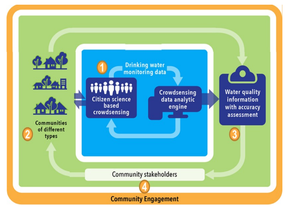
SCC: Smart Water Crowdsensing: Examining how innovative data analytics and citizen science can ensure safe drinking water in rural versus suburban communities

Dong Wang, University of Illinois Urbana-Champaign

Award Type: IRG; Award ID: 2140999

Project Challenge



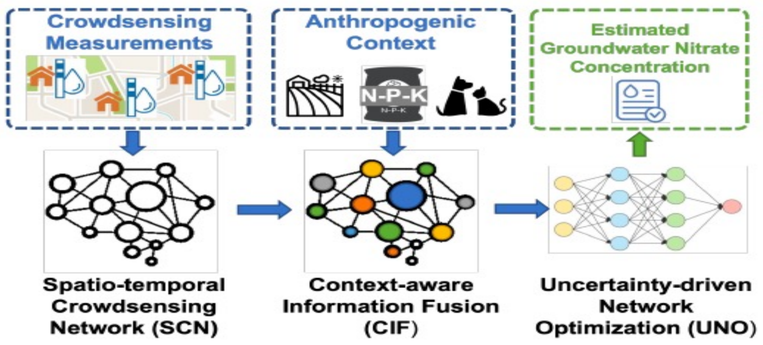
Technological:

- How to obtain reliable information from crowd measurements on water contamination?
- How to explore the tradeoff between crowdsensing cost and measurement errors?

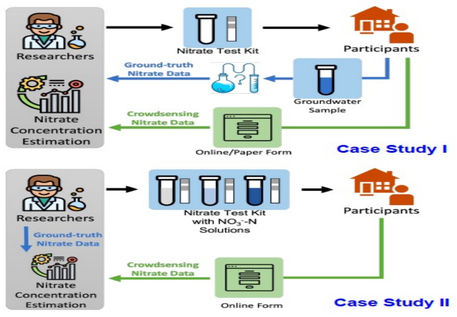
Social:

- How do social-demographic qualities influence crowdsensing quality in different types of communities?
- How does involvement in smart water crowdsensing changes in participants, educational programming and policy implementation in target communities?

Major Outcomes/Progress

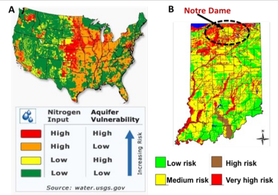


Overview of the CrowdWaterSens Framework



- Developed a CrowdWater Sens model.
- Evaluated the model in well-dependent communities.

Intellectual Merit



Technological:

The project developed and tested novel crowdsensing data analytical models in SWC. The results demonstrated that it is feasible to obtain reliable crowdsensing data on drinking water contamination using unreliable crowd sensors for community level well water monitoring.

Social:

By comparing different community types (suburban, urban, and rural), it is found that the socio-demographic qualities may influence crowdsensing participation and data quality.

Major Outcomes/Progress

Method	MAE	MSE	RMSE	R^2
CrowdWaterSens	**0.4639**	**0.4817**	**0.6829**	**0.3618**
SmartWaterSens	0.4993	0.5032	0.7125	0.3247
NCE	1.0327	2.9376	1.7783	-0.2543
ELR	0.7794	1.6832	1.2784	-0.1407
NCRA	0.5376	0.6597	0.8133	0.2970
GWR	0.7926	1.1247	1.1359	0.0823
AVI	0.7326	0.7548	0.8837	-0.1032
BNN	0.7821	0.8733	0.9417	-0.2015
GCN	0.6849	0.8446	0.8973	0.0372
GTN	0.8734	0.9728	1.1873	-0.1769

Table 3: Nitrate Concentration Estimation Performance - Case Study I

Method	MAE	MSE	RMSE	R^2
CrowdWaterSens	**0.8932**	**2.9836**	**1.7729**	**0.3374**
SmartWaterSens	0.9628	3.1726	1.8932	0.3089
NCE	1.9722	11.0278	3.3208	-0.0459
ELR	1.2376	6.7738	2.3849	0.1839
NCRA	1.0287	4.0215	2.1634	0.2337
GWR	1.3486	7.3849	2.5381	0.1329
AVI	1.4295	7.9447	2.8328	0.0916
BNN	1.4872	8.2476	3.0182	-0.1837
GCN	1.2293	6.2145	2.2935	0.1748
GTN	1.1834	5.6724	2.2403	0.1183

Table 4: Nitrate Concentration Estimation Performance - Case Study II

CrowdWaterSens Estimation Performance Comparison

Method	MAE	MSE	RMSE	R^2
CrowdWaterSens	**0.4639**	**0.4817**	**0.6829**	**0.3618**
CrowdWaterSens\S	0.5327	0.5287	0.7748	0.1938
CrowdWaterSens\T	0.5106	0.5172	0.7183	0.2174
CrowdWaterSens\C	0.4985	0.5013	0.7031	0.2635
CrowdWaterSens\U	0.5182	0.5216	0.7227	0.2218

Table 5: Ablation Study - Case Study I

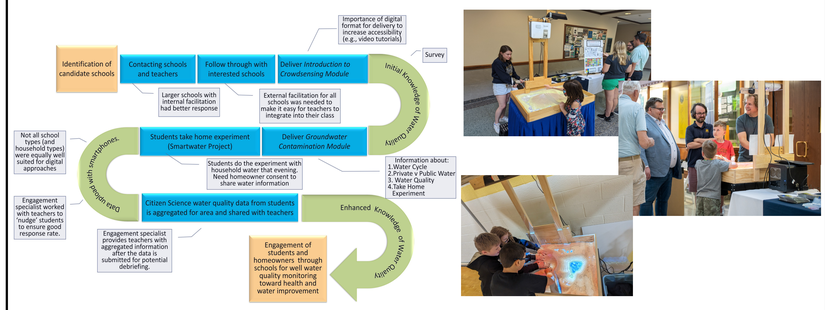
Method	MAE	MSE	RMSE	R^2
CrowdWaterSens	**0.8932**	**2.9836**	**1.7729**	**0.3374**
CrowdWaterSens\S	0.9026	3.1195	1.8278	0.3185
CrowdWaterSens\C	0.8983	3.0837	1.8026	0.3027
CrowdWaterSens\U	1.1277	6.0739	2.2334	0.1039

Table 6: Ablation Study - Case Study II

CrowdWaterSens Ablation Study

- Results showed the effectiveness of our model in accurately estimating ground water contamination;
- Ablation study shows the necessity of major modules.

Broader Impact



- Determined barriers and motivational factors at different scales in the literature to help inform school, teacher and student engagement in well water data collection.
- Refined the larger multistate Qualtrics survey that would help to validate some of the barriers identified in the smaller number of schools and teachers within our case study.
- Organized "Family Science Night" event and 417 visitors attended the event and learned how to improve their water quality and reduce health risks.
- Repeated the outreach activities to "ND Explores Stem" for approximately 200 visitors.

Future Goals

- Further study the adaptability and robustness of our smart water crowdsensing framework in communities of different size and density.
- Continue to evaluate the educational impact of the project and understand factors to help engage participants through school systems.
- Summarize the key findings and results in the final report and explore how those findings can be generalized into future research in other SCC application domains.