Value beyond money

Health benefits of recreational water accessibility

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1 Study background

The value of water is often investigated from a monetary perspective. In multiple disciplines, research questions such as "Does water quality impact nearby property values?" (Gibbs et al., 2002; Poor et al., 2001) or "How much are people willing to pay for blue spaces?" (Carson & Mitchell, 1993; Park & Song, 2018; Söderberg & Barton, 2014) have been extensively examined.

More recently, researchers began to notice non-monetary values of water resources (i.e., blue spaces), particularly physical and mental health benefits for residents (Georgiou et al., 2021). Although several studies have examined community health benefits of blue spaces for a specific region (Pearson et al., 2019) or country (White et al., 2021), such studies often assume that the health effect of blue space is homogeneous for people.

This work deviates from the current studies in health benefits of recreational water resources, by posing the following question: *Value for whom?* We argue that the benefits of blue spaces can be disproportionate to other social and ecological factors.

2 Research questions

- Is accessibility to recreational water (e.g., lakes and rivers) associated with residents' mental health?
- What social and ecological factors influence the relationship between recreational water accessibility and residents' mental health?

3 Methods

This study chose the state of South Carolina as the study area. Data on residents' mental and physical health status for 408 ZIP codes were obtained from the CDC's PLACES project. Considering the impact of the COVID-19 pandemic on mental and physical health, we used estimates based on 2019 health data. Accessibility to green spaces, inland water bodies, and coastal areas were calculated using geographical information system (GIS) software. The model also controlled for the influence of social factors on residents' health. Following the Office of Disease Prevention and Health Promotion, we included nine measures of Social Determinants of Health (SDOH) that were calculated using American Community Survey data (see, **Table 1**).

Collected data were analyzed in two stages. First, the effects of independent variables on the prevalence of mental disorders were estimated using Multiscale Geographically Weighted Regression (MGWR). This approach enable us to capture local variations of effects over space (spatial nonstationarity) by estimating regression parameters for each location (Fotheringham et al., 2002). Subsequently, regions were categorized based on the strength of the effect of blue space accessibility on mental health. Using quartile as a criterion, we conducted ANOVA to examine the difference in social and ecological factors among different levels of effect strength.

4 Results

Our model explained a significant proportion of variation in the prevalence of mental health concerns (R^2=87.5%). MGWR result indicates that blue space accessibility is negatively related to the proportion of residents who self-rated their mental as "not good." Yet, this relationship showed variation by region, ranging from B=-0.142 to B=0.019 (see, **Figure 1** and **Table 2**).

Further analysis revealed a difference in social and ecological characteristics of regions among quartiles of blue space accessibility's effect (**Table 2**). The negative relationship between recreational water accessibility and proportion of self-rated mental disorders was stronger in regions where:

- the coast is further away
- vegetation density is higher (more green space)
- inland water area is inaccessible
- proportion of adults not completed high school is higher
- inaccessibility to broadband internet is higher
- prevalence of physical health disorders is higher
- proportion of older adults is smaller

5 Conclusions

Results underlie the non-monetary value of recreational water for improving the mental well-being for residents and disparities in beneficiaries of these resources, particularly benefiting those who are less accessible to coastal area. The findings can aid more informed policy decision-making about sustainable use of blue spaces, by considering the heterogeneous distribution of these benefits across different communities. For instance, the benefits of conserving in recreational water resources need to be weight differently for inland and costal regions during a cost-benefit analysis for policy making.

Figure 1 Visualization of the effects of blue space accessibility on residents' mental health status

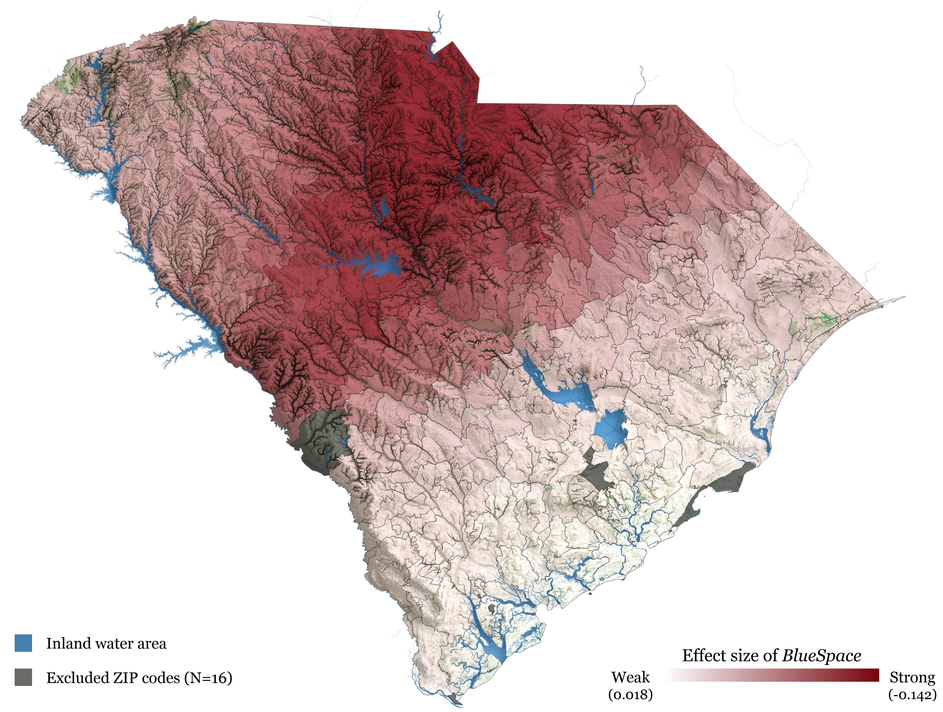

Table 1 Summary of variables

Description	Variable	Source
Mental & physical health status (adults ≥18 years)		
Mental health not good for ≥14 days (%)	*MenHealth*	CDC
Physical health not good for ≥14 days (%)	*PhyHealth*	CDC
Natural resource access		
Average Normalized Difference Vegetation Index (NDVI)	*GreenSpace*	USGS
Proportion of water area (per km²)	*BlueSpace*	USGS
Distance to coastline (km)	*Coast*	USGS
Social determinants of health (SDOH)		
Persons aged ≥ 65 years (%)	*Age65+*	ACS
No broadband internet subscription among households (%)	*NoInternet*	ACS
Crowding among housing units (%)	*Crowding*	ACS
Housing cost burden among households (%)	*HousingCost*	ACS
No high school diploma among adults aged ≥ 25 years (%)	*NoHSEduc*	ACS
Persons living below 150% of the poverty level (%)	*Pov150*	ACS
Persons of racial or ethnic minority status (%)	*Minority*	ACS
Single-parent households (%)	*SingleParent*	ACS
Unemployment among people aged ≥16 years in the labor force (%)	*UnEmp*	ACS

Table 2 MGWR and ANOVA results

	Stage 1: MGWR					Stage 2: ANOVA	
	OLS	Min.	Mean	Max.	BW	*F*	Groups
PhyHealth	0.444 ***	0.449	0.657	0.874	407	4.36 **	Q2, Q3 > Q4
GreenSpace	<0.001 *	-0.175	-0.101	-0.011	92	25.57 ***	Q1, Q2, Q3 > Q4
BlueSpace	-0.014	-0.142	-0.057	0.019	291	11.97 ***	Q4 > Q1, Q2, Q3
Coast	<0.001	-0.032	0.065	0.204	256	130.81 ***	Q1, Q2, Q3 > Q4
Age65+	-0.121 ***	-0.847	-0.396	-0.062	230	3.45 *	Q4 > Q1, Q2
NoInternet	-0.002	-0.254	0.041	0.309	73	4.38 **	Q4 > Q3
Crowding	0.010	-0.042	0.039	0.109	117	1.44	n.s.
HousingCost	0.034 ***	0.041	0.129	0.206	310	1.91	n.s.
NoHSEduc	0.017	-0.166	0.052	0.199	222	8.38 ***	Q1, Q2, Q3 > Q4
Pov150	0.036 ***	-0.134	0.274	0.723	161	2.76 *	n.s.
Minority	-0.012 ***	-0.215	-0.121	0.000	55	2.76 *	n.s.
SingleParent	-0.051 ***	-0.105	-0.066	-0.023	129	1.44	n.s.
UnEmp	0.027 *	-0.067	-0.01	0.076	388	1.22	n.s.
Intercept	0.113 ***	0.138	0.146	0.159	293		
R^2	72.6%				87.5%		
Adjusted R^2	71.7%				84.8%		

Note. * p<.05, ** p<.01, *** p<.001, n.s=not significant. Q1=strongest effect size, Q4=weakest effect size