Bay Area Groundwater and Sea level Rise Workshop Summary
November 13, 2019 | Oakland, CA

Introduction

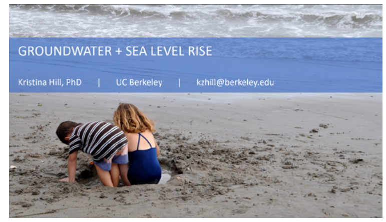
Coastal communities throughout California are actively planning for coastal impacts from climate change. Many impacts, such as sea level rise, storm surges, shoreline change and bluff erosion, have a comprehensive suite of scientific information that can help communities plan. Accordingly, many communities have completed vulnerability assessments and have begun identifying adaptation strategies to plan for coastal flood hazards. However, emerging research indicates that sea level rise, in addition to its potential to increase overland flooding, can also lead to rising shallow groundwater tables and create flooding hazards where we might not expect them. Two different scientific studies are currently underway in the San Francisco (SF) Bay Area (Plane et al, 2019[1], referred to here as the Silvestrum and UC Berkeley study) and for the CA coast and SF Bay (building from Befus et al 2017[2], referred to as CoSMoS-GW) that attempt to better understand and estimate how the shallow groundwater table will respond to sea level rise to support adaptation planning.

In recognition of the growing body of scientific study and interest by coastal communities, the County of San Mateo (SMC), the US Geological Survey (USGS), Silvestrum, and the SF Bay Conservation and Development Commission (BCDC) convened a workshop on November 13, 2019 in Oakland, CA, to discuss the importance of considering the influence of sea level rise on the shallow groundwater table and how some Bay Area stakeholders are planning for and adapting to this threat. Workshop participants included representatives from local municipalities throughout the SF Bay Area, including the coastal counties of Marin, San Francisco, Alameda, Santa Clara, and San Mateo, the Regional Water Quality Control Board, as well as state and federal agencies. During the half day meeting, the science teams set the context for shallow groundwater rise and presented on their respective methodologies, model outputs, and resulting maps. These were complemented by presentations from two local jurisdictions who are using groundwater information in their vulnerability assessments and planning. The City of Alameda Climate Action and Resilience Plan and the Hayward Area Shoreline Planning Agency's Shoreline Master Plan both include an assessment of rising groundwater levels. After the presentations, participants joined small break-out groups and discussed how rising groundwater tables may impact coastal communities and infrastructure and identified potential regional and local scientific information and guidance that would assist communities as they begin planning for this impact.

In this workshop summary, we provide an overview of the different modeling methodologies, key points from the group discussions and suggested next steps for the SF Bay Area region. Links to the presentations are included alongside their description.

1. Plane, E., K. Hill, and C. L. May. 2019. A Rapid Assessment Method to Identify Potential Groundwater Flooding Hotspots as Driven by Sea Levels Rise in Coastal Cities. Water 2228:8–10. DOI:10.3390/w11112228
2. https://pubs.er.usgs.gov/publication/70194664

Overview of the Science



Presentation available at: http://www.adaptingtorisingtides.org/wp-content/uploads/2020/02/01Hill-groundwater-workshop-Nov-13-2019-ADA.pdf

Kristina Hill, Ph.D. (UC Berkeley) provided on overview of the science that defined what the shallow coastal groundwater layer is, and why rising groundwater is a new problem. The shallow groundwater layer is defined as the unconfined aquifer that sits above the confined deep groundwater table. The concept that the shallow groundwater table will rise in response to sea level rise was first published 2007[3] and explored further in a 2012 USGS study of New Haven, Connecticut[4]. In the simplest estimate, in nearshore coastal areas (within about ½ mile of the Bay shoreline, depending on soil conditions and other factors), three feet of sea level rise can cause a three foot rise in the shallow groundwater table. This can result in emergent groundwater surface flooding in low-lying areas (Figure 1).

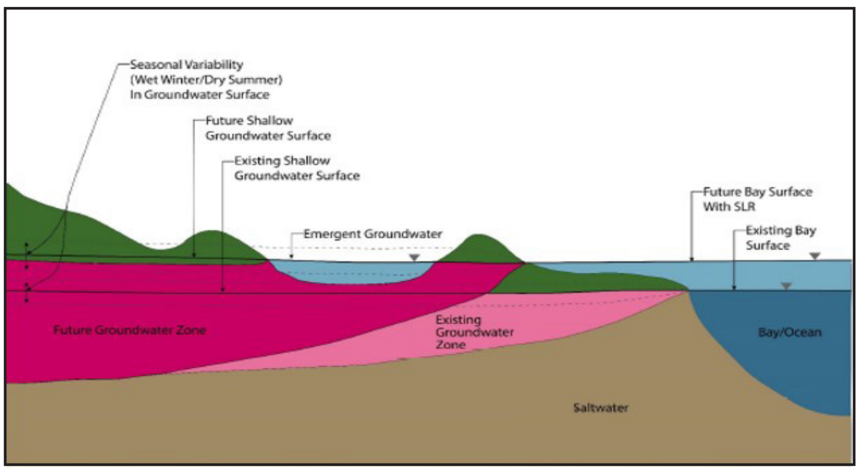


Figure 1. This illustration, included in the presentation by E. Smith from the City of Alameda, provides an overview of the interaction between the Bay/Ocean and the existing groundwater zone. It also depicts how risng seas can influence the existing zone and lead to the potential expansion of the groundwater zone, emergence of groundwater in previously dry areas, and the shallowing of the groundwater table in the backshore.

Rising groundwater can:

- Infiltrate underground sanitary and storm sewer pipes, cause foundations to heave, and require extensive underground waterproofing;
- Increase the risk of soil liquefaction in a seismic event;
- Remobilize old soil contaminants, creating problems for public health and Bay ecosystem health;
- Emerge at the surface as ponded water, or discharge to creeks and cause additional creek flooding.

The presentation included an overview of the mapping approach presented in Plane et al, 2019[5]. The mapping highlights locations around the Bay Area that could flood by emergent groundwater with 1 meter of sea level rise. The area that could be flooded by emergent

3. https://ngwa.onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.2006.00279.x
4. Bjerklie, D.M., Mullaney, J.R., Stone, J.R., Skinner, B.J., and Ramlow, M.A., 2012, Preliminary investigation of the effects of sea-level rise on groundwater levels in New Haven, Connecticut: U.S. Geological Survey Open-File Report 2012–1025
5. Plane, E., K. Hill, and C. L. May. 2019. A Rapid Assessment Method to Identify Potential Groundwater Flooding Hotspots as Driven by Sea Levels Rise in Coastal Cities. Water 2228:8–10. DOI:10.3390/w11112228

groundwater often extends farther inland than the areas projected to be flooded by sea level rise alone. The regional mapping thus estimates that about 26,000 additional acres of land in the Bay Area could be exposed to surface flooding when the rising groundwater table is considered.

To date, pumping is the most common approach used to address high groundwater tables. However, as sea level rise, larger and larger pumps will be required. Flooding could occur inland of the pump stations when the pumps cannot keep up with the volume. In many areas, pumping will increase subsidence rates (i.e., the land will sink, increasing the flood risk, such as occurs today in New Orleans), potentially exacerbating flood-related challenges.

Comparison of Approaches

Two emerging approaches to analyze and map the response of the shallow groundwater layer to sea level rise were presented. The attached document provides a more detailed summary of the two approaches.

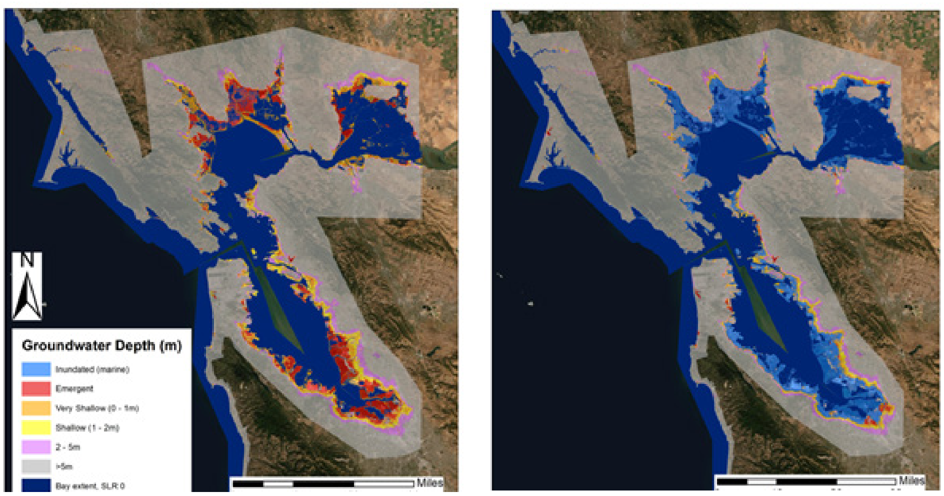
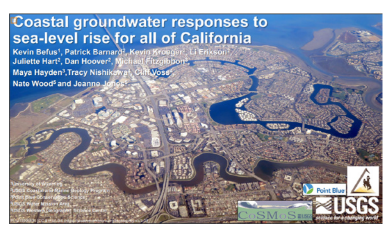


Figure 2. Preliminary CoSMoS-GW modeling showing (A) current groundwater tables with red depicting sites of emergent groundwater and (B) groundwater tables with 6 feet of sea level rise. Blue indicates coastal-driven flooding and inundation.

CoSMoS-Groundwater (CoSMoS-GW)



Presentation available at: http://www.adaptingtorisingtides.org/wp-content/uploads/2020/02/02BefusGW_SLR_Oakland_13Nov19-ADA.pdf

Kevin Befus, Ph.D. (University of Wyoming) presented on the recent work to assess the groundwater response to sea level rise for the entire California coastline, including the SF Bay region. Stakeholders throughout the state have expressed a need for this mapping, and this work is a logical complement to the overland flooding projected by the USGS Coastal Storm Modeling System (CoSMoS)[6] for coastal California and SF Bay. This work has been advised by a national Scientific Advisory Committee that includes experts and academics, including Dr. Kristina Hill and Dr. Kris May. A publication describing this methodology, along with the raw data are expected to be released in the Spring 2020.

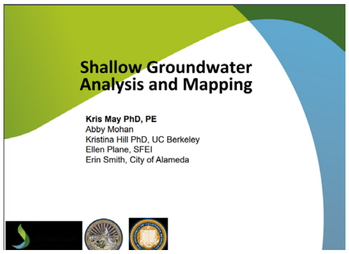
6. http://www.usgs.gov/cosmos

The CoSMoS-GW approach uses numerical modeling to represent the physics of groundwater flow. The groundwater mapping is based on steady-state groundwater flow modeled in three dimensions using the U.S. Geological Survey (USGS) MODFLOW program[7]. Water tables for present-day to +5 meters are simulated separately over 12 increments, allowing water tables to equilibrate to each sea-level scenario. Seasonal and tidal fluctuations are not considered, nor are any human activities (e.g. pumping, drains, augmentation), instead the model is forecasting shifts in the baseline (i.e., average) water table conditions.

The groundwater mapping represents the baseline water table height that is overprinted by seasonal, tidal, and other transient signals. Areas with emergent groundwater (when the groundwater table rises above the surface of the ground and creates surface flooding) are likely to experience chronic 'sunny day' surface flooding (i.e., surface flooding in the absence of heavy precipitation).

Silvestrum and UC Berkeley

Kris May, Ph.D. (Silvestrum) presented on the recent and ongoing work by UC Berkeley and Silvestrum to assess the response of the shallow groundwater table to sea level rise along the San Francisco Bay shoreline (i.e., the Bay-side nearshore areas of the nine Bay Area counties). The groundwater mapping is based on an empirical approach, using observation data collected at over 10,000 shallow groundwater modeling wells to estimate the shallow groundwater surface.



Presentation available at: http://www.adaptingtorisingtides.org/wp-content/uploads/2020/02/03MayGroundwater.Silvestrum.Workshop.11132019-ADA.pdf

The well monitoring data was filtered to consider the most current the most current data (i.e., collected between the year 2000 and the present) and to remove measurements representative of deeper aquifers and artesian wells. The regional mapping relies on the highest measurement on record at each well (i.e., the smallest depth to water measurement) and 1 meter of sea level rise (Plane et al., 2019). The goal of the mapping was to identify areas at risk of emergent groundwater flooding during storm conditions.

Locally refined mapping was created for select areas identified in the regional mapping as being at high potential risk of emergent groundwater with sea level rise. The well observations were sub-filtered to consider depth to water measurements collected during wet winters (i.e., wells without measurements collected during a wet winter were discarded). Although this reduces the number of wells that are used to develop an interpolated groundwater surface, it provides a more robust estimate of how high the shallow groundwater surface becomes during and shortly after heavy precipitation events. In areas with limited well data, geotechnical soil borings collected in wet winters after the year 2000 were used to fill data gaps. Areas with emergent groundwater under existing conditions were groundtruthed with the local community or adjacent local businesses. The

7. MODFLOW is the USGS's modular hydrologic model. MODFLOW is considered an international standard for simulating and predicting groundwater conditions and groundwater/surface-water interactions: https://www.usgs.gov/mission-areas/water-resources/science/modflow-and-related-programs.

locally refined mapping considers seven of the ten sea level rise scenarios mapped as part of the Adapting to Rising Tides (ART) program: 12", 24", 36", 48", 52", 66", and 108" of sea level rise.[8]

The resulting mapped groundwater surface represents the water table at its highest observed elevation during wet winters, when emergent groundwater is likely to occur during or shortly after a large winter storm event.The mapping represents a temporary or episodic condition that would occur sporadically in response to heavy precipitation.

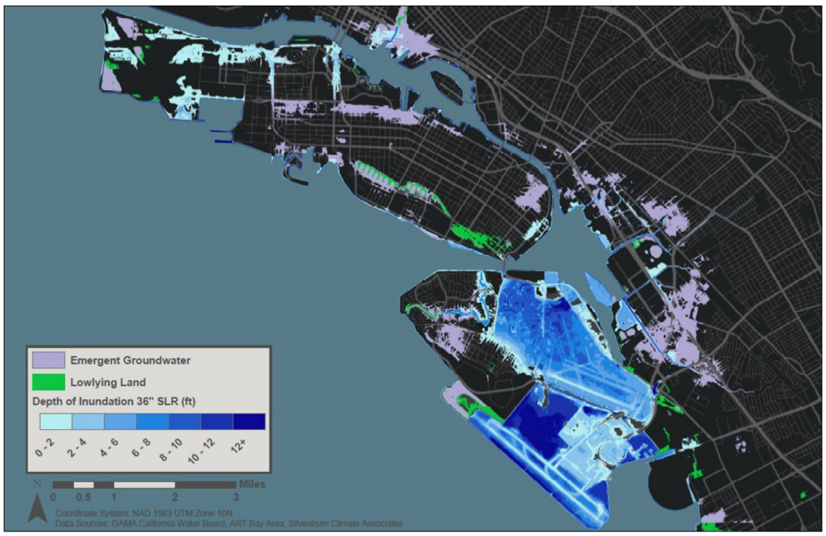


Figure 3. An example of a map of the Silvestrum and UC Berkeley groundwater modeling, as interpreted and used by the City of Alameda in their analysis. This map shows the areas that would be inundated by sea level rise (in blue), and the additional areas that would be flooded by emergent groundwater with 3 feet of sea level rise (in purple).

Summary of Approaches: Rising Groundwater in Practice

Adapting to Rising Tides

- Predicts the annual high, wet weather groundwater conditions
- Data-driven, based on 10,000+ well observation locations
- Assumes linear response to sea level rise
- SF Bay Area coverage

CoSMoS-GW

- Predicts daily groundwater conditions
- Model-driven, validated by observations
- Assumes homogenous sub-surface geology
- CA statewide coverage, including the SF Bay Area

A compendium document provides a more detailed description of the two modeling methodologies. It provides an overview on: how and why the modeling projects were initiated; their intended uses and users; the geographic range of the work; details on the approach including information about the underlying terrain, boundary conditions and mapping; a description of the resultant groundwater surfaces; and the sea level rise scenarios included in the analysis.

8. https://www.adaptingtorisingtides.org/

Two presentations provided insight into how rising groundwater levels are being considered within climate adaptation planning.

City of Alameda

Erin Smith (City of Alameda) provided an overview of the Alameda Climate Action and Resiliency Plan (CARP). The City released a combined climate action and climate adaptation plan in 2019 after an extensive public engagement and review process. The City adopted a "Climate Safe Path" that considered both mitigation and adaptation and identifies implementable actions that provide significant co-benefits for Alameda. The adaptation plan included a vulnerability assessment and the identification of strategies that focused on sea level rise and coastal storm surge, using the ART program sea level rise scenarios. The CARP identified 11 location-based priority flooding areas for adaptation. Rising groundwater levels and the potential to re-mobilize groundwater contaminants was identified as a priority next step within the CARP.

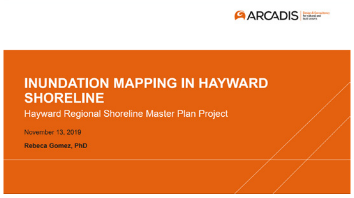
Presentation available at: http://www.adaptingtorisingtides.org/wp-content/uploads/2020/02/04SmithGW-Workshop111319PPT-ADA.pdf

Working with AECOM and Silvestrum, Alameda developed an existing condition foundation of the shallow groundwater layer and the existing contaminants located in the below ground soils and groundwater. Using the approach described by Kris May (Silvestrum), the City and the Oakland International Airport collected recent geotechnical reports with soil boring logs collected throughout the city, with a focus on areas with limited monitoring wells. The assessment focused on 9 contaminants with concentrations that exceeded human health benchmarks between 2000 and 2018. The assessment also considered contaminated sites that are regulated by the Department of Toxic Substances Control. The shallow groundwater table was raised in response to 7 sea level rise scenarios that paired with the ART program sea level rise scenarios. Areas with emergent groundwater level across the 7 scenarios were evaluated to assess if and when areas with high contaminant concentrations would become emergent, if considering emergent groundwater would modify the 11 location-based priority flooding areas, and if additional areas should be considered for adaptation based solely on rising groundwater elevations.

The final report will also include strategies for addressing rising groundwater levels and the potential impacts on utilities, buildings, underground storage tanks, and former disposal sites (landfills). Adapting to sea level rise and rising groundwater levels will require monitoring changing conditions and planning accordingly.

Hayward Area Shoreline Planning Agency (HASPA)

Rebeca Gomez (Arcadis Design and Consultancy) presented on the Hayward Shoreline Master Plan and the importance of considering rising groundwater levels in this nearshore environment. The master plan will serve as a guide for protection of important assets vulnerable to sea level rise along the shoreline. The master plan selected three sea level rise scenarios for planning purposes: 2 ft, 4 ft, and 7 ft of sea level rise. The sea



Presentation available at: http://www.adaptingtorisingtides.org/wp-content/uploads/2020/02/05GomezGonzales_20191106_Hayward-Inundation-Mapping-ADA.pdf level rise mapping was leveraged from the ART program, and the rising groundwater table scenarios used the approach presented in Plane et al, 2019, examining the potential for groundwater emergence during the winter season (i.e., minimum depth-to-groundwater). This study also used the FEMA Flood Insurance Rate Maps and Flood Insurance Study.

Four inundation maps were developed for each of the three sea level rise scenarios:
1. Coastal inundation depth at mean higher high water (MHHW) plus 2, 4, and 7 feet of sea level rise
2. Minimum depth-to-groundwater emergence with 2, 4, and 7 feet of sea level rise
3. Composite of 1 and 2
4. Composite of 2 and the FEMA 1% annual chance storm surge condition

The groundwater emergence zones were used to identify vulnerable assets, including residential areas, industrial areas, the State Route 92 bridge approach, the water treatment plant, oxidation ponds, and the Calpine/Russel City Energy Center. The next step is to identify strategies to mitigate coastal flooding and groundwater emergence in the Hayward Shoreline area. The strategies will be used to form alternatives and ultimately select a preferred alternative for the Master Plan.

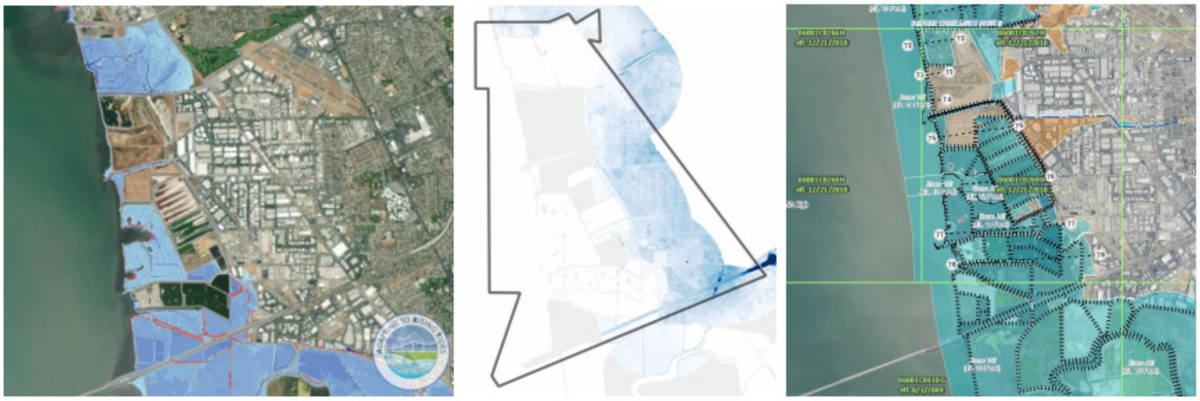


Figure 4. This series of images demonstrates how HASPA combined coastal inundation mapping with groundwater modeling to develop depth-to-groundwater emergence maps, which were then used to identify vulnerable assets.

Small Group Discussion Findings

Following the scientific and stakeholder presentations, workshop participants broke into small groups to dive deeper into the modeling results and to discuss a suite of questions on how they are currently planning for sea level rise and groundwater impacts; how the information presented today can support their planning; what issues they see arising with the rising groundwater table; and what other information is needed to support addressing this concern within their existing planning efforts. Discussions are summarized below.

1. How are you approaching groundwater and sea level rise in your own jurisdictions?

At the time of this workshop, most communities indicated that they had not yet begun planning for the impacts of sea level rise on groundwater. Two notable exceptions were presented at the workshop: City of Alameda Climate Action and Resiliency Plan and the Hayward Shoreline Master Plan. During the small group discussions, it was also noted that Santa Clara Valley Water, the City of Palo Alto, and Marin City are also currently assessing their vulnerability to groundwater rise. While most communities are not actively considering rising groundwater tables, communities with shallow groundwater tables are already implementing strategies to limit groundwater intrusion within their existing and planned infrastructure.

Figure 5. During the small group discussion, workshop attendees addressed a series of questions with the goal of understanding what groundwater challenges they already face and their perception of how that would change with rising groundwater tables due to sea level rise.

At the state level, as noted for instance by Caltrans, groundwater is considered on a project-by-project basis for existing groundwater depths; Caltrans has not yet considered the impact of sea level rise on groundwater tables.

All participants came away from the workshop indicating that they are now eager to incorporate the potential for rising groundwater tables in response to sea level rise in their current and future planning.

2. What issues do you see arising as a result of a rising groundwater table?

Contaminants – Several of the small groups raised the concern of rising groundwater at contaminated sites, including military installations, capped areas, as well as areas built on artificial fill and contaminated soils. Groundwater rise could have implications for remobilizing contaminants that have been capped. Many contaminated sites remove the upper layers of contaminated soil and replace these layers with clean soil, leaving residual contamination below the layers of clean fill. Rising groundwater levels could mobilize the residual contaminants within the layer of clean fill.

There were questions about the timing of when the rising groundwater table would impact various sites and how the timing compares with existing remediation efforts. At present, remediation efforts generally consider a static groundwater table. Concerns were also raised about the emergence of soil vapors beneath infrastructure and utilities. It was noted that this is an area of interest for CalEPA, via the DTSC and the State and Regional Water Boards.

Subterranean Utilities – Many critical lifeline assets such as wastewater and stormwater pipes, as well as utility and gas lines, are buried. Even without the emergence of groundwater and flooding aboveground, changes in soil water content can have deleterious implications for these assets. Many communities know the locations of their pipeline and assets, but the depth of the assets below the ground is often located in disparate technical reports and record drawings. It was also noted that there is the potential for rising groundwater levels (particularly if the groundwater is more saline or contaminated) to reduce the lifespan of buried infrastructure, utilities, and building foundations. Because these assets are buried underground, the impact of increased corrosion and a reduced lifespan often goes unseen until a pipe break or structural collapse occurs.

Septic Systems – In addition to the utility and assets described above, several communities raised the concern about the impact of rising groundwater levels on existing septic systems. Most septic systems are estimated to be located ~6 feet below the ground surface. Septic systems were not designed with the assumption that groundwater levels would rise gradually over time. To function properly, the septic tank and its associated drainfield must maintain a minimum vertical separation of 24 to 48 inches between the bottom of the drainfield and the wet season high water table (the highest observed seasonal water table). Septic systems can fail hydraulically, resulting in wastewater surfacing on the ground or backing up into the plumbing. This is often evident immediately and can occur during short episodes of high groundwater levels and heavy precipitation. Septic systems can also suffer treatment failure, which can go unnoticed for years. Treatment failure can occur if there is insufficient depth between the bottom of the drainfield and the groundwater elevation, allowing the wastewater to move relatively unimpeded through the surrounding soils. If the soil below the drainfield is saturated, wastewater would move through the soil faster, reducing treatment time, and potentially impacting nearby surface waters. Wastewater that enters the groundwater increases the risk of contamination and the risk of human health impacts. Septic system vulnerability to rising groundwater elevations is a growing problem in many coastal states. Miami has been active in ongoing research and could provide insights for Bay Area communities with septic systems in the nearshore coastal zone.

Figure 6. Geophysical contractors use a drill rig to install monitoring wells at Stinson Beach, Calif. Image from: https://news.stanford.edu/news/2010/may/septic-wastewater-sea-052010.html

Building Foundations - Buildings, bridges, and other critical asset foundations penetrate below the surface and may see new or increased seepage from groundwater rise. This could lead to unplanned for and unexpected impacts to subterranean structures.

Transportation Infrastructure – Shallow groundwater flooding of below grade or at grade transportation structures may have serious implications for the ongoing operation of the Bay Area's transportation network. For instance, Bay Area Rapid Transit (BART) expressed concern that they will experience increased seepage in their tubes that already experience with groundwater flooding. Similarly, Caltrans currently manages existing groundwater flooding issues along some roadways. The saturation of roadbed material can drastically reduce the useful life of roads and cause increased maintenance costs.

Figure 7. Workshop attendees were provided with hard copies of the different modeling outputs to help guide their discussions.

Liquefaction – Many areas along the SF Bay shoreline were filled in the past to increase the area of developable land. These areas are susceptible to liquefaction risks during an earthquake. It is expected that rising groundwater levels (and thus increased soil saturation) could increase the susceptibility to liquefaction. This problem has been observed in Christchurch, New Zealand. Since this workshop was held, researchers at USGS received a small grant that will allow them to assess the combined impact of sea level rise and rising groundwater tables and liquefaction in the SF Bay area.

Wastewater Systems – Effluent in wastewater treatment pipes increases during precipitation-based storms because of infiltration into the pipes. It is likely that rising groundwater levels could also increase infiltration rates into the pipes. As the groundwater table continues to rise in response to sea level rise, groundwater-based infiltration into wastewater treatment pipes could also occur in the absence of precipitation.

3. What other information is needed to support planning? What are additional important research questions that still need to be answered?

The overwhelming question for all workshop participants was - how do communities prepare for this impact? As noted in the introduction, most communities around the Bay have assessed their vulnerability to sea level rise and many have also started to identify a range of potential sea level rise adaptation strategies for coastal flooding and sea level rise that can overtop the Bay shoreline. These strategies, however, are focused on actions that mitigate overland flooding. The most pressing question is whether these strategies would also address the impacts associated with rising groundwater tables and emergent groundwater.

There was also considerable discussion regarding green (or nature-based) adaptation strategies and whether these strategies would be more effective at mitigating the combined impact of underground and overland flooding. It was noted that grey infrastructure, such as seawalls or traditional engineered levees, would not lessen the impacts of a rising groundwater table and areas protected by these structures could still experience emergent groundwater flooding; it was also noted that the rising groundwater table could undermine the structural integrity of some grey solutions.

Important research questions that emerged from this discussion include:

- How does groundwater impact the different suite of grey to green adaptation strategies?
- Are there any adaptation strategies that could work in combination to protect both overland and subterranean flooding due to sea level rise?
- How do we avoid maladaptation to one impact, when planning for another? For instance, if you seal a pipe to limit groundwater infiltration, where does that water go; does this lead to potential emergence and more flooding at another site?
- What are the appropriate scales for responding to rising groundwater tables: watersheds, operational landscape units, other?
- Can the Adaptation Atlas for the SF Bay Area be updated to include exposure and response to rising and emergent groundwater?
- Should additional monitoring wells be installed to monitor the groundwater table elevation? In the absence of known potential contamination? Would more frequent monitoring provide more insight?
- There is a wealth of data in geotechnical soil boring logs that can inform research into the elevation and movement within the shallow groundwater layer. A mean to collect and collate this information could be beneficial.

It is important to mention a recurring question during the workshop - how does this information support the State of California's Sustainable Groundwater Management Act (SGMA). SGMA requires governments and water agencies in "high and medium priority basins" to develop groundwater management plans. The main goal of SGMA is to reduce overdraft of groundwater basins, as well as to encourage recharge of existing aquifers. There were many questions about whether the rising of the shallow groundwater table (as opposed to the deeper aquifers) would be of interest to the Groundwater Sustainability Agencies (GSA) that are formed out of the SGMA process. It was observed that most of the coastal groundwater tables being addressed at this workshop are not usually used for potable water, which is what SGMA was developed to help regulate and manage. The basins of interest for GSAs are generally deeper basins located further from the coast. However, there was consensus that the GSAs should be made aware of this research and included in subsequent discussions.

Next Steps

A Regionally Consistent Approach

A key takeaway from the group discussions and the workshop was the consensus that there should be a regionally consistent approach to both communicating about this science and the impacts to coastal communities, as well as consistency in the methodology used by communities when planning for this issue. Several recommendations were provided on how to achieve this:

- There is a need for primers, slide decks and a consistent suite of talking points for this group and other interested partners so that we can quickly elevate the importance of this impact to a broad range of audiences. This is new information for many, so we need a shared vocabulary, decision pathways when assessing multiple impacts, and glossaries to help educate partners.

- Seek funding from grants, local agencies, and other opportunities to develop regionally consistent data and information, conduct analysis of vulnerability, and develop communication products.
- As data and information is published, efforts should be made to integrate this with existing sea level rise and storm flood hazard mapping.
- Guidance about how best to use the various sources of information and the ways data sources can complement planning should be developed. Recognizing that each jurisdiction will want to address this issue for their own assets, but that this is a regionally-scaled impact, there should be a standard approach for identifying the problem and analyzing the problem. This will ensure that each jurisdiction is assessing the vulnerability in a similar way and can consolidate info from local to regional.
- Not all planners have the capacity (time, staff, knowledge or leverage) to ask projects to deal with this flood risk. What are some important points to include in an RFP so that all communities can begin to incorporate this exposure analysis in their immediate projects and long-term planning? Similarly, it would be helpful to develop a toolkit with generalized/sample language that counties/jurisdictions can use when updating local plans.
- On the heels of the recent Legislative Affairs Office report providing legislation recommendations, the Bay Area also has 27 states legislators whose constituents will be impacted by GW shoaling. What recommendations can this group provide to help them support local and regional climate adaptation planning (policy, planning, funding)

Commitments from Partners

San Francisco Bay Conservation and Development Commission

BCDC sees shallow groundwater as an important component of regional vulnerability to sea level rise. The recently completed Adapting to Rising Tides Bay Area project identified groundwater flooding as a key information gap in addressing shoreline adaptation. Based on the outcomes of this workshop, BCDC will continue to work with regional partners to help bring technical resources to local jurisdictions in the Bay Area to help support planning for groundwater. As BCDC leads the development of a Regional Shoreline Adaptation Strategy in the coming year, resources may be used to fill this information gap and integrate locally refined groundwater modeling with the ART Bay Shoreline Flood Explorer.

USGS CoSMoS-GW

The USGS / Befus team will share all the model results via the USGS Sciencebase Data Catalogue. Visualizations of groundwater shoaling and flooding will be provided in Point Blue's Our Coast Our Future (OCOF) flood hazard viewer. In addition, the USGS Hazard Exposure and Reporting Analytics (HERA) team will provide information on the socioeconomic impact of groundwater shoaling and emergence. This will be provided as part of the suite of products that are available in combination with the coastal flooding provided via CoSMoS.

Conclusion

Groundwater flooding due to rising sea level is an emerging issue that has implications for much of the Bay Area's shoreline infrastructure and the communities that depend on that infrastructure. Much of the adaptation planning work to date has not accounted for this flood risk and strategies that have been developed to deal with overland flooding from sea level rise and storm surge may be ineffective against groundwater rise. As the region begins to implement shoreline adaptation strategies information about groundwater rise are essential to ensuring our shoreline adaptation can also address this vulnerability.

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