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Spatial interactions between organizations and the symbolic landscapes created by their public information campaigns

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Abstract

This study investigates public information as a component of the democratic process, advancing previous frameworks by considering information as a spatial product of multiple governmental and civil society organizations. The symbolic weight of information campaigns is a critical component of two democratic processes: awareness of the public's vulnerability to formal water policy change and the perception within the public that the policy space is open to their participation. This research examines the locations of water-centered public information across 31 organizations in metropolitan Phoenix, Arizona, USA. The patterns of disparities found in the study indicate that the neighborhoods in the eastern portion of the study region receive more information than those in Phoenix or cities to the west. There is also more information in areas with large numbers of rental homes, but less information in regions with larger Latino populations. Results support a need to evaluate new initiatives for public information with respect to the content and distribution of materials originating from multiple sources. Evaluating the patterns created by water information providers could aid more strategic coordination among groups and provide a bellwether of whether public interests are adequately considered in local water decision-making processes and the distribution of outcomes.

Keywords: Arizona; Geographic information systems; Information; Phoenix; Public inclusion; Water governance

1. Introduction

In a single region, municipal, county and federal government agencies, environmental groups, museums and other special interests all distribute public information (Cutts *et al.*, 2008; Mol, 2009). Organizations construct pamphlets, websites, school programs and special events focused on local water conservation, pollution, transportation and storage. Irrespective of the effect on demand, the interactions create a symbolic landscape of public inclusion and exclusion, with respect to water supply and

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water quality. The symbol of inclusion created through information is the product of effort across all organizations, presenting a measurement challenge.

Interactions between organizations may have an impact in surprising ways on the extent to which the public perceives water supply sustainability as a relevant issue. Diverse institutional cultures often stymie data collection and analysis across organizational boundaries. Similar policies may be implemented differently across organizations. Understanding limitations in the effectiveness of effort to reach – and represent – the public is critical. This study investigates spatial patterns in information provision that may undermine the capacity of organizations involved in water governance to engage and/or represent the public inclusively. The theoretical objective of the study is to introduce information as a symbol of public inclusion and adequate public representation in water decision-making.

The introduction and discussion describe the implications of disparities in proximity to information. The methodological objectives are to: (a) present a method for and case study results of estimating spatial distribution of water information as a product of both formal policy and activities initiated by civil society organizations and (b) evaluate the landscape of opportunity for public engagement created by information provided to residents of metropolitan Phoenix, Arizona as part of the regional water decision-making process. The methods and discussion present a quasi-participatory mapping method and an economic proxy to estimate the extent and depth of information dispersed to the public. The central hypothesis is that multiple, overlapping water information campaigns will send disparate signals of public inclusion within a metropolitan region. The prediction is that these will mirror patterns of inequity in access to safe drinking water and the political and ecological security of water supplies. Within the study area of metropolitan Phoenix, Arizona, findings in support of the following predictions would corroborate this hypothesis: P1. Information will be distributed differently depending on the complexity and security of water supply; P2. Neighborhoods with large ethnic and linguistic minority communities will have lower access to information; P3. Neighborhoods with large renter populations will have lower access to information; P4. Neighborhoods in which there are a larger number of households with children will have higher access to information.

1.1. Information as a symbol of public inclusion and adequate representation in water decision-making

Public information campaigns can be defined as 'intended to generate specific outcomes or effects in a relatively large number of individuals, usually within a specified period of time and through an organized set of communication activities' (Rogers & Storey, 1987, p. 821). Under this definition, public information has been examined as a mechanism for promoting behavior change, a tool of control and a component of a democratic society (reviewed in Weiss & Tschirhart, 1994). In the environmental domain, public information campaigns are often dismissed as ineffective or trivial (Syme, 2004; Noar, 2006). This presumption is based on the relatively weak effect of information on specific behavior changes measured over small time steps (Kaiser & Fuhrer, 2003). However, the implications of disparate exposure to and engagement with water conservation education are not limited to the measures residents take to conserve water. Nor are the roles of information campaigns in democratic process limited to one campaign, as it has been presented in the literature (reviewed in Syme, 2004; Noar, 2006).

The effects of low information may extend to issues of public participation and influence on policy (Young, 1990; Schlosberg, 2007; Walker, 2009; Howard, 2010). Providing information to

some communities and not others can widen power imbalances in political processes (e.g. Chong & White, 2007; Mol, 2009). While organizations may not intentionally limit the distribution of water information, their combined effort may be uneven. The spatial locations of information programs represent two democratic processes: awareness of the public's vulnerability to formal water policy change among policy actors and the perception within the public that the policy space is open to their participation. Water-related government agencies and civil society organizations assert recognition of vulnerability to water supply issues by providing information to the public. The location of information reflects the ability of formal policy change to consider adequately how impacts are distributed among the public.

Although the internet has made it easier for active information seeking to result in information access, physical modes of communication are likely to continue to play a large role in public perception of the importance of water issues and the public's legitimacy in water decision-making. The images and words included in physical forms of information can be encountered and interpreted by a wider range of the public. Through their content and form, these physical representations convey the importance of water issues to audiences (Burgess *et al.*, 1998). When provided to neighborhoods and audiences that have historically been burdened by water supply or quality issues, information has the capacity to unmask persistent and highly localized water poverty (e.g. Westcoat *et al.*, 2007).

The second component of the democratic process is the reaction of the public to information. Efforts to enhance participation require both creating opportunities for the public to receive invitations for participation, but also to create their own opportunities for engagement, and to reconfigure relationships between citizens and institutions (Cornwall, 2002). This moves the focus beyond the government to other political spaces in which the public may take action (Schlosberg, 2007). Thus, the politics of water problems is an inherently geographic problem (Agnew, 2011).

The paucity of studies examining geography as a barrier to environmental information exposure is partially due to a tendency for evaluations of information campaigns to focus on a behavioral change resulting from a single information campaign, rather than on access to information across sources (Syme, 2004; Noar, 2006). Conversely, information-seeking studies consider information exposure to be an immeasurable component of the context in which information seeking occurs (McCreadie & Rice, 1999). Between the two literatures is a gap in knowledge and methodology. This study addresses this gap by linking information to its geographical proximity to the public, rather than to its impact on knowledge or behavior. In conjunction with the mapping procedures, this new framework for considering information allows deeper analysis of the extent to which information campaigns compound or mitigate disparities in power associated with socioeconomic class or degree of social organization (McCreadie & Rice, 1999).

2. Case description: metropolitan Phoenix, Arizona

The Phoenix, Arizona metropolitan region of the United States (Figure 1) presents a useful case study of the role of information policies in building an inclusive water decision-making system because aridity and population growth have accelerated the rate at which the region is presented with new water decision-making challenges and the proliferation of information providing organizations. As in many other metropolitan regions, information is a pervasive policy tool in the metropolitan Phoenix area.

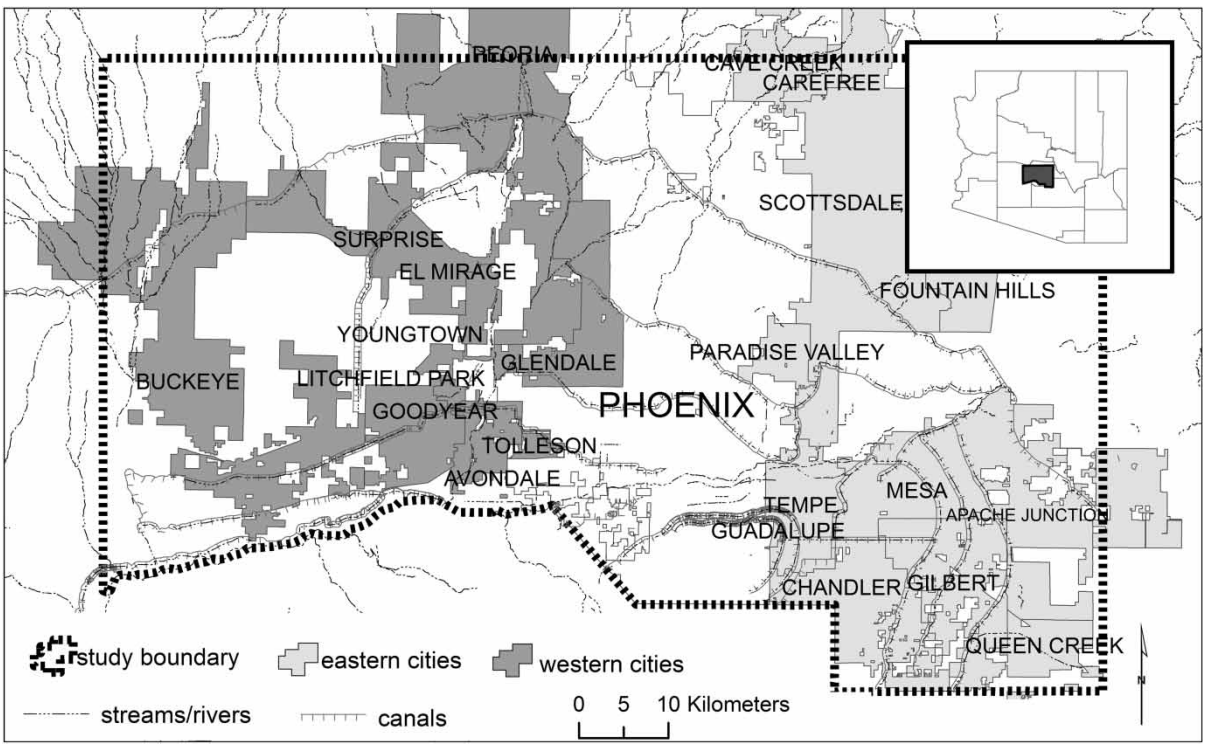

Fig. 1. Map of the study region with city boundaries. Notes designation sub-regions 'eastern cities' and 'western cities' used in analyses.

Table 1. Organizations providing water information to some or all of metropolitan Phoenix, AZ. A total of 31 organizations participated in the research.

Type of water information organization	Total identified	Respondents
Water provider	13	10
Education or research group	11	8
Environmental NGO	7	7
Government agency (not including water utility)	5	2
Multi-organization coalition	3	2
Total	39	31

Previous work identifies 39 organizations creating and/or disseminating information about water (Cutts *et al*., 2011). These groups represent water utility providers, education and research groups, environmental non-governmental organizations (NGOs), non-utility governmental agencies and collaborative stakeholder partnerships (Table 1).

2.1. P1. Information will be distributed differently depending on the complexity and security of the water supply

Water for the Phoenix, Arizona metropolitan area (Figure 2) comes from three primary sources: groundwater, surface water from the Salt and Verde rivers of Arizona, and Colorado River water. In total, the region received 2,837 million cubic meters (m^3) of water annually region (Larson *et al.*, 2005). From previous studies of Phoenix, it is expected that the complexity of institutions and the diversity of water sources will create differences in information distribution. Differences in water rights and formal policy exist, creating unique water governance challenges for cities west of Phoenix, Phoenix and cities east of Phoenix (Hirt *et al.*, 2008). Climate change and increasing residential uses of water have introduced new vulnerabilities to shortages of drinking water that disadvantage fringe communities and more recently developed cities (Bolin *et al.*, 2010). Cities west of Phoenix have access to fewer water sources than either Phoenix or municipalities to its east. Canal systems delivering water from the Salt River do not extend to these communities. As cities west of Phoenix transition from agricultural to residential land (and water) uses, many do not have the infrastructure or personnel to maintain the water system properly or treat water to meet increasingly stringent water quality standards (Smith *et al.*, 2007). Newer communities – more frequently in the west – are expected to be less robust to drought impacts (Bolin *et al.*, 2010). This vulnerability may drive public information activity west of Phoenix.

Water management policies in cities east of Phoenix have introduced more public information. While all cities have had trouble meeting conservation targets designed to reduce groundwater withdrawal (Jacobs & Holway, 2004), higher population densities and fewer opportunities to phase out agriculture or annex additional land have made this an especially difficult task in the east (Gober, 2005; Hirt *et al.*, 2008). After suing the state, four cities east of Phoenix (Tempe, Chandler, Scottsdale and Gilbert) are mandated to provide more public education than other cities in lieu of meeting conservation targets dependent on reducing water consumption on a per capita basis (Hirt *et al.*, 2008). Cities to the east are expected to have more information due to both municipal policy and their collaboration with NGOs (Wolch & Geiger, 1983; Bielefeld *et al.*, 1997).

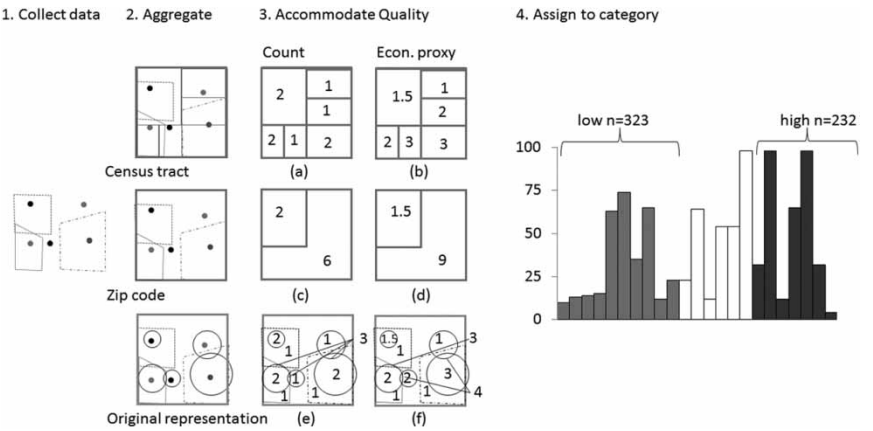

Fig. 2. Illustration of the process used to create maps of water policy efforts. Beginning from the same raw information, information campaigns were aggregated to either census tract or zipcode boundaries before summarizing the estimated total potential effect by either summing a count of the number of programs or an estimate of effort based on an economic proxy. A full decision model for representation appears in Table 2.

2.2. P2. The percentage of the population that is Latino may vary between areas with high and low information availability

In the 2000 US Census, 25.1% of the population of metropolitan Phoenix was identified as Hispanic or Latino (US Census Bureau, 2000). Based on findings in other studies, the prediction is that Latino populations will have lower access to information than others is based on previous research on environmental burdens. This prediction is also supported by the perceptions of water information providers (Cutts *et al*., 2008). As in other urban regions, technical solutions and policy changes in metropolitan Phoenix have increased disparities in access to clean and reliable water supplies. Disparities perpetuate differences between races and ethnicities across municipalities. For example, the Salt River bed passes through a section of Phoenix that is predominantly Latino. The riverbed is host to gravel pits and landfills that leach toxins into the community after a flood. None of the local Latino activist groups were included in the Environmental Impact Assessments conducted in advance of a project to use treated effluent to restore riparian habitat in a portion of the Salt River (Brittle, 1998). Water information providers also perceive themselves as unable to provide culturally appropriate information and information in Spanish (Cutts *et al*., 2008).

2.3. P3. The proportion of owner occupied homes may vary between areas with high and low information availability

In the 2000 US Census, 32.0% of the population of metropolitan Phoenix rented their homes (US Census Bureau, 2000). Given the emphasis of water information in Phoenix on outdoor water conservation (Cutts *et al*., 2008), the prediction is that neighborhoods with large populations of renters will have low access to information. Many drought management plans explicitly state an interest in equitably sharing the impact of drought across society. However, their plans for doing so advocate a flat 5% reduction in residential water use across all users (e.g. City of Glendale, 2004). This strategy, as well as that of rate increases, often results in larger water use reductions among the poorest residents than wealthier residents who already use more water (Gilbert, 2007).

2.4. P4. The number of households that include school-aged children may vary between areas with high and low information availability

In the 2000 US Census, 36.1% of households included children under 18 years old (US Census Bureau, 2000). Both information providers and communities recognize youth as an important factor in social organization. Many communities organize change through connections made at schools and their ability to empower youth directly (e.g. Checkoway *et al*., 2003) and improve community interactions generally (e.g. Foster-Fishman *et al*., 2007). Similarly, many water information providers look to the success of school-based programs in encouraging behavior like recycling (e.g. Folz, 1991). Given the emphasis of water information providers on reaching adults through programming in schools, it is expected that neighborhoods with higher densities of children will have access to more information. Water information providers in the study region have previously indicated that they devote substantial resources toward programs for students from kindergarten to grade 12 (Cutts *et al*., 2008). They perceive that this contributes to high levels of information in neighborhoods where a high percentage of homes include one or more school-aged child (ages 5–18).

Results that support the predictions will indicate that formal organizations may not be adequately or equitably representing the public interest. Significant relationships between demographic data and information access indicate that the location of information creates and/or perpetuates differences in the extent to which the public is invited to participate in water governance.

3. Data and methods: estimating the spatial distribution of water governance

Data collection and analysis phases included: (1) data collection interviews and document analysis to generate maps of information locations, (2) organization validation of researcher-generated map information derived from individual participation, (3) focus group validation of an initial information map and aggregation methods, (4) additional data collection interviews and document analysis, (5) final research-generated maps of the distribution of public information campaign effort aggregated to 'high', 'medium' and 'low' levels across all organizations, and (6) binary logistic regression analysis of demographic differences between areas consistently ranked as receiving 'high' and 'low' amounts of information. Participation and interactions between organizations involved in water governance is fully described in Cutts *et al.* (2011). Thirty-one of thirty-nine (79%) organizations contributed to one or more of the participatory stages and have information represented in the final maps.

Using an interview method adapted from Brown (2004) and Brody *et al.* (2002), organizations discussed the location and efforts of several information dissemination policies including landscaping classes, information about technology rebates, advertisements about water conservation methods and community meetings about using reclaimed water for irrigation (Table 2). They also provided information through articles in local newspapers, broadcasts on public access channels, street canvassing about climate change, meetings about riparian habitats, giveaways at football games, banners on main streets and puppet shows. Interview questions focused on the location, extent and participation rate of all programs that aimed at educating the general public about water issues over the course of 1 year. Additional data were extracted from websites, annual reports and other organization documents to identify the location and extent of water information programs to supplement interview information and provide some basis for including organizations unable to participate in the initial interviews. Each organization received a map, based on the content they provided, to validate and/or correct. Follow-up interviews and focus groups led to additional opportunities to update program effort and location using a comprehensive list of program types (Cutts *et al.*, 2011; see Appendix, available online at http://www.iwaponline.com/wp/015/059.pdf).

Researchers and water information providers met collectively to develop and discuss representation options (described fully in Cutts *et al.*, 2011). The meeting culminated in a comprehensive list of public information efforts (Appendix). This list provided a guide to additional data collection and more consistent reporting across organizations. Water information providers discussed the merit of several research approaches to account for differences in the nature of the data they reported. For example, some information programs were distributed to the public (and thus, could be represented as an area), while others were available for the public from a particular point. Information sources varied in the depth and complexity of content. Ultimately, the group agreed that the most credible process was to develop six maps derived from different combinations of data aggregation methods and approaches to content (Figure 2).

Of the three aggregation methods, two use political boundaries – census tract or zip code (Figure 2). Representations assume that all dispersed and central locations for information within a political unit

Table 2. Decision tree to support data transformation into comparable formats.

1. Did the estimation of policy effort come from a person or a document?
    - 2a. If a document, does the document repeat information already coded from an interview? (Continue to 3)
        - 3a. If yes, does the document corroborate interview information? (Continue to 4)
            - 4a. If yes, then map only once. (STOP)
            - 4b. If no, then find a third source to resolve conflict. (STOP)
        - 3b. If no, discuss with interviewee before adding to the map. If the interviewee does not respond, substitute document for interviewee. (SKIP TO 2b).
    - 2b. If a person, was the information distributed to the public from a central location (can it be represented as a point on a map)? (Continue to 5)
        - 5a. If yes, is the source certain about the location of the information? (Continue to 6)
            - 6a. If yes, geocode the point. (SKIP TO 12)
            - 6b. If no, can the source provide additional information to refine the estimate? (Continue to 7)
                - 7a. If yes, geocode each potential point and weight by the probability an event occurred. (SKIP TO 12)
                - 7b. If no, find a second source (document or person) that can identify the location. (STOP)
        - 5b. If no, was the information dispersed to the public (can it be represented as an area within the study boundary)? (Continue to 8)
            - 8a. If yes, can the source provide the area boundaries? (Continue to 9)
                - 9a. If yes, map the effort to these boundaries. (SKIP TO 14)
                - 9b. If no, find a second source. (STOP)
            - 8b. If no, does the information rely on internet, television, or radio? (Continue to 10)
                - 10a. If yes, apply effort to the range of the media channels (typically the entire study region). (SKIP TO 14)
                - 10b. If no, Can the source provide an estimate of the likely geographic extent of the program? (Continue to 11)
                    - 11a. If yes, map the effort to this boundary. (SKIP TO 14)
                    - 11b. If no, find a second source. (STOP)
12. Identify the type of interaction characterized by the point (information kiosk, booth, class, advertisement, or exhibit). (Continue to 13)
13. Calculate the average distance between similar sources and apply a buffer of that distance to relevant points, thus assigning an areal measurement to the program. (Continue to 14)
14. Calculate the economic proxy. Is all data entry complete?
    - 15a. Yes. (Continue to 16).
    - 15b. If no, return to 1 with another source.
16. When all information has been entered, aggregate across information programs using zipcode or census ‘container’ methods or original area. (Continue to 16)
17. Add together all weights in the area by count (using probabilities in 7a for uncertain events) or economic proxy (see Appendix, available online at http://www.iwaponline.com/wp/015/059.pdf). (Continue to 17)
18. Categorize the lowest third of all values as ‘low, omit the middle third, and categorize the top third of all values as ‘high’. (END)

serve only those residents. The third data representation uses information boundaries derived from the data. Dispersed information retains boundaries appropriate to the municipality, school district, or other regional area over which it is available, while distance buffers distribute the impact of central locations over all the area they potentially serve. In this representation technique, residents of one city are presumed to gain information from nearby information sources in other cities. Buffer circumference is

the average distance between event sites providing similar resources. Average distance calculations considered locations providing similar resources. Unstaffed permanent information kiosks, staffed event booths, classes, billboard advertisements and interactive demonstrations or exhibits were considered separately. The radii of the buffers are as follows: information kiosk = 10 km, booth = 18 km, class = 15 km, advertisement = 35 km, exhibit = 46 km. All mapping used ArcGIS version 9.0 (ESRI, 2004). In a few instances, interviewees provided probabilistic information about points. For example, one organization reported attending five of 40 neighborhood events sponsored by the police department, but could not specify exactly which ones. In these cases, each potential site was assigned a probability of hosting the water information program. In the case of information campaigns that distribute materials to the homes, polygons represented the information extent. These included school-based programs (presumed to reach adults dispersed throughout the district), mailings and local news sources (Table 2).

Without a satisfactory existing metric to accommodate the relative impact of different public information methods, discussion with water information providers resulted in the development of a novel economic proxy approach. The proxy accounts for both differences in program breadth (reaching large populations) and depth (providing detail and higher levels of engagement) while attempting to normalize across organizational budget differences. The economic proxy uses a combination of real expenses and estimated costs to create standardized estimates of effort for each program type (Table 3). This method assumes that each organization strives to allocate resources (including financial and volunteer capital) effectively and efficiently, maximizing information transfer and the potential for use (O'Reilly, 1982; Saunders & Jones, 1990). Each estimate can then be calculated as a per capita expense for the intended reach of the program:

$$\text{Economic proxy} = \frac{\text{PC} + (h \times w_h) + w_t + \text{DIC}}{\text{POP}_t}$$

Table 3. Examples of economic proxy calculations used to rank the effort to reach the public associated with each water information effort.

Education program	Calculated expense data	Source
Insert included in other mailing	US$0.055 printing cost per mailing × number of households receiving mailing/total number of households (assume postage charge included in cost of primary reason for mail)	www.printingforless.com; US Census (2000)
Organization member mailing	(US$1.06 for 28 page printing + 0.80 for mailing) × (number of members in region (by city if possible))/ total households in region	www.printingforless.com; Organization documents; US Census (2000)
Residential water audits	(US$12.50 hourly wage × 2.5 × (average round trip 40 miles at US$0.43 per mile) × 395 days/population of city	Comparable job advertisement; Government mileage rate; US Census (2000)
Newsletter	(US$0.20 to print) × (US$0.32 to send to homeowners))/number of households	www.printingforless.com; US Census (2000); US Postal Service
Cable channel still-screen Public Service Announcement (PSA)	US$2000 screen shot/households in intended service area	Station rates listed online; US Census (2000)
Xeriscape and other rebate information	Estimated total rebate dollars dispersed × effort to advertise rebate/city population	www.watercasa.org; US Census (2000)

where PC is the material production cost, h is the volunteer hours, w_h is the hourly wage for similar work as a paid position, w_t is the total paid wages (assuming standardized rate), DIC is the material development and implementation costs and POP_t is the total population of estimated service area.

The proxy can be summed across all programs operating in the same geographic area to calculate the cumulative effort to inform the public across all organizations (see Table 3 for examples).

In each map, the highest third of values is assigned to the high information class and the smallest third of all values is assigned to the low information class (Table 2; Figure 2). Binary logistic regression was used to test associations between high spatial access to information within (1) sub-regions of the study area (western cities, Phoenix, or eastern cities), (2) percentage Latino, (3) percentage of the population that rent their home and (4) percentage of households with at least one school-aged child (ages 5–18). Backward stepping conditional removal approaches were used to select logistic regression models (SPSS v. 15.0, 2007). Percentages of Latinos, renters and school-aged children were selected from candidate variables including the percentages of the population with (i) no education beyond high school, (ii) below the poverty level, (iii) with Spanish as a dominant language, (iv) foreign born and (v) not a citizen, which are all highly correlated with percentage of Latinos in 2000 US Census data for Phoenix (see Cutts *et al.*, 2009).

Separate logistic regressions test the relationship between predictor variables (percentages of Latinos, renters and homes with one or more school-aged children) and location near high or low levels of water information exposure for eastern cities (which are mandated to provide more public information), Phoenix and western cities (where there are fewer unique water supplies). Finally, analyses compared areas consistently ranked as exposed to either high or low levels of information access across at least four of the six representations (Figure 4). In each analysis (Table 4), high is the reference category.

4. Results: evaluating the landscape of opportunity for public engagement

Results indicate the increase in probability of a region's rank as an area of high water information exposure with a unit increase in the predictor variable. The Cox and Snell R-square for the models ranges from <0.001 to 0.40 indicating a broad spectrum of model fits across regions (eastern cities, Phoenix and western cities) and mapping techniques. Models using zip codes have the highest R-square values and results.

4.1. Information availability is higher in the east and west cities, where formal policy plays a larger role in information distribution

Logistic regression analyses test the patterns of information against the demographic variable that water information providers perceive to be important barriers to adequate public representation in governance. All representations of information (Figure 3) indicate that the spatial arrangement of effort to provide public information about water issues is not distributed evenly or randomly in any representation. Separate logistic regressions for the west valley cities, Phoenix and the east valley cities indicate that the direction and strength of relationships varies across these areas. In the west, analyses

Fig. 3. Illustrations of water information levels constructed through participatory mapping approaches. Each panel represents the map resulting from a unique combination of aggregation techniques (census tract, zip code, or distance buffer) and accounting method (count or economic proxy). (a) Census tract (count), (b) census tract (economic proxy), (c) zip code (count) (d) zip code (economic proxy), (e) original map representation (count) and (f) original map representation (economic proxy). High water information levels are shaded darkly. Low water information levels are shaded lightly.

indicate a net negative relationship between percentage Latinos and access to information, while the relationship is positive in Phoenix and the eastern cities (Table 4). In the west and east, analyses indicate a positive relationship between school-aged children and access to information, while in Phoenix, the

Table 4. Logistic regression analysis using census tracts for count-based classification of high and low information exposure areas using. Panels correspond to maps in Figure 3. High information effort = 1.

Figure 3 map	Location	Aggregation technique	Weighting method	n	% Latino β	% School-aged β	% renters β	Constant β	Cox and Snell R^2
A	West	Census tract	Count	49	0.48	–1.34	–0.48	0.69	>0.01
B			Effort	62	1.34	–4.12	1.88	1.41	0.01
C		Zip code	Count	12	–27.04	131.31	–27.59	–20.71	0.42
D			Effort	4	0.23	29.44	–7.94	–4.37	0.27
E		Original	Count	69	–1.78	10.16	2.02	–2.83*	0.10
F		Representation	Effort	131	–4.62**	6.74**	5.18**	–1.08*	0.15
A	Phoenix	Census tract	Count	252	–	–	–	–	NA
B			Effort	203	3.84**	–5.60	–1.85	–1.52	0.11
C		Zip code	Count	29	–6.56	42.47	9.76	–14.10	0.14
D			Effort	8	14.28	–1539.41	645.17	–81.15	0.40
E		Original	Count	338	3.83***	–7.75**	1.39*	–0.5	0.18
F		Representation	Effort	311	0.84	4.83	6.64	–0.61***	0.11
A	East	Census tract	Count	103	–6.68†	1.51	13.59**	0.39	0.13
B			Effort	134	–5.82	2.06	12.40**	0.58	0.05
C		Zip code	Count	28	5.66	–23.21	10.70	4.49	0.28
D			Effort	6	11.26	–23.98	7.24	2.12	0.29
E		Original	Count	323	–1.37	4.43*	5.63**	–0.59	0.11
F		Representation	Effort	345	2.56*	0.30	3.48***	–1.31***	0.14

†If $p < 0.10$.
*If $p < 0.05$.
**If $p < 0.01$.
*** If $p < 0.001$.

relationship is negative (Table 4). Across all areas, there is a positive relationship between information availability and high percentages of renters.

4.2. Information availability is higher in neighborhoods with a high percentages of Latinos overall, but the relationship is reversed in western cities

There is a positive and significant relationship between the percentage of Latinos in a region and information availability in models B and E for Phoenix and model F in the east. There is a negative and significant impact in cities to the west in model F (Table 4). Globally, the percentage of Latinos has a negative and statistically significant impact on local information availability (Table 5).

4.3. Information availability is higher in areas with larger percentages of homes occupied by renters

The percentage of renters has a positive and significant impact on local information availability in all regions of the study. The model developed from map F was significant for the west, model E for Phoenix and models A, B, E and F all found positive and statistically significant relationships between the percentage of renters and the information availability in the east (Table 4). Globally, the percentage of renters has a positive and statistically significant impact on local information availability (Table 5).

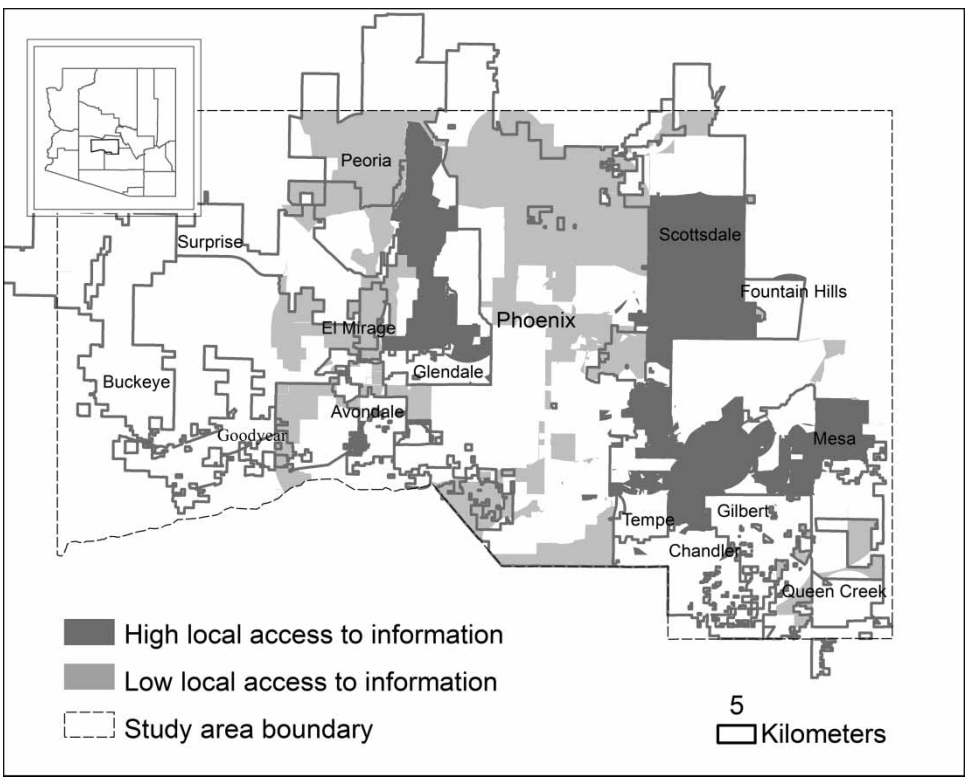

Fig. 4. Consistency of neighborhood designation exposed to high or low amounts of water information.

4.4. Information availability does not differ with the percentage of households with children overall; however, there is a significant positive relationship in the west and east and a negative relationship in Phoenix

The percentage of the population that is school-aged has a positive and significant impact on local information availability in the west (Table 4 – F) and east valley cities (Table 4 – E). The percentage of school-aged children is a negative and statistically significant predictor of local information access in model E for Phoenix (Table 4). Globally, the percentage of school-aged children does not have a statistically significant impact on local information availability (Table 5).

Table 5. Logistic regression analysis for patterns in consistency of ranking. High information effort = 1.

Predictor	*N*	β	SE β	χ^2	*df*	*p*	Wald's $e\beta$ (odds ratio)
	1,220						
% Latino		–1.94	0.54	12.92	1	<0.001	0.17
% School-aged children		1.67	1.24	1.80	1	0.18	5.30
% Renters		4.39	0.47	87.88	1	<0.001	80.41
Constant		–0.69	0.25	7.45	1	0.01	0.50
Tests of model coefficients				χ^2	*df*	*p*	Cox and Snell R^2
Overall model evaluation				105.31	3	<0.001	0.08

5. Discussion

As water decision-making systems strive for sustainability at the watershed scale, more formal and informal actors have the capacity to alter the process (e.g. Syme & Nancarrow, 1992; Sabatier, 2005; Jacobs *et al*., 2010). Thus, reaching sustainability goals through decentralized water decision-making systems requires new modes of assigning responsibility for creating and enforcing policy. Increasing the capacity for inclusive processes and adequate recognition of the public will be important features (Pearson *et al*., 2010). However, higher-order accountability is challenging, given the range of institutional cultures disseminating water information.

The data collection and analysis methods developed in this paper suggest that water decision-making systems can be collectively evaluated and held responsible for their effort to recognize the public and use information as a symbolic tool. The study considers this a collective responsibility of public, non-profit and private sector organizations that mediate between the public and decision-makers. One difficulty in evaluating activities distributed across multiple sectors and organizations is that it relies on coordination across numerous actors, all of which may vary in their willingness or ability to provide data. This study presents a method and interactive mapping protocol that relies on both interviews and document analysis. This gives all organizations numerous opportunities to be represented. The economic proxy was developed to reconcile differences in information richness and audience penetration. Broad categories assign neighborhoods to 'high' and 'low' categories using one of six techniques that accommodate differences in content depth and information delivery method. This approach limits the study in its precision and uses categorical representations of water information dissemination. The work used two political boundaries and buffers to accommodate the differences in information reporting. Differences in specificity provided by each organization precluded more precise analysis (Brody *et al*., 2002). However, the aim of this study is to present an effective method for evaluating the distribution of information resulting from the system, aggregated across all of its members. While it requires negotiation at the science–policy interface (detailed in Cutts *et al*., 2011), this approach holds the system accountable to the public rather than individual organizations for poor performance. Using the mix of interview, document analysis and focus group methods developed in this study, it is possible to evaluate the extent to which they collectively have the capacity to recognize diversity and claim legitimacy as public representatives. The resulting map can help identify neighborhoods that may be overlooked or disenfranchised by poor representation in decisions at the scale of industrial, agricultural and municipal water decisions. The mapping exercise presented here presents a useful guide for future efforts to identify patterns of underrepresentation in both traditional public comment processes or more intensive modes of public engagement.

5.1. Information distribution favors regions with complexity, yet insecure water supplies; Latinos and renters

The results of this study support most predictions about disparities in access to information. Residents of the City of Phoenix are less likely to receive information than residents living in the surrounding cities. The distribution of information within each region differs (Table 4). Across all cities, neighborhoods with smaller percentages of Latino residents and larger numbers of renters are more likely to live in areas highly targeted by water information (Table 5).

Low engagement among residents of Phoenix, for whom water supplies are relatively secure, reinforces paternalistic modes of water resource decision-making. Paternalism, or the tendency to make decisions under the assumption that they are not adequately equipped to do it on their own, tends to widen injustices in terms of who incurs the costs and who reaps the benefits in comparison to more inclusive modes of decision-making (Chong & White, 2007). The implications of paternalistic decision-making are especially relevant in the case of metropolitan Phoenix, since many drought management plans explicitly state an interest in equitably sharing the impact of drought across society through a flat 5% reduction in residential water use across all users (Gilbert, 2007). Further, the actions of municipal water suppliers and civil society groups, act in parallel rather than as a complement to municipal policies. That is, in a system that prioritized inclusion, one would expect the actions of non-governmental organizations to mitigate differences created by formal policy. Instead, the results indicate that some audiences are doubly targeted – a phenomenon that has been observed in other studies examining the evenness of public services provided by the non-profit sector (Wolch & Geiger, 1983; Bielefeld *et al.*, 1997).

Counter to predictions, renters receive more information than homeowners. The result is puzzling, given the consistency with which water information providers report that they include content that focuses on reducing outdoor water consumption (Cutts *et al.*, 2008). The finding suggests a mismatch between the messages of content and location that might undermine public engagement in the policy and politics of local water decisions more severely than either limitation alone, thus creating a mutually reinforcing barrier to creating new spaces for political activity related to water issues, a process that is critical to enabling deep public engagement (Cornwall, 2002; Schlosberg, 2007). More evenly dispersed information could improve the potential for Phoenix residents and homeowners across the metropolitan region to initiate conversations that would reduce their own supply security in support of acute water crises in other regions.

Although many studies have noted the importance of information in mobilizing a community (e.g. Overdevest & Mayer, 2008) and the uneven barriers erected through highly technical information (e.g. Shapiro, 2005), there has been little attention afforded to the ways information may affect awareness of the public's vulnerability to formal water policy change or the perception within the public that the policy space is open to broad public participation. Overlooking diversity among the public can further disenfranchise sub-populations that are traditionally underrepresented by limiting their capacity to organize themselves against threats or to advocate their interests.

It is not only access to water of an appropriate quality and quantity that is a justice concern. The public's access to information and recognition of the symbolic role information campaigns play in that process are important (Howard, 2010). Weiss & Tschirhart (1994) discuss the capacity of individual information campaigns to enhance the richness and fairness of idea competition, to inform the least-informed citizens and to inspire creative and imaginative public policy solutions generated by the public. Considering information as spatially heterogeneous represents an opportunity to elevate the profile of recognition justice concerns among quantitative environmental justice studies and enriches the way environmental behavior studies contextualize information campaigns. Information can be used as a way to form environmental claims, and the act of providing information to a particular area can be interpreted as a type of recognition and legitimacy afforded to some populations. Disparities in effort may indicate inadequate consideration of issues salient to residents of underrepresented neighborhoods and social groups. This is especially relevant to policy when racial and ethnic minorities or women are excluded, because these social groups tend to perceive risk differently (Satterfield *et al.*, 2004) and thus might reject policy choices made without their involvement.

6. Conclusion

This study advances water policy studies in two ways. First, the study introduces information as a symbol of public inclusion and an indicator of the capacity of water decision-makers to recognize the unique consequences of water management. Second, it introduces mapping techniques, and several analysis methods (Figure 3) relevant to the study provide analytical approaches that can be applied to any social, environmental, or technical domain in which multiple overlapping groups are responsible for engaging the public. Information symbolizes the legitimacy of claims for action on behalf of the public interest or public good. In addition to empowering communities directly by providing them with information, the act of providing information to some communities and not others can influence how communities view themselves as legitimate participants in political processes and advocates for alternative futures that reflect their own values. Spatial differences in information availability that correspond to demographic differences reveal limitations in the ability of current water decisions to be inclusive. For policy, this is a useful way to discover improper recognition, which may limit the impact of public information on behavior, directly undermining demand management and water quality protection. Systematically under-representing groups in decisions that redistribute benefits and burdens may reproduce and/or create spaces of exclusion (Young, 1990; Schlosberg, 2007; Walker, 2009). Evaluating the collective impact of water information is critical. While not appropriate to systems with high amounts of information manipulation (Mol, 2009), this study suggests that coordination between organizations may improve the ability of the water governance system to empower representations from the public that include diverse interests. The mapping method and economy proxy developed in this study present a useful guitofor future efforts to identify patterns of under-representation in both traditional public comment processes and more intensive modes of public engagement.

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