) potential for greater resilience endorsement. The frequency with which respondents indicated potential for greater resilience endorsement by principle is presented in Table 3. All principles showed respondents' potential to shift preferences based on this interpretation. Between 11 and 30% of those responses included the fullest expression of resilience statement in those selected by the respondent, but it was not chosen as the most preferred.

To further explore this finding, a 'potential for improvement' score was calculated for each participant by summing the number of questions (out of 10) on which the participant showed room for improvement (as described above). Scores ranged from 0 (i.e. no questions on which the participant ranked lower resilience endorsement statements as more preferred than higher resilience statements) to 10 (i.e. participant ranked a lower resilience statement as more preferred than a higher resilience statement on every question), with a mean potential for improvement score of 2.29 (SD = 2.48). We then conducted a hierarchical regression

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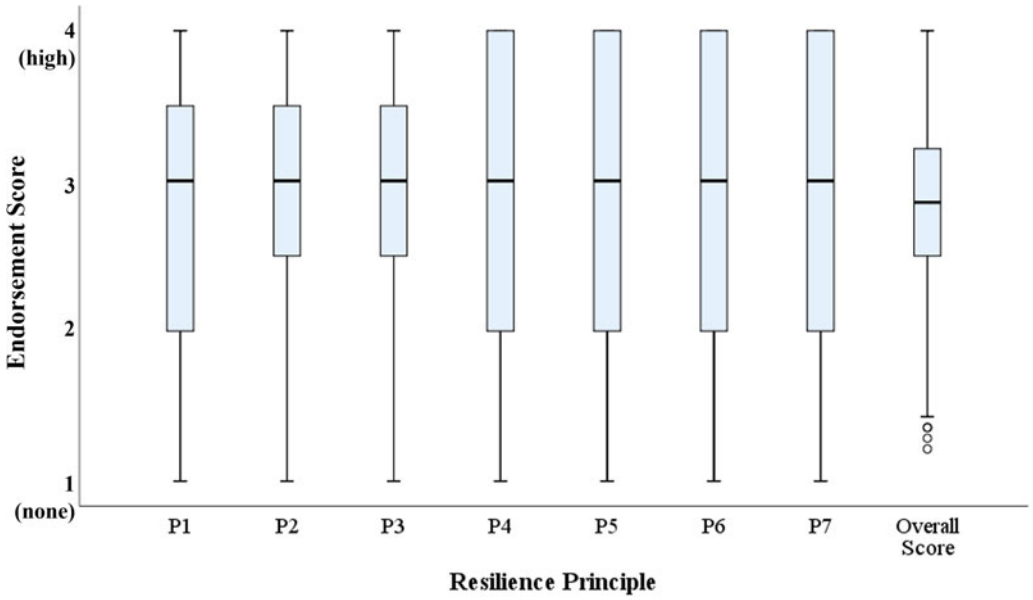


Figure 1. Boxplot showing distributions and minimum/maximum scores for each of the seven resilience principles, as well as the overall (mean) resilience endorsement score ($N = 2144$).

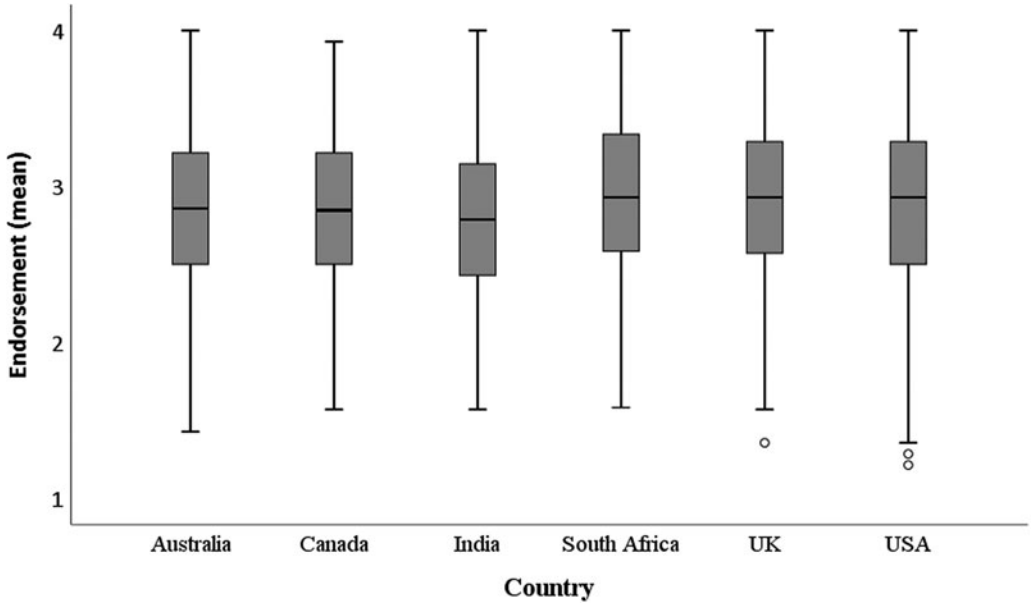


Figure 2. Boxplot showing distributions and minimum/maximums for the overall (mean) resilience endorsement scores as a function of country ($N = 2644$).

analysis to determine whether demographic differences predicted potential for improvement scores (see Table 3).

Because demographics differed as a function of country (see Table 2), we entered country into the first step of the regression. This allowed us to examine the predictive power of our demographic variables unconfounded by country. Each of the remaining demographic variables (sex, age, type of area, years in area, highest education, children, religious importance, and political affiliation) were entered as predictors into the second step of the regression, with potential for improvement scores as the criterion. Each of the demographic predictors, apart from sex and political affiliation, explained significant, unique variance in potential for improvement (see Table 4) such that well-educated participants who were younger, lived in urban areas, lived in the same area for 10+ years, had children, and rated religion as more important had greater potential for improving their resilience endorsement scores.

5. Discussion

Water resilience is a desirable paradigm, or worldview, to address the escalating global water crisis. We posit that moving toward societal alignment with this worldview requires an understanding of endorsement and the latent potential for greater water resilience endorsement, which we measured at the individual level through attitudes. Previous research has indicated that water resilience

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Table 3. Frequency of responses that indicated potential for greater resilience endorsement by principle and the frequency and percentage of those responses that included the statement that represents the fullest expression of the principle

Resilience principle	Frequency of responses with some potential for greater endorsement	Included statement that represents full expression of resilience
P1: Diversity and redundancy (ecological perspective)	534 (33%)	119 (22%)
P1: Diversity and redundancy (social perspective)	566 (35%)	61 (11%)
P2: Connectivity (ecological perspective)	617 (38%)	154 (25%)
P2: Connectivity (social perspective)	687 (42%)	105 (28%)
P3: Slow variables and feedbacks (ecological perspective)	662 (40%)	121 (18%)
P3: Slow variables and feedbacks (social perspective)	600 (37%)	133 (22%)
P4: Understanding system as complex adaptive system	583 (36%)	163 (28%)
P5: Learning and experimentation	612 (37%)	186 (30%)
P6: Broaden participation	588 (36%)	143 (24%)
P7: Promote polycentric governance	542 (33%)	148 (27%)

Table 4. Hierarchical multiple regression analysis examining predictors of potential for improving resilience endorsement

		Unstandardized		Standardized	
	Predictor	*B*	St. error	*β*	*t*
Step 1: $R^2 = 0.008$**	Country	−0.126	0.028	−0.090	−4.51**
Step 2: $R^2 = 0.092$**	Country	−0.079	0.027	−0.056	−2.86*
	Sex	−0.027	0.096	−0.006	−0.29
	Age	−0.028	0.003	−0.194	−8.80**
	Type of area	0.235	0.073	0.066	3.23**
	Years in area	0.122	0.051	0.047	2.38*
	Highest education	0.320	0.098	0.064	3.26*
	Children	0.383	0.103	0.076	3.70**
	Religious Importance	0.126	0.023	0.117	5.54**
	Political affiliation	0.040	0.030	0.027	1.34

Significant predictors are denoted by an asterisk (* or **). $N = 2496$.
*$p < 0.05$; **$p < 0.001$.

endorsement among the general population in Canada and the United States is generally relatively high (Baird et al., 2020a). We found the same in this much larger and geographically diverse study, with a mean around 'moderate' resilience endorsement when aggregating all responses across six countries (between which there were only small differences). To illustrate what 'moderate water resilience endorsement' represents, we can use the example question from Box 1. In that vignette, where a severe drought is threatening agricultural viability and a task force is being assembled, moderate endorsement would result in broadening participation in the task force that 'includ[es] representatives of government agencies who have a focus on agriculture and water. Other groups (e.g., farmer associations, businesses) should participate in all parts of plan development. Final decisions on the plan would be made by the entire task force'. While the full resilience endorsement option from that vignette includes aspects of equity and access for all task force members, the option representing moderate resilience endorsement is highly supportive of broadening participation and creating an inclusive and participatory governance system.

Moderate water resilience endorsement is a good indication that there is substantive alignment with a water resilience worldview. Further, there is measured potential for attitude shifts in favor of greater water resilience endorsement. Attitudes are one piece of the system transformation puzzle. Attitudes influence individuals' actions (Ajzen et al., 2018), and depending on their individual, political, and collective agency (e.g. through actions from voting aligned with their attitudes to activism to formal engagement in decision making processes/governance where possible) (Bandura, 2000; O'Brien, 2015; Vogel & O'Brien, 2021), broader transformation is possible.

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There is still room to improve water resilience endorsement, and our questionnaire design allowed us to identify the extent to which there is potential for improvement. We allowed respondents to choose multiple statement options in relation to the vignette questions they were asked, and to rank selected statements in order of preference. This design provided richer quantitative data (general agreement *and* preferences) as a basis to formulate assessments of opportunity for greater resilience endorsement in individuals. We feel that this approach, using general agreement and preferences in a two-step process, holds promise as sustainability scientists engage more deeply with the 'inner worlds' of individuals (Ives et al., 2020), and specifically attitude-based research. It recognizes that attitudes may be broad, have variability, and that preference rankings support individuals in thinking through and organizing their attitudes.

The preference ranking activity and analysis identified that more than 60% of respondents showed potential for greater resilience endorsement for at least one resilience principle, and about 40% showed that potential for three or more principles. This indicates that there is substantive room to potentially shift attitudes upward, toward greater water resilience endorsement. The principles all showed relatively similar frequencies for how many respondents demonstrated potential for greater resilience endorsement for that principle (ranging from 534 for P1: diversity and redundancy – ecological to 687 for P2: connectivity – social). Further, between 11 and 30% of those respondents who showed potential for greater resilience endorsement selected the statement that expressed resilience in the fullest way, but that statement was not ranked as most preferred. This provides additional evidence that there is cause to believe that greater societal water resilience endorsement is possible through a shift in attitudes.

By pooling data across six countries in the Global South and North and controlling for country-specific effects, we found predictors of the potential to shift attitudes that transcend country of residence. Those who demonstrated the greatest potential for greater resilience endorsement were younger and viewed religion as more important (though specific religions were not queried), in addition to being more likely to live in an urban area, more likely to have resided in the same area for 10+ years, more likely to be highly educated, and more likely to have children. Attitudes toward the environment are malleable: studies in environmental and behavioral psychology have shown that attitudes can be shifted through various approaches, including gain/loss framing, compassion framing, and celebrity endorsement (Lu & Schuldt, 2016; Olmedo et al., 2020; Spence & Pidgeon, 2010). From this characterization of those who hold the most potential for greater resilience endorsement, future research can focus on testing attitude-shifting interventions, such as those identified above, focusing on the factors that best predict that potential. For example, previous studies related to climate change attitudes have shown that many of the same demographic factors as were found in this study are associated with climate change skepticism and variations in pro-environmental behaviors, including age (where older adults were more skeptical; Poortinga et al., 2019), religiosity (where different religious groups show differences in climate change beliefs and behaviors in relation to those with no religious belief; Morrison et al., 2015), and education level (those with less education were more skeptical; Zhou, 2015). Further, organizations and agencies that work internationally, as well as those that work at other levels and have a mandate or mission for system change/transformation can draw on these findings as key points of entry to engage the public and shift attitudes.

While attitudes supported moderate resilience endorsement, and the potential for even stronger endorsement by the majority of the respondents in this study, it is important to situate these results within the broader literature and ongoing discussion about the relationship between attitudes and behaviors, individual agency, and the design of our study. The results here indicate that attitudes reflect moderate endorsement of water resilience. While attitudes are one factor that is a direct determinant of behavioral intention, we recognize that the relationship between attitudes and behavior is complex, with multiple stages and influence from many factors (e.g. the transtheoretical model of change [Abrash Walton et al., 2022]; theory of planned behavior [Ajzen, 1991]). Attitudinal intensity has been shown to influence behavior; strong attitudes are related to more pro-environmental behavior (Casaló & Escario, 2018). Further, past empirical work has differed in its findings about the relationship between attitudes and behavior/behavioral intention in the context of sustainability, and especially around the importance of the role attitudes play in behavior/behavioral intent (Heimlich & Ardoin, 2008). Further exploration of the relationships between strength of attitudes and behavioral intention (and behavior) in relation to water resilience endorsement is needed.

The finding that receiving a vignette that was related to a water issue experienced personally was correlated with a higher overall water resilience endorsement score in some countries, and not others, is worth exploring further. A personally relevant water issue may evoke a stronger connection to the vignette through personal experience and/or sense of place. Previous research has demonstrated relationships between personal experiences with extreme weather – including flooding – and environmental attitudes (e.g. Demski et al., 2017; Wong-Parodi and Rubin, 2022). Likewise, sense of place – the 'meaning or importance of a place based on human experience, social relationships, emotions, and thoughts' – has been linked to pro-environmental attitudes as well as behaviors, including environmental stewardship (Budruk et al., 2009; Chapin III & Knapp, 2015, p. 39). Further, Devine-Wright (2013) emphasizes that local relevance does not mean that more distant events are less relevant to an individual, lending support to the salience of a non-localized vignette to respondents in this study.

Respondents for this study did not necessarily include any individuals with formal decision-making authority. However, the role of individuals of all levels of agency in system-level transformations for sustainability is increasingly being developed and emphasized in the sustainability science literature (e.g. Benessaiah and Eakin, 2021; Naito et al., 2022; Scoones et al., 2020). Creating the conditions, through enabling attributes of individuals that underlie structures and systems, is one piece of a larger puzzle that can mobilize broad change (Scoones et al., 2020). Further, structural and individual behavioral changes can be mutually supportive (Leiserowitz et al., 2006). Of course, this is not to discount that individuals ultimately hold varying agency, depending on structural and systemic factors, and focusing on those who hold disproportionate influence over decision-making in systems is an important future research direction.

This study had limitations associated with its design and approach to data collection. First, we relied on a third-party data provider to collect responses from their bank of registered respondents. These individuals often complete multiple questionnaires per day and are paid to do so. This may have provided an incentive for respondents to complete the questionnaire as quickly as possible, or complete the minimum required for it to be

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considered complete. Samples for each country were not always representative of their populations with respect to age or level of education and thus extrapolating to the broader population in each country is not possible. Questions were not mandatory (as per our ethics requirements) and many respondents skipped multiple questions or completed the questionnaire so quickly that there was no possible way they read and considered their responses. We reviewed response times and response patterns to remove as many of these types of responses as possible, but this still may have impacted the quality of data collected. Related to this, the vignettes used, while offering the benefits of context and nuance to the questions about the resilience principles, may have been cognitively demanding for respondents to complete. Accordingly, the quality of responses, reliant on consideration of all options and selecting and ranking those the respondent agreed with, may not have been thoughtfully completed in all cases. The approach we used did not allow for exploration of the role of context and cultural differences among countries/regions.

Finally, we acknowledge that the separation of social and ecological dimensions for the first three principles is somewhat artificial given that the principles represent aspects of social–ecological systems. We continue to consider other methodological approaches (qualitative or mixed methods designs) to assessing water resilience endorsement in such a way that it is both accommodating of the complexity of the concept and appropriate for large sample sizes.

Future research could focus on specific countries and the cultural and contextual nuances in each, as country-level factors have been shown to be important (and potentially complex) for people's attitudes related to climate change and skepticism in multinational research (e.g. Smith et al., 2017; Tranter and Booth, 2015). Other promising avenues of study include identifying other potential individual-level factors that influence water resilience endorsement, drawing from broader policy endorsement research, which is diverse in its application and findings (e.g. climate change mitigation policy endorsement affected by compassion [Lu and Schuldt, 2016]; environmental public policy endorsement affected by nostalgia and future optimism [Kwan et al., 2017]; climate change policy endorsement associated with risk perception [Smith and Mayer, 2018]).

6. Conclusion

Water resilience is a promising approach to address the increasing complexity and uncertainty of this Anthropocene era. Individuals and their inner worlds, including worldviews, mindsets, and attitudes (Abson et al., 2017; Baird et al., 2020a; Ives et al., 2020; O'Brien, 2019), have been a particular focus by sustainability science scholars. Baird et al. (2020a) identified water resilience endorsement as one approach to study individual-level factors in support of ultimately realizing a water resilience paradigm at a whole system level. This study, conducted across six countries representing the Global South and North, shows that water resilience endorsement is moderate overall. We find that there is 'room to improve' and that, for all principles, there is potential from a substantive subset of the respondents for greater water resilience endorsement, presenting opportunities to explore and test approaches to realize this shift at a societal level. Respondents who showed a lower or greater potential for water resilience endorsement differed with respect to age and religiosity, such that individuals who were younger and viewed religion as more important showed greater potential for improving their resilience attitudes. The type of area in which participants lived and length of residence in a given area, education level, and whether respondents had children were also significant predictors of potential for improvement. Using this demographic information to design interventions that target attitudinal shifts is an important next step in this research agenda. Further, those who received a more personally salient vignette (i.e. a vignette that related to a water issue the respondent had personally experienced) scored more highly on their water resilience endorsement in some countries. This represents another potential pathway for building water resilience – using specific water issues as a basis for these efforts. In addition to considering interventions to build water resilience endorsement, consideration of the permanency of these attitudes, experimental approaches to identify other factors that may mediate or moderate the relationship between water resilience endorsement and behavior, and expanding the geographical scope of water resilience endorsement assessments to more countries around the globe present important future research directions.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/sus.2023.23.

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