Supplement of

Estimating the thickness of unconsolidated coastal aquifers along the global coastline

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Table S1. Borehole validation dataset sources

Dataset Name	Source
CPRM	Geological survey of Brazil, c2016, published by Companhia de Pesquisa de Recursos Minerais [Accessed 2016, August], http://www.cprm.gov.br/
GeoVIC	Online geology portal of Victoria, Australia, c2016, published by the state of Victoria [Accessed 2016, October], http://er-info.dpi.vic.gov.au/sd_weave/anonymous.html
CGS	China Geological Survey, 2012. Groundwater serial maps of Asia: Hydrogeological map, Groundwater resources map, Geothermal map, Sinomaps Press.

Table S2. Literature validation dataset sources

Polygon ID	Source
1	Lagudu, S. et al., 2013. Use of Geophysical and Hydrochemical Tools to Investigate Seawater Intrusion in Coastal Alluvial Aquifer, Andhra Pradesh, India. In C. Wetzelhuetter, ed. Groundwater in the Coastal Zones of Asia-Pacific. Dordrecht: Springer Netherlands, pp. 49–65.
2	Singh, S.C., 2013. Geophysical Viewpoints for Groundwater Resource Development and Management in Coastal Tracts. In C. Wetzelhuetter, ed. Groundwater in the Coastal Zones of Asia-Pacific. Dordrecht: Springer Netherlands, pp. 67–87.
3	Duerrast, H. & Srattakal, J., 2013. Geophysical Investigations of Saltwater Intrusion into the Coastal Groundwater Aquifers of Songkhla City, Southern Thailand. In C. Wetzelhuetter, ed. Groundwater in the Coastal Zones of Asia-Pacific. Dordrecht: Springer Netherlands, pp. 155–175.
4	Sherif, M., Almulla, M. & Shetty, A., 2013. Seawater Intrusion Assessment and Mitigation in the Coastal Aquifer of Wadi Ham. In C. Wetzelhuetter, ed. Groundwater in the Coastal Zones of Asia-Pacific. Dordrecht: Springer Netherlands, pp. 271–294.
5	Leonhard, L., Burton, K. & Milligan, N., 2013. Gascoyne River, Western Australia; Alluvial Aquifer, Groundwater Management and Tools. In C. Wetzelhuetter, ed. Groundwater in the Coastal Zones of Asia-Pacific. Dordrecht: Springer Netherlands, pp. 359–378.
6	Wagner, F., Tran, V.B. & Renaud, F.G., 2012. Groundwater Resources in the Mekong Delta: Availability, Utilization and Risks. In F. G. Renaud & C. Kuenzer, eds. The Mekong Delta System: Interdisciplinary Analyses of a River Delta. Dordrecht: Springer Netherlands, pp. 201–220.
7	Benkabbour, B., Toto, E.A. & Fakir, Y., 2004. Using DC resistivity method to characterize the geometry and the salinity of the Plioquaternary consolidated coastal

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8	Chen, J. et al., 2014. Clay minerals in the Pliocene - Quaternary sediments of the southern Yangtze coast, China: Sediment sources and palaeoclimate implications. Journal of Palaeogeography, 3(3), pp.297–308. Available at: http://dx.doi.org/10.3724/SP.J.1261.2014.00057.
9	Cobaner, M. et al., 2012. Three-dimensional simulation of seawater intrusion in coastal aquifers: A case study in the Goksu Deltaic Plain. Journal of Hydrology, 464-465, pp.262–280. Available at: http://dx.doi.org/10.1016/j.jhydrol.2012.07.022.
10	Carretero, S. et al., 2013. Impact of sea-level rise on saltwater intrusion length into the coastal aquifer, Partido de La Costa, Argentina. Continental Shelf Research, 61-62, pp.62–70. Available at: http://dx.doi.org/10.1016/j.csr.2013.04.029.
11	Rasmussen, P. et al., 2013. Assessing impacts of climate change, sea level rise, and drainage canals on saltwater intrusion to coastal aquifer. Hydrology and Earth System Sciences, 17(1), pp.421–443. Available at: http://www.hydrol-earth-syst-sci.net/17/421/2013/.
12	Kalm, V. & Gorlach, A., 2014. Impact of bedrock surface topography on spatial distribution of Quaternary sediments and on the flow pattern of late Weichselian glaciers on the East European Craton (Russian Plain). Geomorphology, 207, pp.1–9. Available at: http://dx.doi.org/10.1016/j.geomorph.2013.10.022.
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21	McPherson, A. & Jones, A., 2005. Appendix D: Perth Basin geology review and site class assessment. Natural Hazard Risk in Perth, pp.313–344. Available at: https://www.icsm.gov.au/image_cache/GA6548.pdf.
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23	Yeates, A.N. et al., 1984. Regional geology of the onshore Canning Basin, Western Australia. The Canning Basin, Western Australia, pp.23–56.
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25	Custodio, E., V. Iribar, M. Manzano, A. Bayó and A. Galofré (1986), Evolution of sea water intrusion in the Llobregat Delta, Barcelona, Spain, paper presented at the 9th Salt Water Intrusion Meeting, Delft, The Netherlands E. Falgas, J. Ledo, T. Teixido, A. Gabas, F. Ribera, C. Arango, P. Queralt, J.L. Plata, F.M. Rubio, J.A. Pena, A. Marti, A. Marcuello (2004), Geophysical characterization of a mediterranean coastal aquifer: The Baixa Tordera fluvio-deltaic aquifer unit (Barcelona, NE Spain), paper presented at the 18th Salt Water Intrusion Meeting, Cartagena, Spain
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31	G. Pranzini (2002), Groundwater salinization in Versilia (Italy), paper presented at the 17th Salt Water Intrusion Meeting, Delft, The Netherlands
32	E. Van Houtte, L. Lebbe, L. Zeuwts and F. Vanlerberghe (2002), Concept for development of sustainable drinking-water production in the Flemish coastal plain based on integrated water management, paper presented at the 17th Salt Water Intrusion Meeting, Delft, The Netherlands Lebbe, L.C. and K. Pede (1986), Salt-fresh water flow underneath old dunes and low polders influenced by pumpage and drainage in the Western Belgian coastal plain, paper presented at 9th Salt Water Intrusion Meeting, Delft, The Netherlands Lebbe, L. and K. Walraevens (1988), Hydrogeological SWIM-excursion to the western coastal plain of Belgium, paper presented at the 10th Salt Water Intrusion Meeting, Gent, Belgium
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35	A. Rogge & V. Josopait (1992), Salinization caused by groundwater abstraction from an aquifer on the german North Sea coast, paper presented at the 12th Salt Water Intrusion Meeting, Barcelona, Spain
36	M.D. Fidelibus, E. Gimenez, I. Morell & L. Tulipano (1992), Salinization processes in the Castellon plain aquifer (Spain), paper presented at the 12th Salt Water Intrusion Meeting, Barcelona, Spain
37	A. Bayo, C. Loaso, J.M. Aragones & E. Custodio (1992), Marine intrusion and brackish water in coastal aquifers of Southern Catalonia and Castello (Spain): a brief survey of actual problems and circumstances, paper presented at the 12th Salt Water Intrusion Meeting, Barcelona, Spain
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49, 50, 51	Whitehead, R.L., 1994. Ground Water Atlas of the United States: Segment 7, Idaho,

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63	Van Camp, M. et al., 2014. Investigating seawater intrusion due to groundwater pumping with schematic model simulations: The example of the Dar es Salaam coastal aquifer in Tanzania. Journal of African Earth Sciences, 96, pp.71–78. Available at: http://dx.doi.org/10.1016/j.jafrearsci.2014.02.012.
64	Kumar, B. et al., 2011. Groundwater management in a coastal aquifer in Krishna River Delta, South India using isotopic approach. , 100(7).

Table S3. Aquifer thickness information provided by the literature sources compared with the ATE values for each coastal area (column "id", corresponds to ID values in Figure S6). For each are the location is also given. The values from literature are shown in columns below the "Measured values" header while our ATE values are below the "ATE values" header. The "calc_avg" column represents the calculated average value in cases where only min., max. or both were given by the literature. The "calc_avg" is calculated as either the arithmetic average between the min. and max. values or as min./max. value +/- half of min./max.

	Measured values (m)				ATE values (m)			
id	thick_max	thick_min	thick_avg	calc_avg	est_avg	est_min	est_max	location
1	600			300	501.1	323.1	768.0	Godavari delta (IND)
2			130	130	174.8	76.2	386.9	Digha (IND)
3			80	80	76.2	35.7	173.9	Songkhla (THA)
4			100	100	84.6	36.0	124.1	Wadi Ham (UAE)
5			50	50	72.9	41.2	120.0	Carnavon (AUS)
6	600			300	272.2	51.0	897.8	Mekong (VNM)
7	100	20	70	70	116.9	30.6	244.3	Rabat (MAR)
8	500	300		400	281.0	41.7	648.4	South Jangtze coast, NE (CHN)
9	600			300	161.9	64.9	308.4	Goksu plain (TUR)
10	20			10	34.9	22.3	51.2	Mar de Ajo (ARG)
11			50	50	277.4	49.0	750.8	Falster island (DKN)
12			50	50	215.6	2.1	5143.4	Riga gulf (EST)
13			200	200	238.5	53.5	615.2	South Jangtze coast, SW (CHN)
14	900			450	484.8	33.5	1394.4	Nile delta (EGY)
15	45		25	25	210.1	83.8	333.9	Thamirabarani delta (IND)
16	100			50	190.9	93.5	310.7	Kuala Lumpur (MYS)
17	150			75	79.9	2.2	371.3	Saloum delta (SEN)
18		1000			261.0	40.7	984.0	Kilwa group (TZA)
19	250		200	200	278.9	44.8	649.5	Coastal aquifer (ISR)
20	300		250	250	268.8	41.5	483.1	Bekasi (IDN)
21	420			210	110.9	9.4	331.7	Perth Basin (AUS)
22	1000	50	600	600	161.8	5.0	1091.9	Great artesian basin (AUS)
23	120			60	106.8	1.1	496.4	Canning Basin (AUS)
24	1000	150		575	166.0	53.4	399.6	Doñana National Park (ESP)
25	180	50		115	109.7	67.3	186.5	Barcelona (ESP)
26	200	80		140	119.0	39.8	163.9	Perpignan (FRA)
27	218	18	120	120	104.2	0.4	247.3	Oristano (ITA)
28	300			150	84.1	40.7	128.5	Muravera (ITA)
29	100			50	177.6	89.2	236.5	Siracusa (ITA)
30	200			100	150.8	81.1	201.2	Grosseto (ITA)
31		100		200	153.4	2.1	317.0	Versilia (ITA)
32	150	25	100	100	116.8	54.5	312.9	Coastal aquifer (BEL)
33	315	30	90	90	185.2	62.1	436.4	Northern dutch coast (NLD)
34	600	100	200	200	441.1	165.4	875.9	Zeeland (NLD)
35	175	125		150	66.3	16.6	261.9	Wilhelmshaven (GER)
36	200	80		140	125.7	58.4	180.0	Castellon de la Plana (ESP)
37			200	200	187.8	91.5	429.0	Ebro delta (ESP)
38			100	100	131.6	78.8	211.3	Scanzano (ITA)
39	300			150	123.7	13.5	331.6	Eureka aquifer, CA (USA)
40	300	30		165	165.8	28.3	520.4	Cape Cod (USA)
41	600	170		385	260.8	1.4	1245.4	Long Island (USA)
42	1200			600	285.0	33.7	815.5	North Atlantic coastal plain, NJ (USA)
43	2400			1200	295.9	21.8	2028.6	North Atlantic coastal plain, MA (USA)
44	3100			1550	444.8	6.4	4983.9	North Atlantic coastal plain, NC (USA)
45	2000	300		1150	266.5	24.5	2652.5	Coastal lowlands aq. system, TX (USA)
46	2400	1200		1800	83.9	72.9	94.8	Coastal lowlands aq. system SE, LA (USA)
47	3600	1200		2400	367.7	120.6	1085.5	Coastal lowlands aq. system NW, LA (USA)
48	1000			500	204.7	22.2	815.7	Mississippi emayment aq. (USA)
49	1000			500	130.8	2.2	496.7	Puget-Williamette trough regional aq. system (USA)
50	35	15		25	97.4	16.2	388.0	Washington coast N (USA)
51	200	35		117.5	138.7	14.1	318.1	Washington coast S (USA)
52	300			150	75.7	3.7	182.3	Santa Clara valley (USA)
53	300			150	162.9	92.7	204.2	Salinas Valley (USA)
54	1200	30		615	286.6	130.3	492.4	Los Angeles - Orange county (USA)
55	1000	200		600	170.2	7.0	1762.3	FL - W and AL coast (USA)
56	1050	850		950	95.5	1.9	1172.4	FL - S (USA)
57	200	60		130	210.7	30.0	1293.4	SC - S (USA)
58	850	200		525	167.0	52.0	723.7	Georgia coast (USA)
59	850	700		775	189.5	6.1	2079.0	FL - N (USA)
60	2000			1000	171.7	1.3	805.5	Niger delta (NGA)
61	1200			600	415.4	46.3	929.4	Po delta (ITA)
62	180	30		105	247.3	4.7	490.5	Jifarah Plain (LBY)
63			150	150	295.2	88.0	1049.5	Dar es Salaam (TZA)
64	450	40		245	286.6	65.2	608.0	Kirishna river delta (IND)

Table S4 Parameter values for the three cross-sections, the values are given for models with minimum and maximum estimated sediment thickness at the coastline. The total length of simulation for the test case in Virginia, USA is larger than for the other two test cases due to the complexity and size of the aquifer system. This was done to ensure that the steady-state (or near steady-state) is reached, for the changes of fresh groundwater cells in time see Figure S10 in the Supplementary information.

	Italy		Israel		Virginia, USA	
Sediment thickness at coastline	50m	500m	100m	1400m	200m	1500m
Number of columns	1,060	1,588	385	494	547	578
Number of layers	53	411	43	110	44	106
Layer thickness (m)	3		10		10	
Column width (m)	25		100		500	
Top elevation (m asl.)	26		95		59	
Bottom elevation (m asl.)	-62	-1,002	-335	-1,005	-381	-1,001
Length of simulation (years)	10,000				100,000	
Number of time steps	2,500				10,000	
Total active cells	13,224	534,879	3,021	30,332	9,319	43,630
Horizontal hydraulic conductivity aquifer (m/d)	10					
Vertical hydraulic conductivity aquifer (m/d)	1					
Horizontal hydraulic conductivity aquitard (m/d)	1.00E-04		1.00E-04		1.00E-04	
Vertical hydraulic conductivity aquitard (m/d)	1.00E-07		1.00E-07		1.00E-07	
Layer type	confined					
Total amount of GHB cells	887	1415	200	321	274	431
Recharge rate (m/d)	0.001		0.0005			
Head change criterion for convergence (m)	1.00E-04					
Residual criterion for convergence (m^3/d)	10					
Porosity	0.35					
Solver type	Finite Difference					
Longitudinal dispersivity	1					
Ratio horizontal transverse disp./ long. disp.	0.1					
Diffusion coefficient (m^2/d)	8.64E-05					

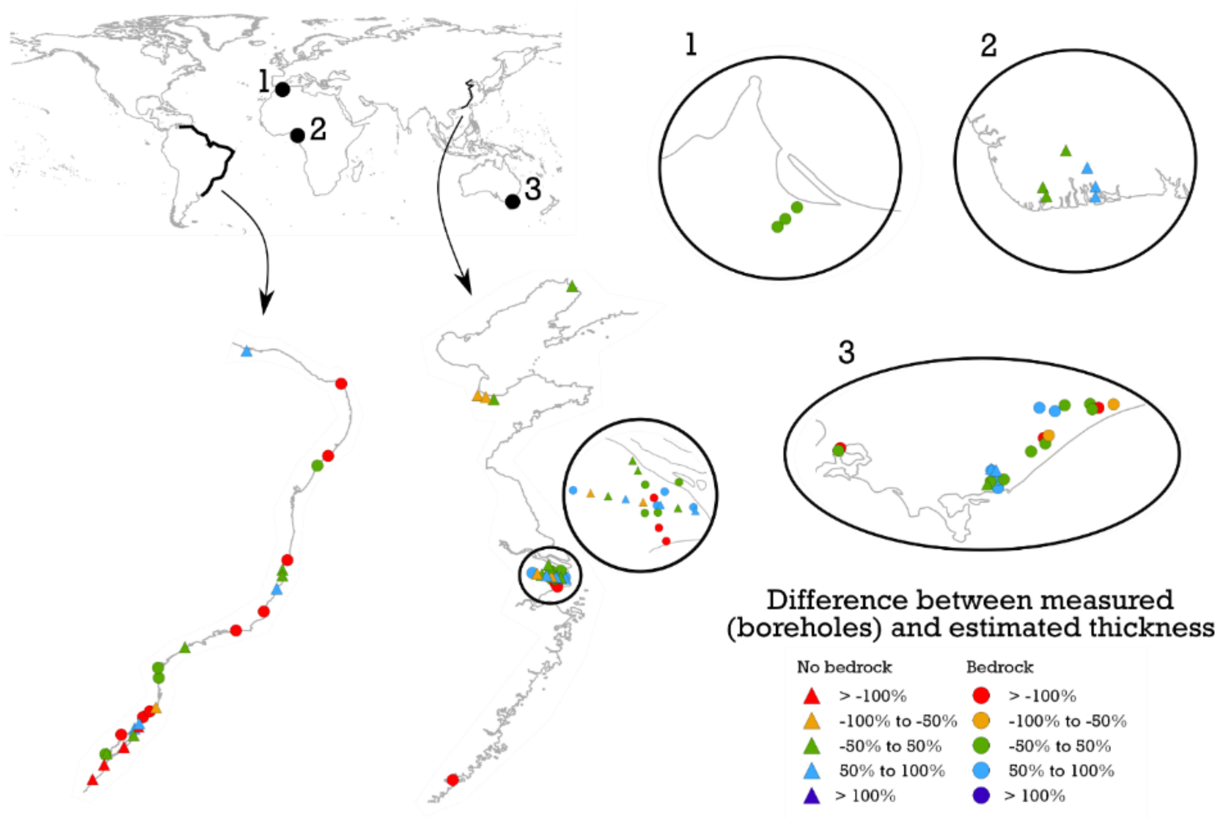

Figure S1. Schematization of borehole validation using the difference between the measured sediment thickness and an average estimated thickness in a radius of 2.5km around the borehole location. The boreholes are divided into two groups depending on any bedrock formation indicated in the borehole report.

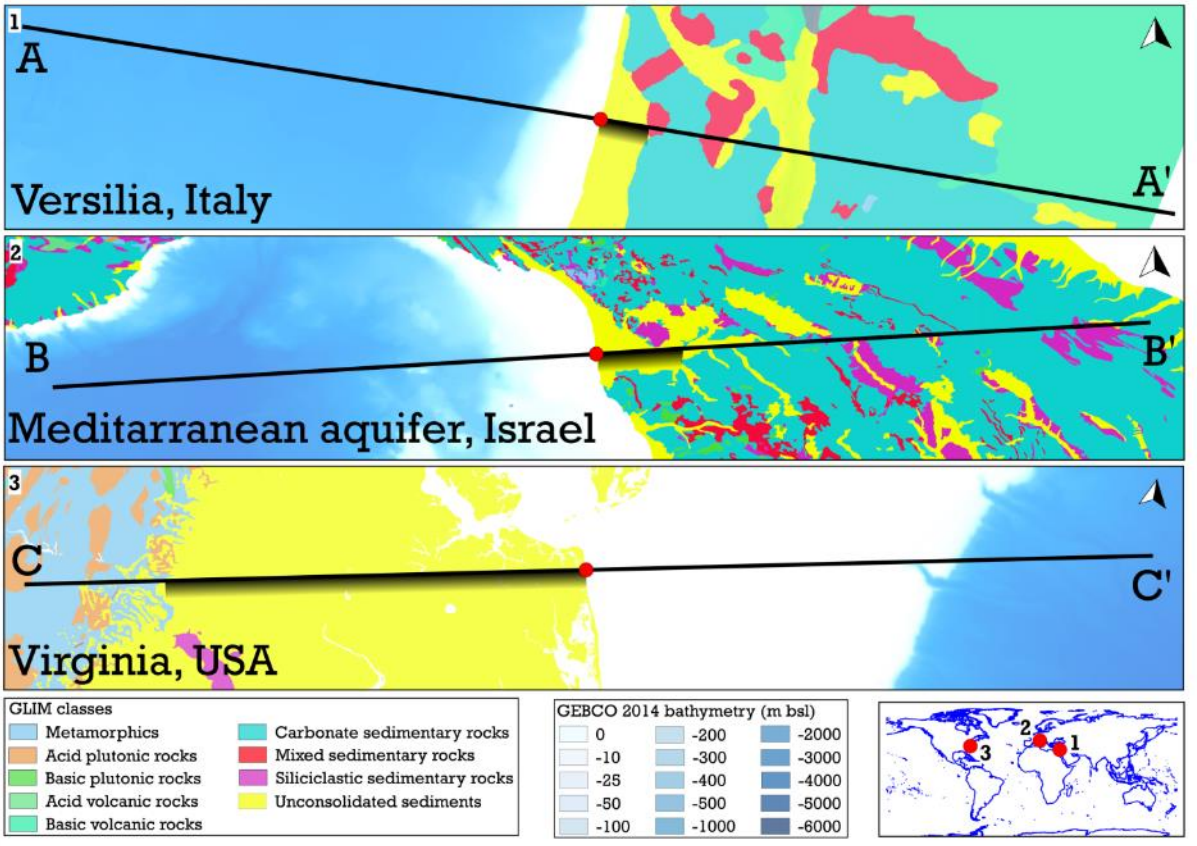

Figure S2. Location of the cross-sections used as examples to illustrate the ATE method. The black shadow represents the extent of the coastal plain in each cross-section while the whole black line indicates the span of the cross-section (in total 400km).

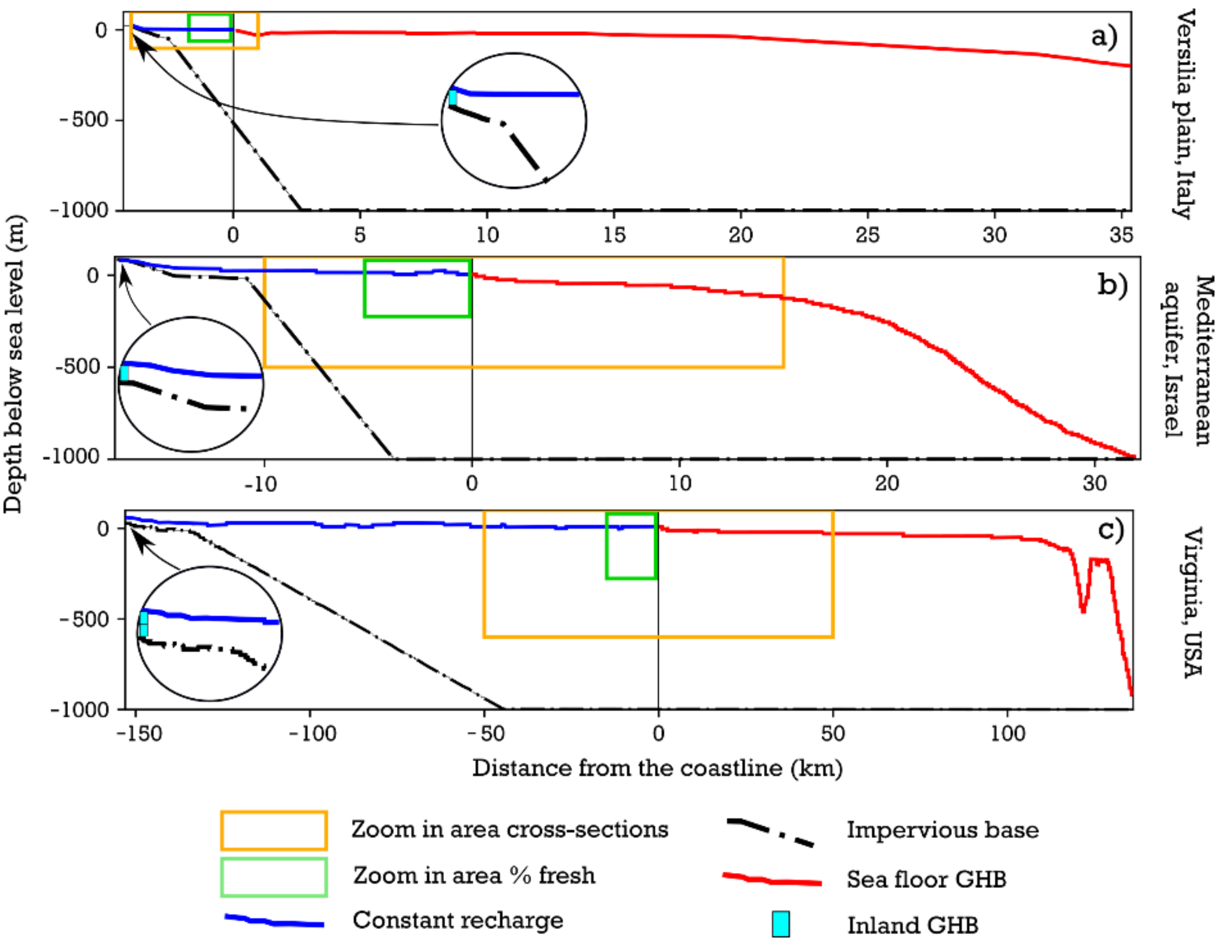

Figure S3. Model concept schematization for all three test cases. a) Versilia plain, Italy, b) Mediterranean aquifer, Israel and c) Virginia, USA. The zoom in area cross-section corresponds to the areas shown in Figures S8-S10 and Figure 4 in the main article.

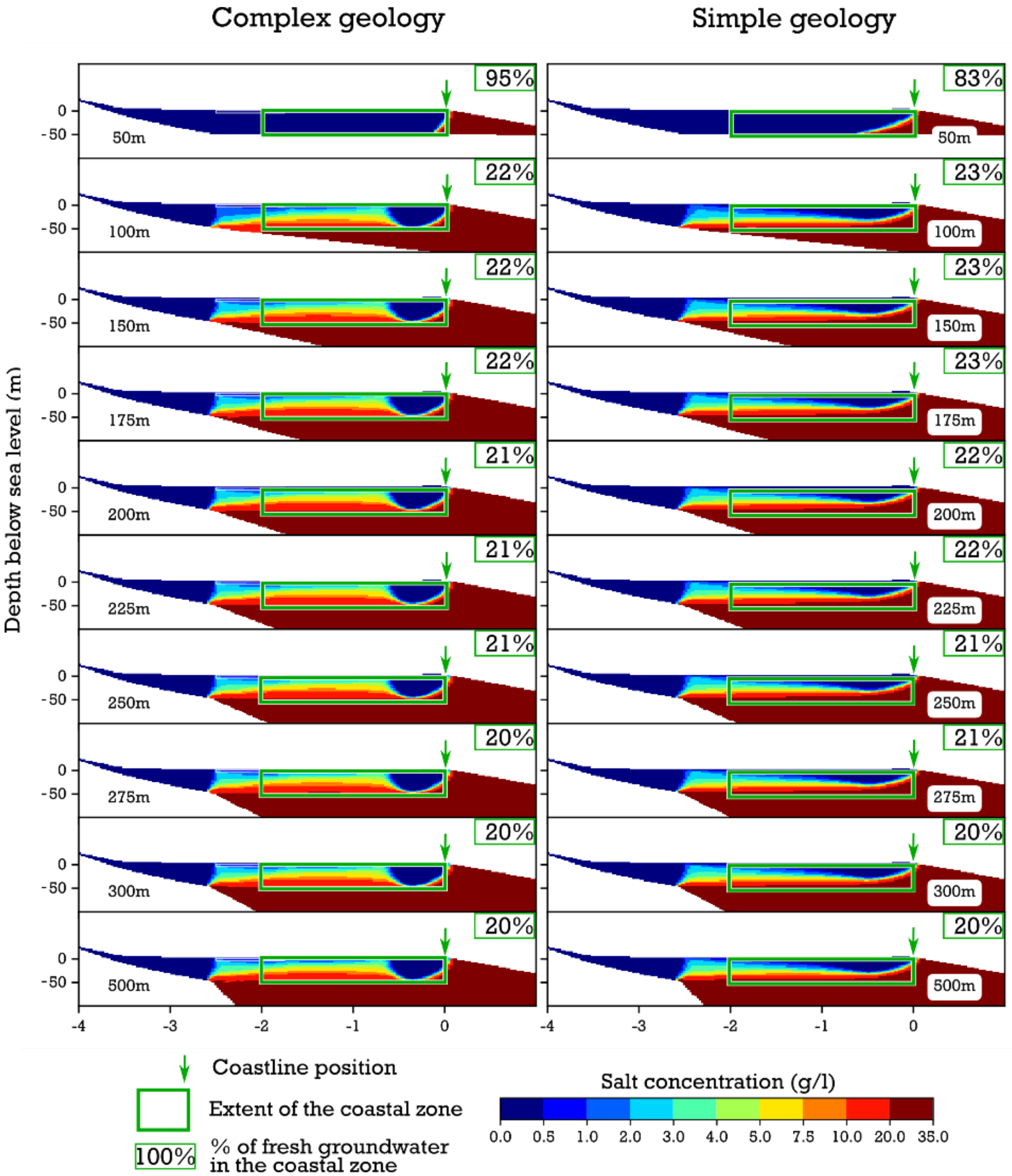

Figure S4. Simulation results for the cross-section located in Versilia plain, Italy. Salt concentration profiles are given for various sediment thicknesses at the coastline and two different geological scenarios (homogeneous and heterogeneous based on information provided by literature).

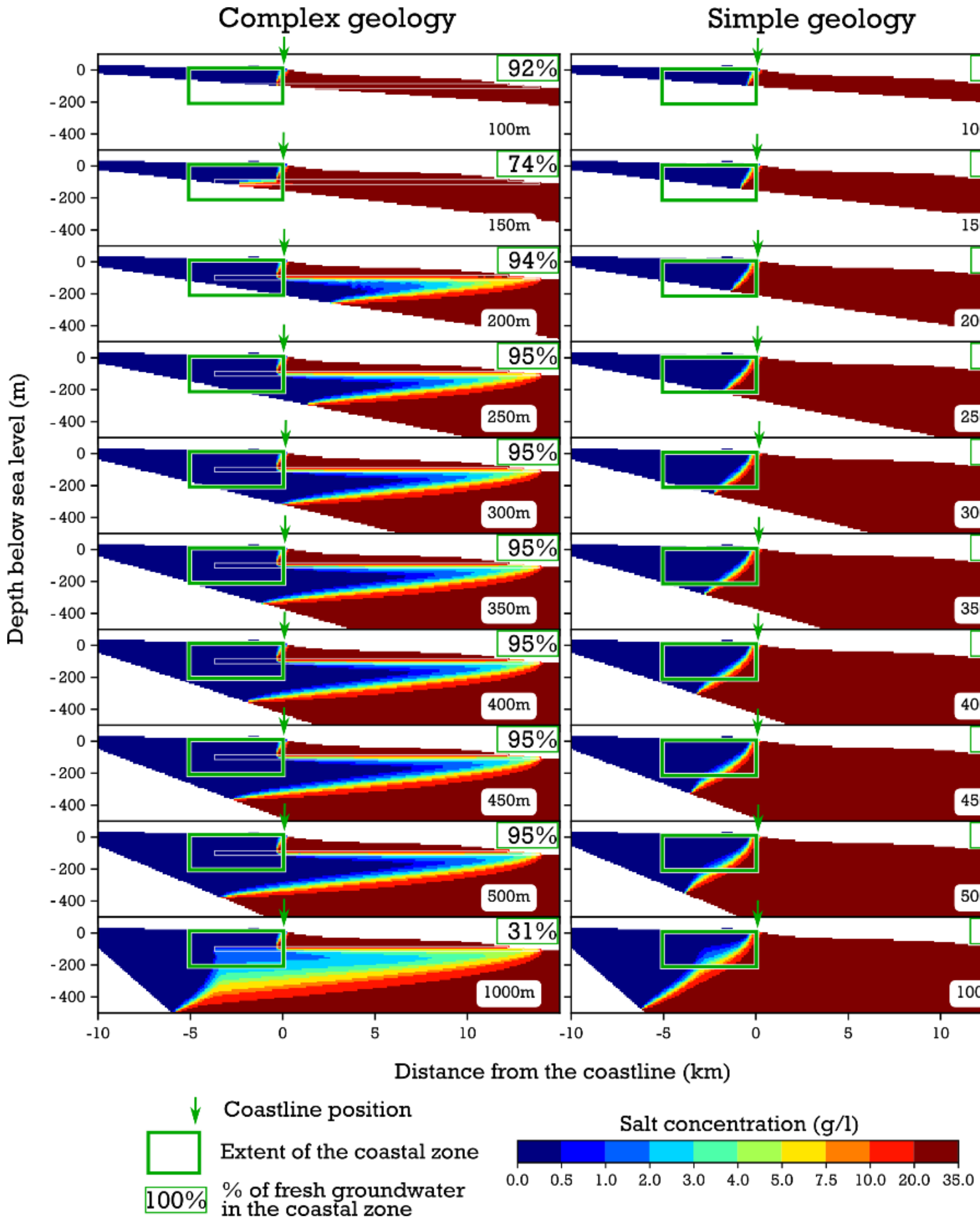

Figure S5. Simulation results for the cross-section located in the Mediterranean coastal plain aquifer, Israel. Salt concentration profiles are given for various sediment thicknesses at the coastline and two different geological scenarios (homogeneous and heterogeneous based on information provided by literature).

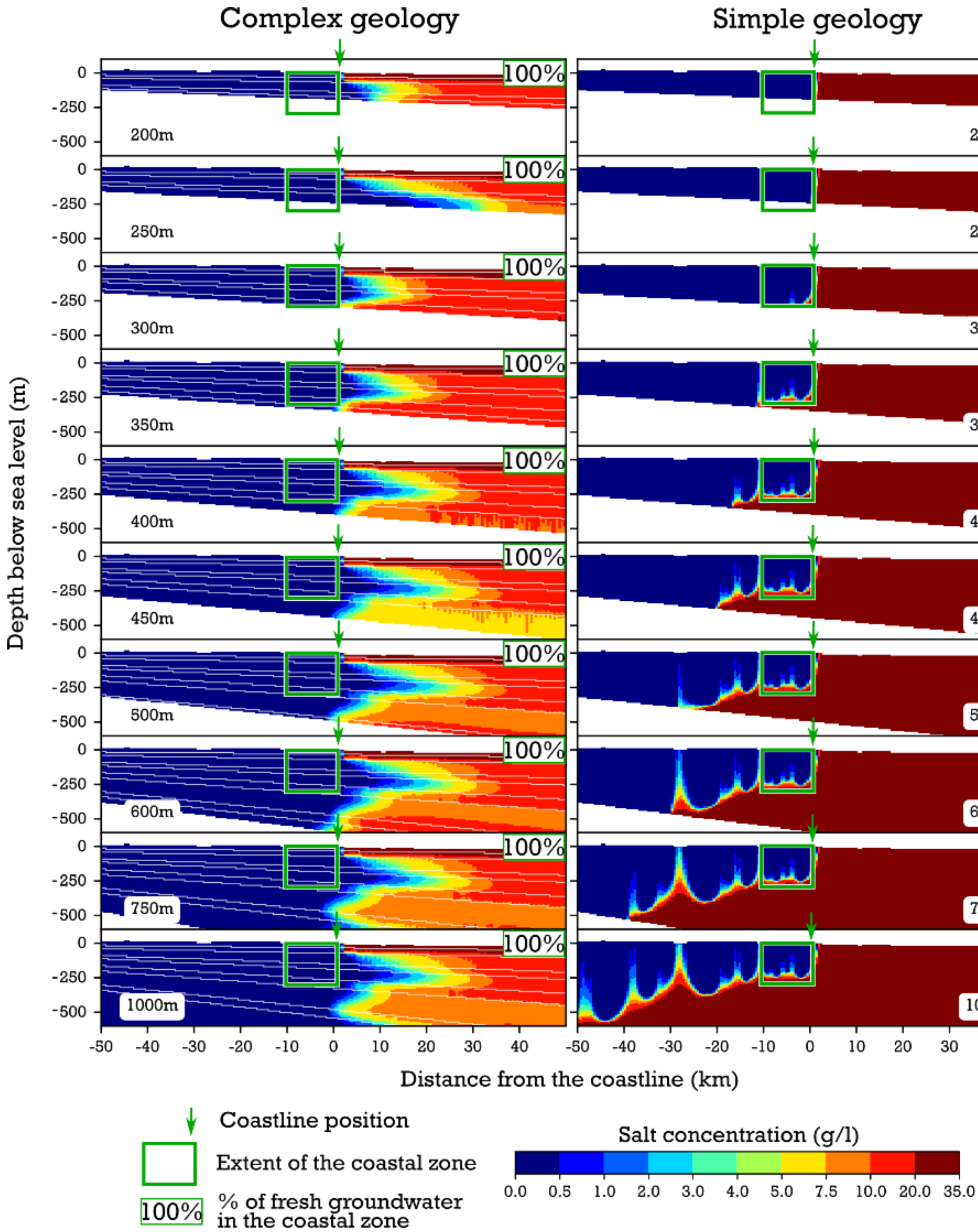

Figure S6. Simulation results for the cross-section located in North Atlantic Coastal Plain, Virginia, USA. Salt concentration profiles are given for various sediment thicknesses at the coastline and two different geological scenarios (homogeneous and heterogeneous based on information provided by literature).