Promoting Resilient Groundwater Resources and Holistic Watershed Management in the southern Kenai Lowlands, Alaska

Project Location

Kachemak Bay and surrounding watersheds, Alaska

Project Duration

October 2017 to October 2019

Project Lead

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Project Type

Collaborative research – Generating science that informs decisions

Project Partners

- Cook Inlet Keeper
- Homer Soil and Water District
- Kachemak Bay National Estuarine Research Reserve
- Kachemak Bay National Estuarine Research Reserve Community Council
- Kenai Peninsula Borough
- Project GRAD
- University of South Florida

Project Webpage

nerrssciencecollaborative.org/project/Walker17

Overview

In Alaska's Kenai Lowlands, groundwater is key to healthy watersheds and resilient salmon, farms, and communities. Groundwater discharge provides important ecological services to salmon streams by moderating temperatures, maintaining stream flows, delivering nutrients, and creating overwintering habitat. At the same time, people tap into this resource by drilling wells for homes, farms, and extractive industries (such as gravel mining). As Kachemak Bay communities prepare for a changing climate, information about groundwater will be essential to manage the watershed for both people and salmon. To better understand the availability of groundwater and how human activities affect this resource, researchers at the Kachemak Bay National Estuarine Research Reserve and the University of South Florida built a predictive model that shows the depth and extent of aquifers and predicts groundwater discharge and recharge.

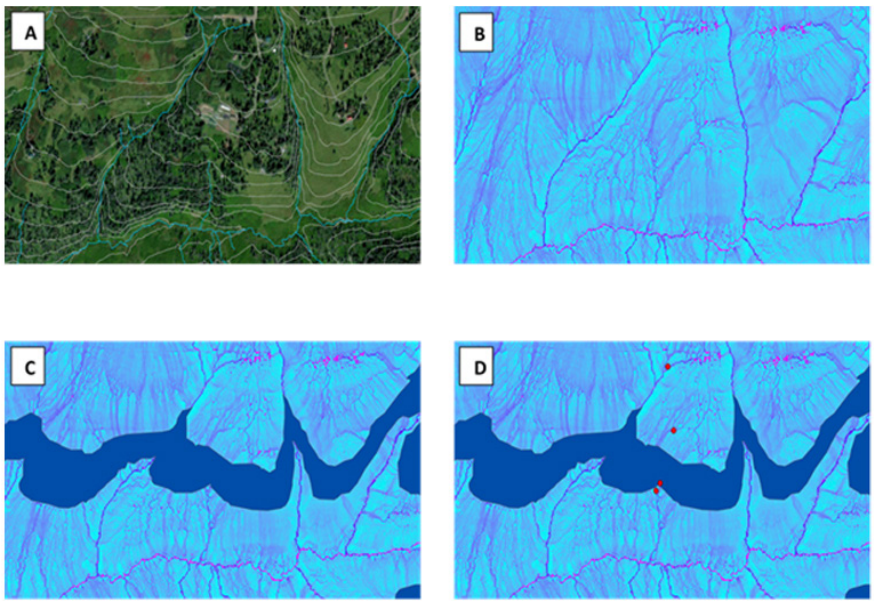
Working collaboratively with a broad range of watershed stakeholders, the team joined this new science with local expertise to interpret the groundwater model for use in land use planning, permitting, policy decisions, and habitat protection. The project developed a suite of tools and trainings to help stakeholders better understand groundwater dynamics, including webinars, story maps, school programs, and targeted field visits with decision-makers.

The project's findings generated new insight into groundwater use and vulnerabilities in southern Kenai Lowland watersheds. The model revealed the precariousness of groundwater resources and the potential for competition among users, while engagement with stakeholders increased awareness of the need to actively manage this limited resource. As a result, the community has begun to make changes to policies and practices to build toward resilient groundwater resources.

Project Approach

This project built on previous efforts by the Kachemak Bay National Estuarine Research Reserve to bring together scientists, resource planners, regulators, conservation nonprofits, educators, Alaska Native communities, farmers, fishermen, and community leaders to envision a thriving Kachemak Bay community in a future affected by climate and environmental changes. The team conducted a situational assessment of the reserve's nine-member Community Council and other stakeholders to identify concerns, create engagement strategies, and ultimately produce tools and communications products that meet specific stakeholders' needs.

To create a predictive groundwater tool that can identify locations of groundwater recharge and discharge and can determine the depth and extent of aquifers, researchers first used available data to map factors that reveal where groundwater is located or that impact groundwater discharge. Twelve geospatial data layers were created related to climate, geological and topographical factors, vegetation, stream solute concentrations and temperatures, human impacts, and water supply well locations. Well Log Tracking System data were used to delineate watersheds and identify where seeps and springs (i.e., groundwater discharge) are likely to occur. In the summers of 2018 and 2019, University of South Florida researchers collected field observations of seeps and springs along with water samples from target ground and surface water sites in order to validate the model. Data layers were then superimposed to find the combination of layers that would be most helpful to determine likely areas of groundwater discharge. The model was optimized to show both shallow hillslope groundwater discharge (released to streams and wetlands over weeks to months) and deeper groundwater flows (released to the surface over years to decades).



Examples of ground-truthed Water-Bearing Formation groundwater discharge. A: Surface and subsurface flowlines and features (e.g., gullies). B: A Topographic Wetness Index, with purple representing higher flower concentrations. C: A Water-Bearing Formation outcrop in dark blue, indicating that the formation can contribute to surface-water flows. D: Field observation points shown by red dots. From top to bottom, these are: shallow groundwater flows, a small seep, a large spring, and the accumulation of a large volume of spring water in an artificial pond.

Results

The groundwater geodatabase represents a first glimpse into the state of the Kenai Lowlands' aquifers. It provides highly accurate new information on the location, quantity, and regeneration time for the region's shallow and deep groundwater resources.

Using the geodatabase, researchers found that the water in the region's aquifers is quite young. Much of the water in deep aquifers was less than ten years old, while in shallow aquifers it was one to two years old. People generally access the youngest, most shallow reserves (one year or less) when they draw on groundwater. Well log data was only available for more highly developed areas, leaving groundwater discharge estimates incomplete for other parts of the Kenai Lowlands. Nevertheless, information generated by the model can be used by stakeholders to examine the potential effects of land-use and climate change scenarios on groundwater across the region. As the region dries, the model shows that Kenai Lowlands communities need to begin planning for a less abundant future.

The most significant outcome of the project was that it brought to light the great potential for groundwater scarcity and competition for resources in future years, a situation that jeopardizes food, water, and livelihoods across the Kenai Lowlands. The project provided baseline information to begin to get ahead of these intersecting issues. It also brought together competing groundwater users and generated momentum within the region's communities to find practical solutions that will work in Alaska's low-regulatory environment.

Products

- A GIS-based groundwater geodatabase
- Story maps about groundwater, salmon, and people
- Situational assessment for stakeholder engagement
- Scientific illustrations of groundwater resources
- Field-based learning opportunities with key decision-makers
- Field-based education programs for middle school students
- Webinar and presentations to promote public engagement
- Site-based profiles for developing stakeholder field trips

Benefits

- Helped key groundwater users better understand the vulnerability of these resources and their connection with salmon habitat.
- Provided a first-of-its-kind tool for science-informed decision-making about groundwater use. This includes vetting agricultural water use best practices with farmers and for improving farm leases; City of Homer watershed and reservoir planning; and land trust conservation planning to protect salmon heritage.

- Made recommendations to Kenai Peninsula Borough Material Site Work Group during code revisions to improve watershed protections.
- Enhanced partnerships with regional schools, remote Alaska Native community of Tyonek, farmers, city and borough decision-makers, and the local land trust. As a result, the region boasts a strengthened stakeholder network around groundwater resources, coastal fisheries resilience, and a changing climate.

What's Next

- The project team continues to work to address limited well data by creating a supervised classification scheme that can algorithmically identify groundwater discharge areas beyond mapped locations.
- Reserve staff will develop case studies that can apply the model to particular land-use decisions, and scenario-building that can show how decisions affect groundwater.
- Reserve staff continue to pursue collaboration with gravel mine operators to make site-specific information about groundwater available.
- Several journal articles are in development.

About the Science Collaborative

The National Estuarine Research Reserve System's Science Collaborative supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is managed by the University of Michigan's Water Center through a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA). Funding for the research reserves and this program comes from NOAA. Learn more at nerrssciencecollaborative.org or coast.noaa.gov/nerrs.