

Sea level rise and the coastal North Carolina economy



Photo credit: Roland Gehrels

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- Saltwater intrusion will increase at an exponential rate as sea-level rises along the coast of North Carolina.
- Greater island width and lower hydraulic conductivity are the greatest insulators to increased intrusion for barrier-island aquifers.



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The impact of sea-level rise on saltwater intrusion for barrier-island aquifers in North Carolina

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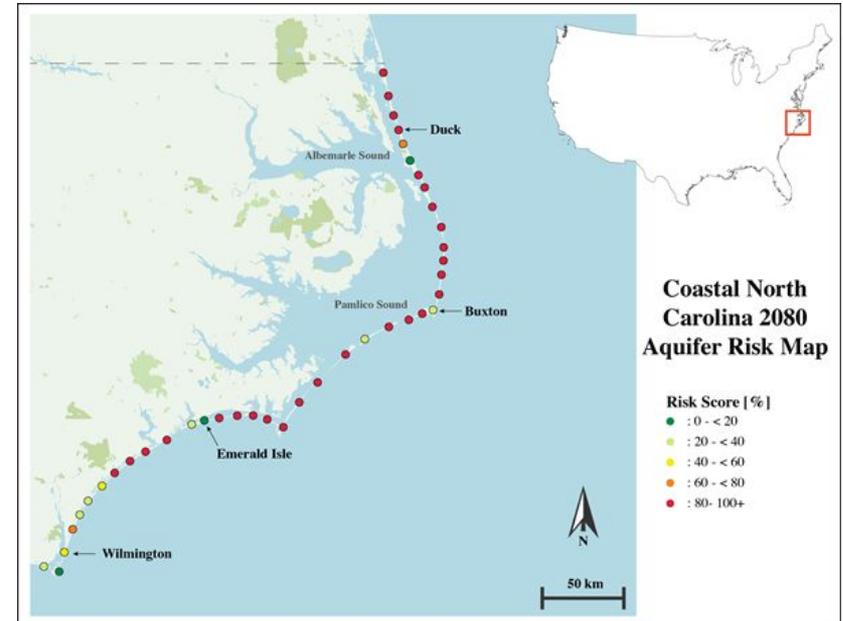
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ABSTRACT

Saltwater intrusion is an increasing problem for coastal aquifers due to rising sea levels, especially in areas of low hydraulic gradient, such as barrier-island aquifer systems. Large-scale studies are particularly useful for identifying trends in the effects of sea-level rise, especially for relatively understudied barrier-island aquifers. The barrier islands of coastal North Carolina, U.S.A., lie in a hot spot of sea level rise, where rates are projected to exceed global means throughout this century. Herein, we present a study of the effects of sea-level rise using four primary study sites, each with varying hydraulic properties, island width, and rates of sea-level rise. We use these sites to understand the viability of barrier-island aquifers in North Carolina, but also to understand in general the factors that are most important to the future viability of all barrier-island aquifers. We utilize a one-dimensional steady-state analytical model that allows the calculation of the position of the toe of the saltwater wedge at the base of the aquifer while limiting a rise in the water table. We determine the position of the toe for various sea-level projections up to the year 2100 and utilize this parameter as an assessment of the viability of the aquifer. Our findings suggest that higher island width and lower hydraulic conductivity are the most sensitive parameters and help to limit the effects of sea-level rise on aquifer viability. Aquifer risk maps calculated for the entire North Carolina coast, which equate risk with the position of the toe relative to island width, demonstrate that sea-level rise is projected to have increasing impact on aquifer viability over time, but that areas with narrower width and higher sea-level rise rates are the most vulnerable.

- It is projected that many surficial barrier-island aquifers in North Carolina will lose the entirety of their freshwater lenses by 2080.
- The northern section of the North Carolina coast will be at a higher risk than the southern section.



April 2022 Survey

- North Carolina residents
 - Dynata panel - delete those with inconsistent age and income responses
 - took an overnight trip to the NC coast in the past 36 months and not coastal property owners (n=423)
- n=286 respondents who planned to take an overnight trip in the next 12 months and provided complete demographic information

Stated preference questions

If the cost of the trip was [\$A] higher would you still take the beach trip?

Take the trip

Do not take the trip

If the drinking water tasted [slightly, moderately, very] salty, would you still take the beach trip?

Take the trip

Do not take the trip

Scenario	Question	Sample size	Yes	Added Trip Cost	Slightly	Moderate	Very
1	1	213	100%	0	0	0	0
	2	213	65%	569	0	0	0
	3	139	49%	1306	0	0	0
2	1	286	100%	0	0	0	0
	2	286	57%	560	0	0	0
	3	164	52%	1288	0	0	0
3	1	286	87%	0	45%	55%	0
	2	248	79%	0	0	0	100%
	3	196	50%	724	0	0	100%

Those who would not take the trip to their chosen beach

- 42% would take a trip to another NC beach
- 33% would take another type of trip
- 24% would stay home

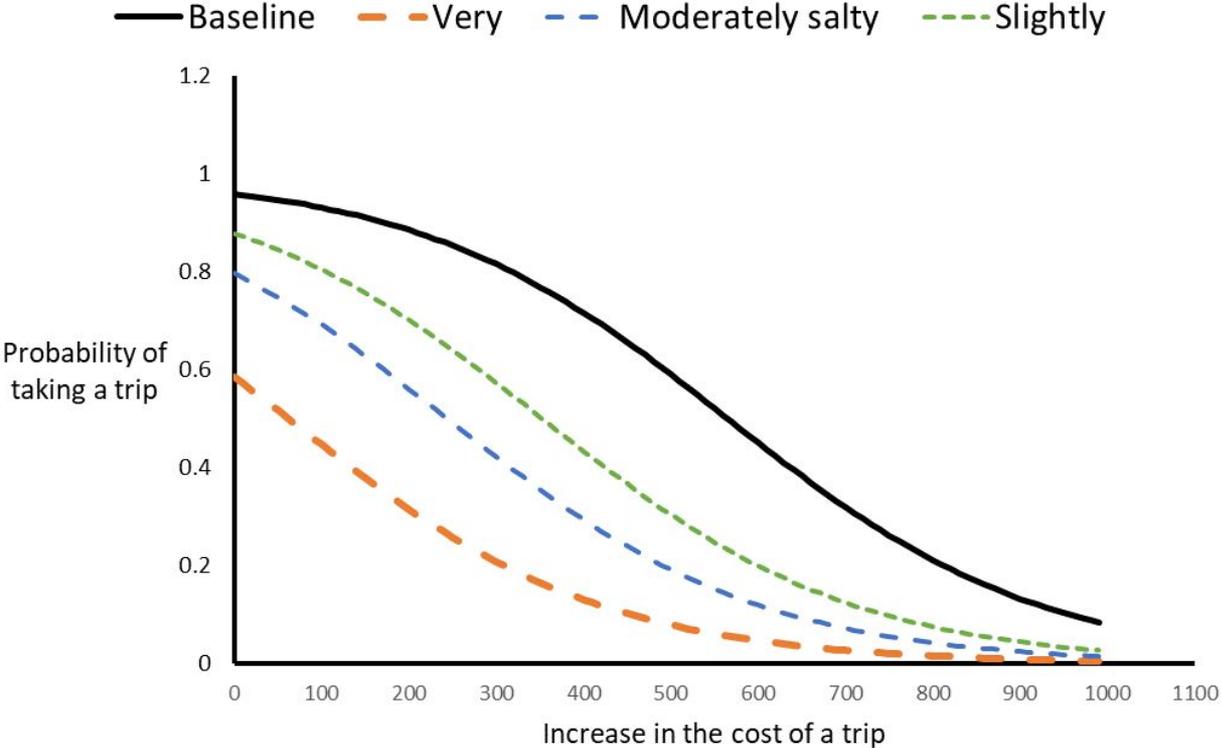
Equality-Constrained Latent Class Logit

YES	Coefficient	Std.Error	z
Constant	3.17	0.16	19.45
Cost	-0.0056	0.00031	-17.83
Slightly	-1.19	0.34	-3.50
Moderately	-1.80	0.31	-5.86
Very	-2.82	0.40	-7.06

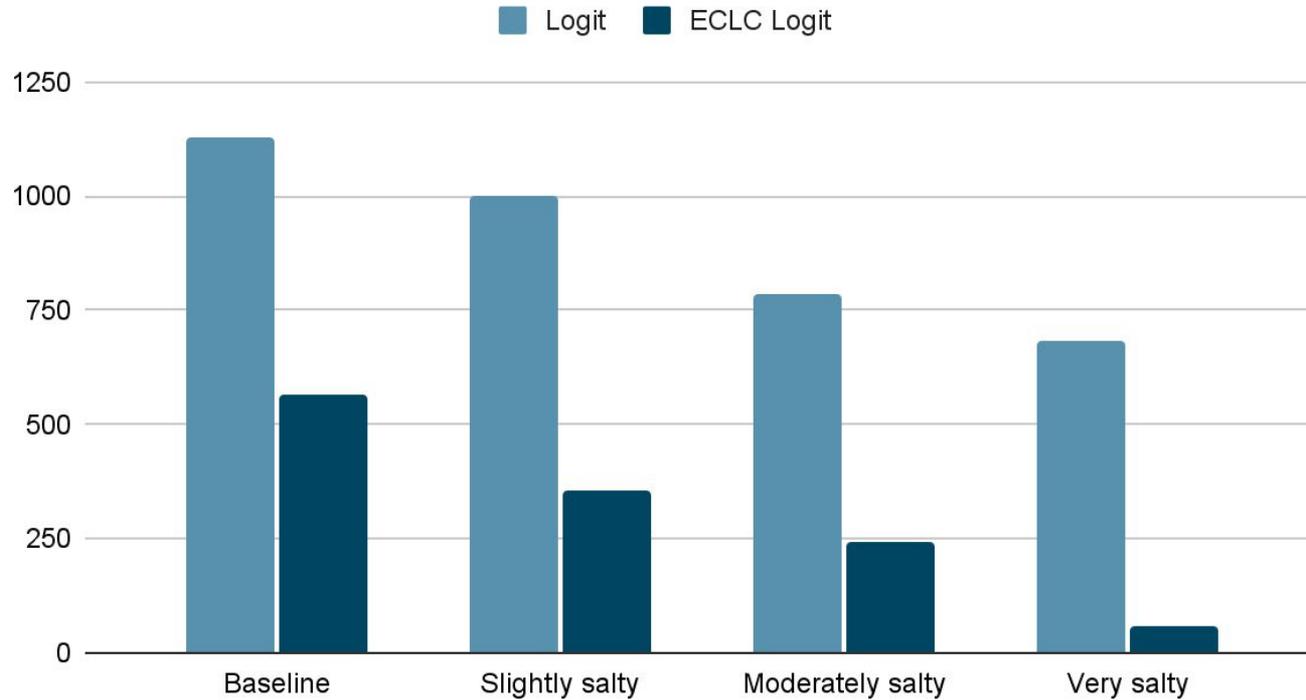
Attribute non-attendance

Full attendance	40%
Cost non-attendance	7.6%
Slightly/Moderately non-attendance	0
Very non-attendance	29%
Full non-attendance	24%

Demand for an overnight beach trip



Willingness to pay for an overnight trip



Results

- Tourists are less likely to take a trip if costs of the trip rise
- 8%, 16%, 37% less likely to take a trip if drinking water tastes slightly, moderately, very salty
- Willingness to pay for a trip falls with the ECLC model but the differences increase.

(Very) back-of-the-envelope conclusions

- Annual aggregate **welfare loss** to North Carolina's 2.86 million overnight visitor beach trips is \$1.44 billion
 - 9.8 million overnight visitor trips to the coastal region
 - 95% for vacation
 - 51% from NC
 - 60% are beach trips