Monitoring of saltwater intrusion in coastal aquifers

Challenge: Sea level rise

Adaptation response: Limiting saltwater intrusion

Description

Scientific monitoring and assessment provide basic characterization of the groundwater resources of an area, an understanding of the different pathways by which saltwater may intrude an aquifer, and a basis for management of water supplies. Water-quality monitoring networks are particularly important in serving as early-warning systems of saltwater movement toward freshwater supply wells, as well as providing information on the rates of saltwater encroachment. Dedicated wells that sample multiple intervals of an aquifer are invaluable for providing a three-dimensional characterization of the extent of saltwater within an aquifer system. (Barlow, P.M., and E.G. Reichard. 2010).

Long-term monitoring of the saltwater-freshwater interface, particularly at sites identified as potentially sensitive to intrusion, will increase the quality and quantity of data used to assess vulnerability to saltwater intrusion.

Scientific modelling is an essential tool in the assessment of coastal aquifer dynamics. Modelling helps identify the different factors (such as recharge) that influence groundwater movement. Models can be further enhanced to incorporate the effect of water density (e.g., salinity) on groundwater flow, and they can be adapted to identify conditions under which groundwater availability is optimized and saltwater intrusion is limited (Barlow and Reichard 2010). Specifically, these optimization models can assist in calculating favourable groundwater yields by identifying the pumping rates, well locations, and human interventions (such as artificial recharge) that are most efficient (Darnault and Godinez 2008; Ferreira da Silva and Haie 2007, cited in Linzei 2011).

Implementation

Saltwater intrusion monitoring networks are designed to determine the inland extent of saltwater intruding from the ocean, and the distribution of saltwater that entered an aquifer by other means. Monitoring networks ideally have wells located near the freshwater-saltwater interface that can be used to detect movement of this interface. The best networks are designed to monitor saltwater intrusion in three dimensions because saltwater can advance unequally through the layers of rock in an aquifer. Monitoring that can distinguish between the different pathways of saltwater intrusion is beneficial because remediation of saltwater intrusion requires an understanding of the contributing pathways (Prinos, Scott T. 2016).

Environmental Benefits

- Provides decision support to reduce risk for saltwater intrusion through management interventions (water use regulations, recharge, and barriers).

Socioeconomic Benefits

- Provides decision support to maintain sustainable abstraction of freshwater thus securing livelihoods and health for local communities.

Opportunities and Barriers

Opportunities:

- Prevention and mitigation of salinity intrusion in coastal aquifers based on continuously updated aquifer baseline, with benefits for multiple users and sectors, including environment.

Barriers:

- High cost for monitoring infrastructure and operation
- Lack of monitoring capacity
- Lack of capacity of assessment (modelling)
- Lack of alternative sources of freshwater in periods with low abstractions.

Implementation considerations*

Technological maturity:	3-4
Initial investment:	3-5
Operational costs:	1-3
Implementation timeframe:	2-4

* This adaptation technology brief includes a general assessment of four dimensions relating to implementation of the technology. It represents an indicative assessment scale of 1-5 as follows:
Technological maturity: 1 - in early stages of research and development, to 5 – fully mature and widely used
Initial investment: 1 – very low cost, to 5 – very high cost investment needed to implement technology
Operational costs: 1 – very low/no cost, to 5 – very high costs of operation and maintenance
Implementation timeframe: 1 – very quick to implement and reach desired capacity, to 5 – significant time investments needed to establish and/or reach full capacity
This assessment is to be used as an indication only and is to be seen as relative to the other technologies included in this guide. More specific costs and timelines are to be identified as relevant for the specific technology and geography.

Sources and further information

Barlow, P.M., and E.G. Reichard. 2010. Saltwater intrusion in coastal regions of North America. Hydrogeology Journal 18: 247–60.

Barlow, Paul M. 2003. »Groundwater in Freshwater-Saltwater Environments of the Atlantic Coast« U.S. Geological Survey Circular: 1262 (U.S. Geological Survey Circular: 1262).

Linzey (editor) 2011. Prince Edward Island Department of Environment, Labour and Justice, Atlantic Climate Adaptation Solutions Association - Saltwater Intrusion and Climate Change

Prinos, Scott T. 2016. Saltwater intrusion monitoring in Florida. Special Issue: Status of Florida's Groundwater Resources. Florida Scientist 79(4) 2016 © Florida Academy of Sciences