MARSH98/PRBO modeling Metadata

Accretion modeling

Marsh accretion (the vertical accumulation of mineral and organic material) was estimated using the Marsh98 model, which has been used widely to examine marsh response to SLR across San Francisco Bay. The Marsh98 model is based on the mass balance calculations described by Krone (1985). This model assumes that the elevation of a marsh surface increases at a rate that depends on the (1) concentration of suspended sediment in the water column and (2) depth and periods of inundation by high tides. Marsh98 implements these processes by calculating the amount of suspended sediment that deposits during each period of tidal inundation and sums that amount of deposition over the period of record. Organic material was added directly to the bed elevation at each time step at a constant rate. Marsh98 was implemented in the Fortran programming language, and multiple runs were executed using MatLab v.2010b. For more details see Stralberg et al. (2011).

Future scenarios

Marsh accretion was modeled for a high and low sediment scenario and a high and low sea level rise scenario. Models were run for 100 years and estimates of elevation values were made for 2030, 2050 and 2100.

Model assumptions and limitations

Base elevation: PRBO made the results of the MARSH98 accretion modeling spatial by applying predicted change values to a base digital elevation model (DEM) created primarily from LiDAR data from several different sources (Figure 1). Approximately 4,300 ha of diked subtidal lands (including several former and active salt ponds) were inundated with water at the time of measurement and thus not captured by LiDAR. While a comprehensive accuracy assessment was not possible, we used available real-time kinetic GPS data (horizontal accuracy: ± 1- 2 cm; vertical accuracy: ± 2-3 cm) from four North Bay study sites to investigate potential systematic biases in two of these sites in Suisun Bay and the western Delta, where marsh vegetation (*Schoenoplectus* spp.) often forms particularly impenetrable mats, we used available vegetation data to develop correction factors throughout the relevant subregions based on available vegetation maps. However, there are likely to be vertical errors remaining because of sparse field sampling available throughout the estuary. Additionally, since the DEM was produced from a compilation of LiDAR data collected at different times over between 2000 – 2010, there are locations where substantial changes in elevation have resulted from management and natural processes (e.g., restoration) that are not captured in the DEM.

Another important clarification is that the 2010 (current) maps viewable on the website (www.prbo.org/sfbayslr) are the LiDAR data classified into habitat types based on the elevation. Users often incorrectly assume that this layer is an output from the MARSH98 model.

Sediment and Organic Accumulation assumptions/scenarios: The estuary was divided up into 15 biogeomorphic subregions. Each subregion was assigned a high and low suspended sediment concentration and an organic accumulation rate (see Figure 2). The high and low values were used for our different scenarios. Sediment and organic accumulation values for each subregion were based on field data where available and expert opinion where data was lacking. A limitation of this approach is that, within a subregion and within a marsh, there is assumed to be spatial homogeneity in sediment concentrations and organic accumulation rates (although organic accumulation is a function of elevation in the MARSH98 model which does vary spatially). Additionally, within scenarios, suspended sediment concentrations and organic accumulation rates were held constant through the 100-year simulation.

As noted above, organic accumulation in the MARSH98 model is a function of elevation. A threshold elevation indicates where accretion from organic material contribution starts. The same threshold elevation for an accreting marsh was used as for a drowning marsh. More recent implementations of the MARSH98 model have used different elevations for an accreting vs. a drowning marsh.

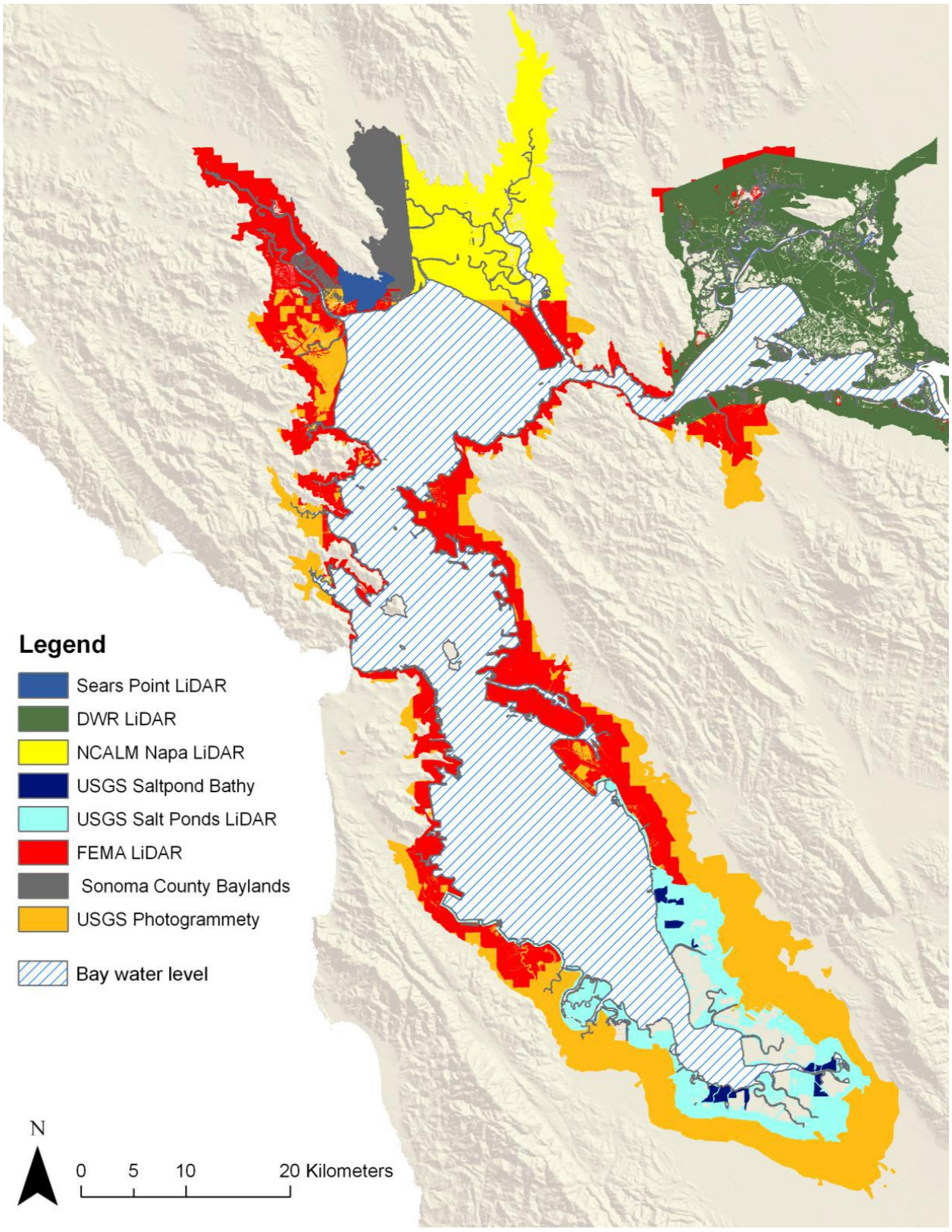
Sea level rise (SLR) scenarios: We chose two nonlinear SLR scenarios within the range of projections that the most recent NRC report (2012) recommends for consideration as mid and high SLR. These scenarios project 0.52 m and 1.65 m of SLR over the next century (2010 to 2110) with most of this change occurring within the second half of the century (Figure 3).

Tidal vs. Diked

The accretion models were run assuming that all barriers to tidal inundation were removed in 2010. This allows for an analysis of the restoration potential of areas currently restricting tidal action. The summaries of tidal marsh elevation changes that were modeled are broken into two groups. Those areas currently open to tidal action (existing tidal marsh habitat) and currently diked areas.

Bayland Goals Boundaries

We used boundaries defined in the original Bayland Goals report to summarize changes in marsh elevation. However, the spatial extent of our modeling extended beyond these boundaries in some cases. This means that our modeling shows some potential areas of marsh transgression which are not included within our summaries for the Goals Update.


Legend
Sears Point LiDAR
DWR LiDAR
NCALM Napa LiDAR
USGS Saltpond Bathy
USGS Salt Ponds LiDAR
FEMA LiDAR
Sonoma County Baylands
USGS Photogrammety
Bay water level
N
0
5
10
20 Kilometers

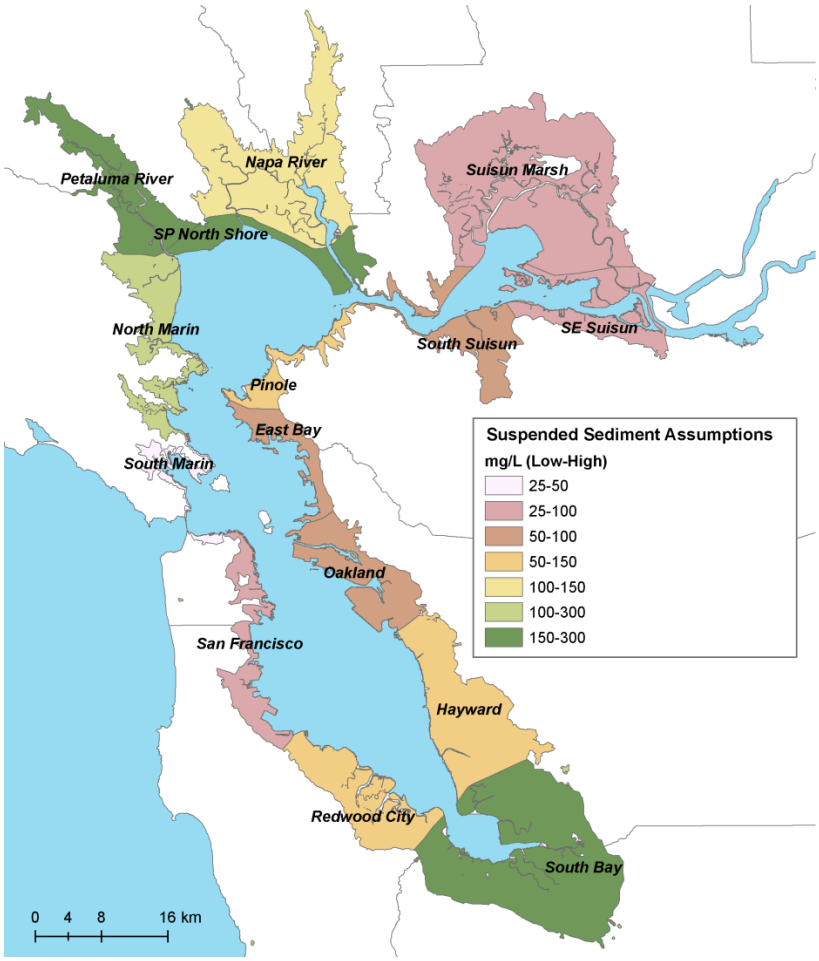


Figure 2. Biogeomorphic subregions within San Francisco Bay study area and assumptions about suspended sediment concentrations for climate change scenarios from Veloz et al (In review).

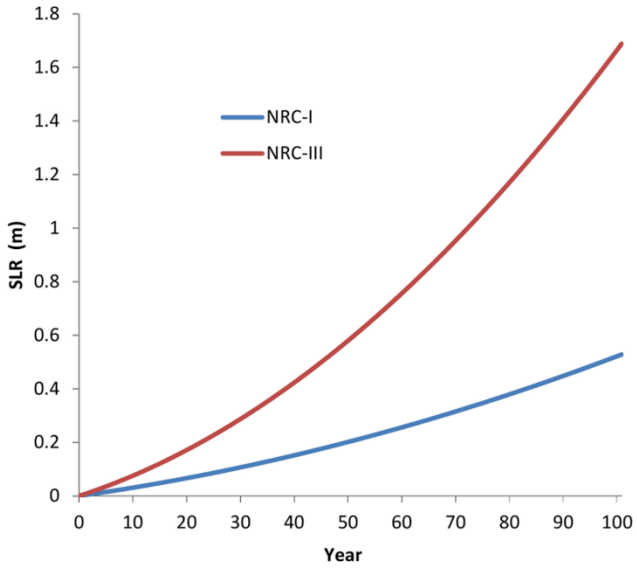


Figure 3. High (NRC-III) and low (NRC-III) sea-level rise trajectories used for climate change scenarios. Year 0 represents 2010 and year 100 represents 2110. Note NRC–I and NRC-III refer to National Research Council 1987 projections of sea level rise. from Stralberg et al (2011).

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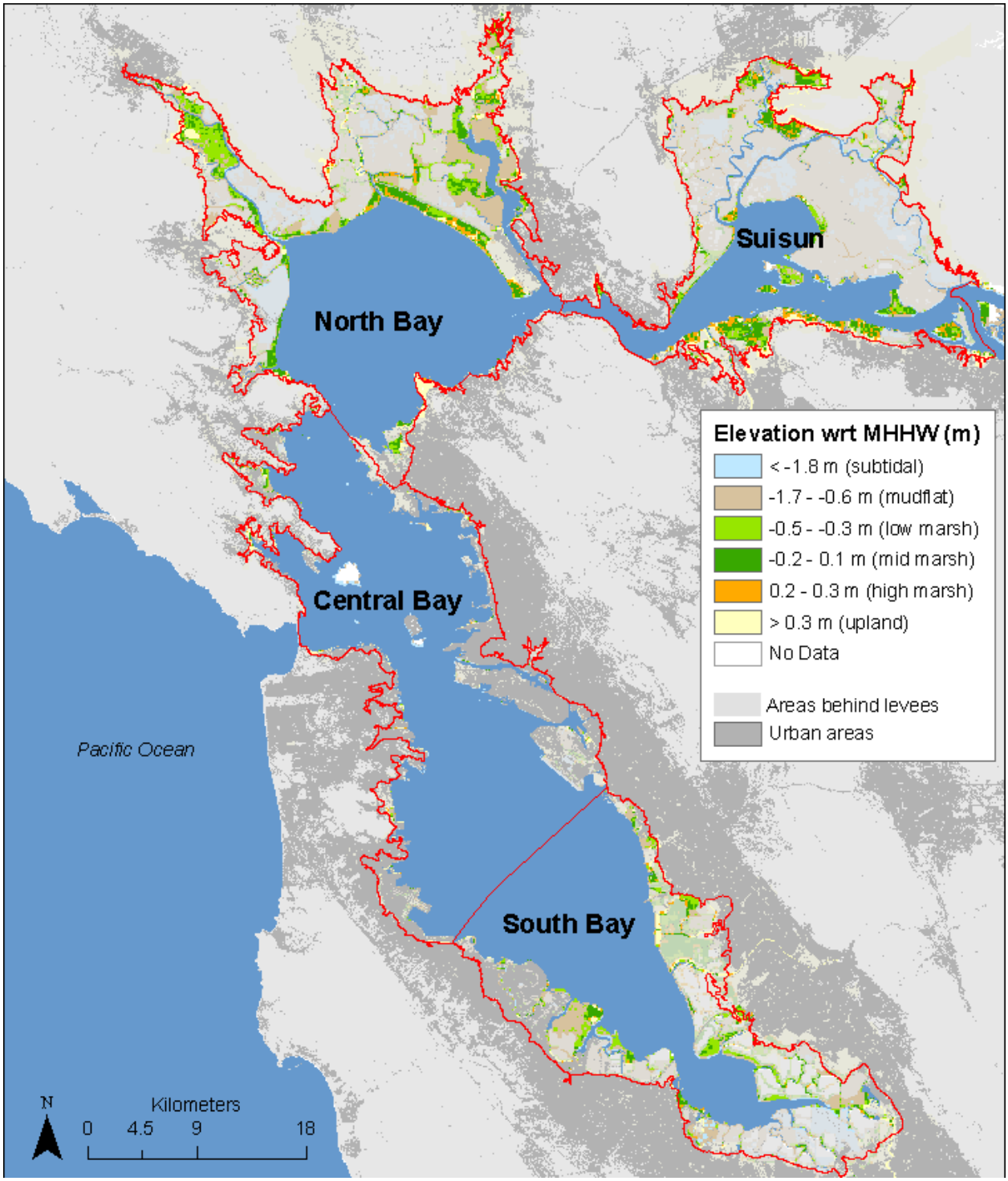
Krone, R.B. (1985) Simulation of Marsh Growth Under Rising Sea Levels." *Hydraulics and Hydrology in the Small Computer Age*. Proceedings of the Specialty Conference, Hydraulics Division, ASCE. Lake Buena Vista, FL. August 12-17. 1985. 106-115.

Stralberg, D., Brennan, M., Callaway, J. C., Wood, J. K., Schile, L. M., Jongsomjit, D., Kelly, M., et al. (2011). Evaluating tidal marsh sustainability in the face of sea-level rise: A hybrid modeling approach applied to San Francisco Bay. PloS ONE, 6(11), e27388. doi:10.1371/journal.pone.0027388.

National Research Council (2012). *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington, DC: The National Academies Press, 2012.

Veloz, S.D**.**, Nur, N., Salas, L. Jongsomjit, D.,Wood, J.K., Stralberg, D. and Ballard, G. (2013). Modeling climate change impacts on tidal marsh birds: Restoration and conservation planning in the face of uncertainty. Ecosphere. 4(4).

2010 elevations from LiDAR



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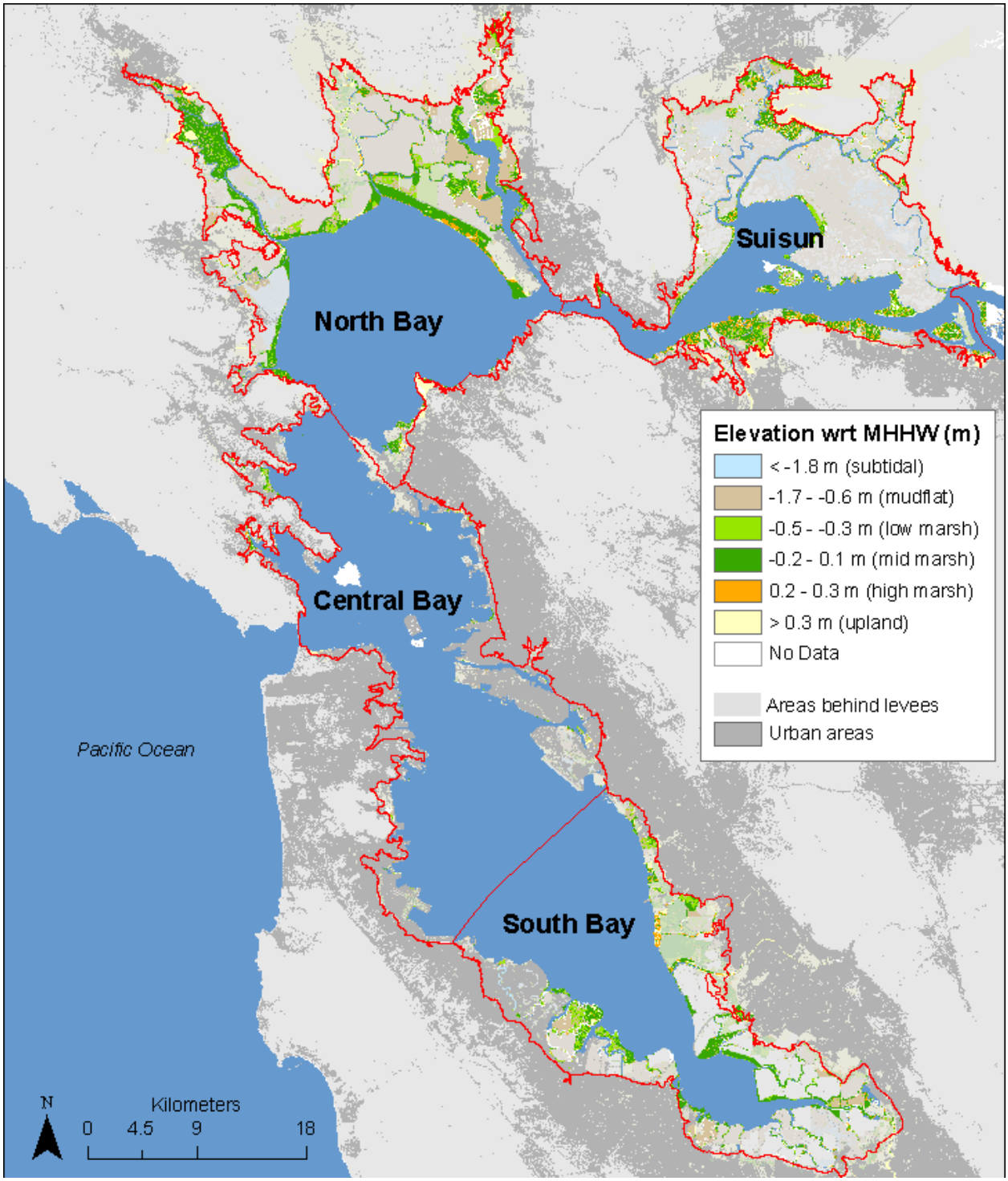
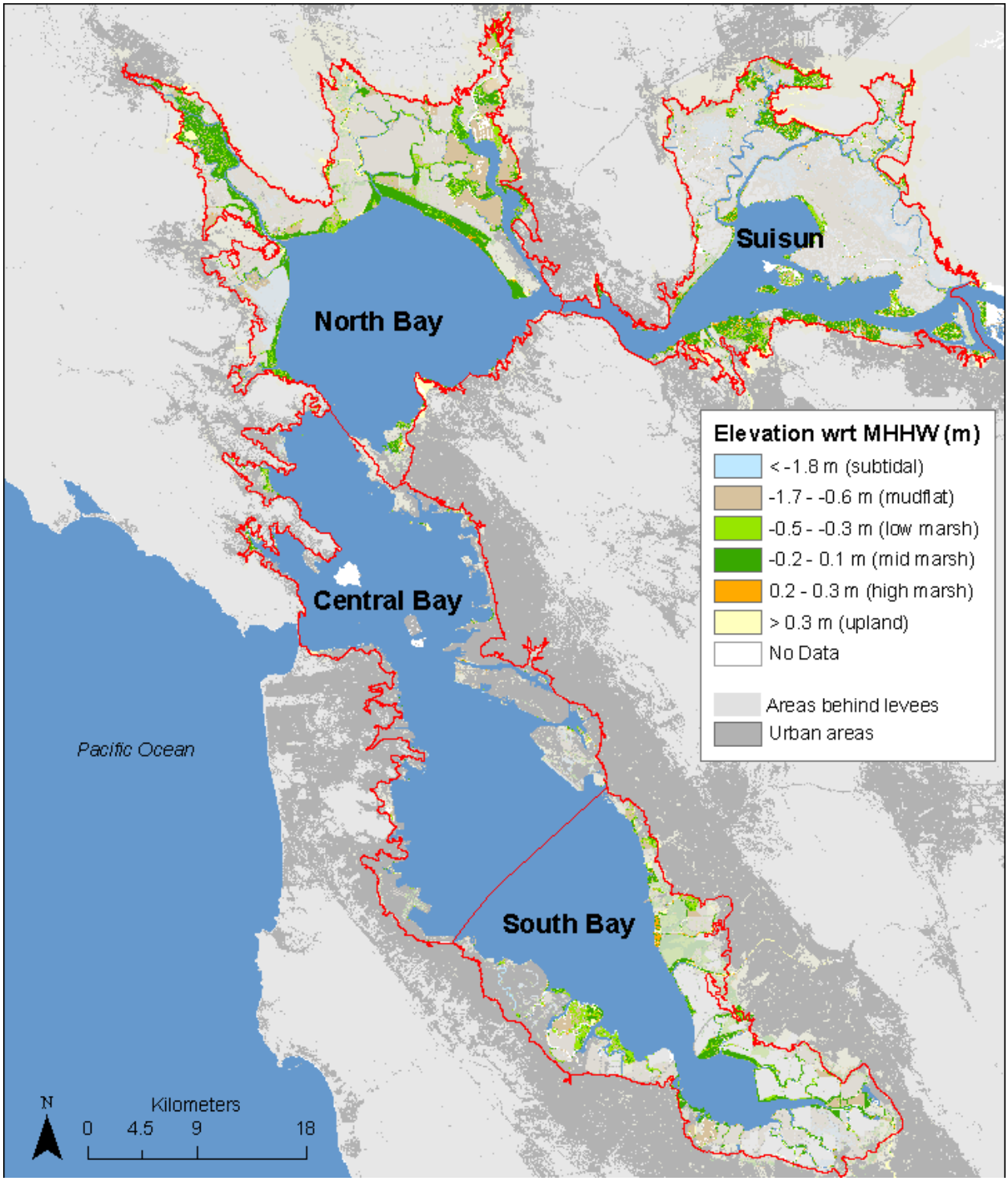


2030 Sed Low/SLR high



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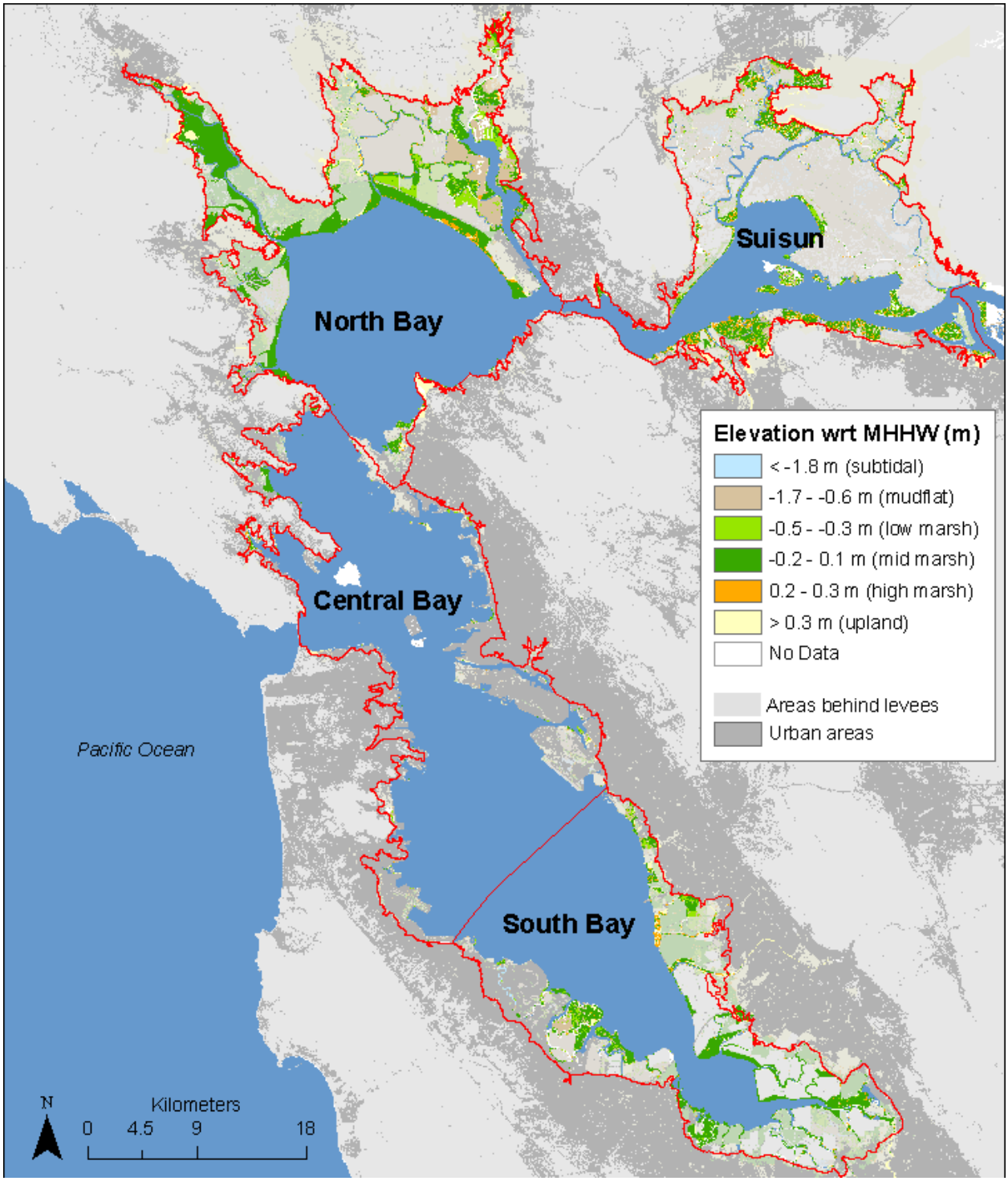

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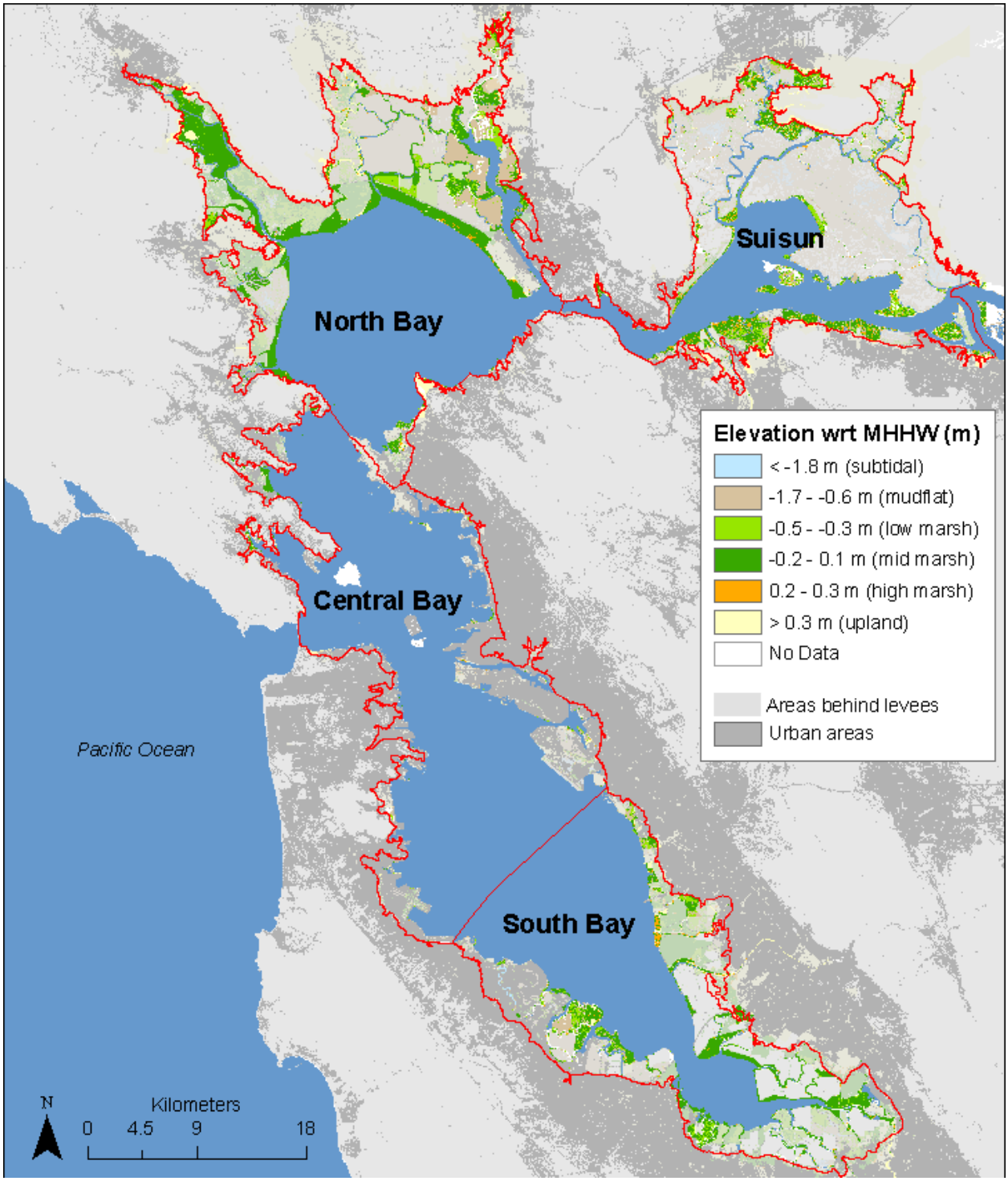

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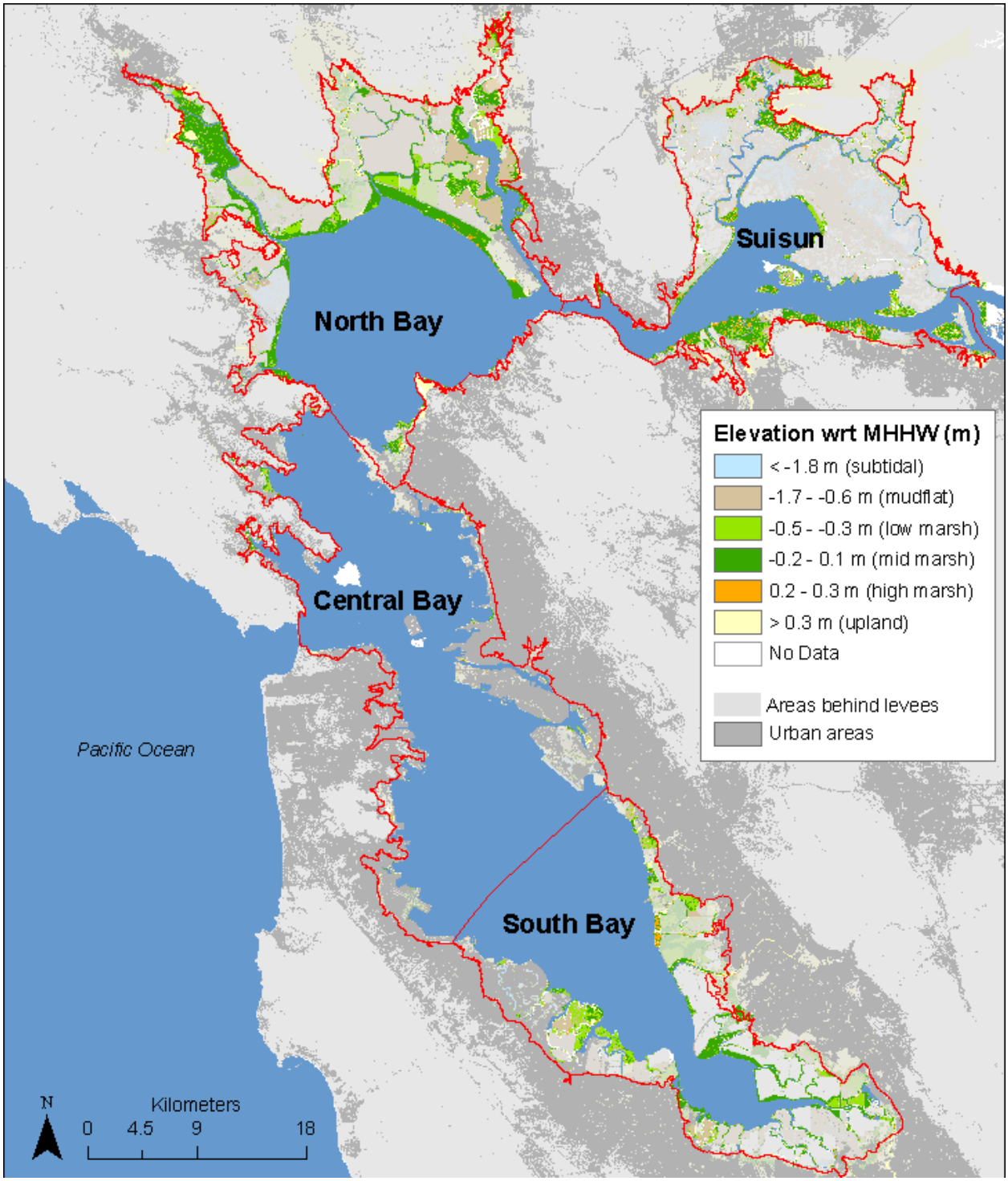

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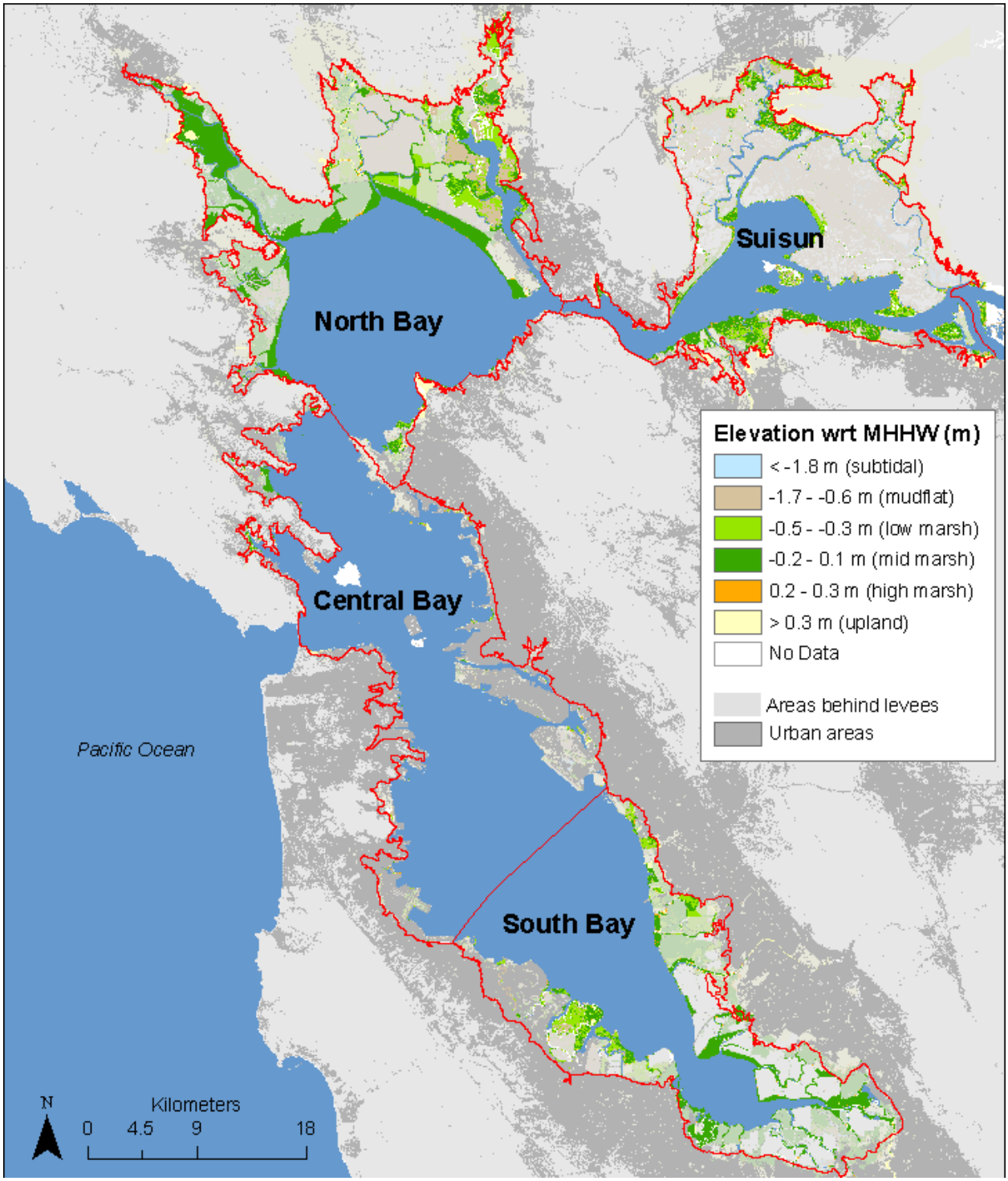

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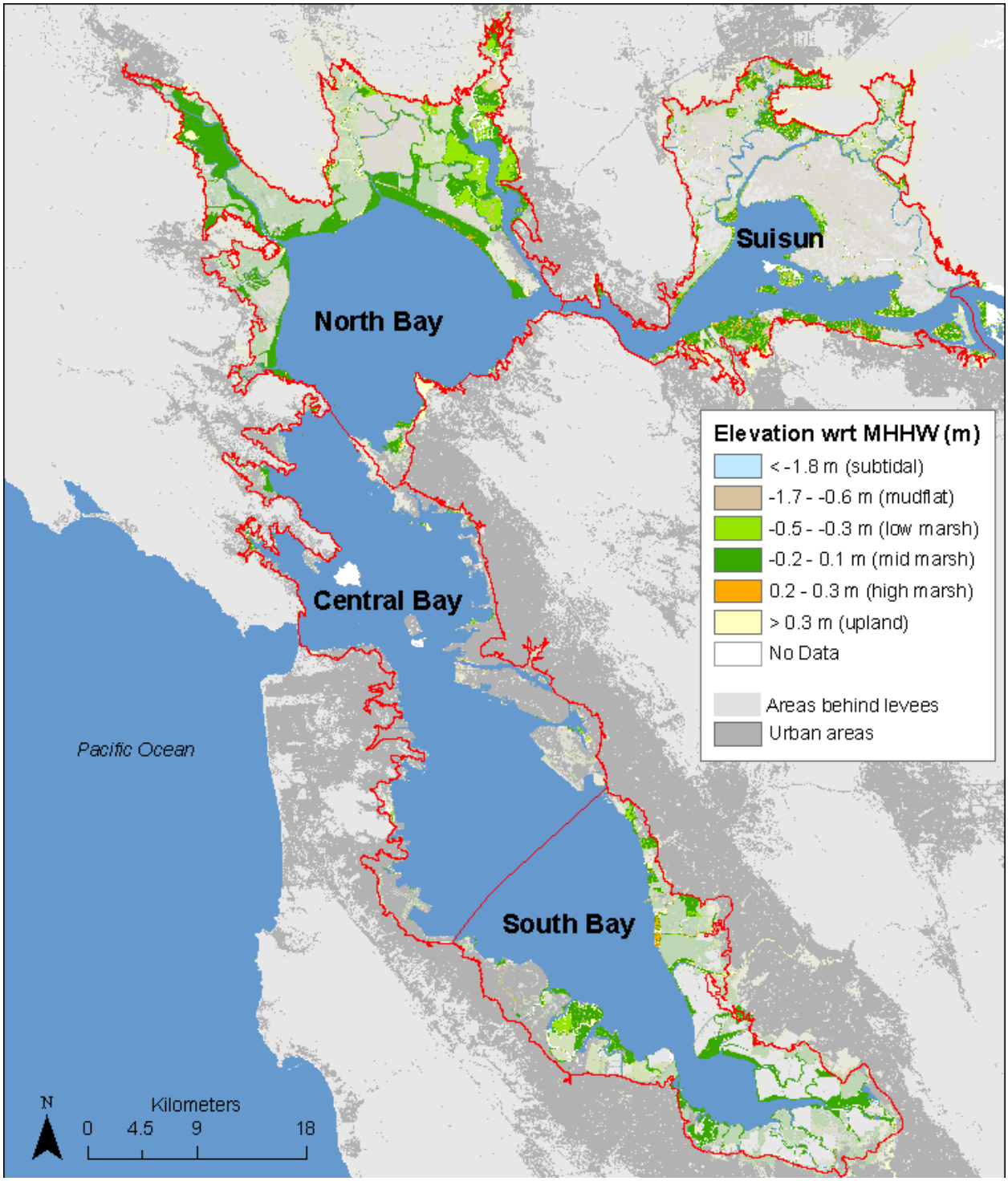

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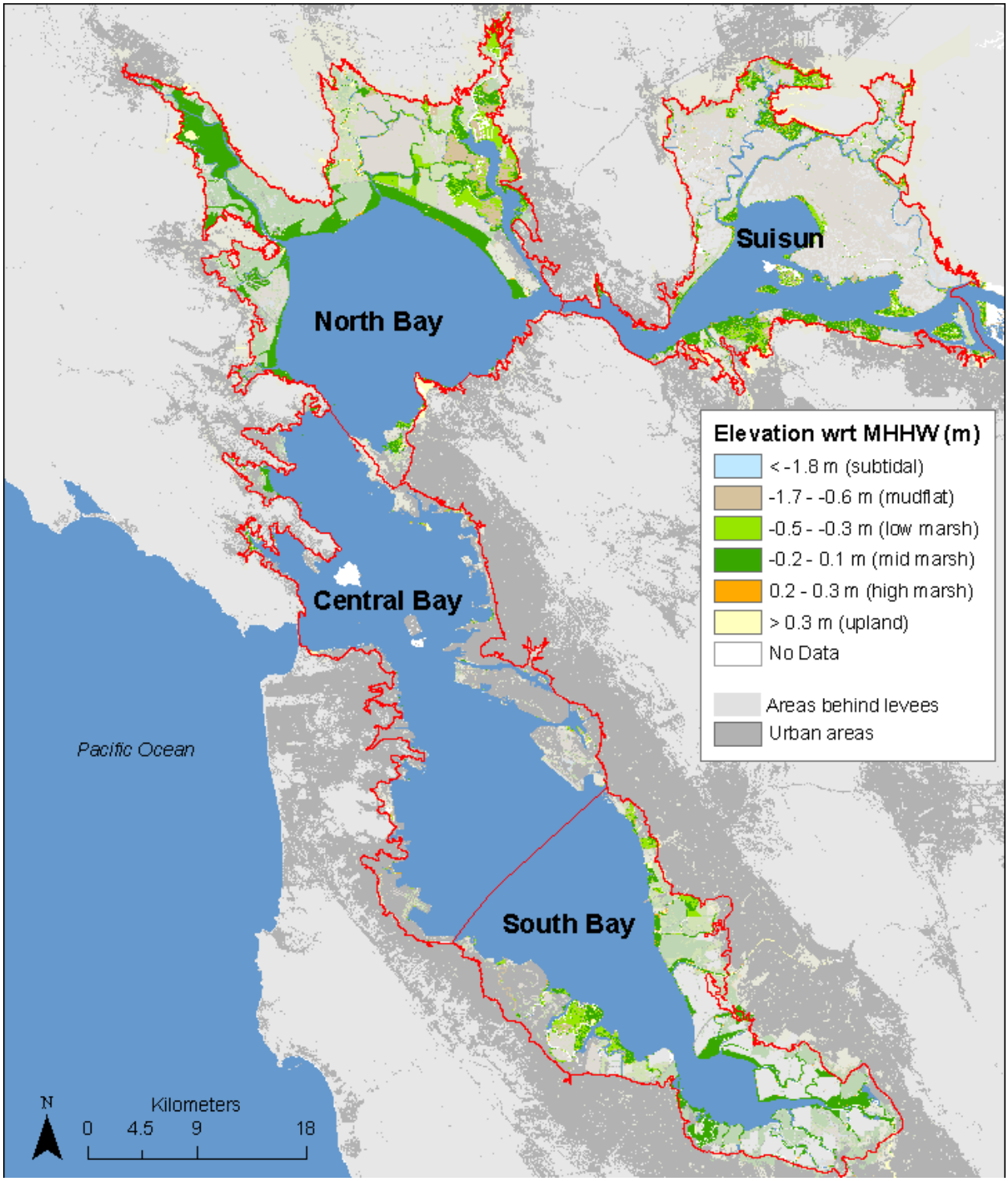
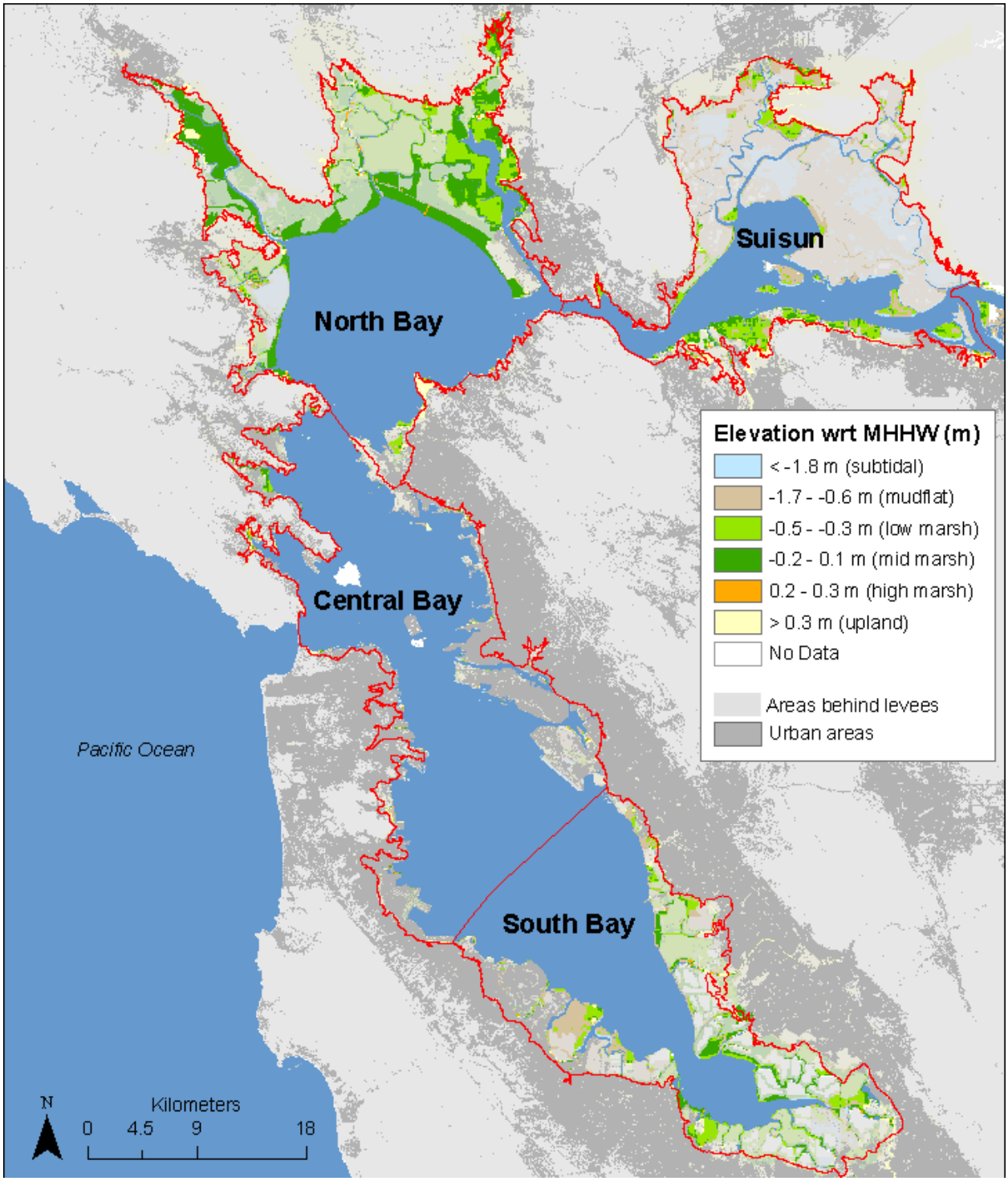


2110 Sed Low/ SLR Low



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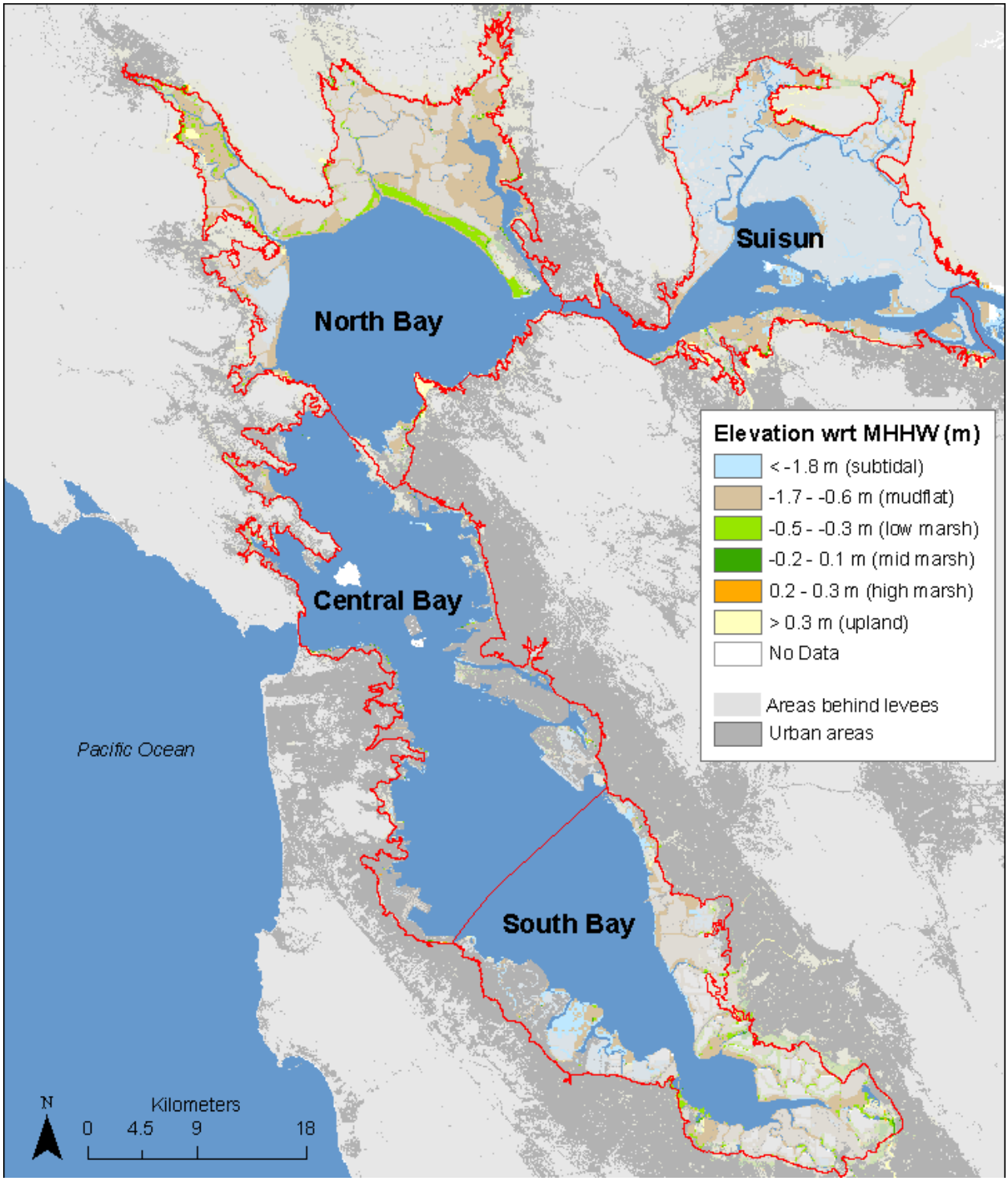

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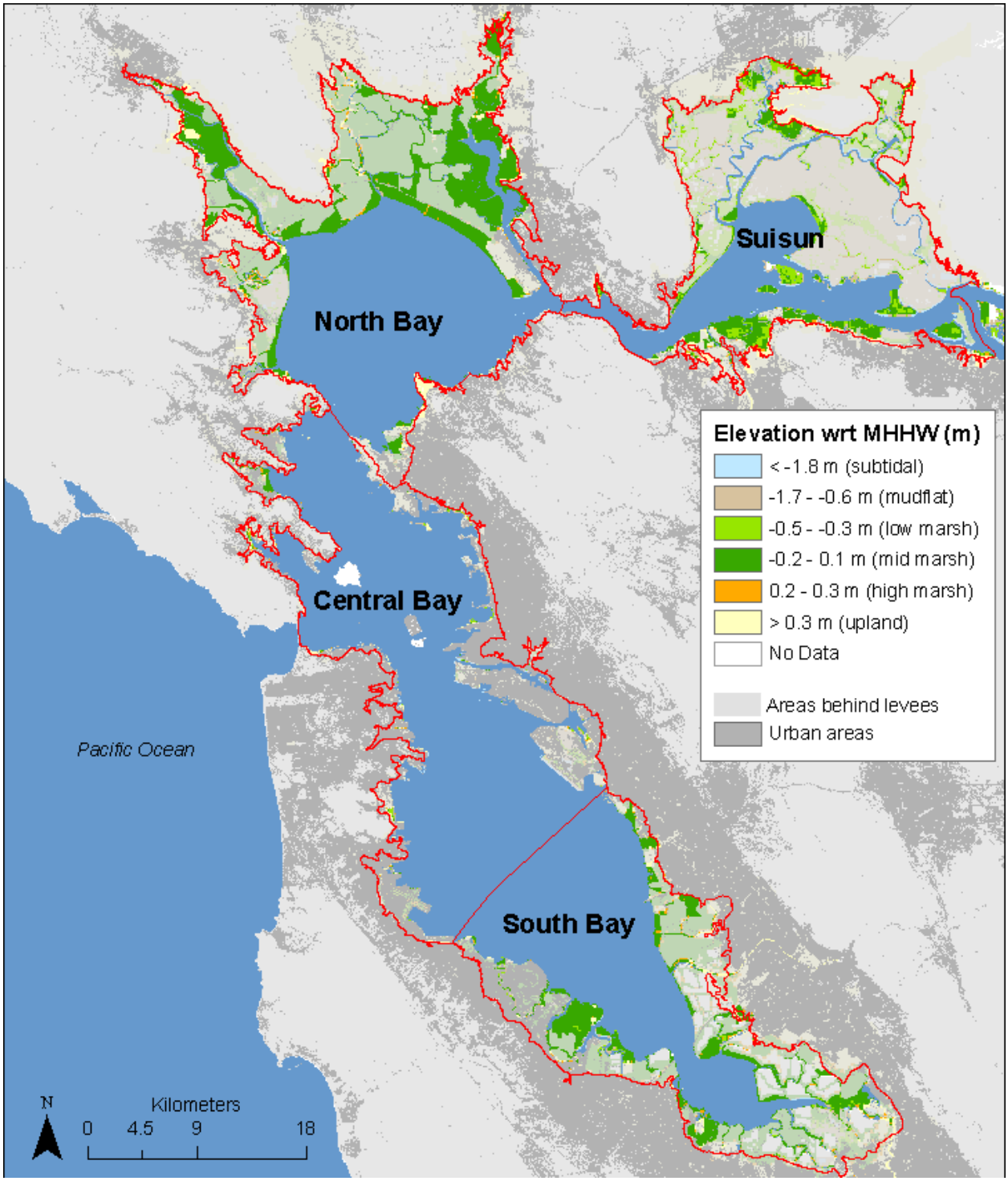

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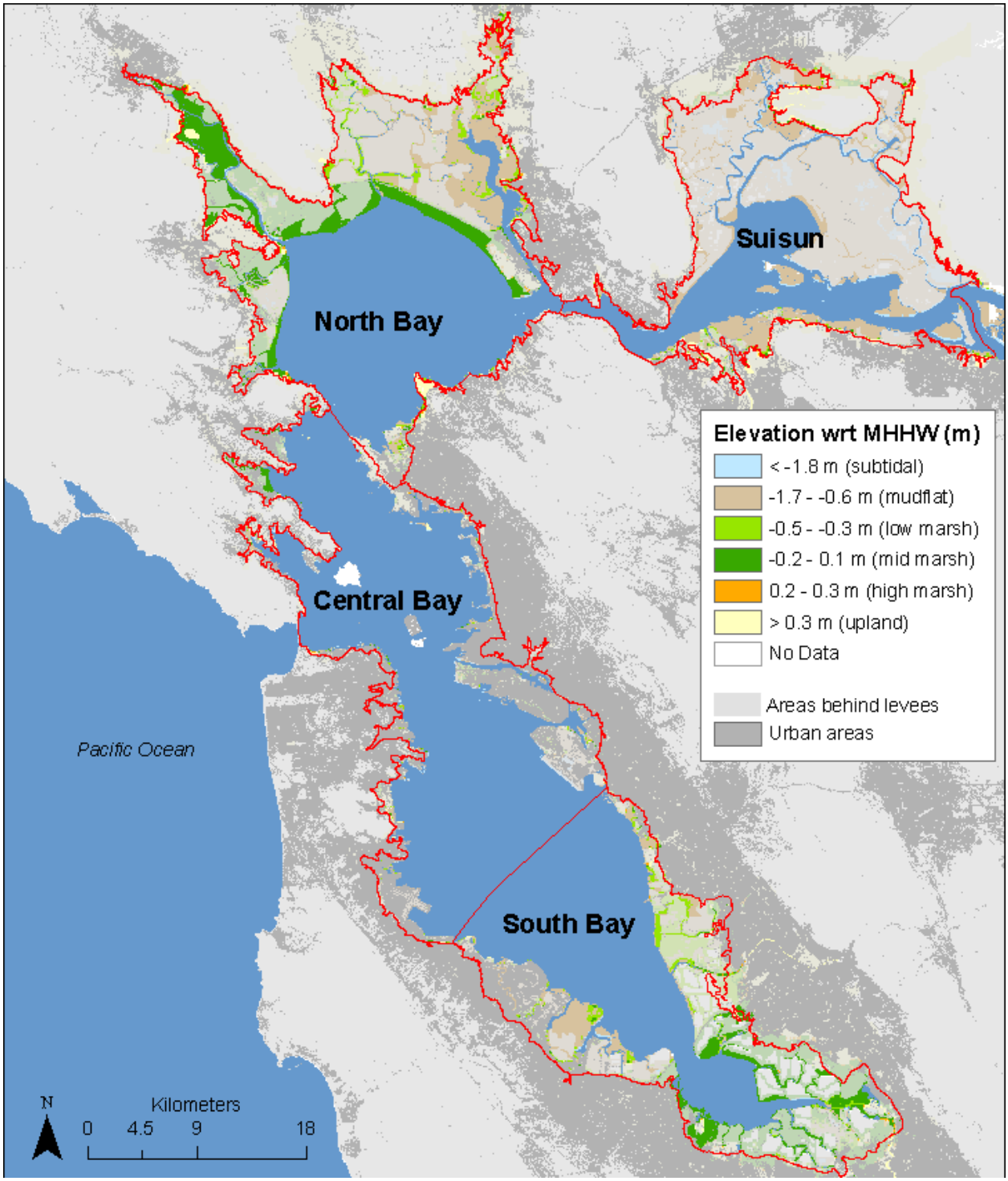
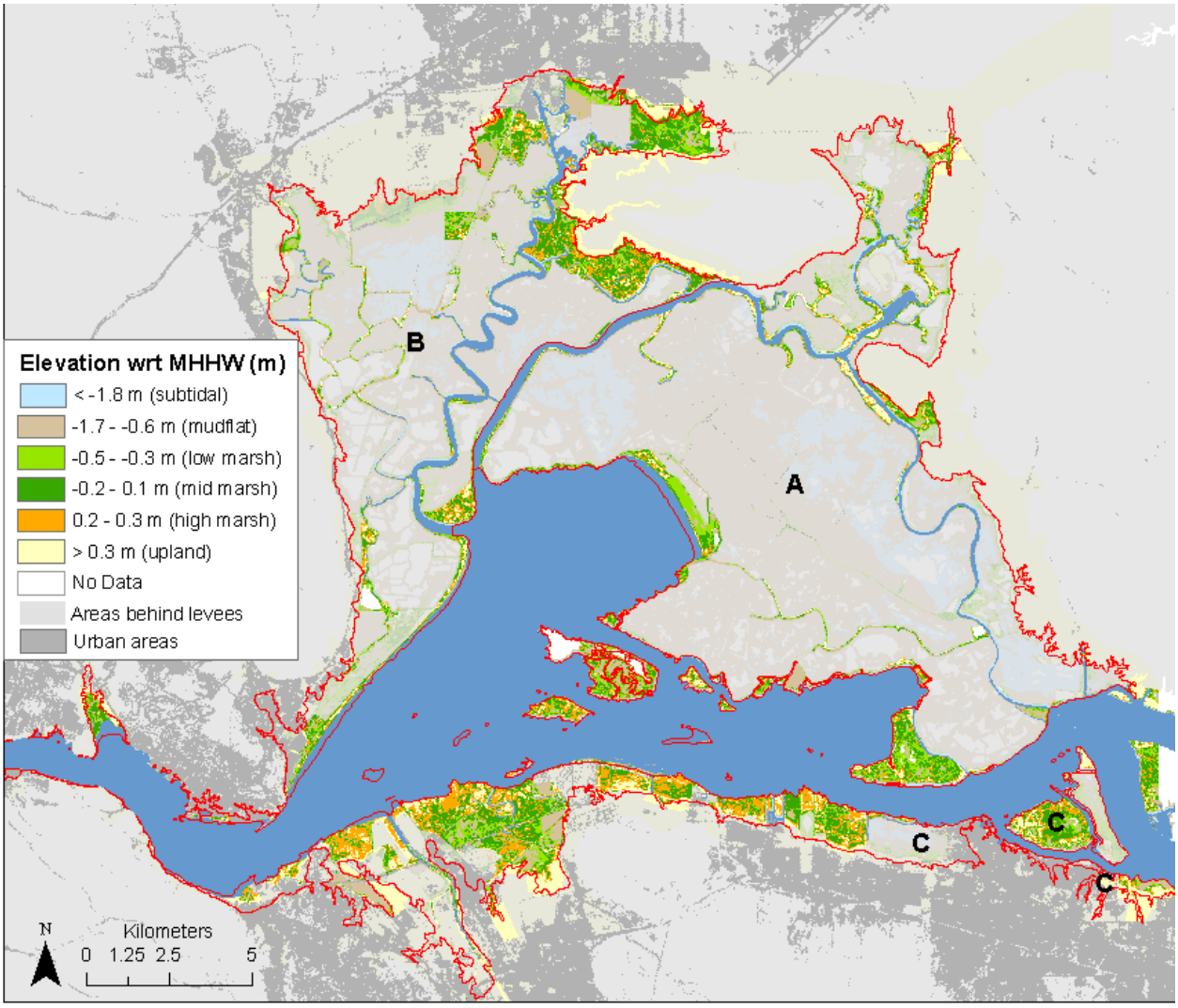
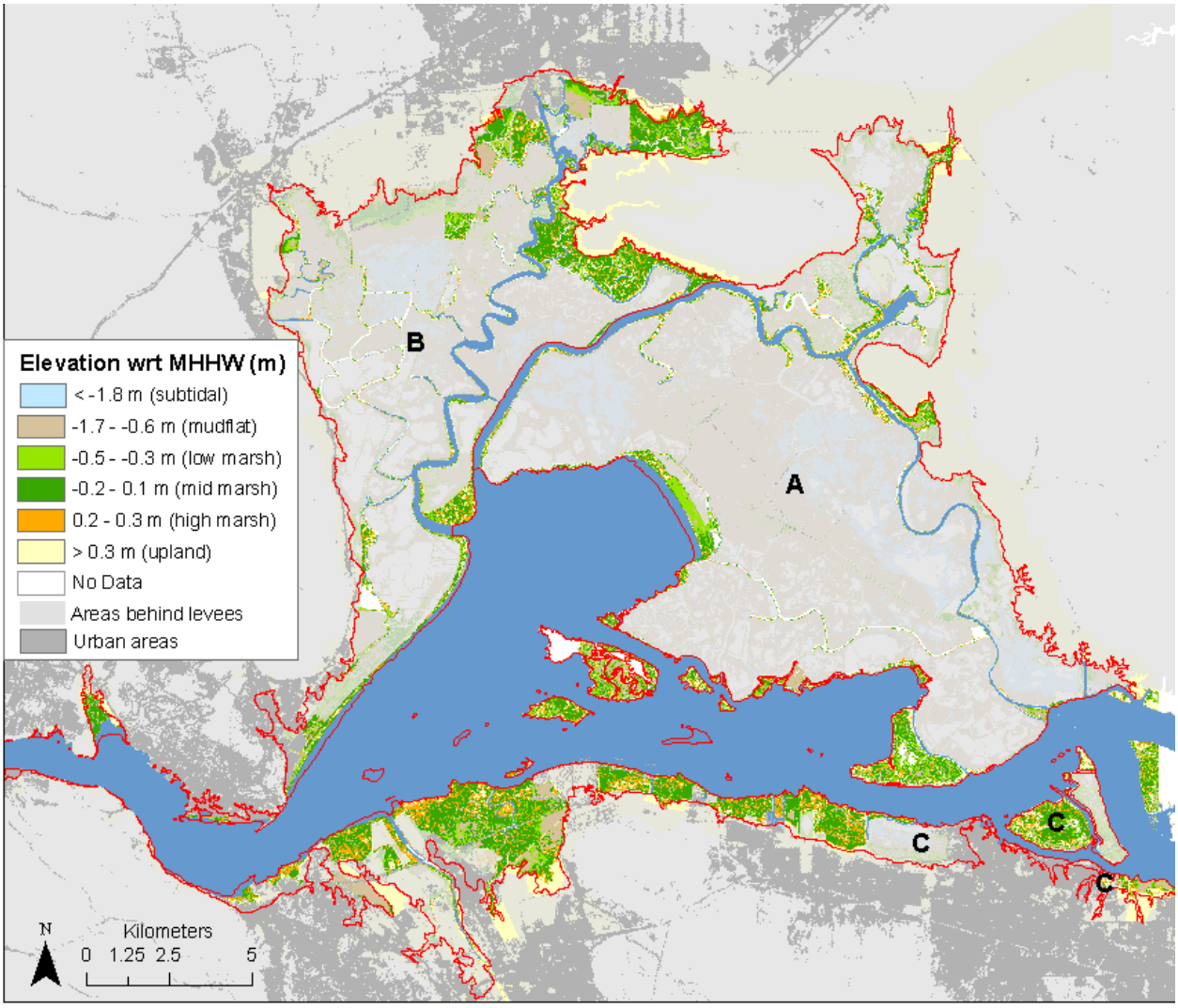


Suisun 2010 elevations from LiDAR



Suisun: 2030 Sed Low/ SLR Low



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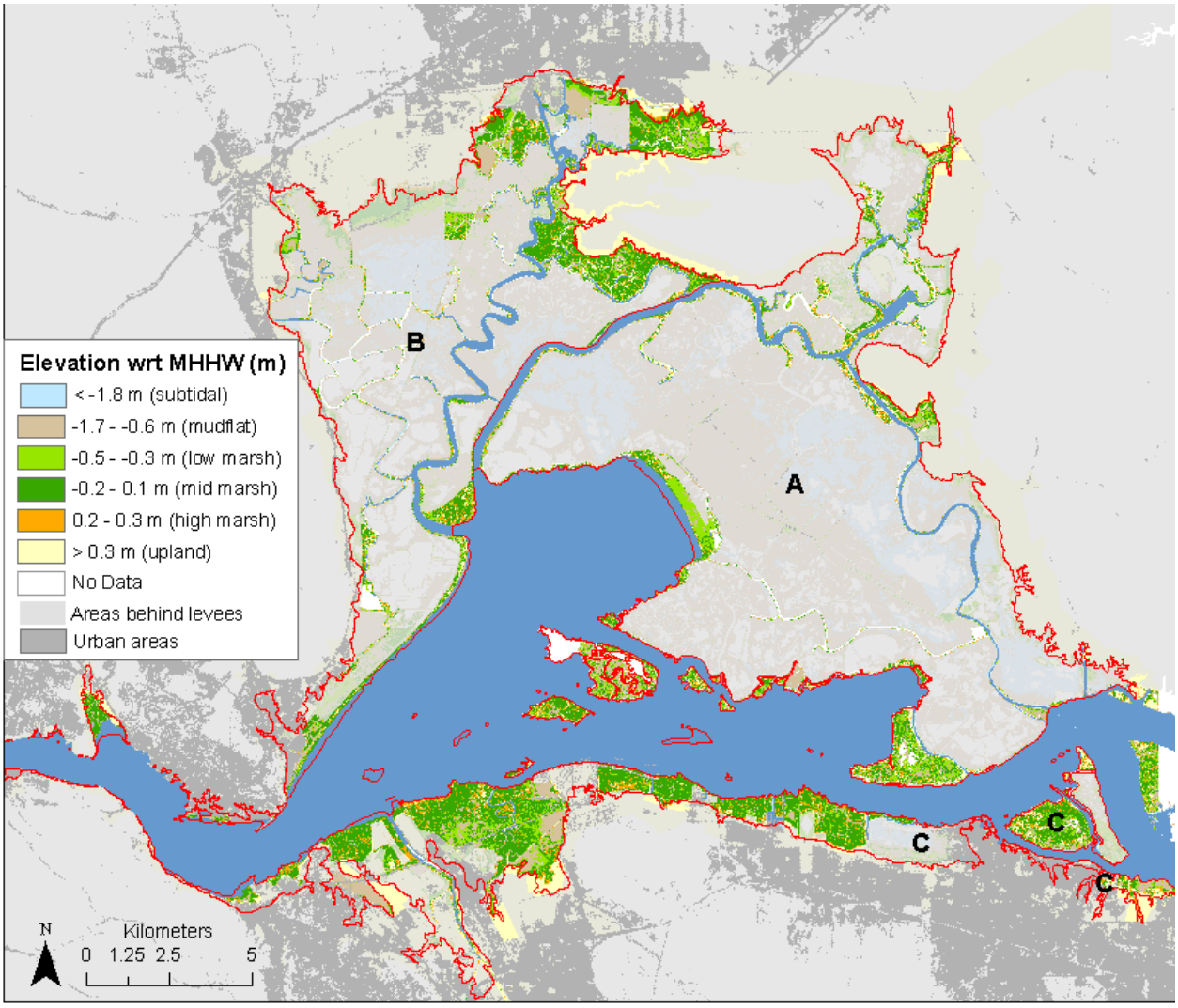

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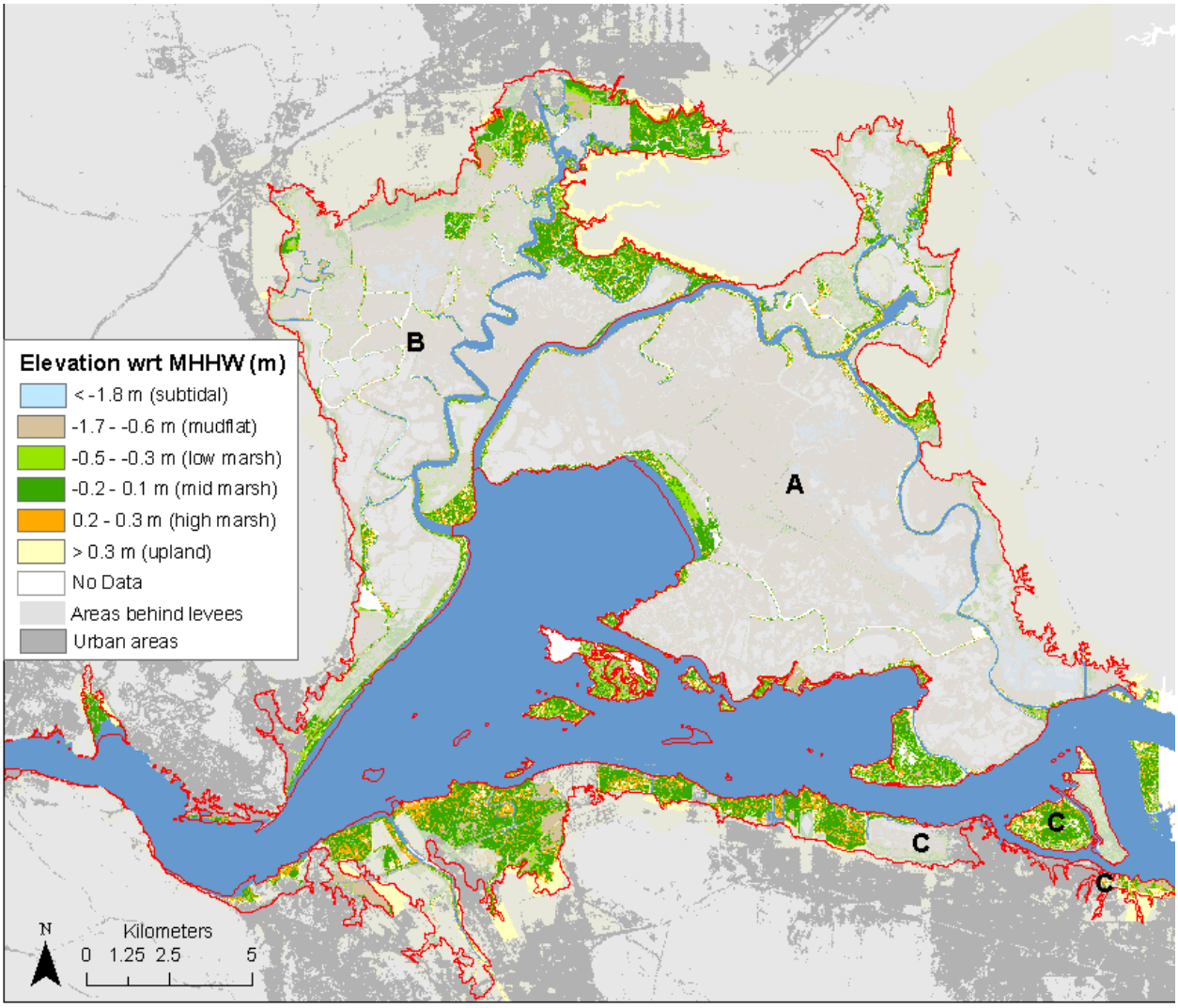

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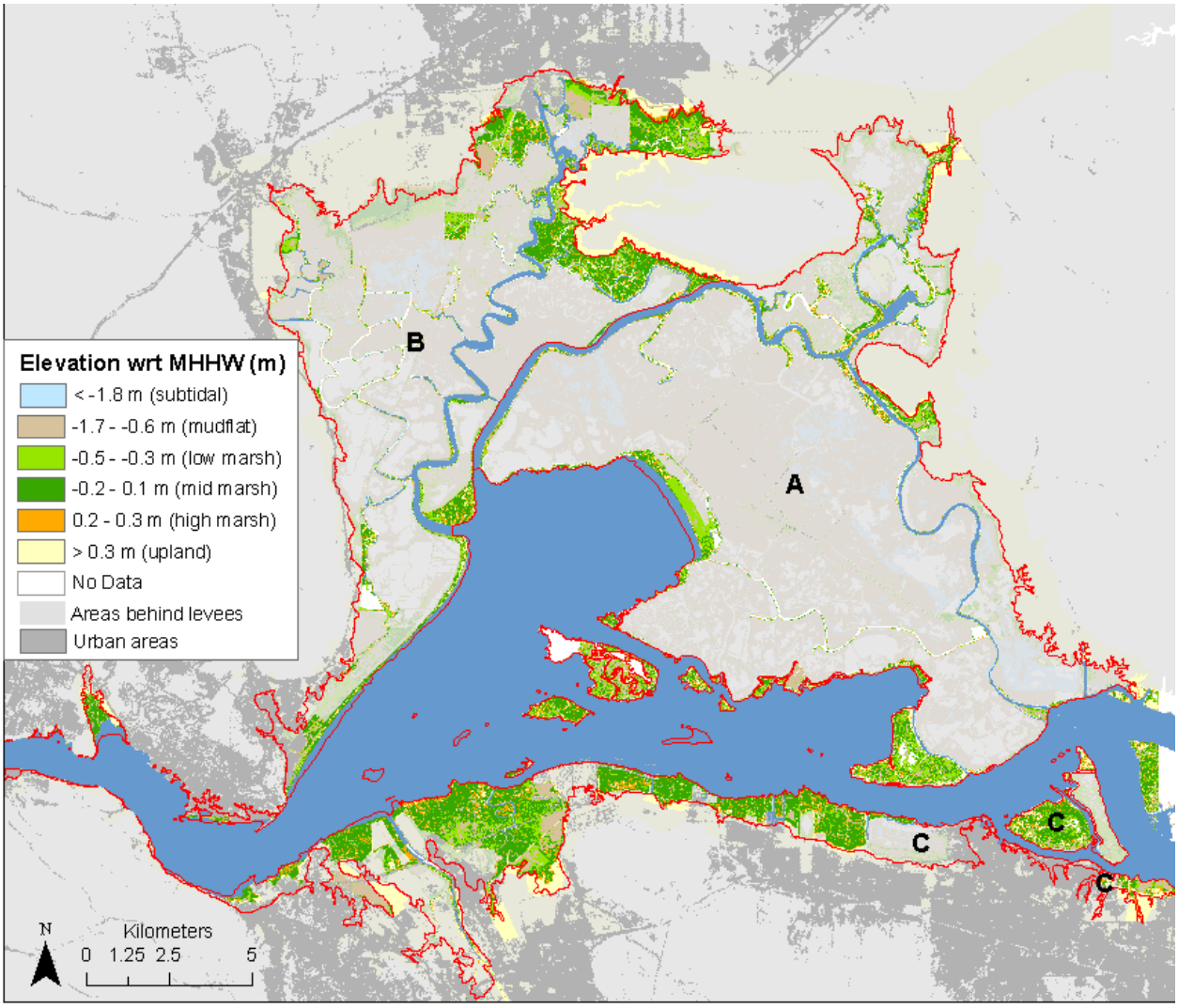

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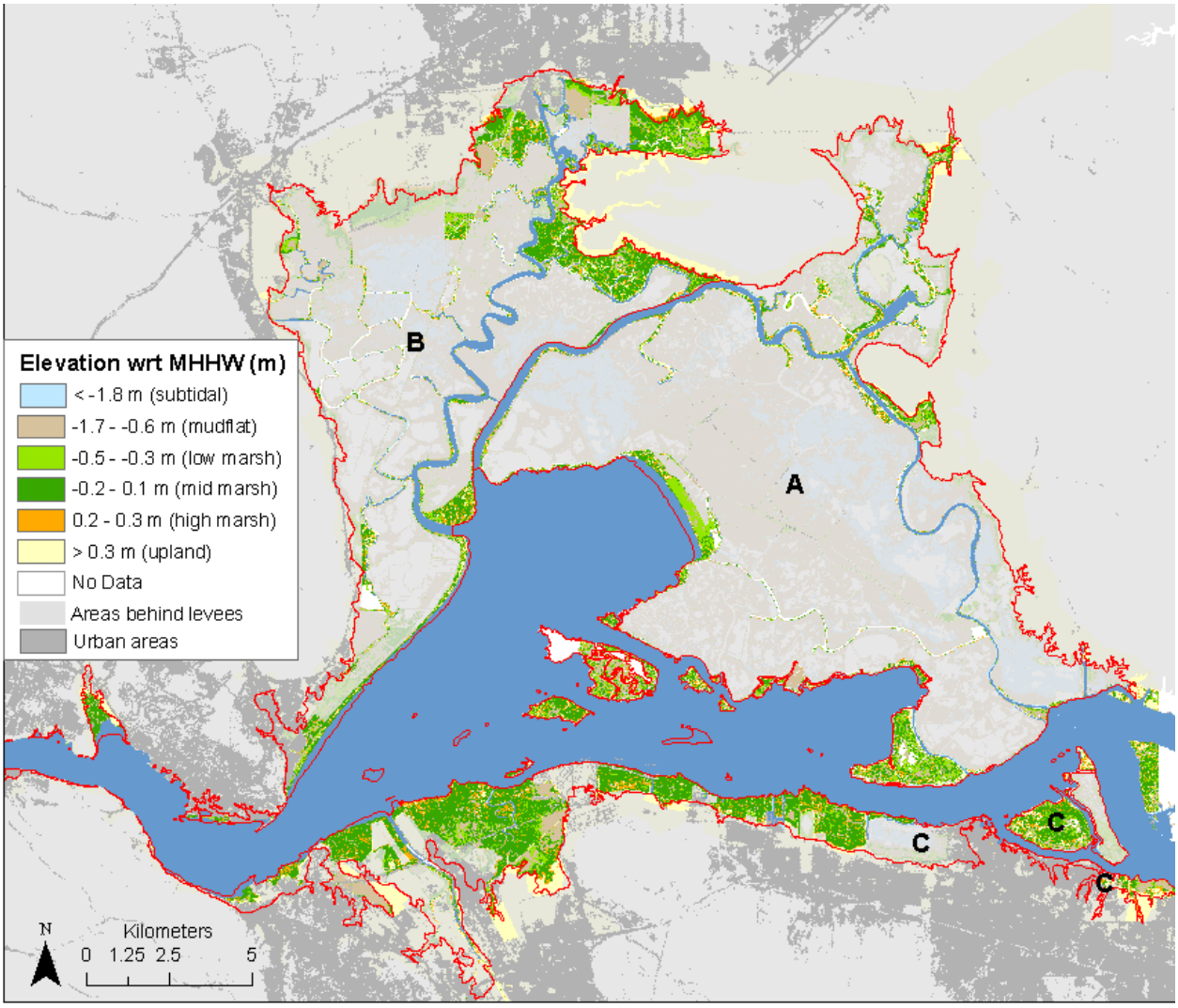

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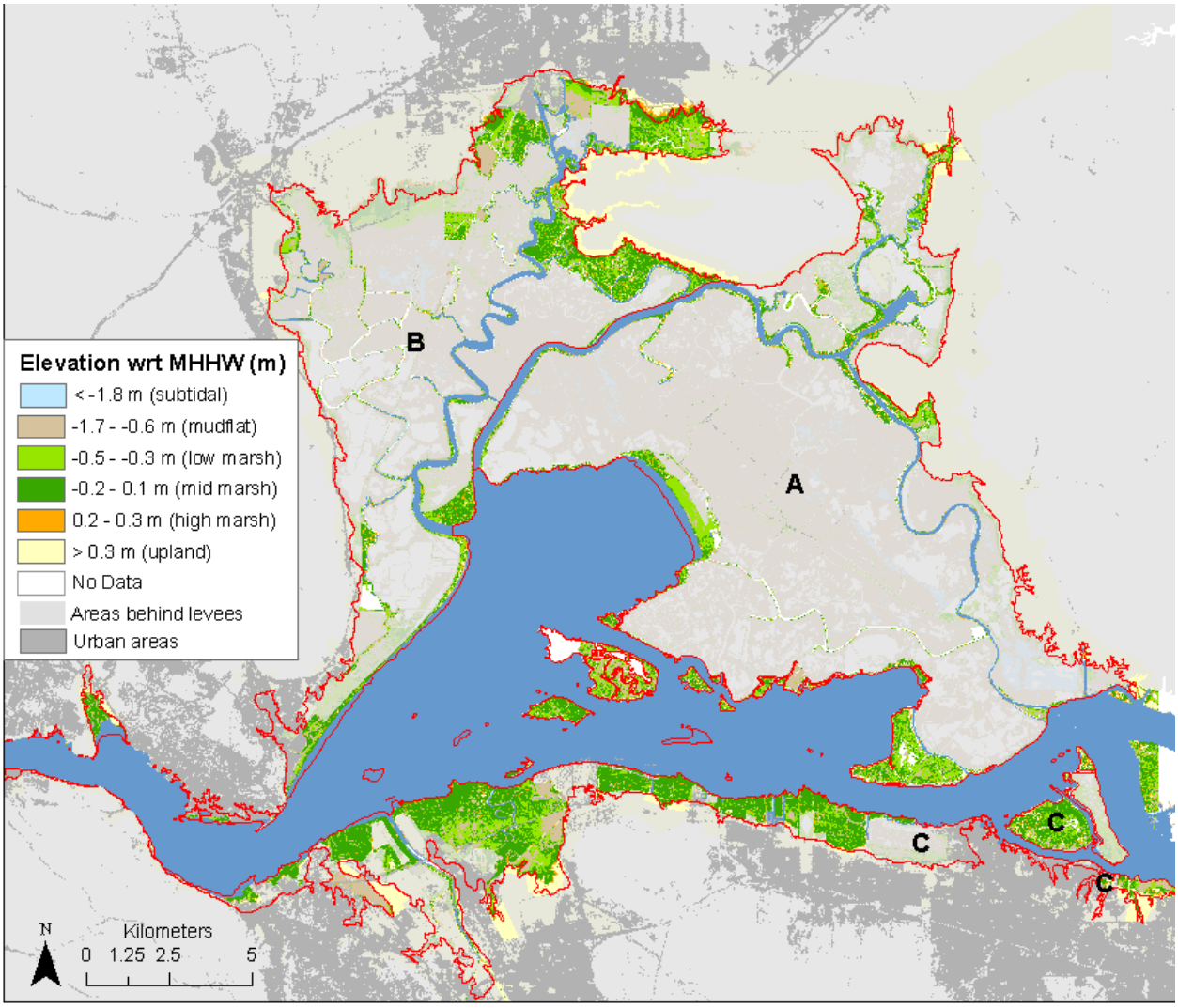

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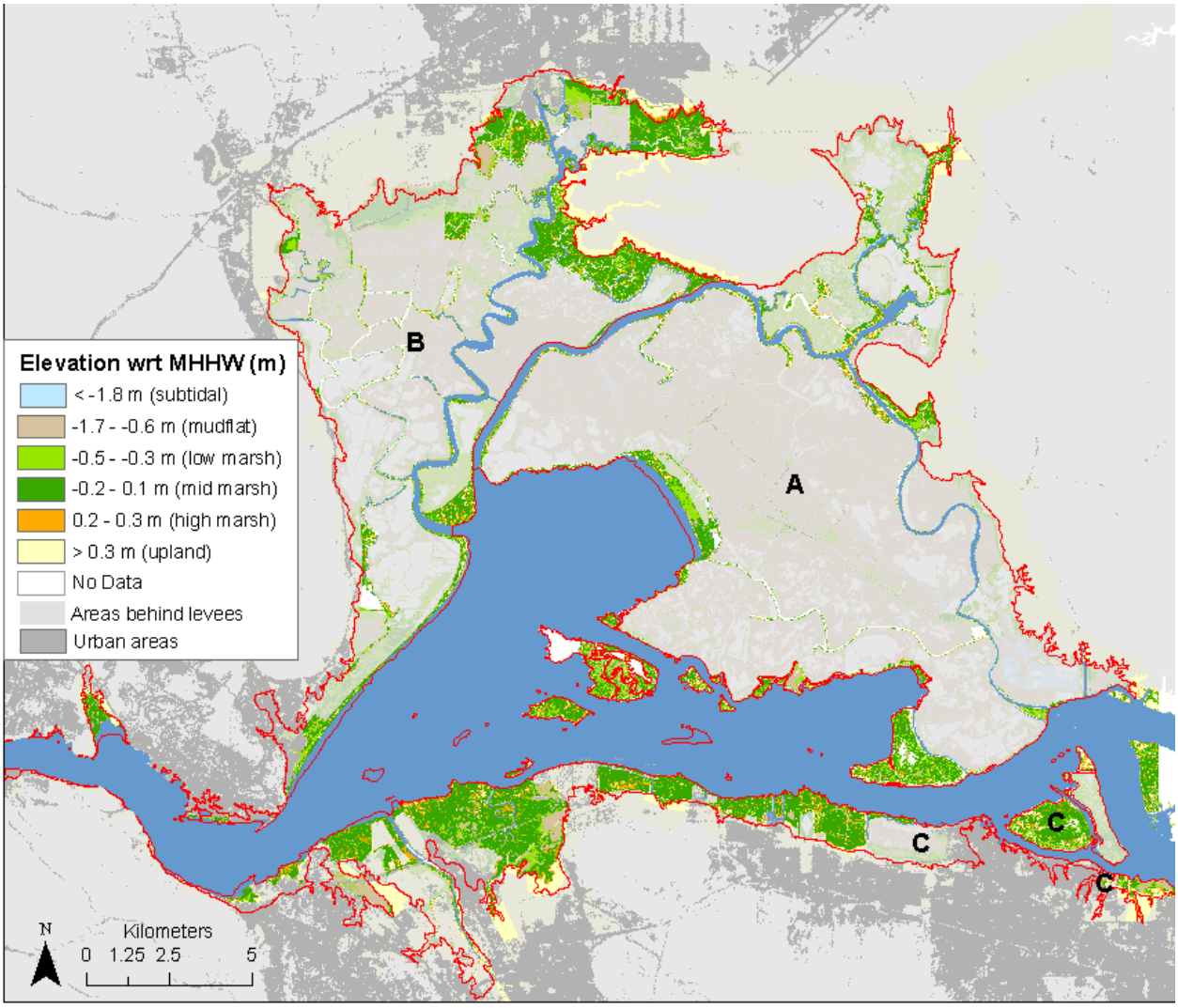

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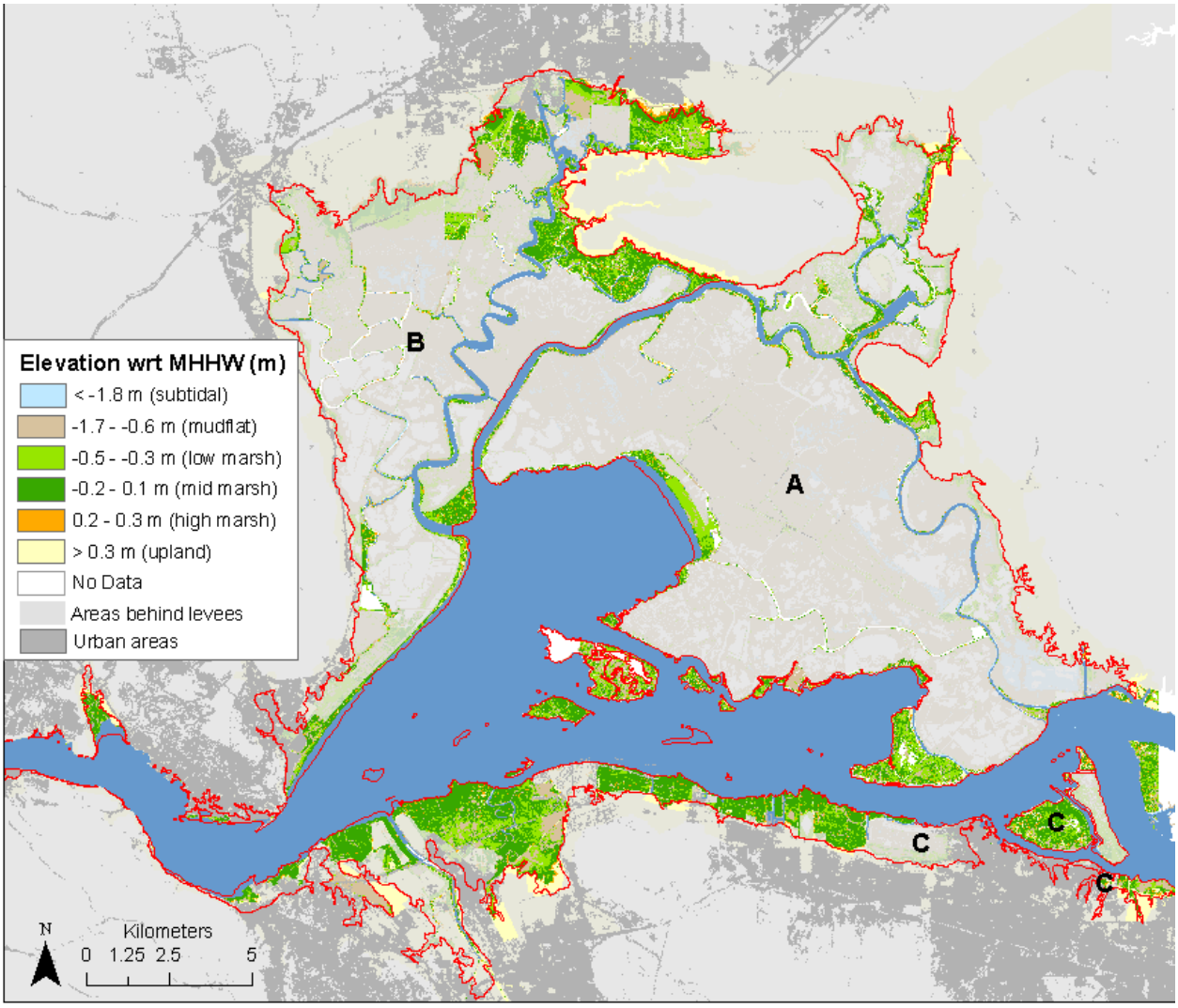

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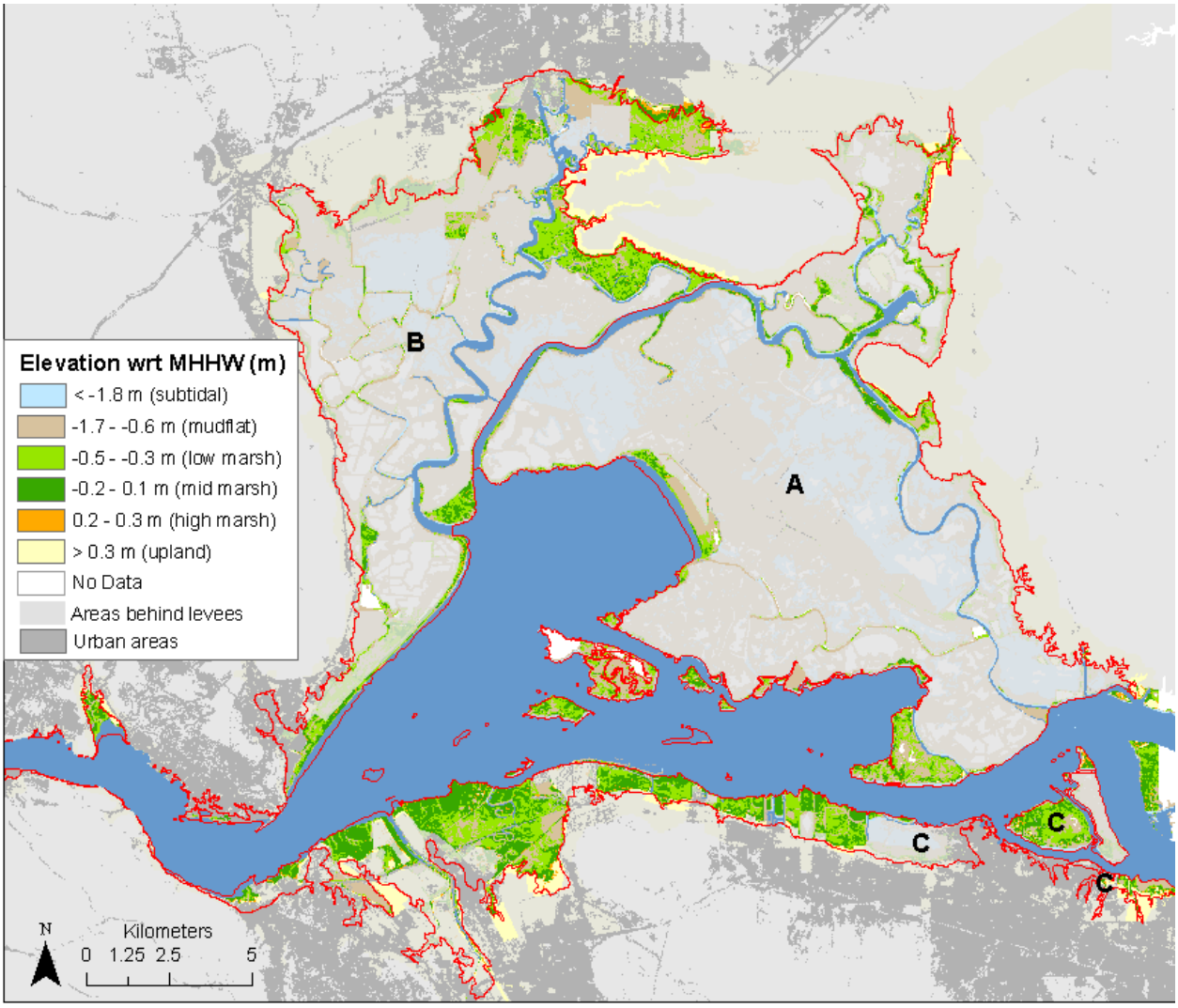

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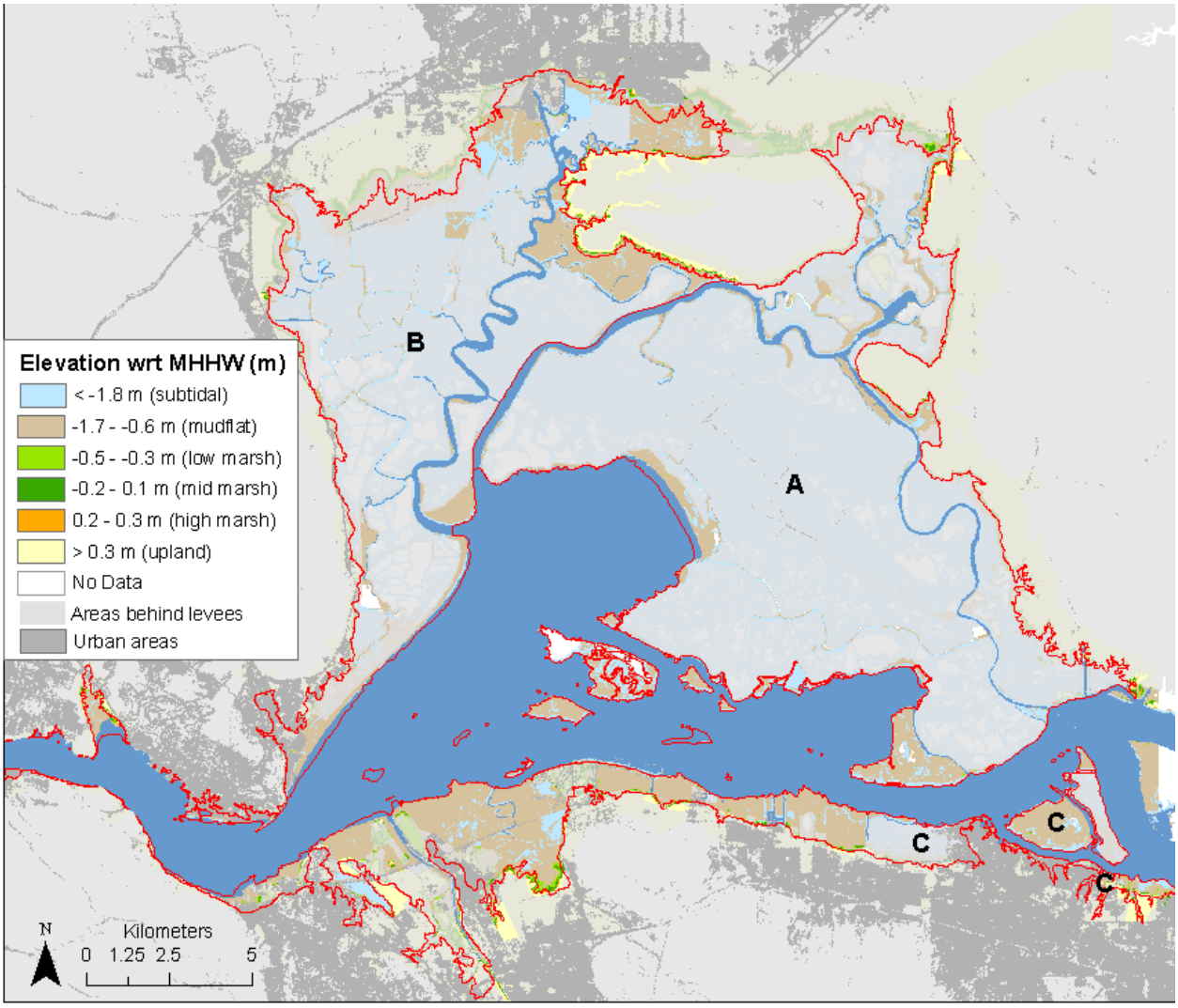

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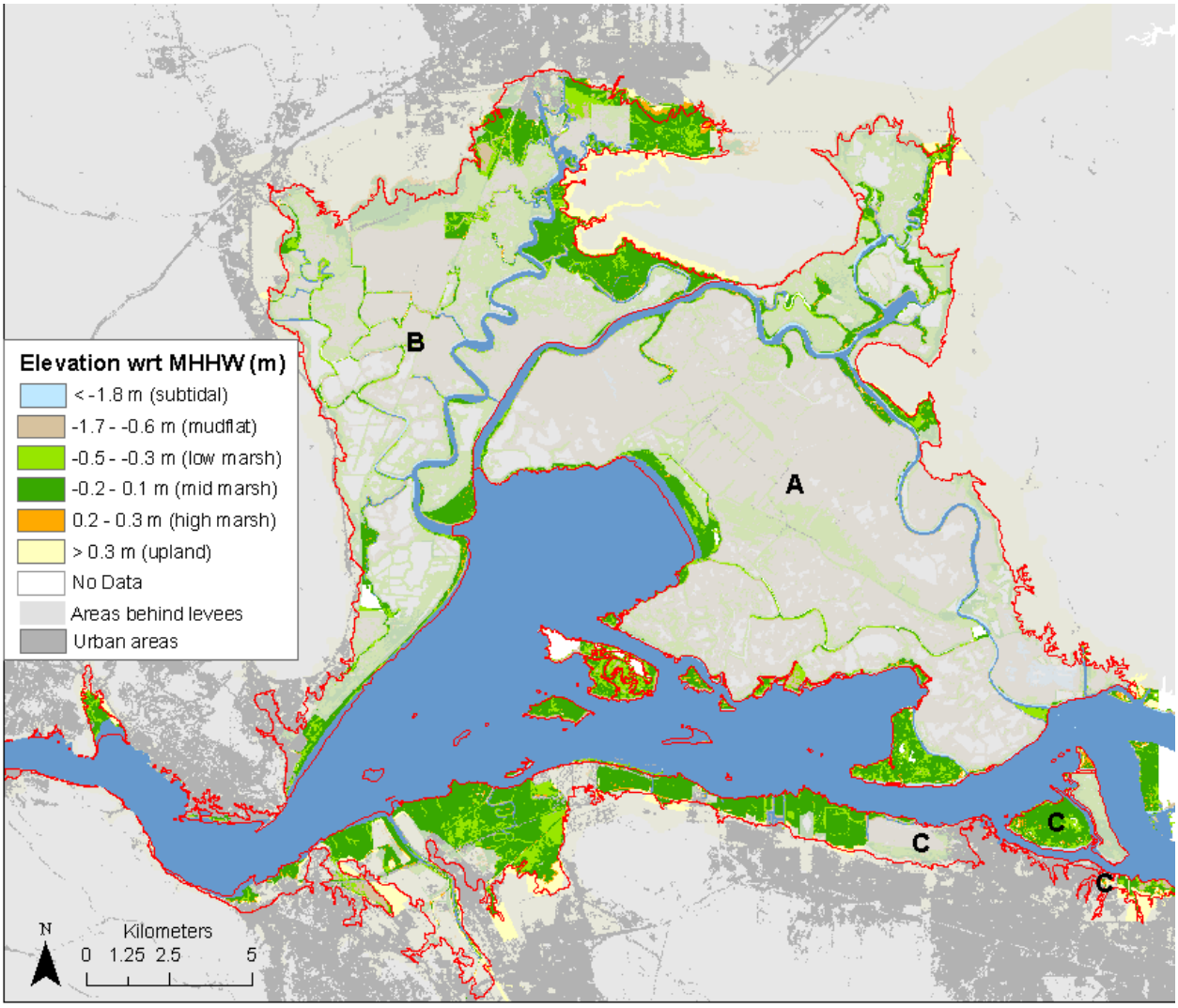

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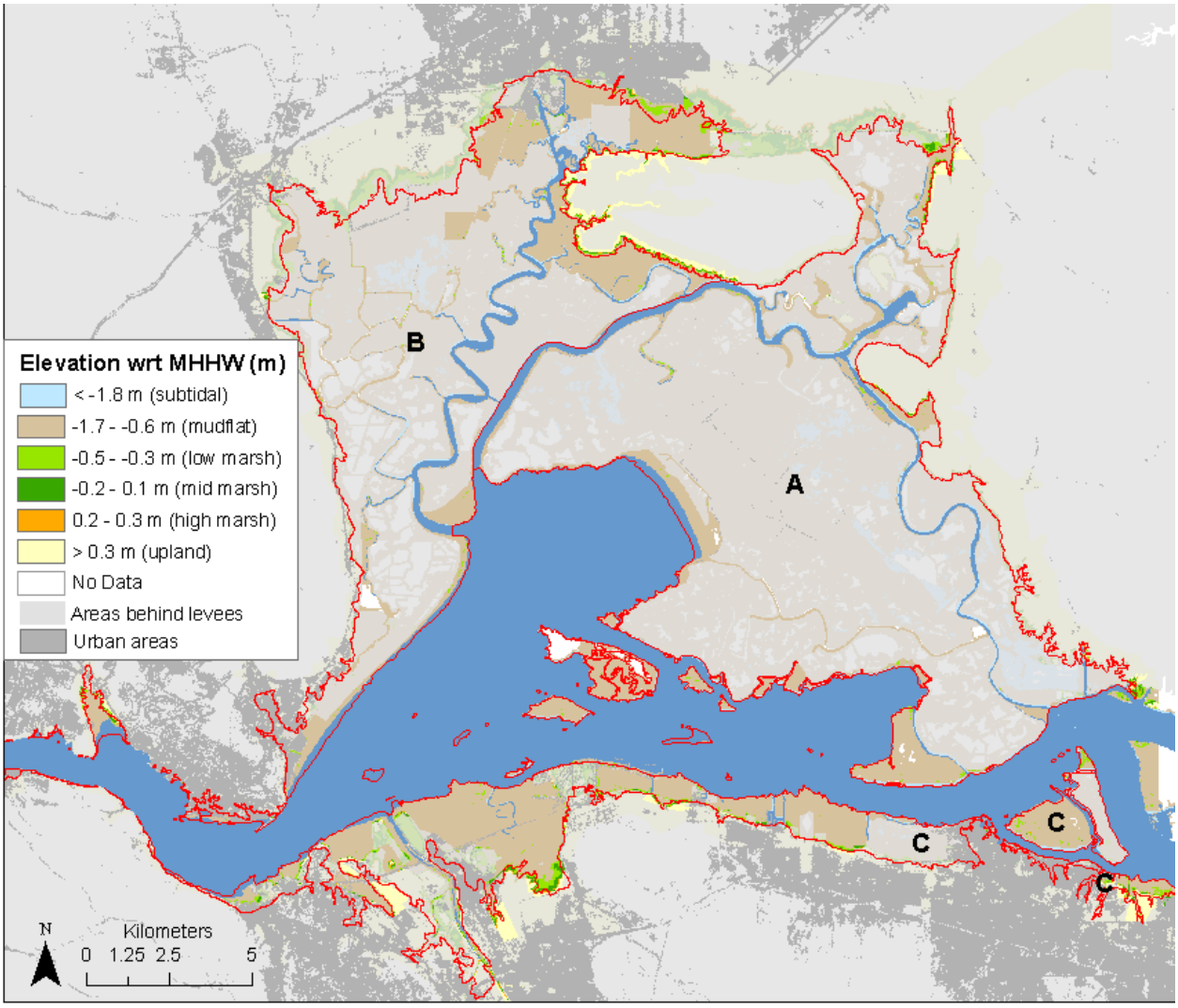
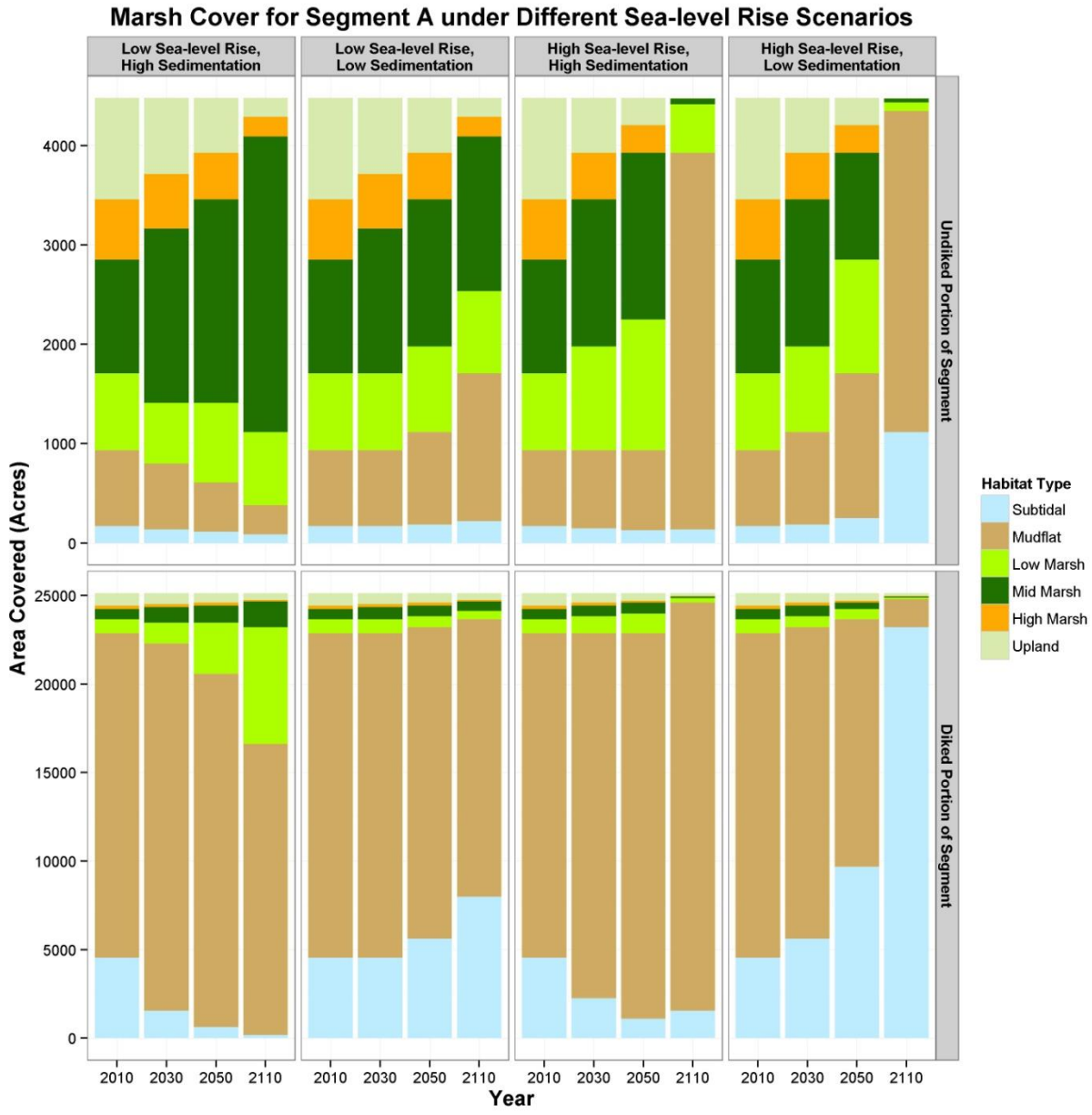


Suisun: Segment A



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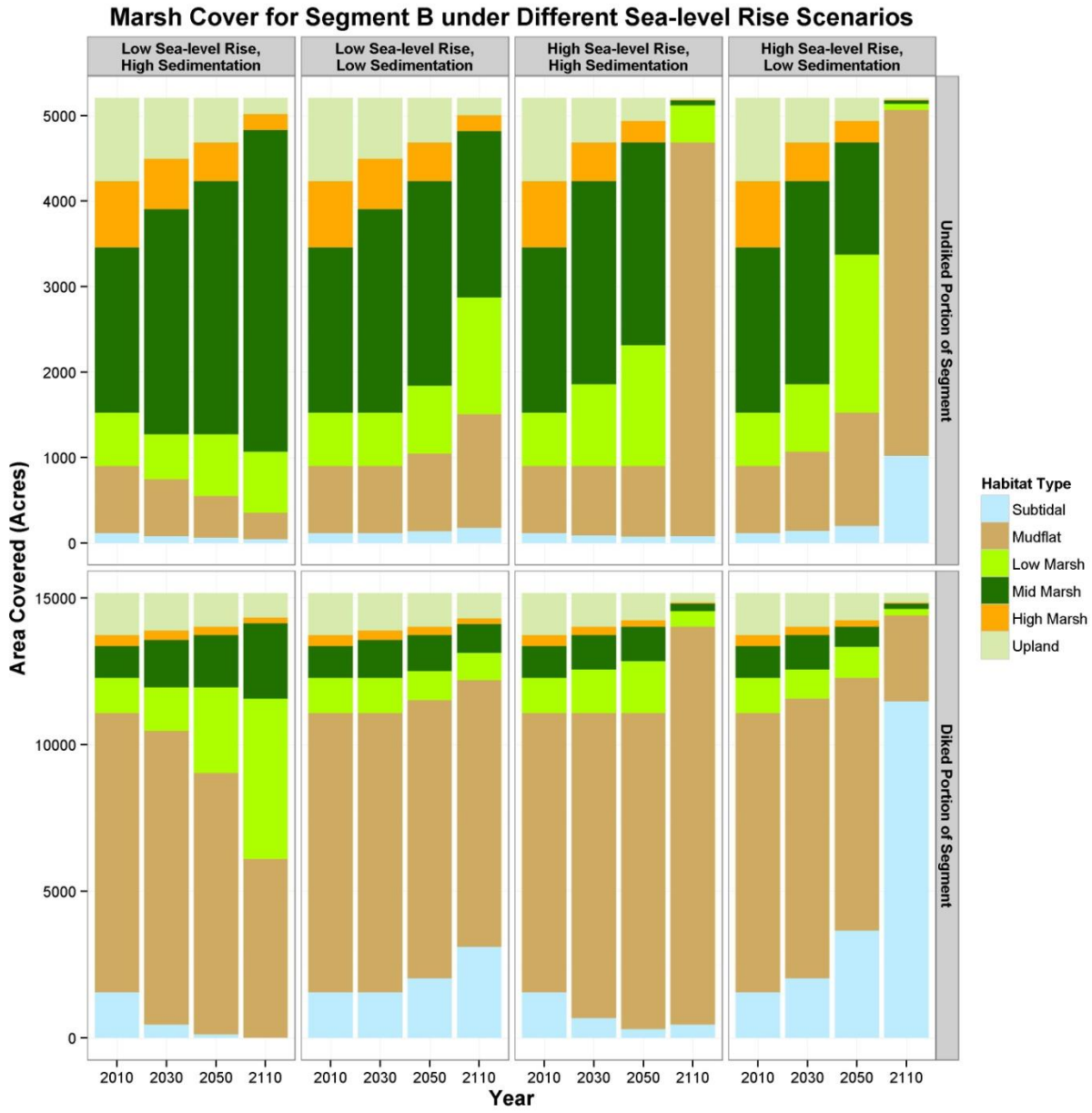
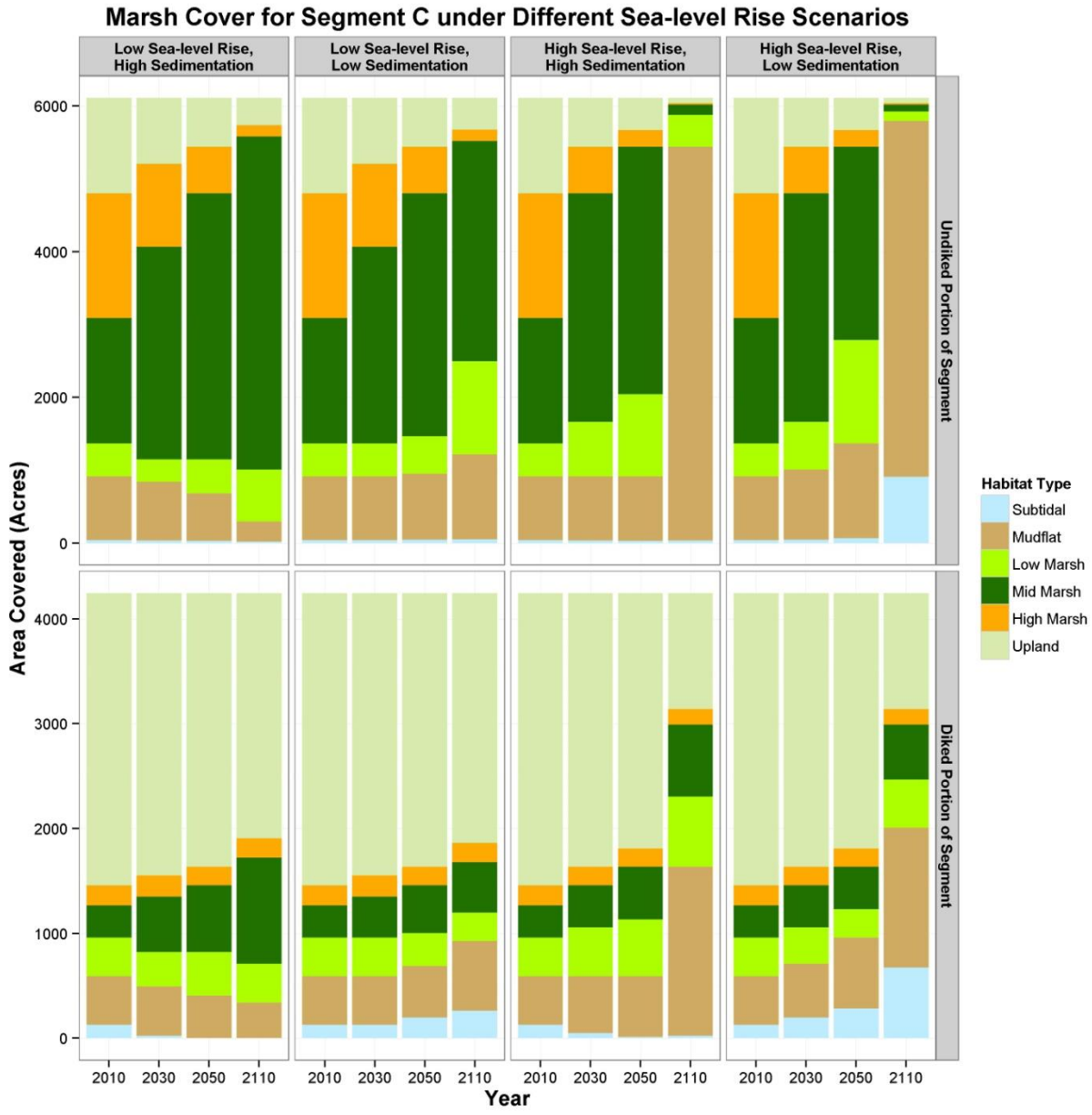
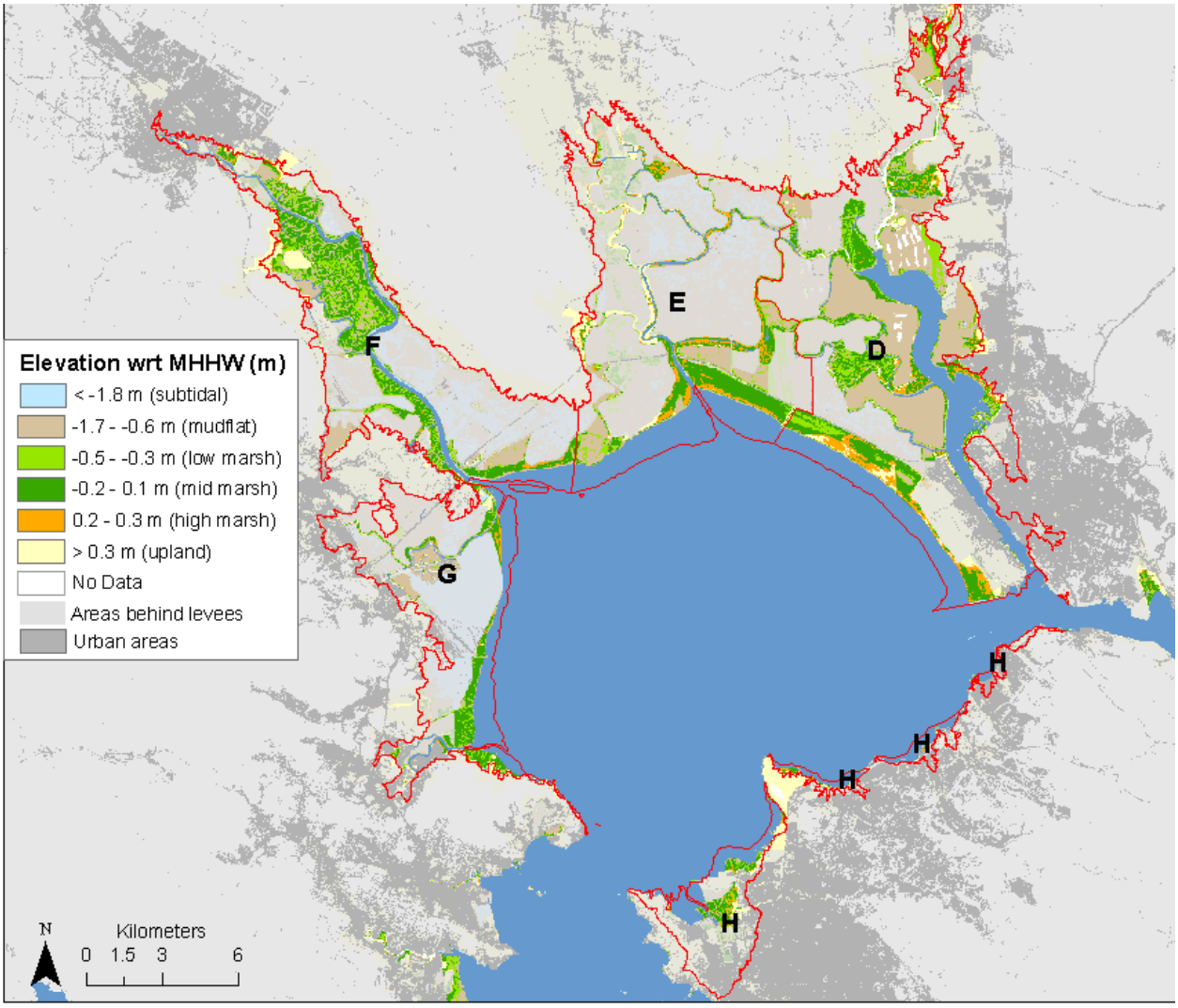


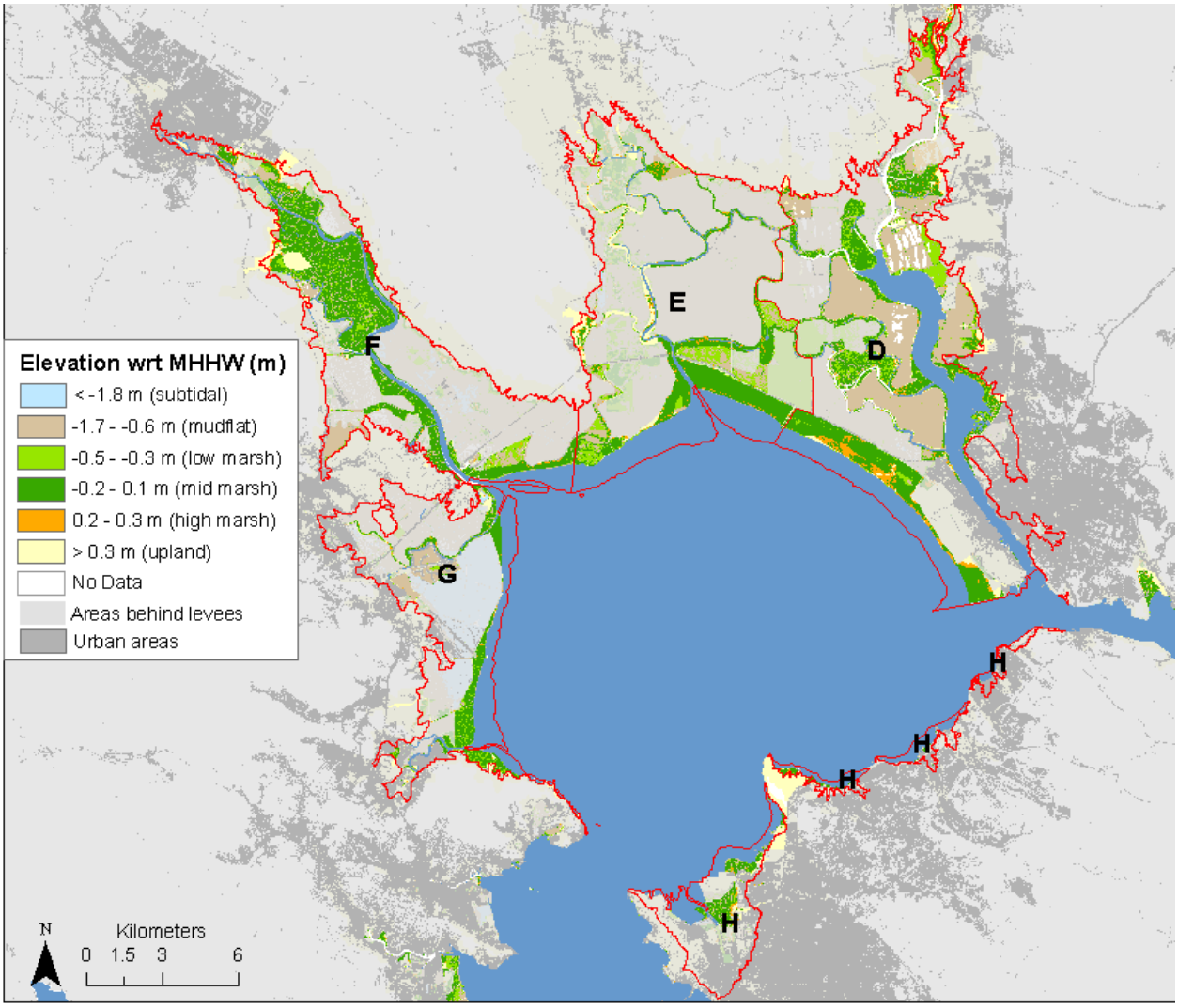
Suisun: Segment C



North Bay: 2010 elevations from LiDAR



North Bay: 2030 Sed Low/ SLR Low



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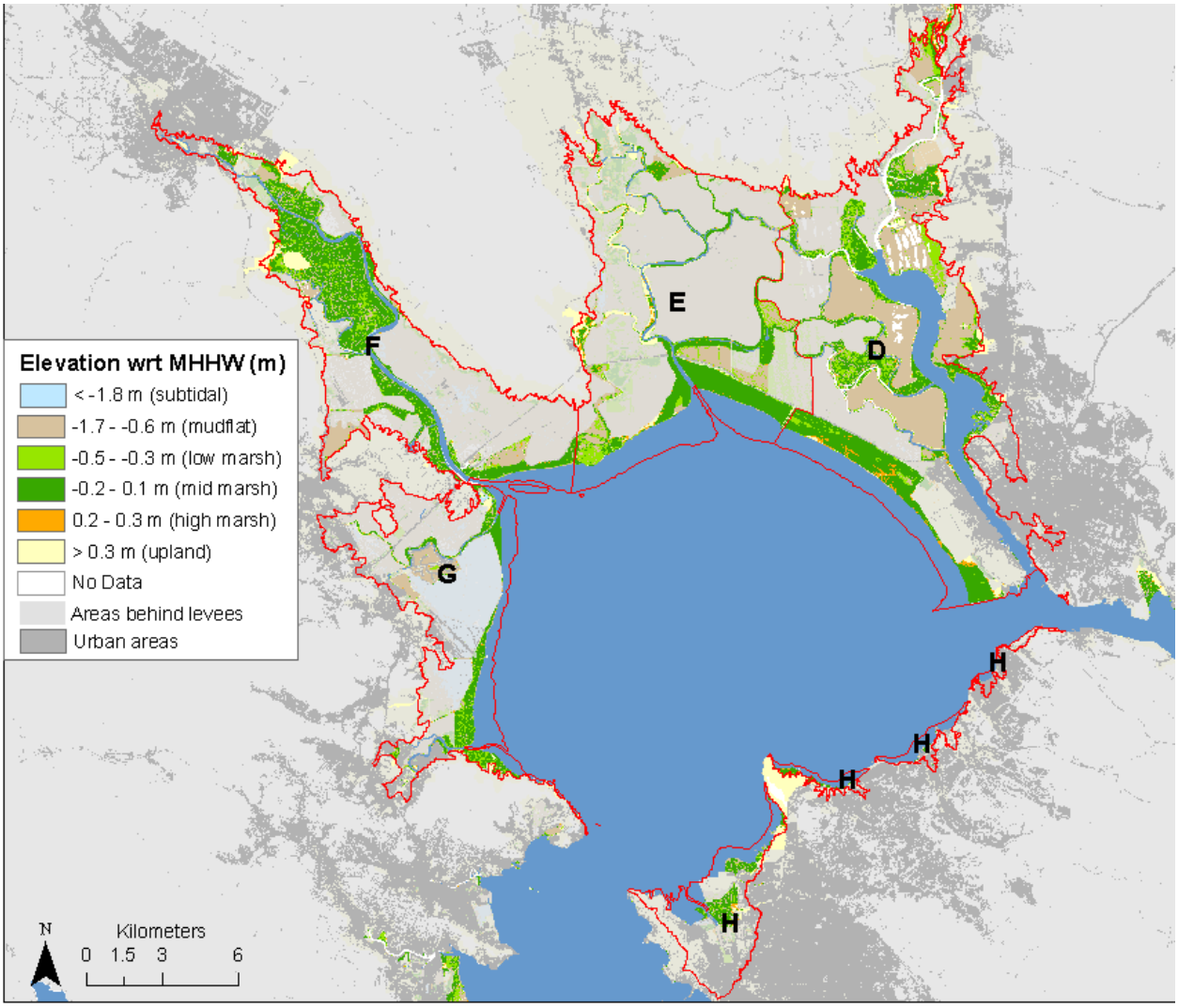

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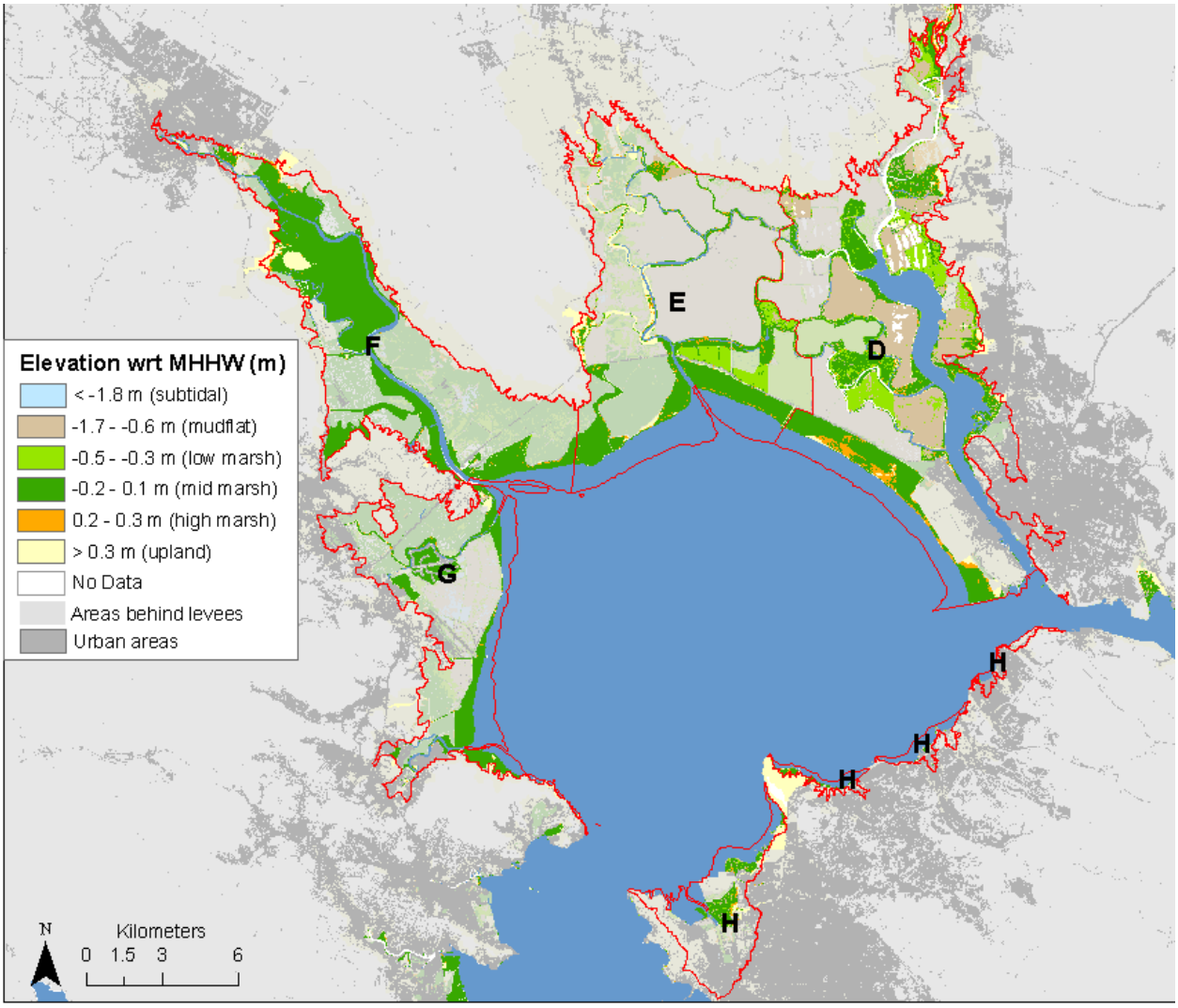
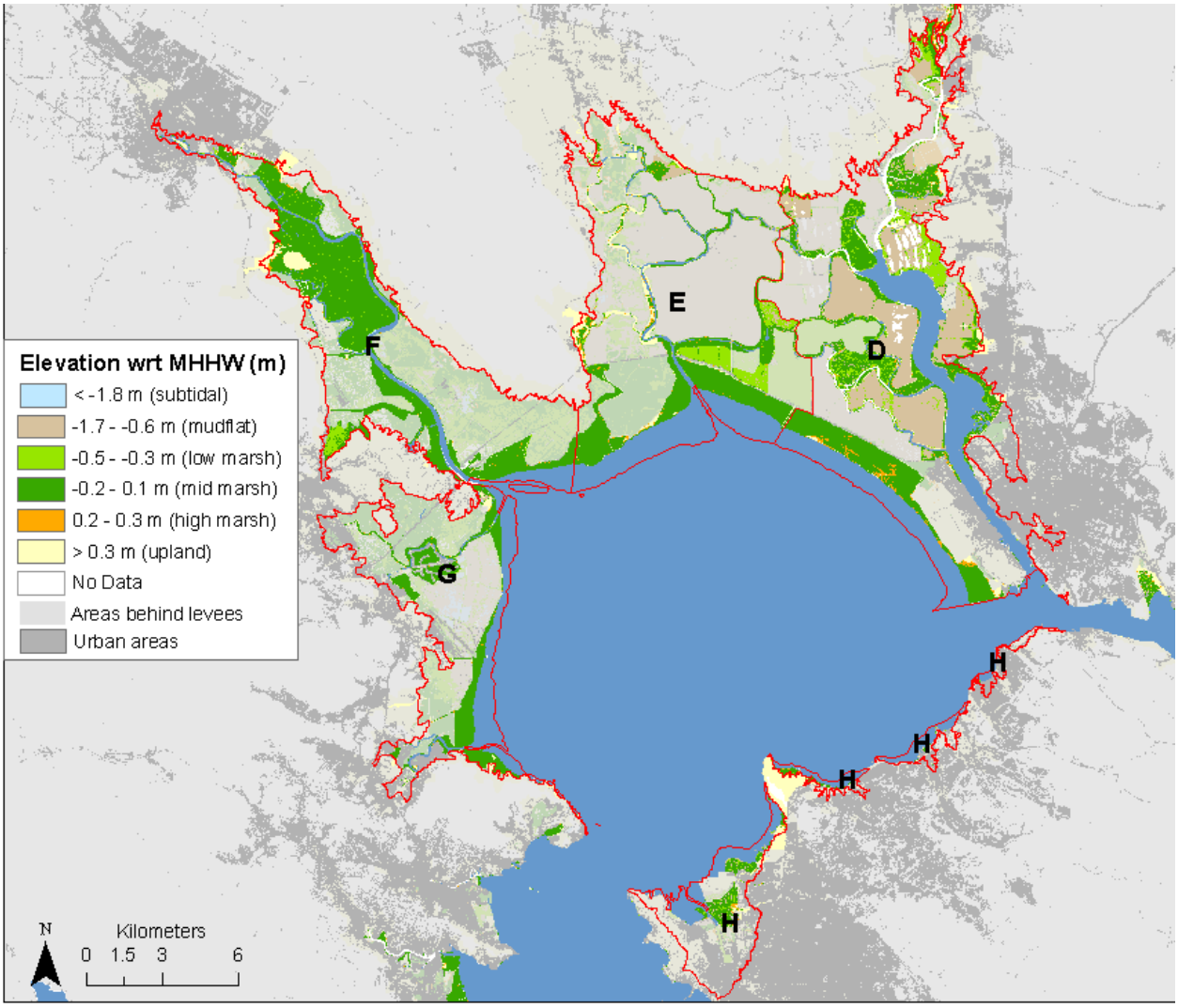
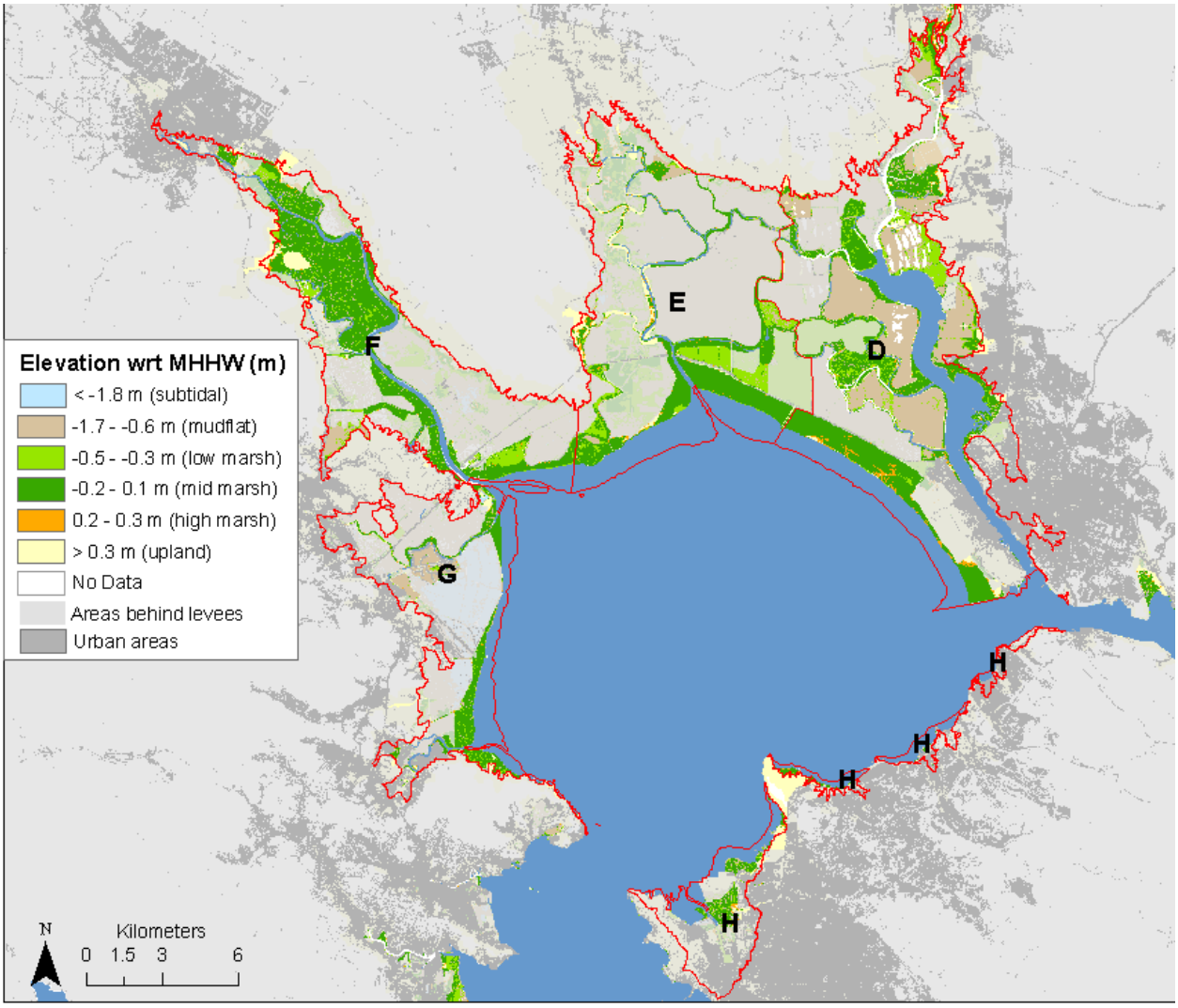


North Bay: Sed High/ SLR High



North Bay: 2050 Sed Low/ SLR Low



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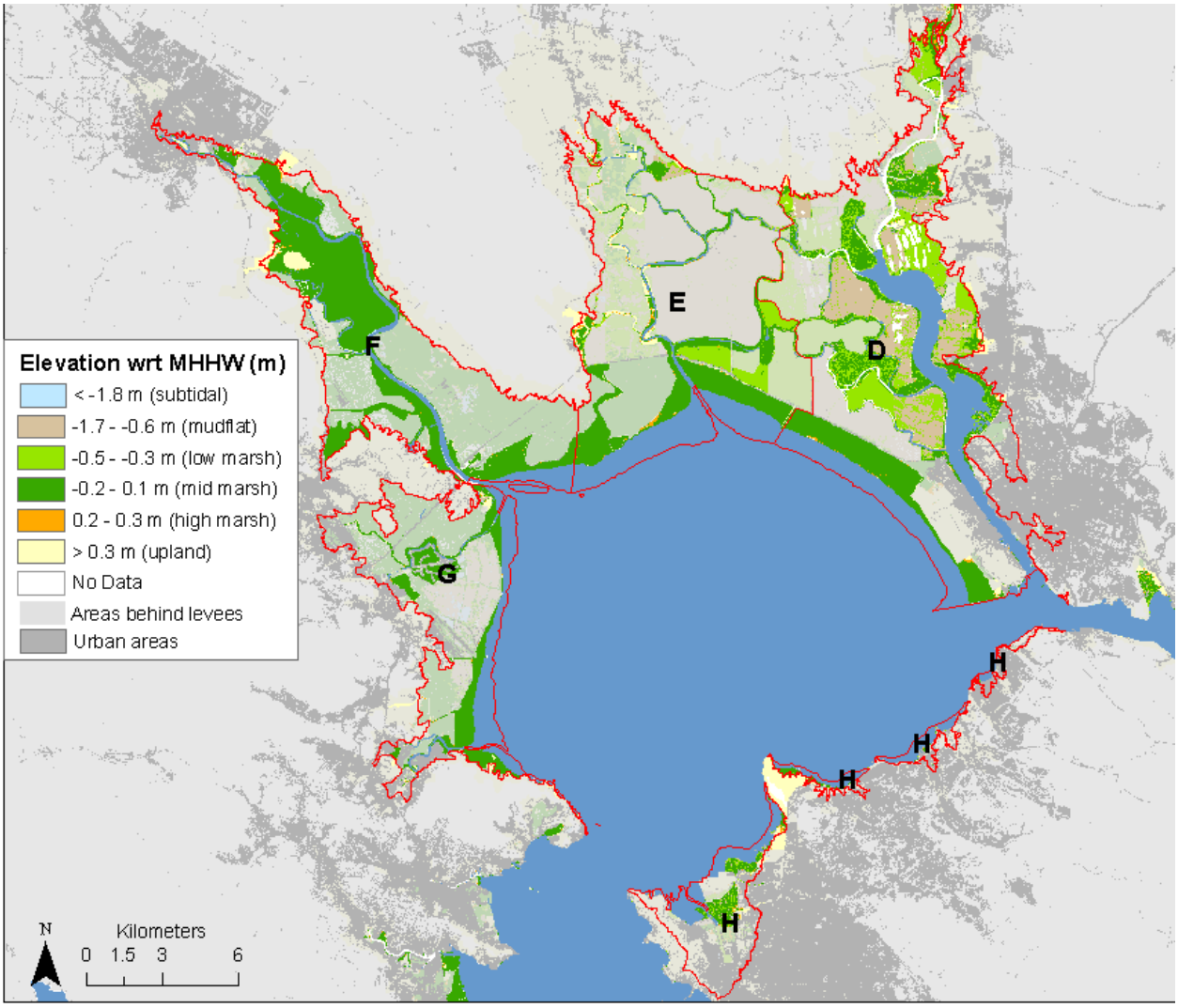
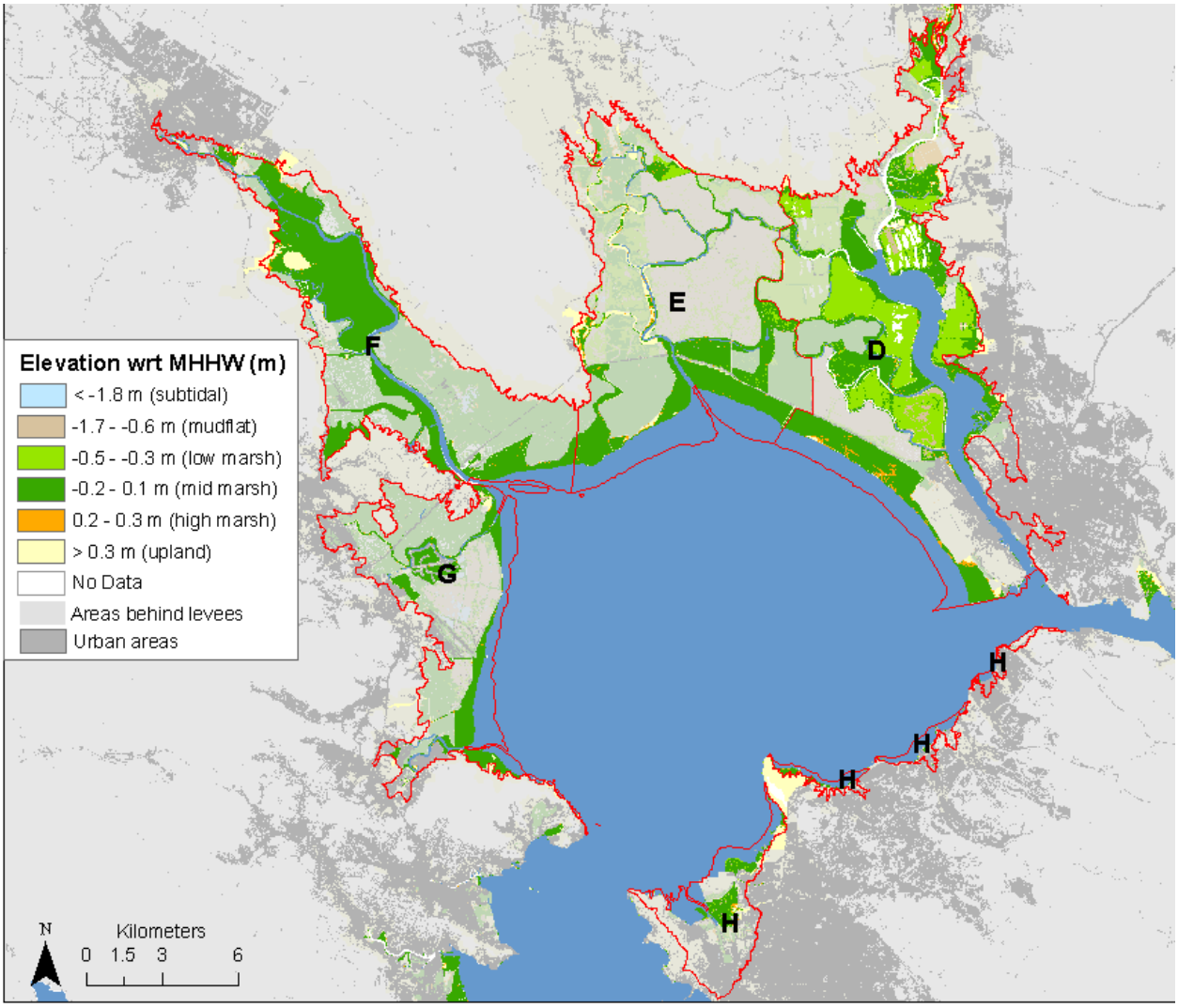
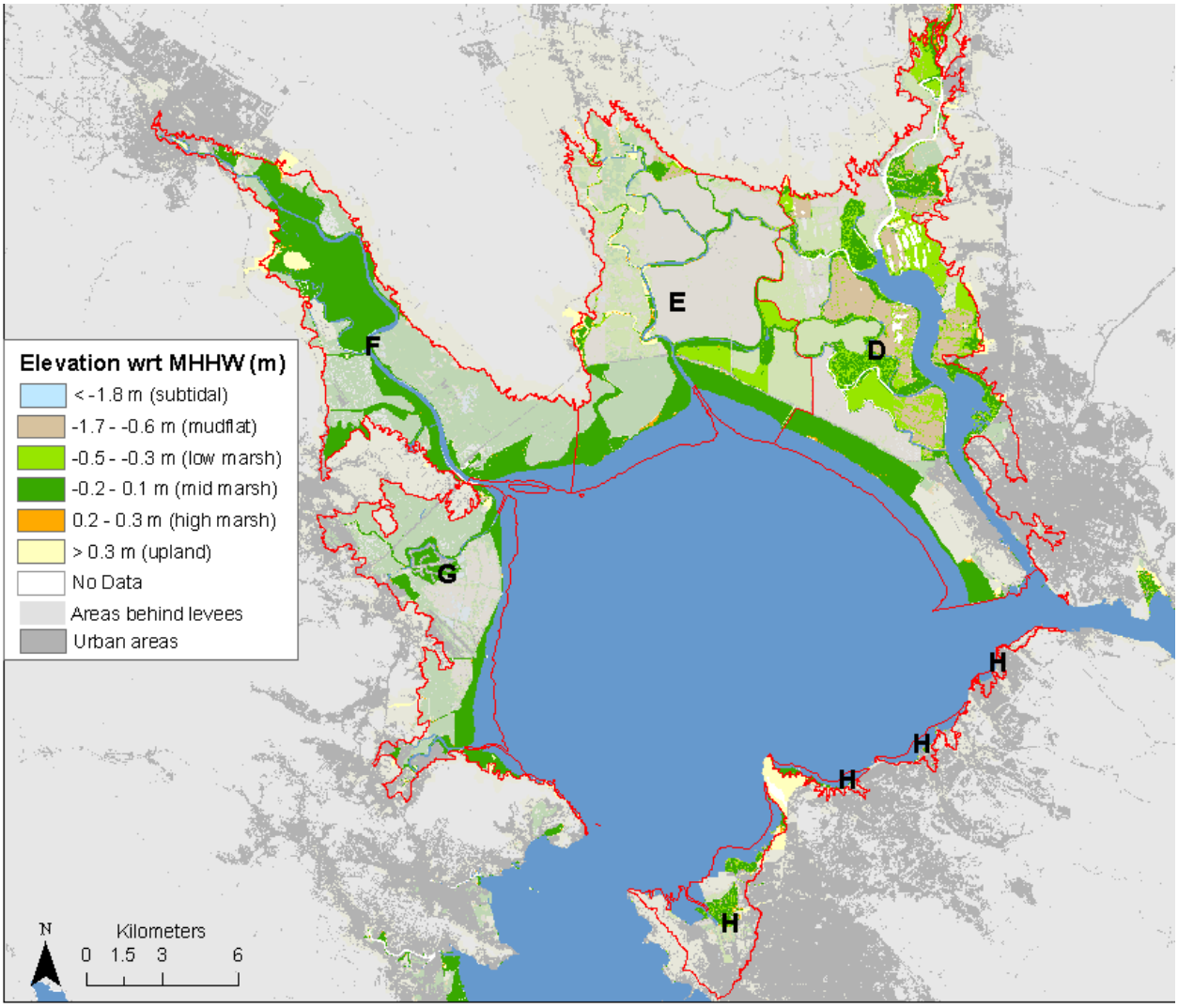


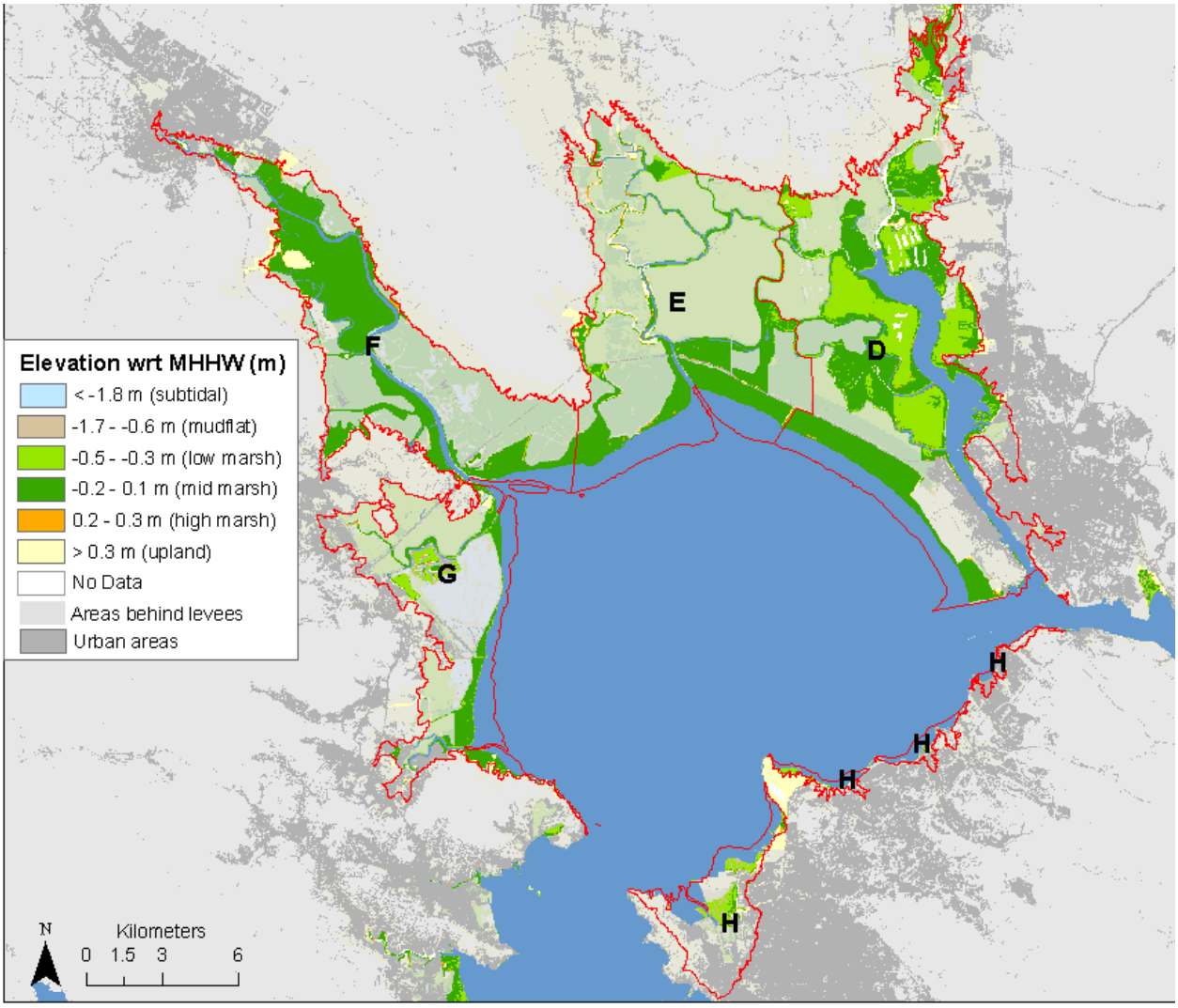
North Bay: Sed High/ SLR Low



North Bay: 2050 Sed High/ SLR High



North Bay: 2110 Sed Low/SLR Low



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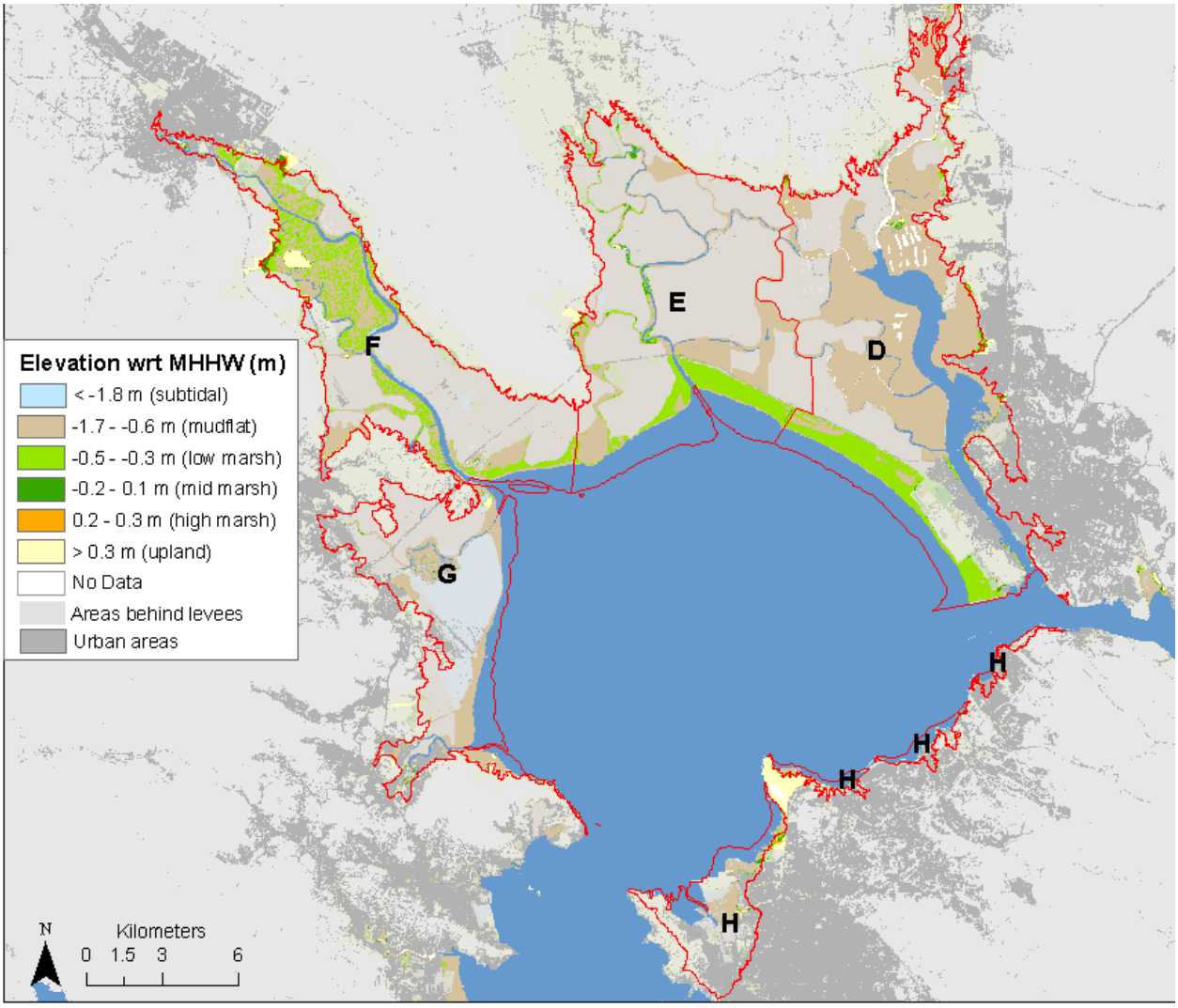

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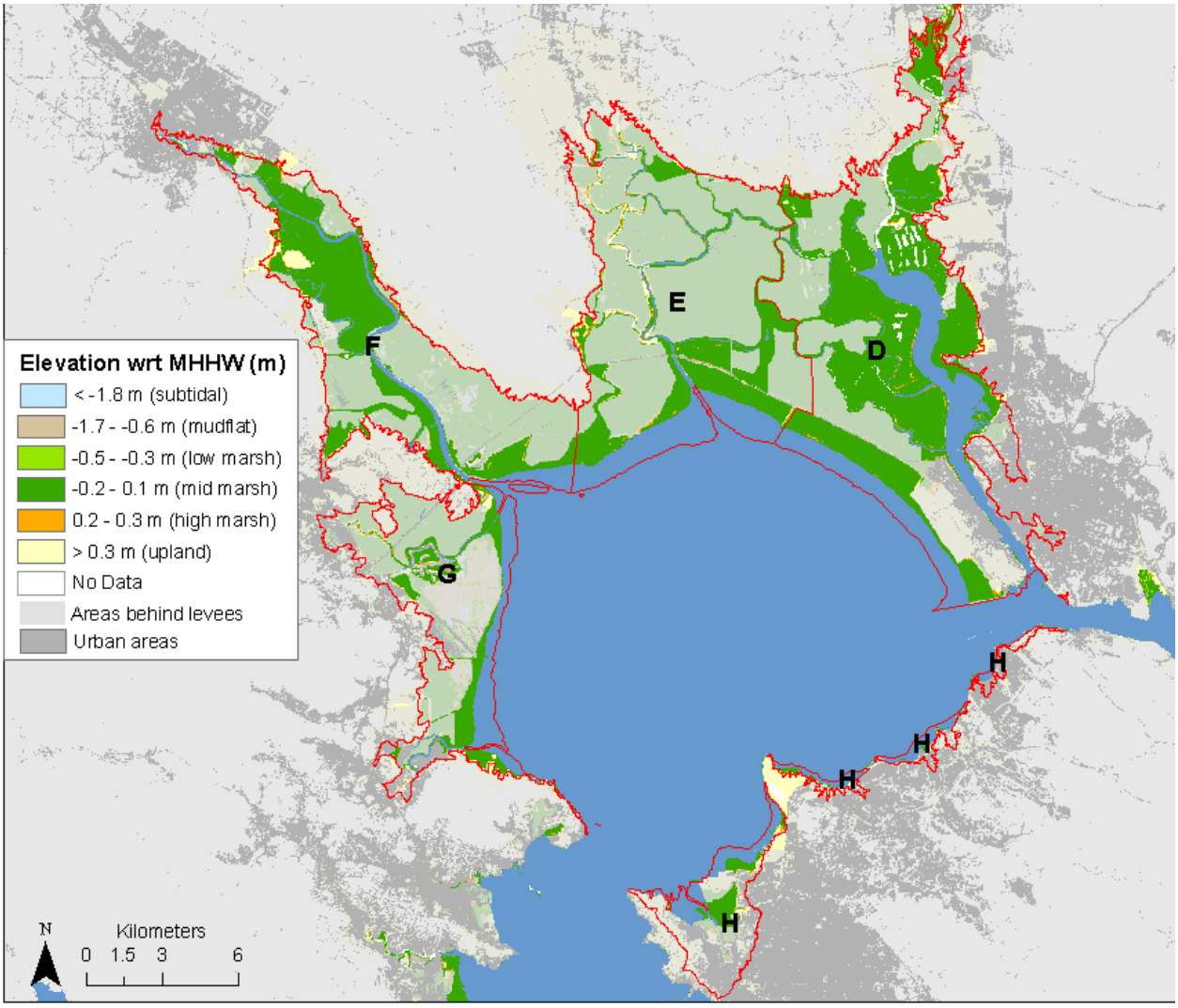

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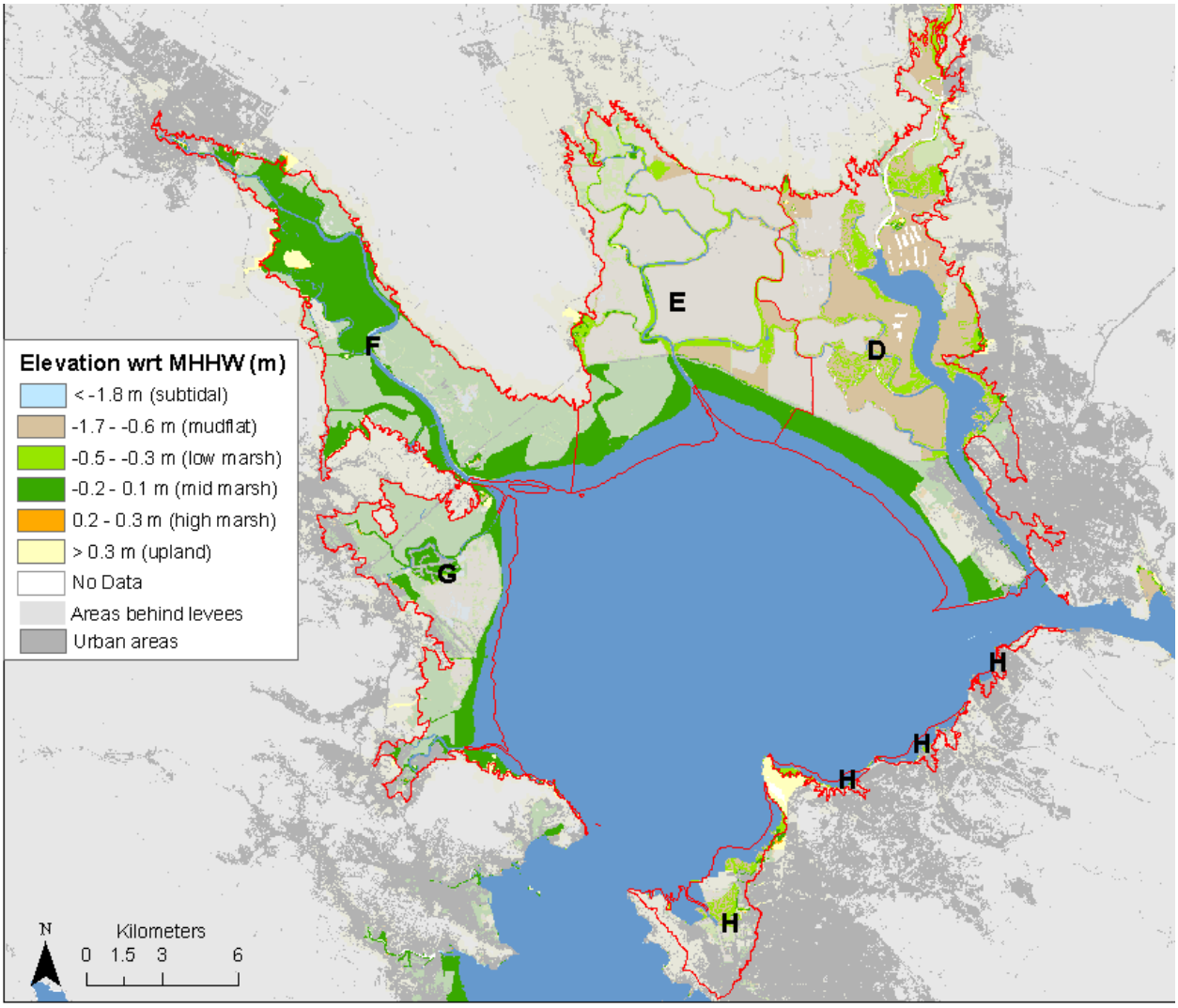

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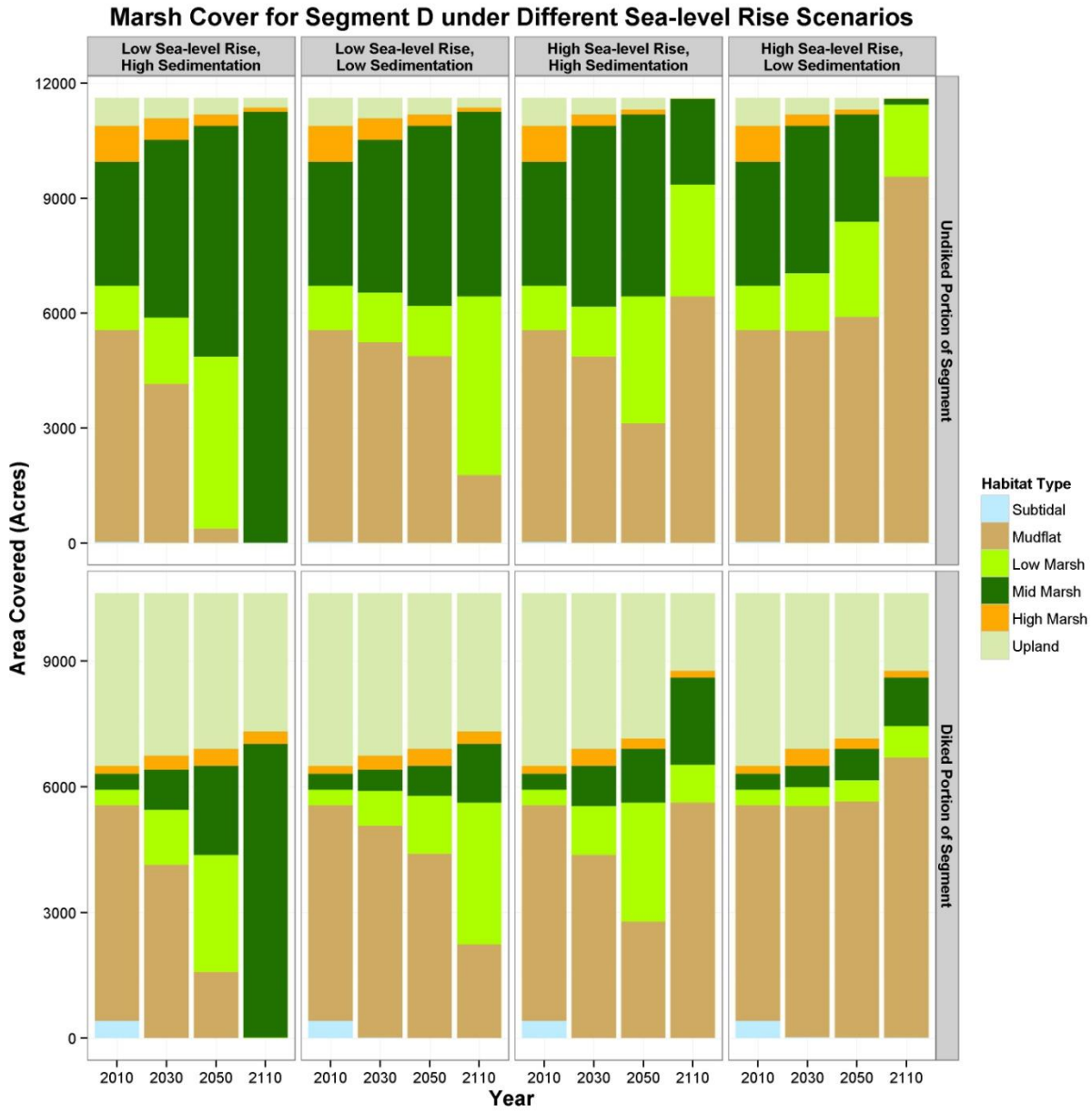

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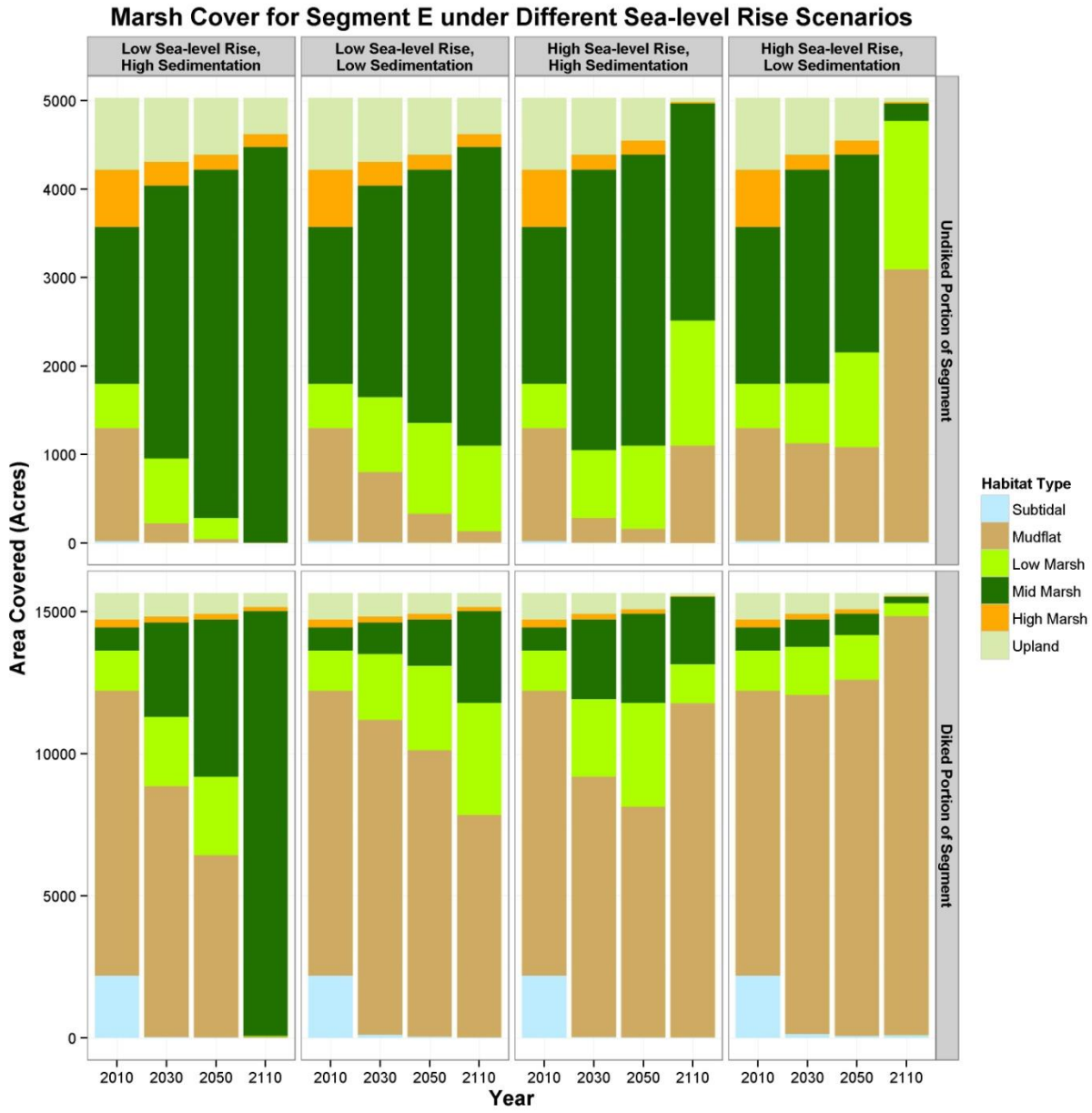

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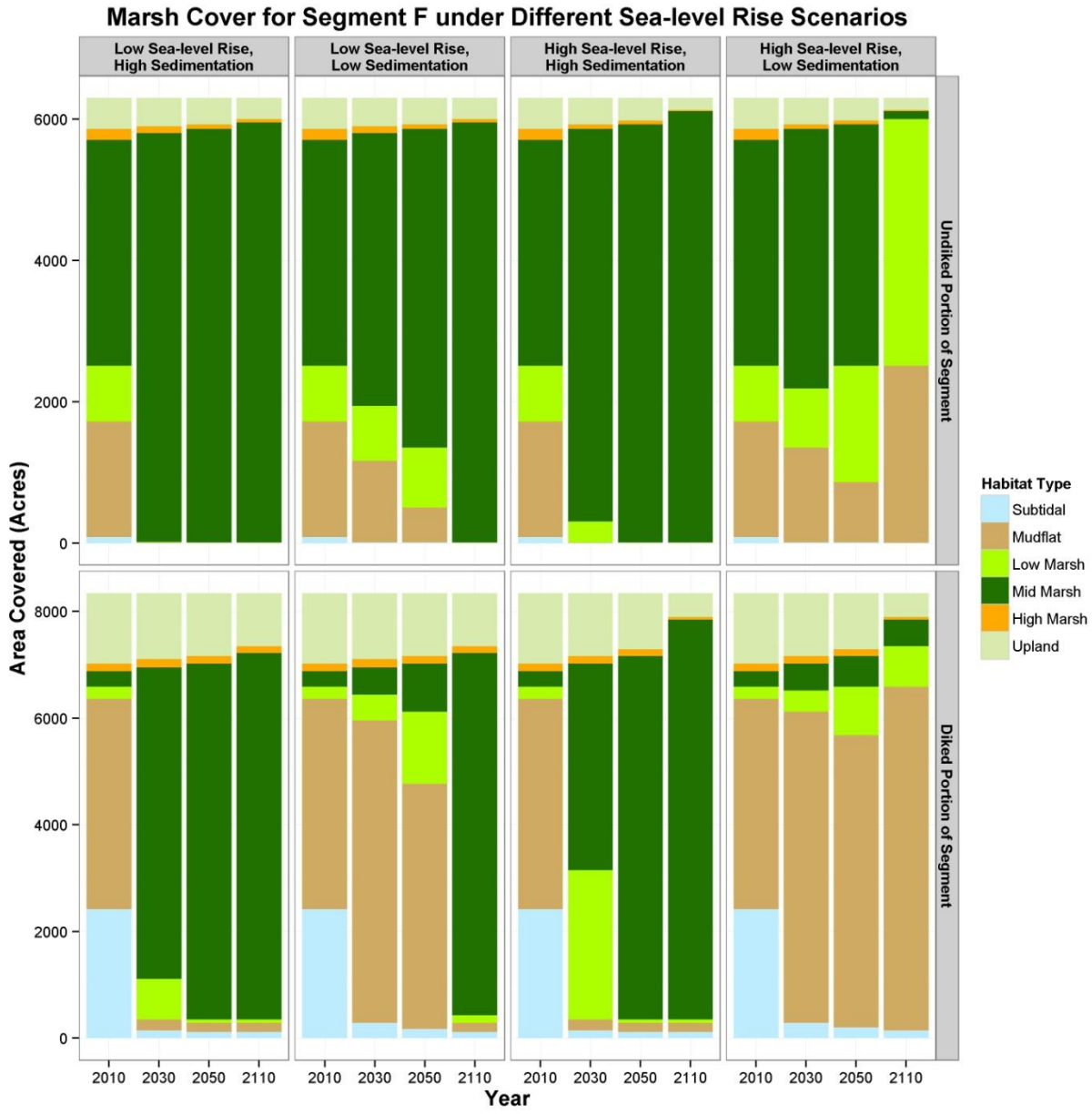
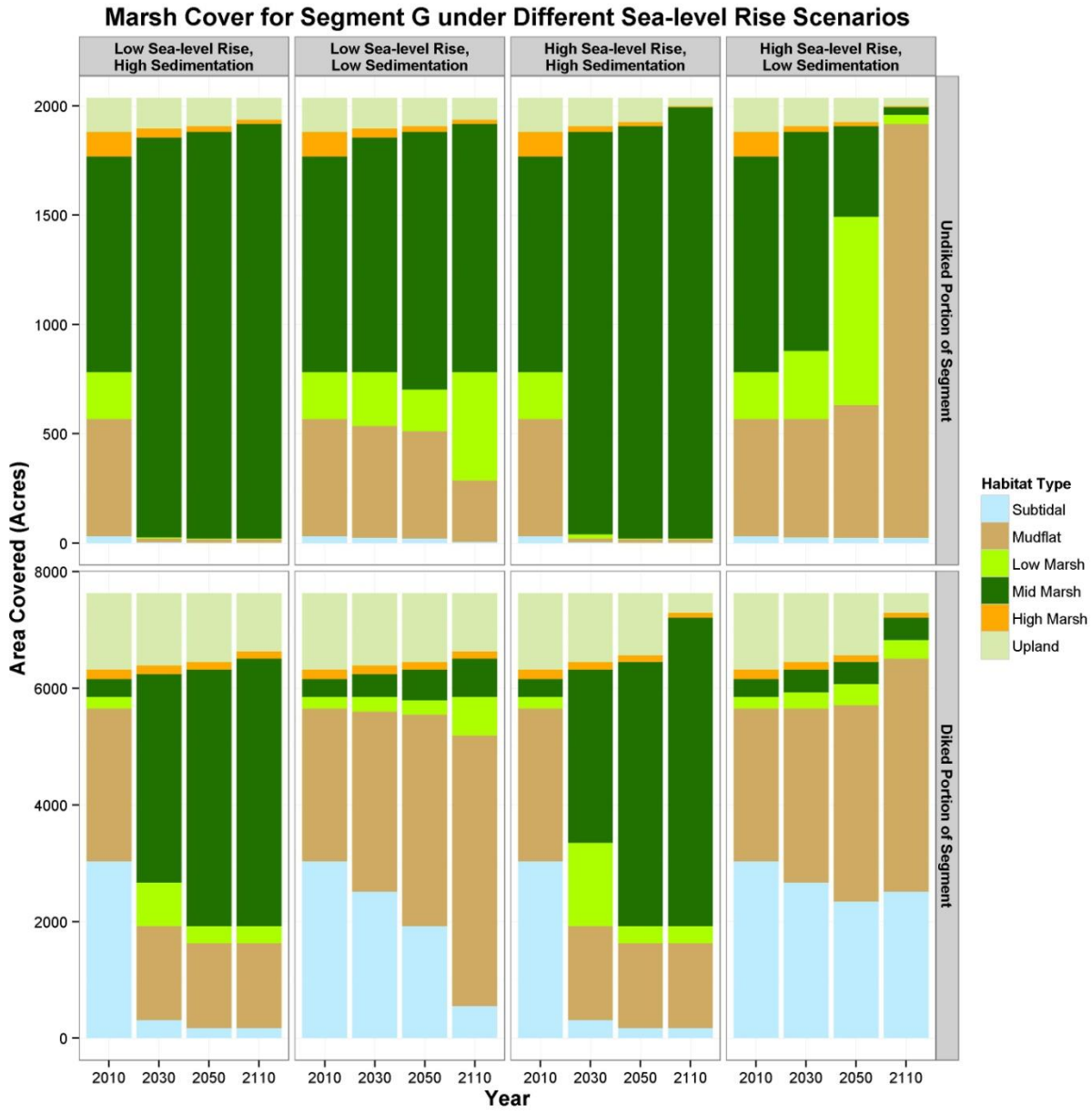
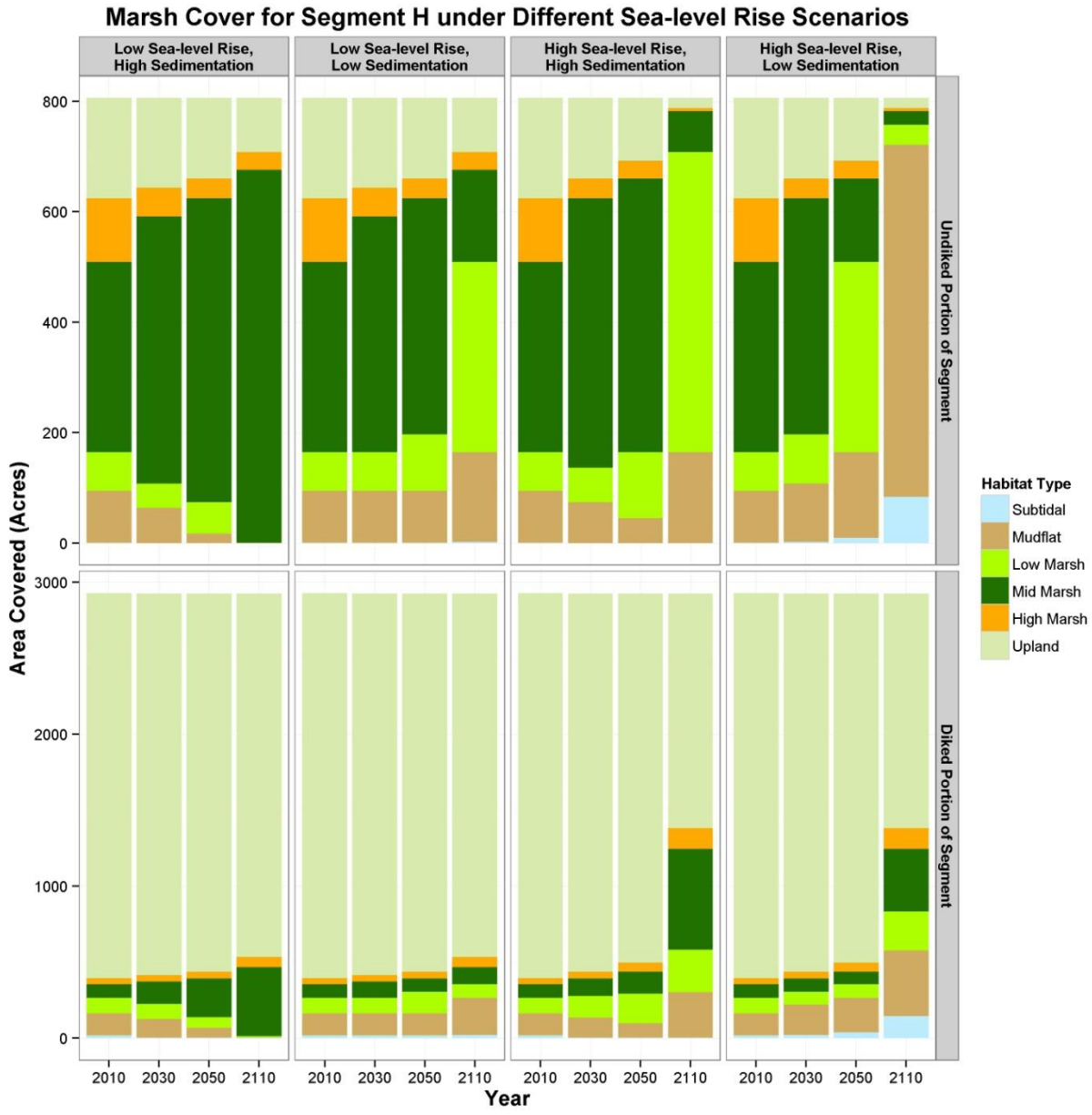


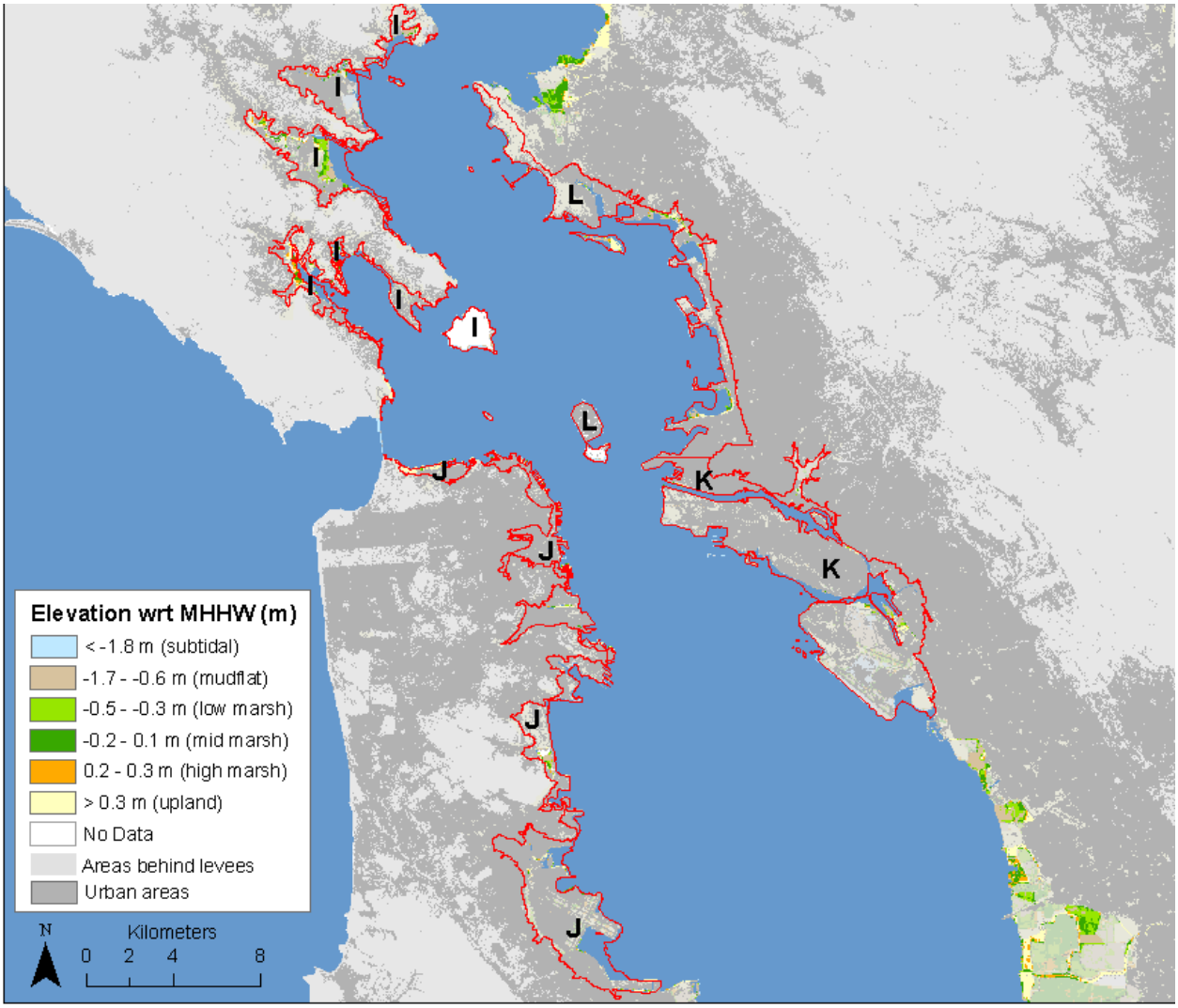
North Bay: Segment G



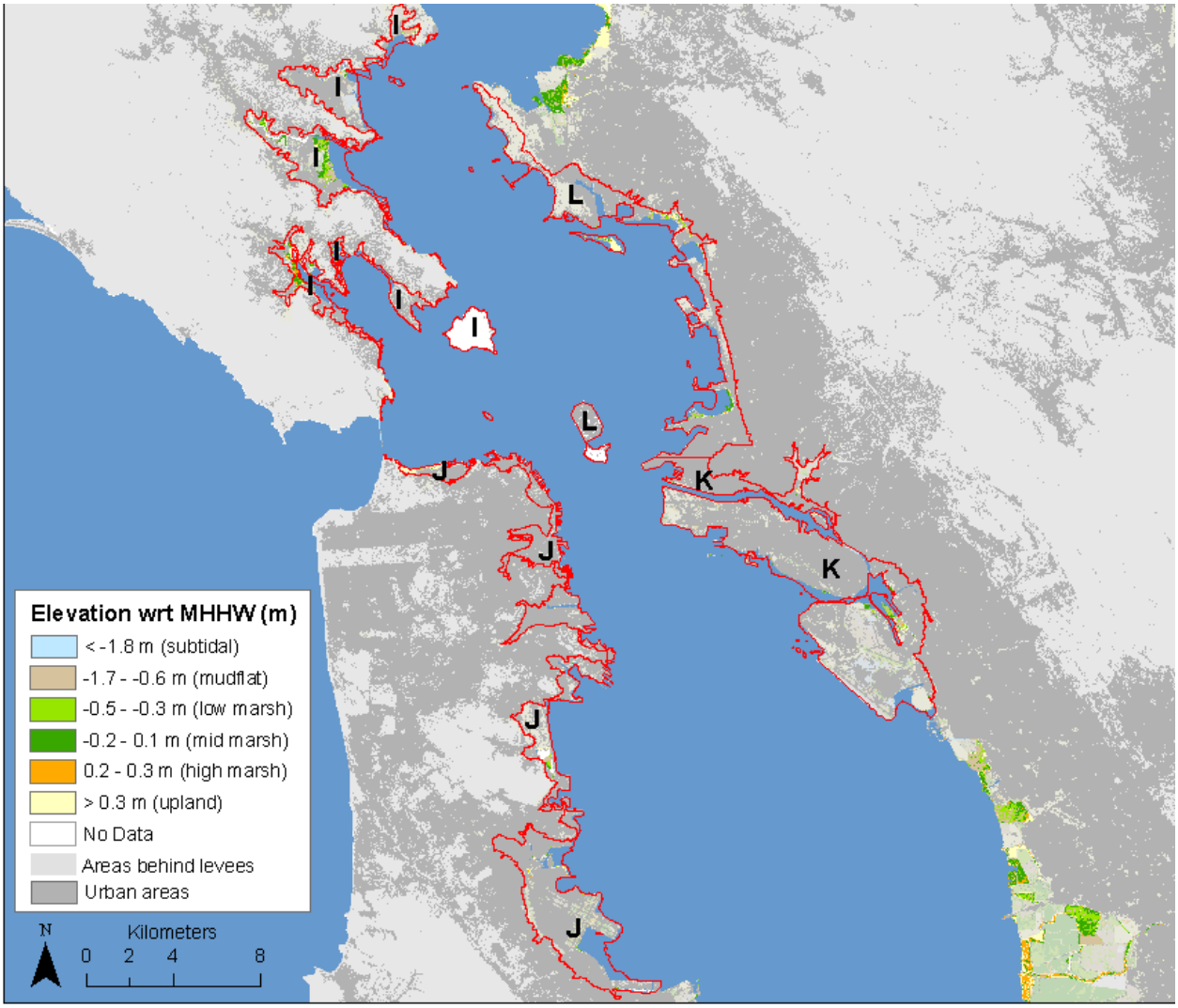
North Bay: Segment H



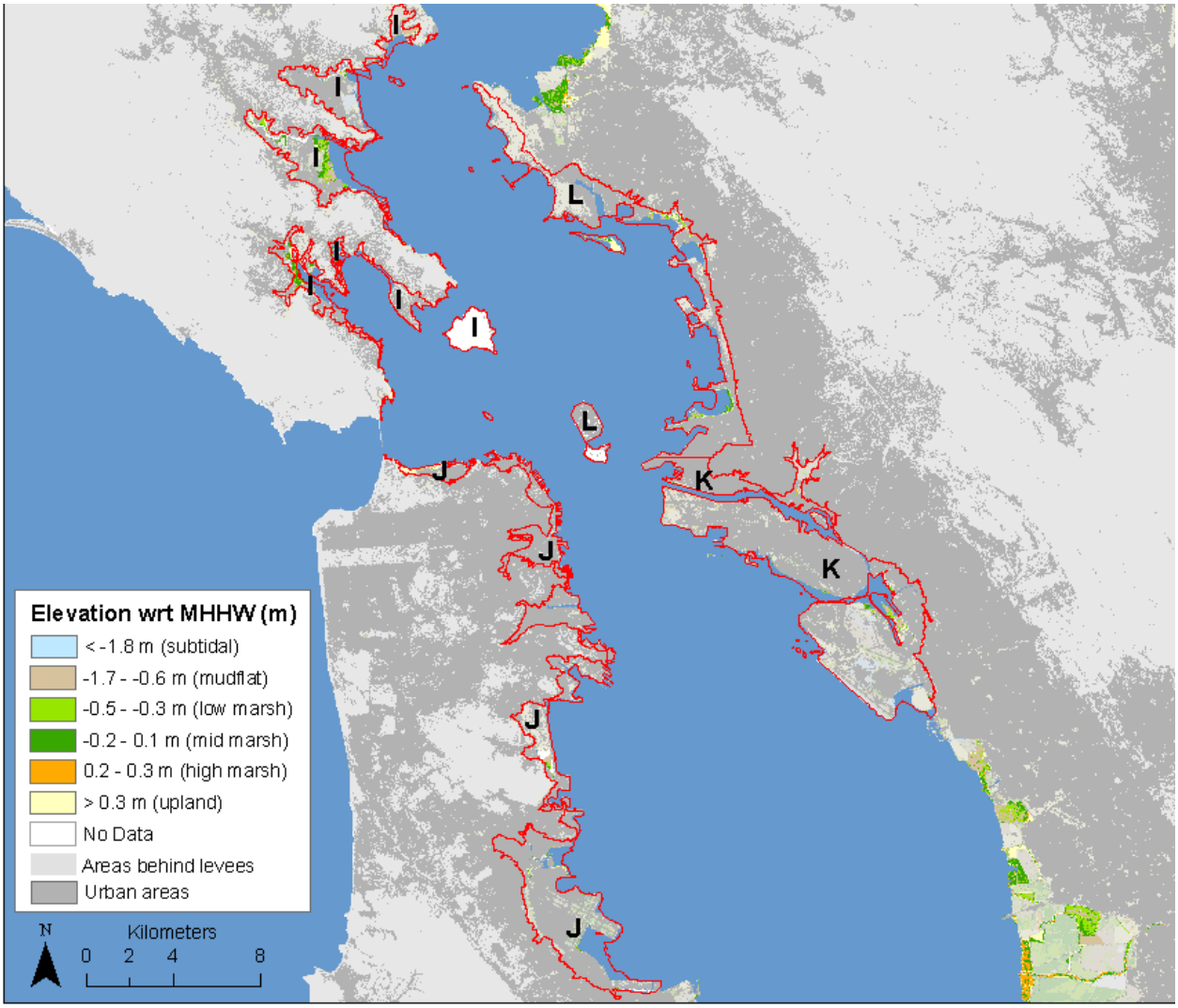
Central Bay: 2010 elevations from LiDAR



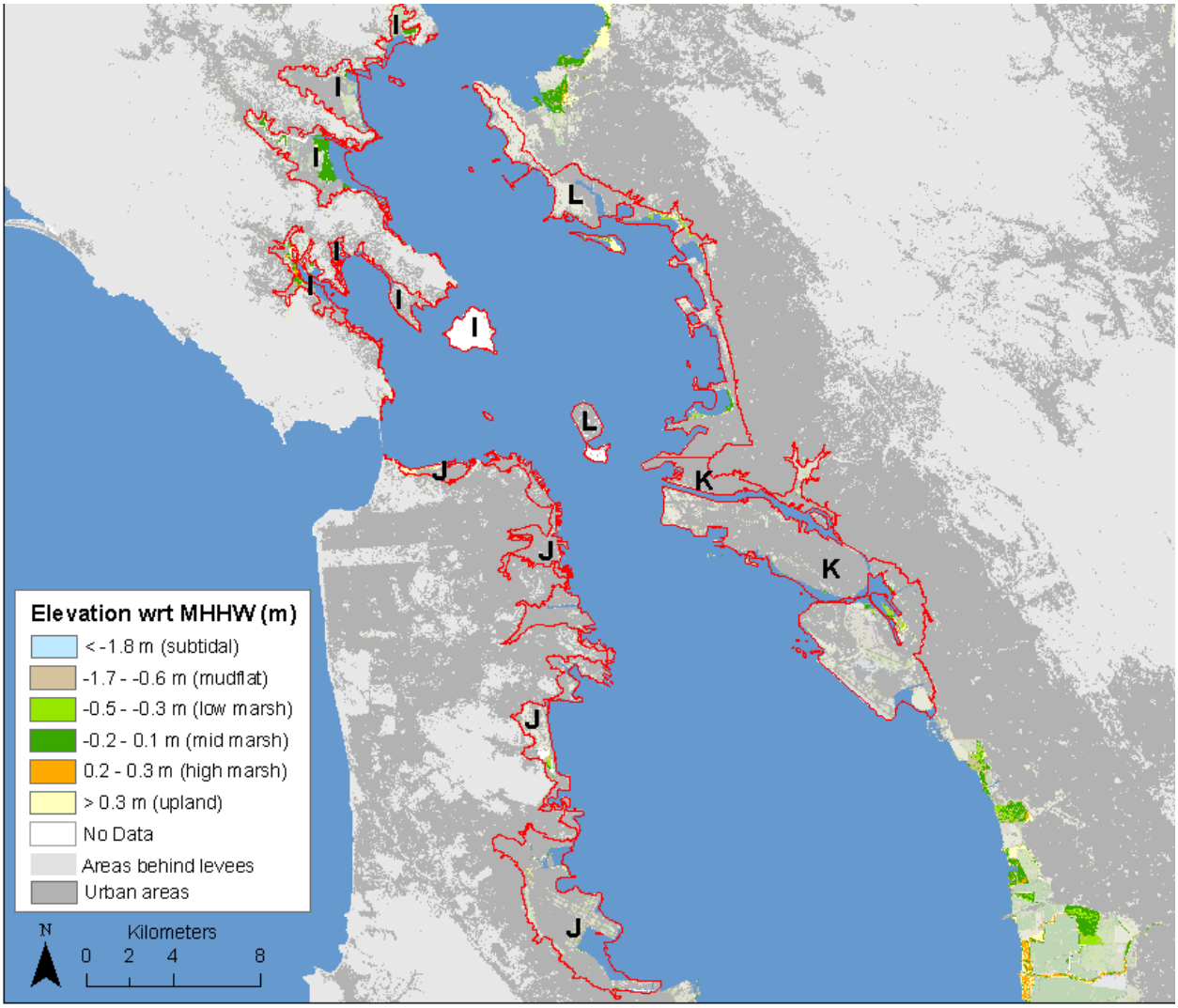
Central Bay: 2030 Sed Low/SLR Low



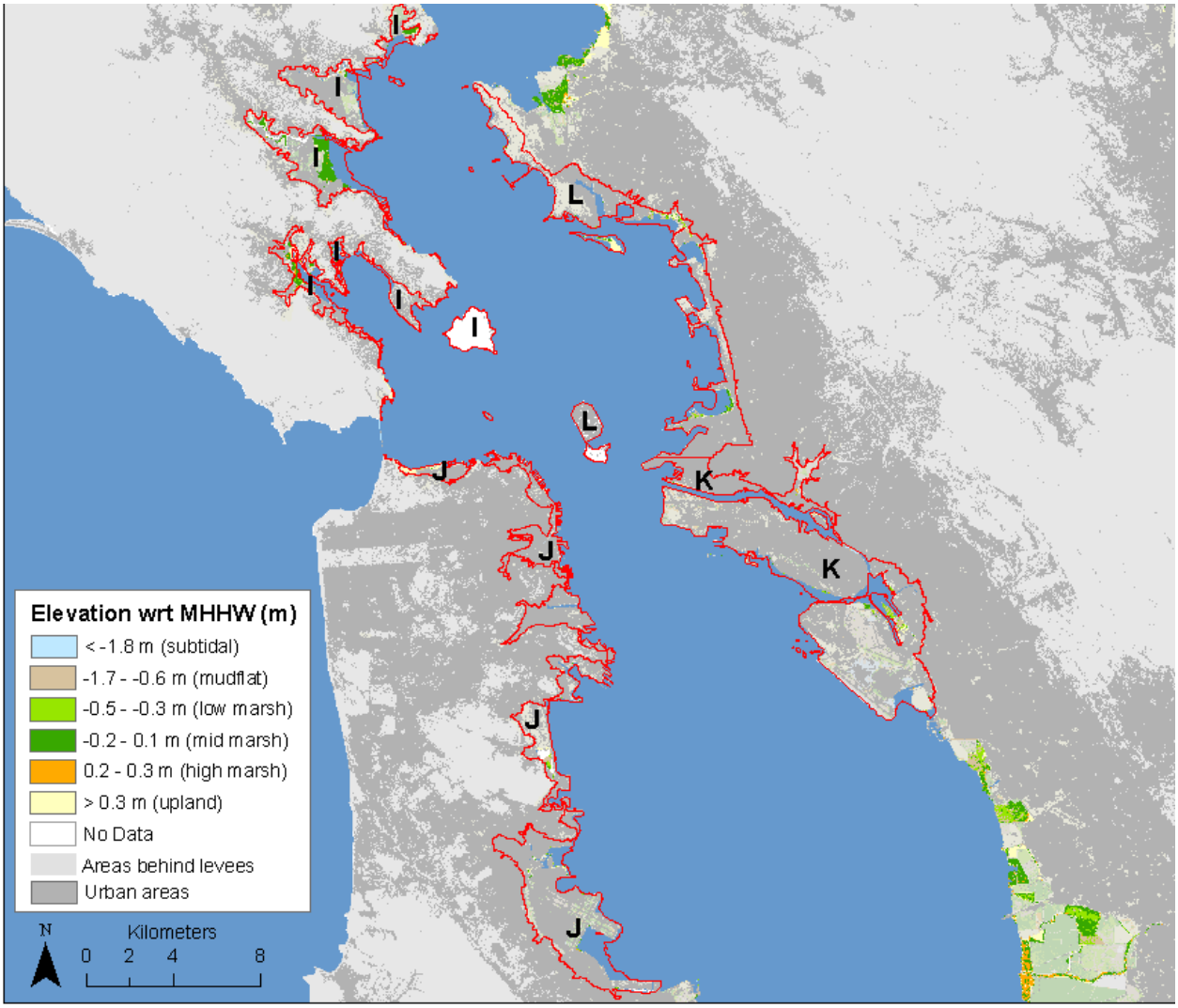
Central Bay: 2030 Sed Low/ SLR High



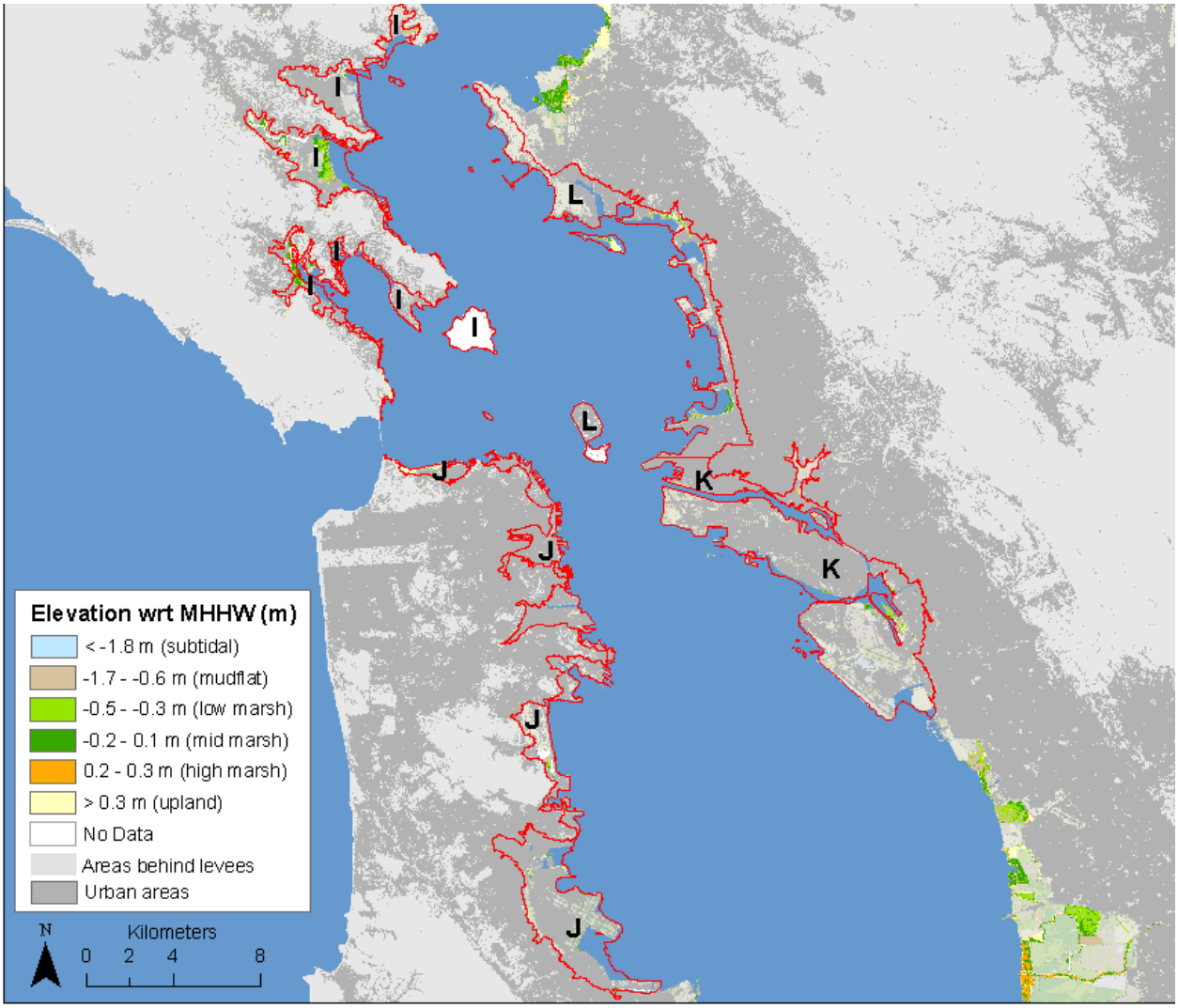
Central Bay: 2030 Sed High/ SLR Low



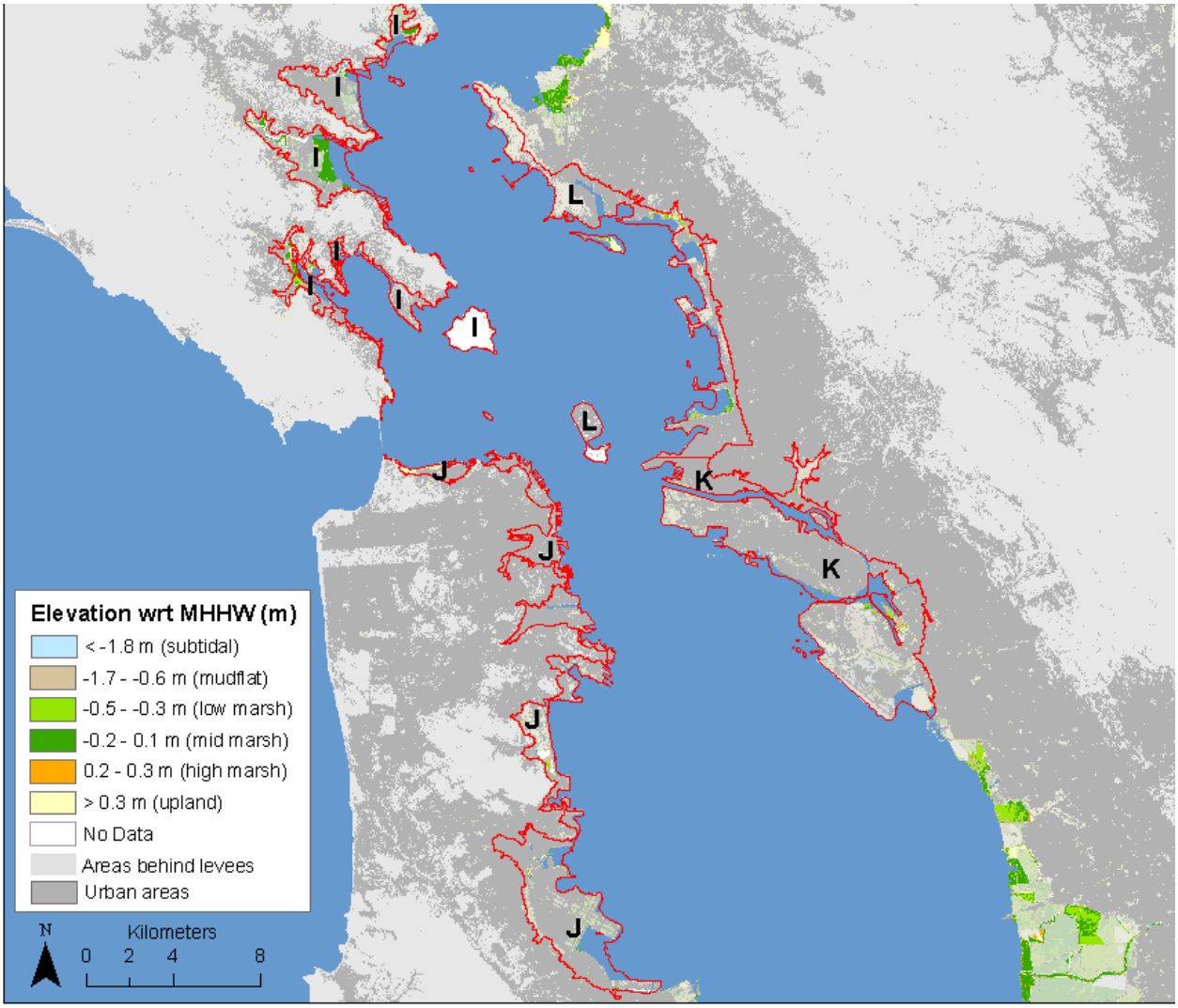
Central Bay: 2030 Sed High/ SLR High



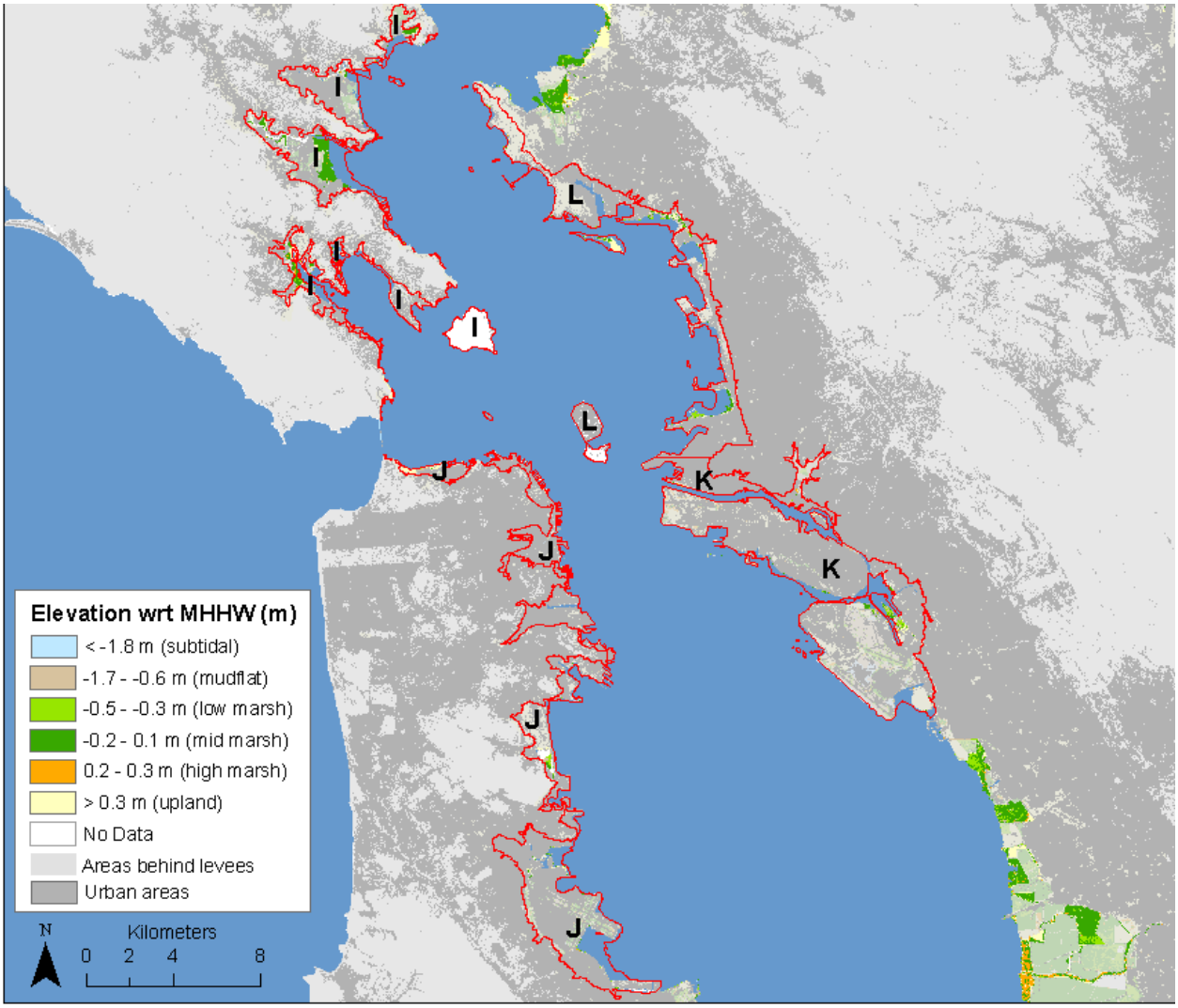
Central Bay: 2050 Sed Low/ SLR Low



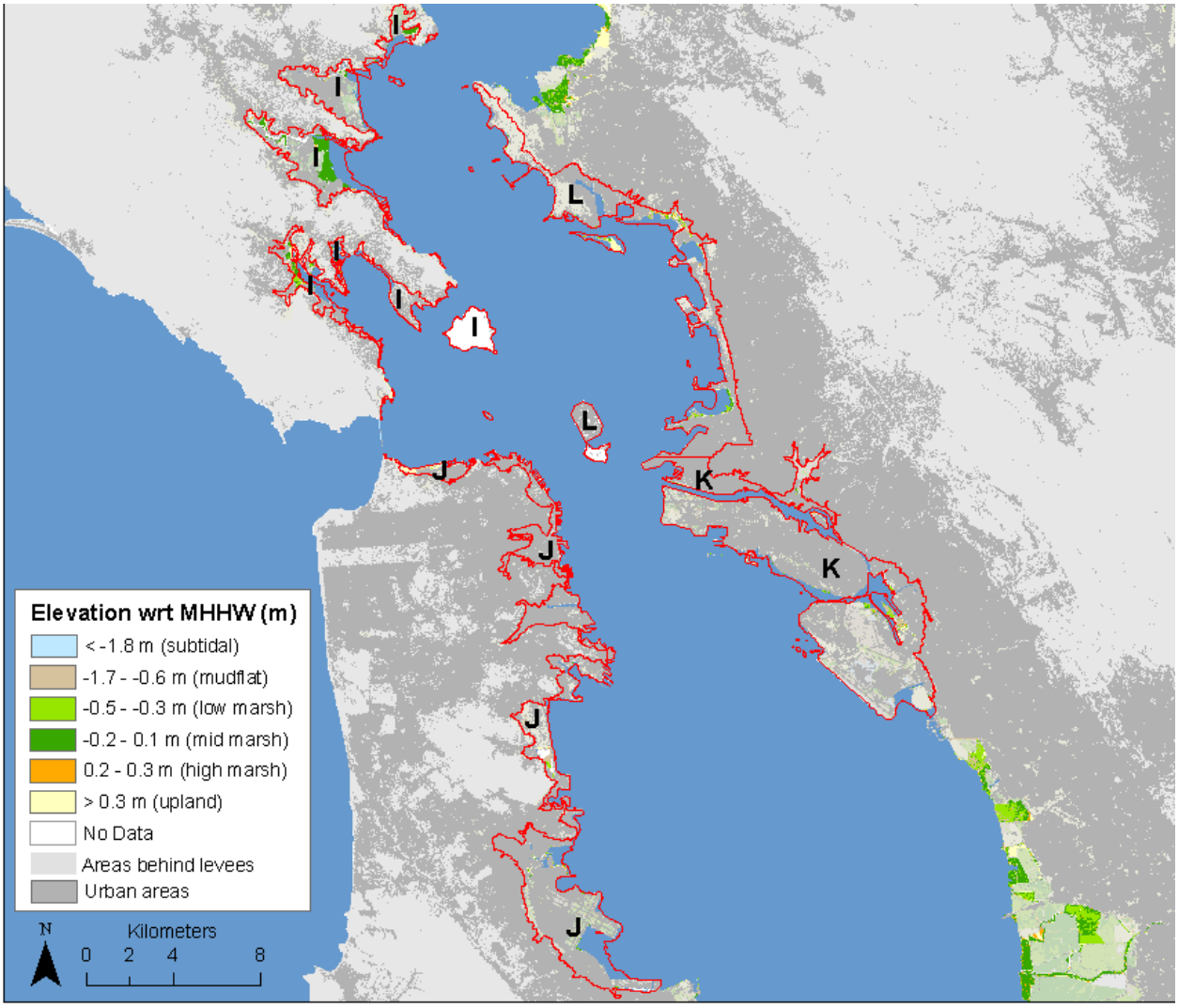
Central Bay: 2050 Sed Low/ SLR High



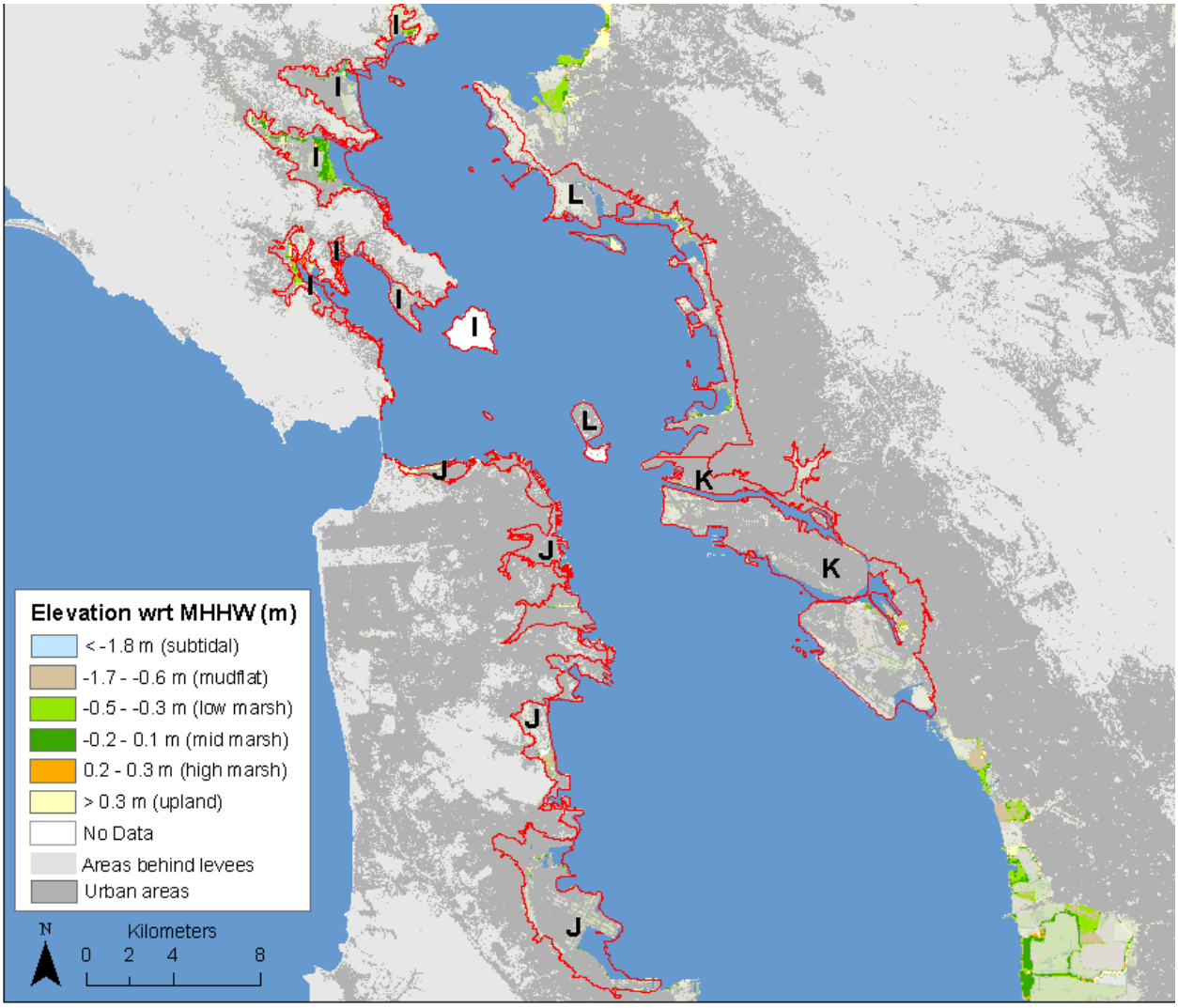
Central Bay: 2050 Sed High/ SLR Low



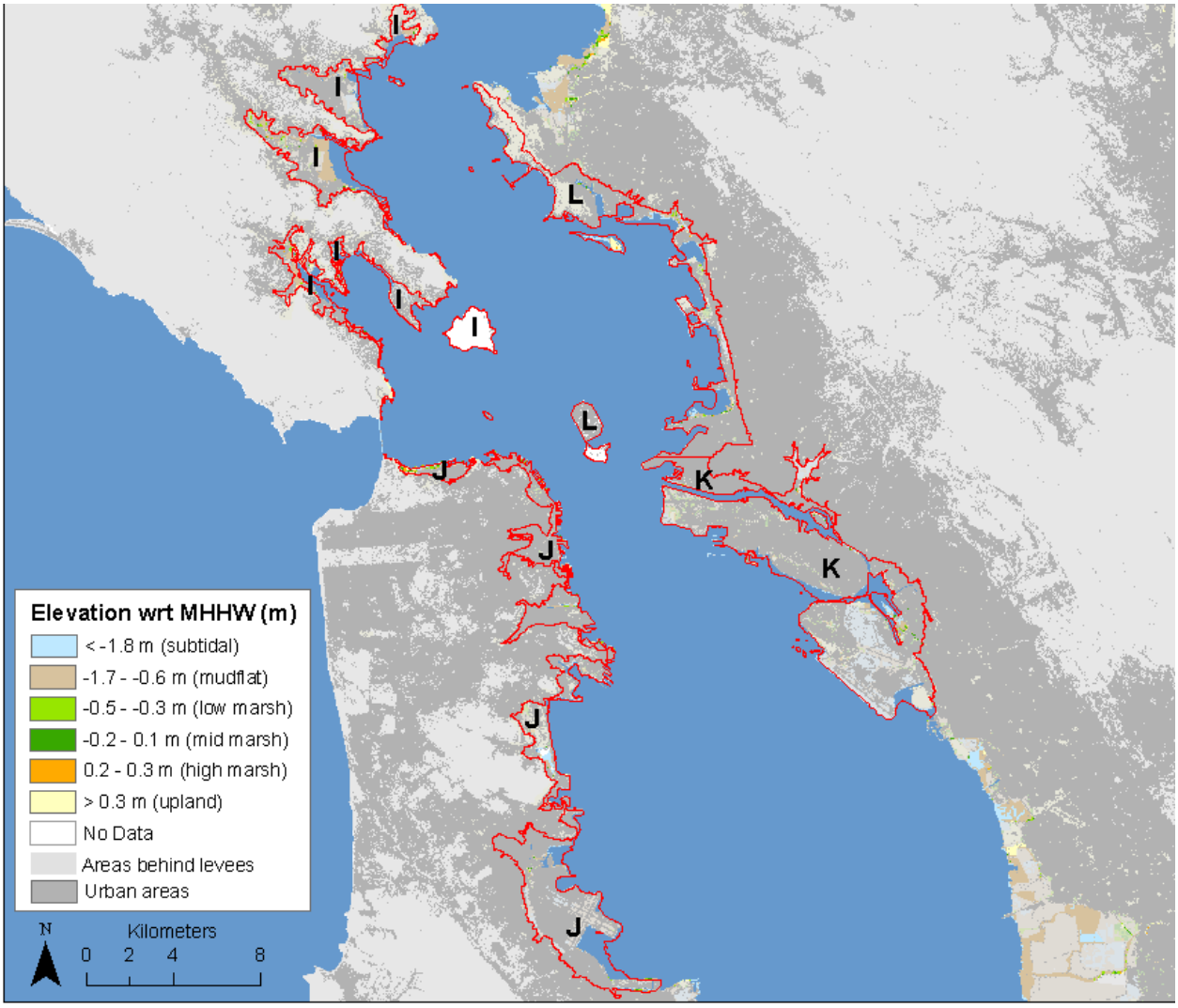
Central Bay: 2050 Sed High/ SLR High



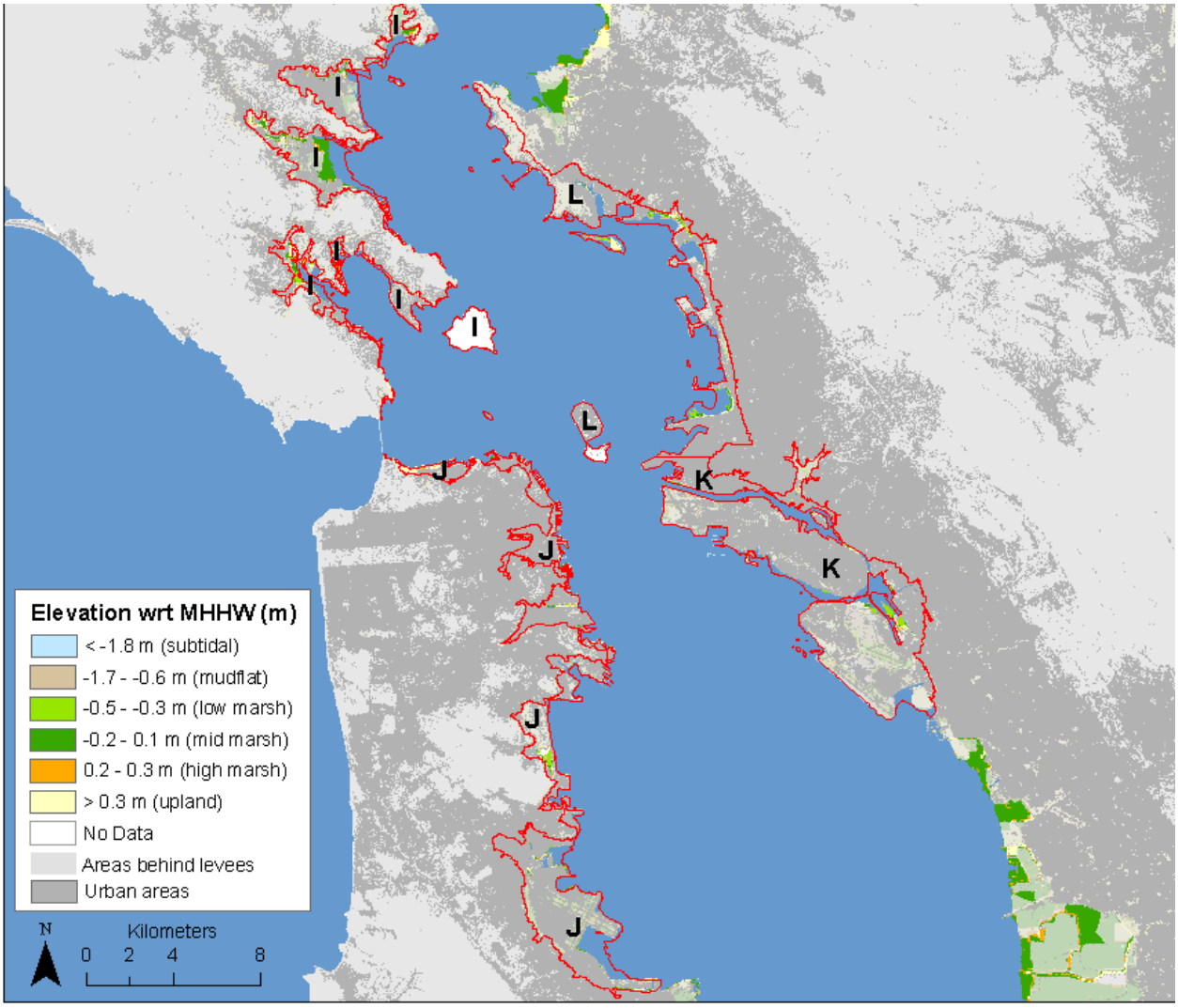
Central Bay: 2110 Sed Low/SLR Low



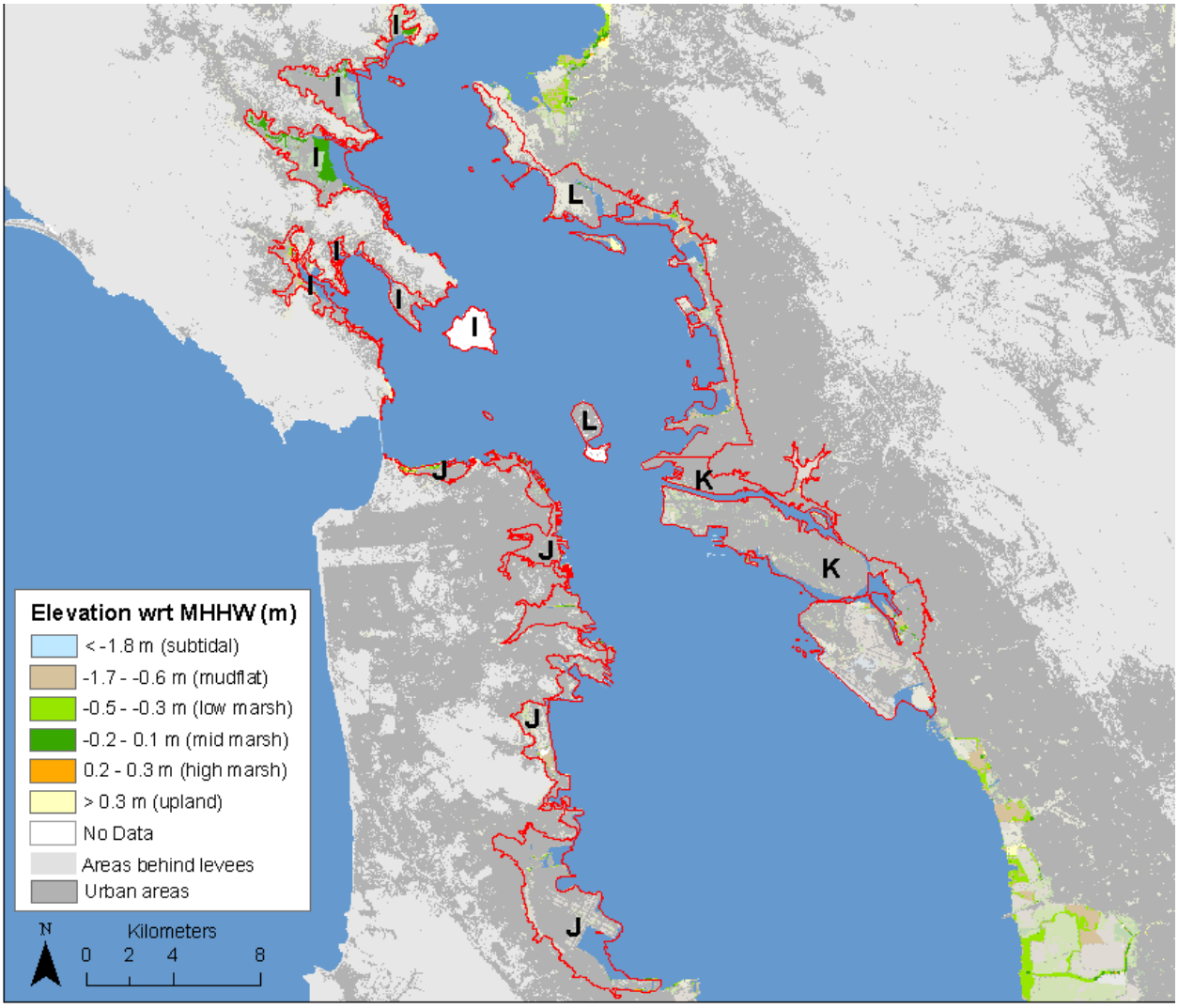
Central Bay: 2110 Sed Low/SLR High



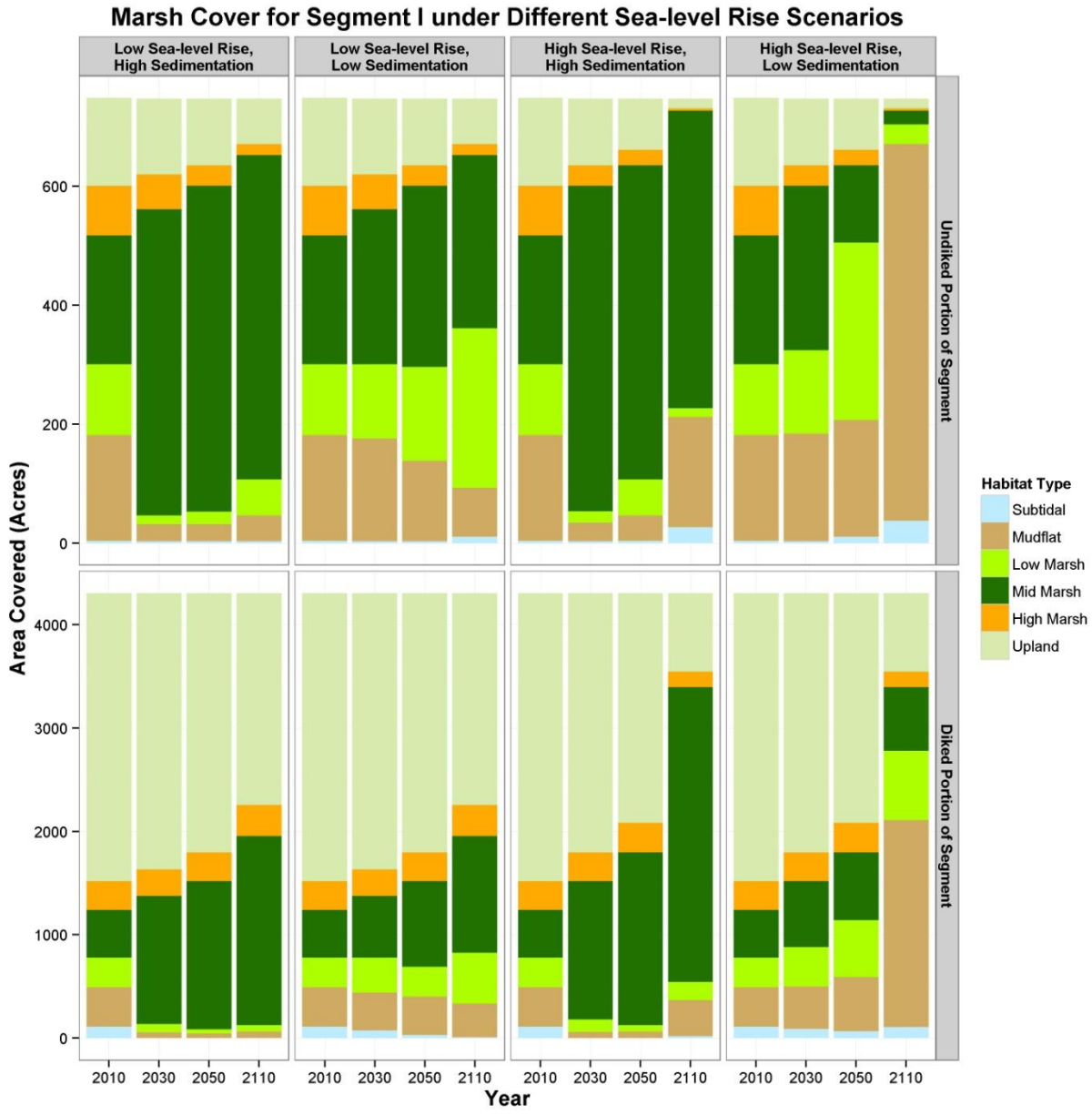
Central Bay: 2110 Sed High/SLR Low



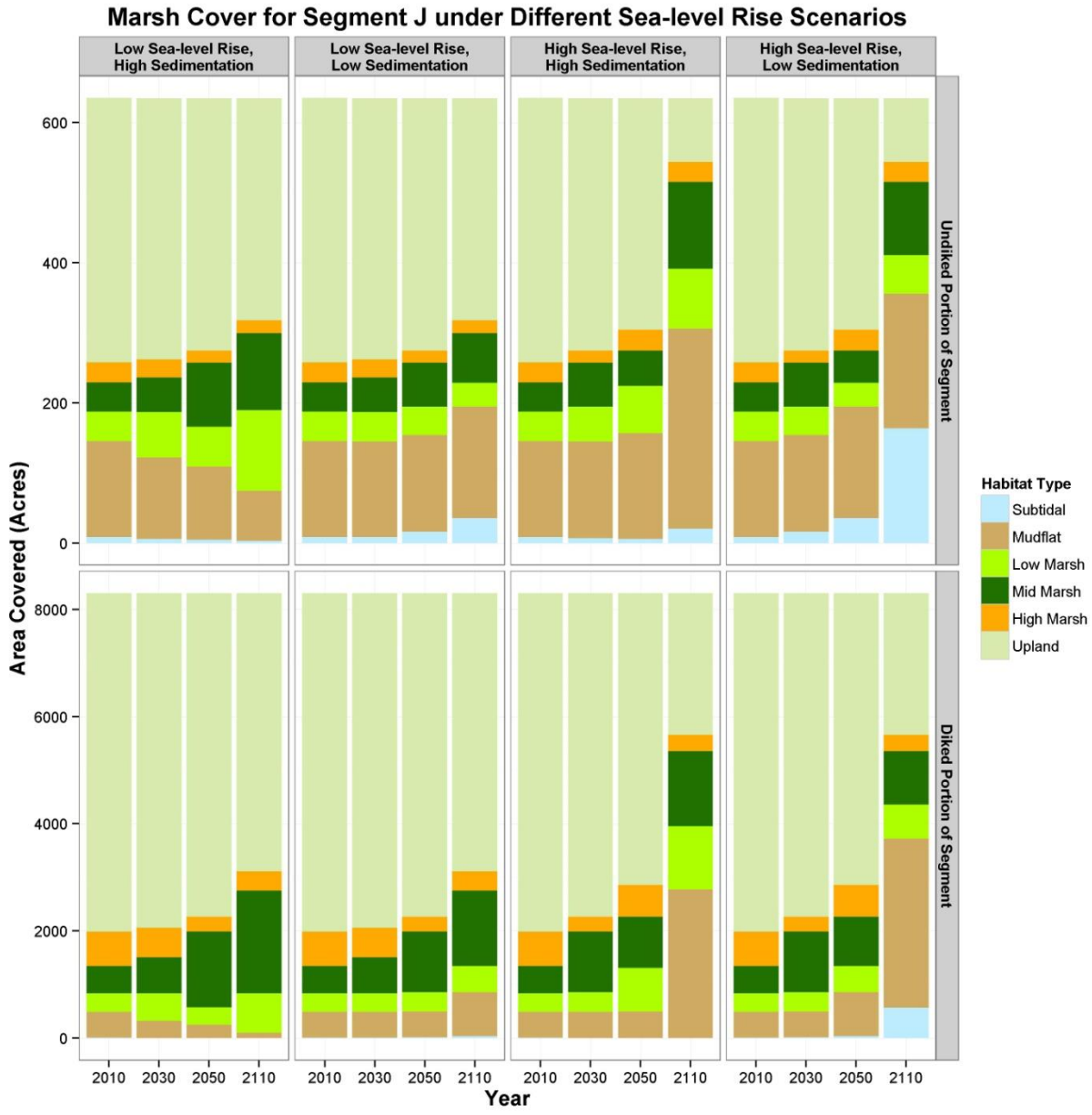
Central Bay: 2110 Sed High/ SLR High



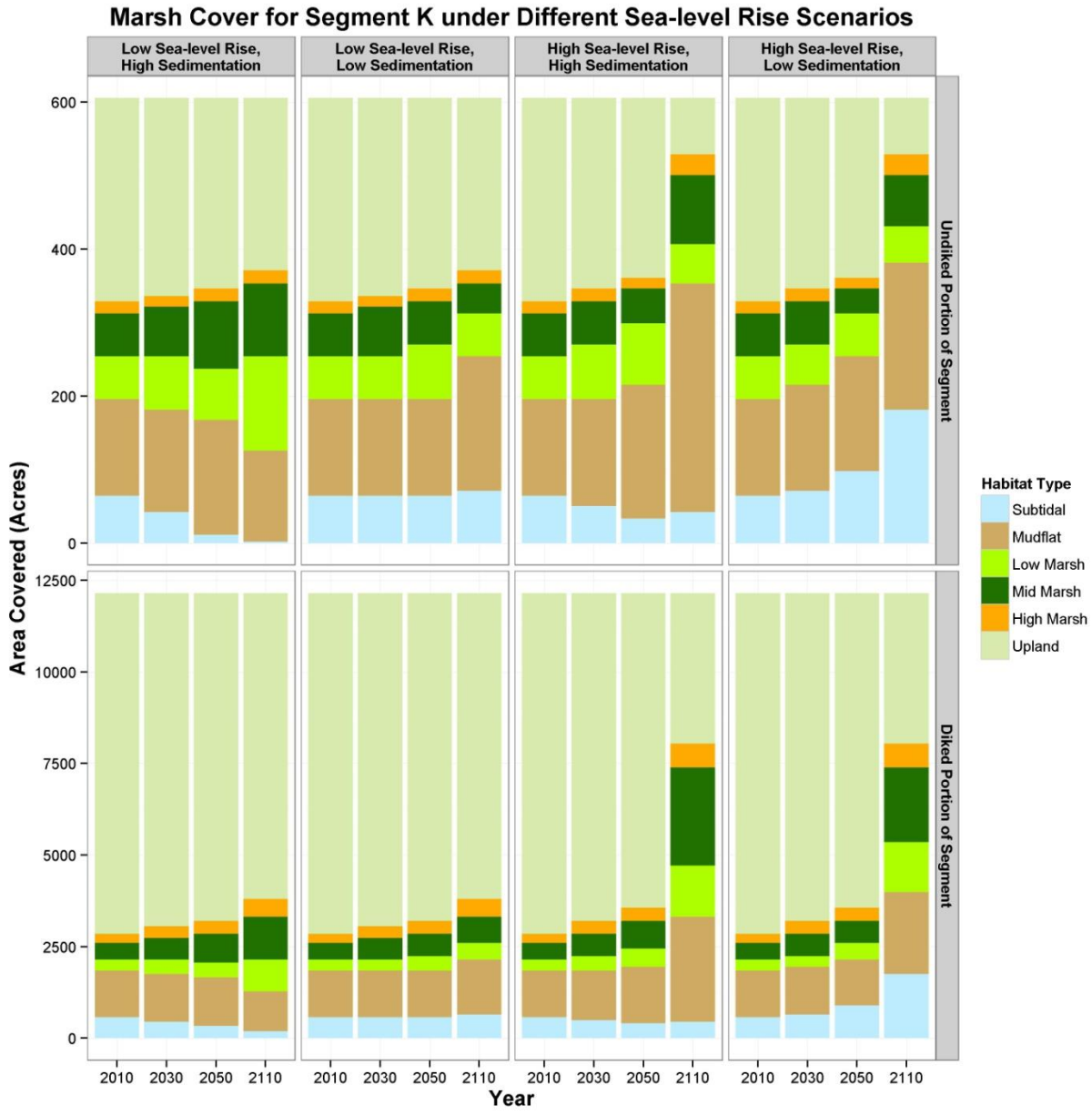
Central Bay: Segment I:



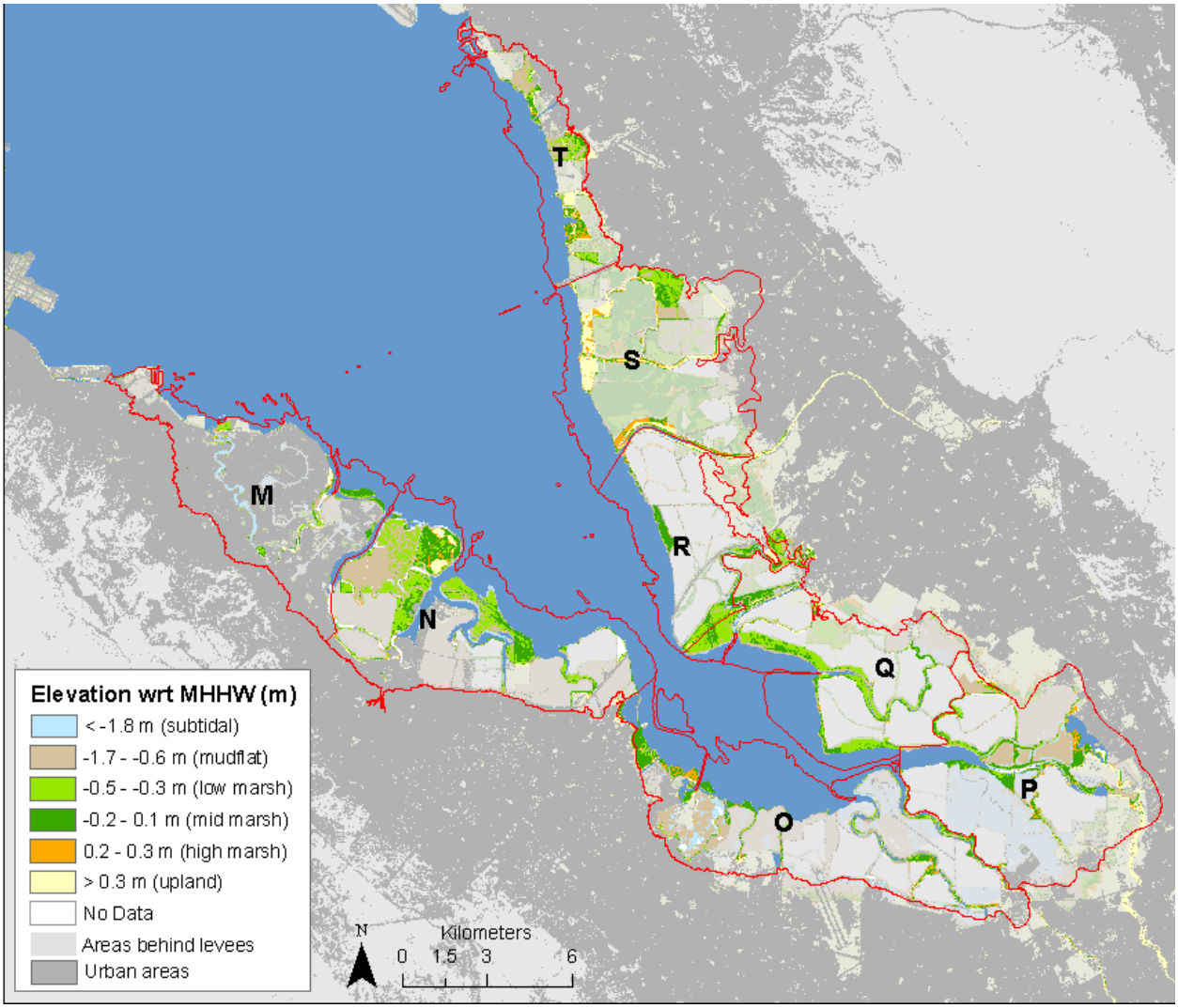
Central Bay: Segment J.



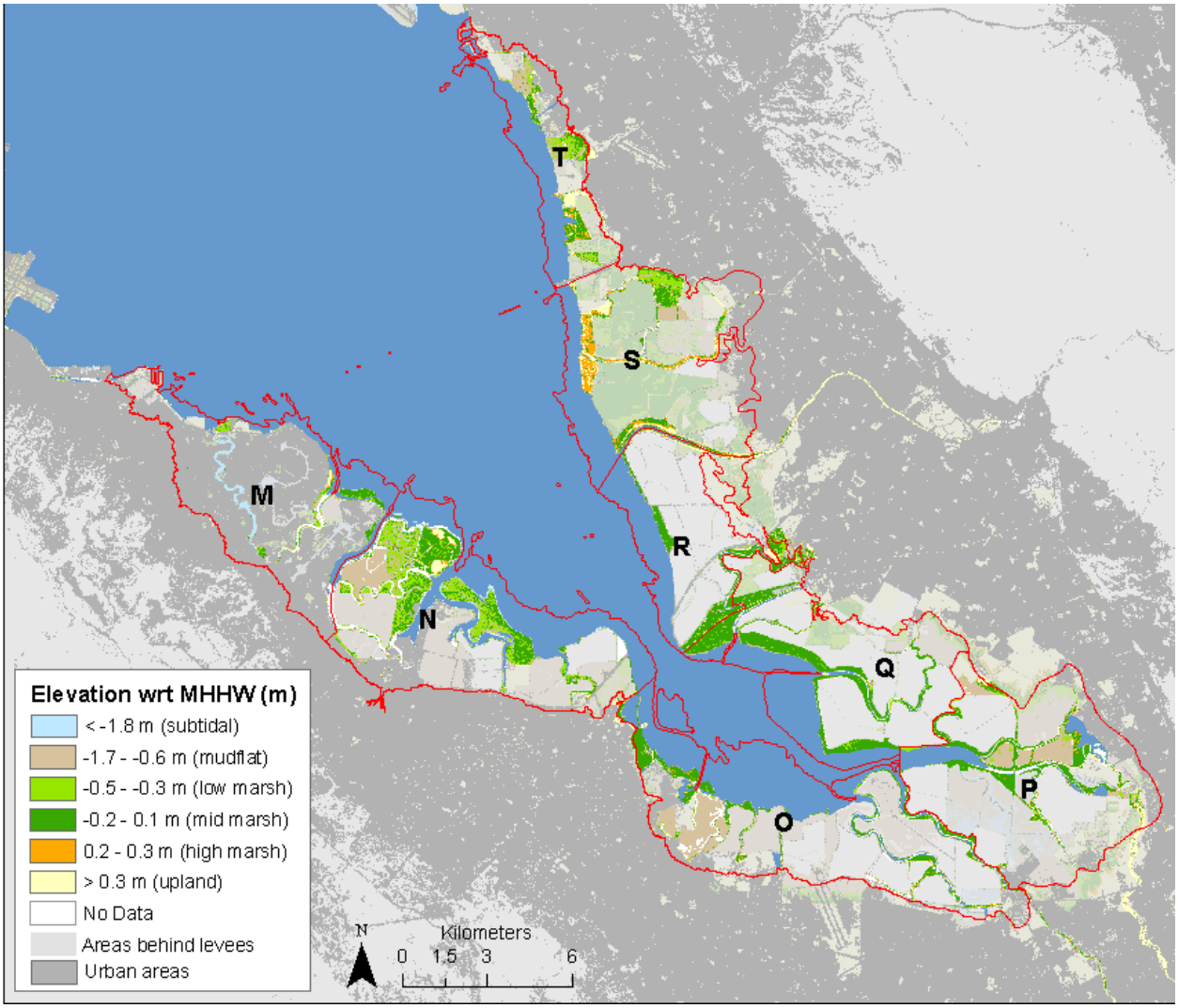
Central Bay: Segment K



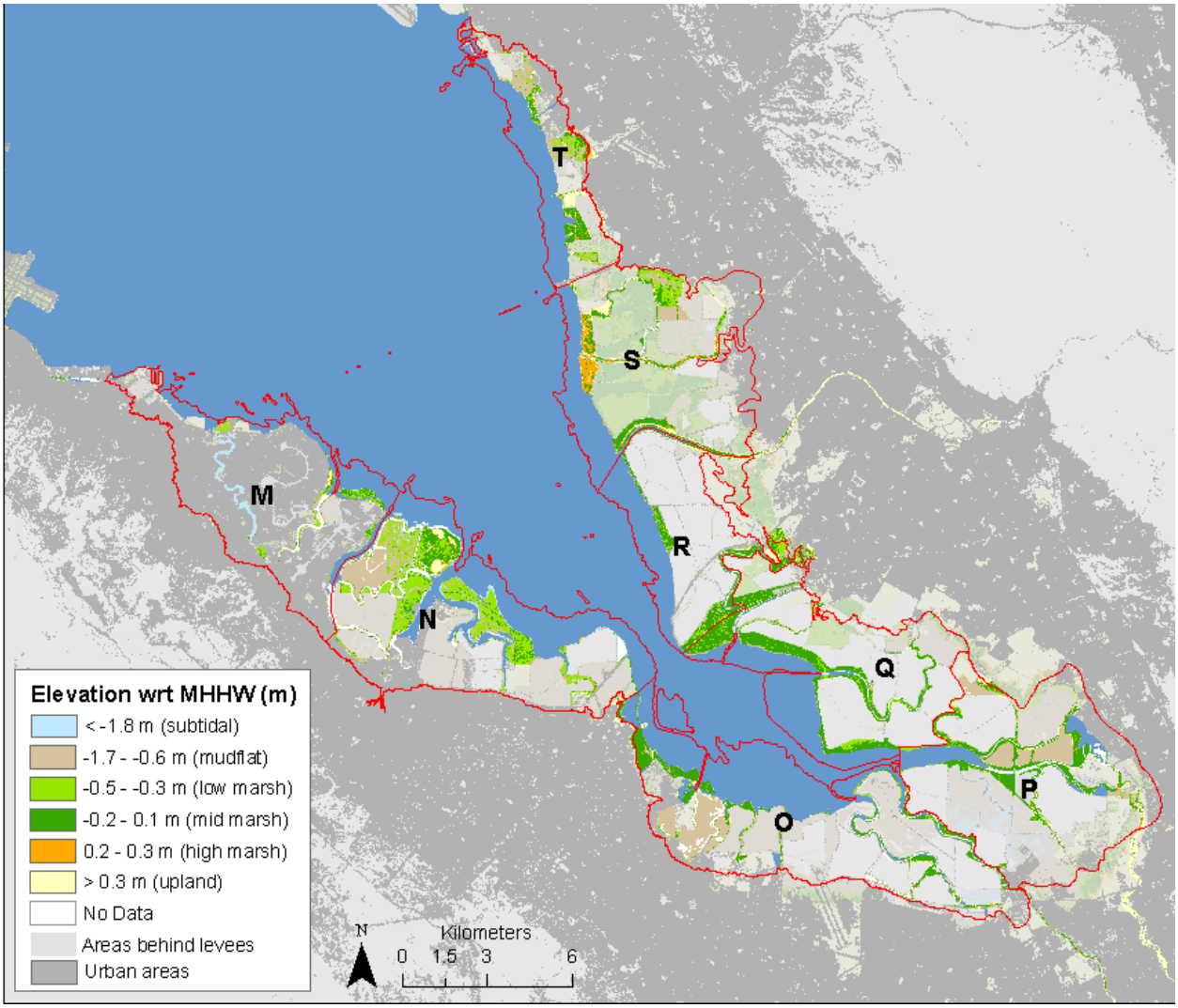
South Bay: 2010 elevations from LiDAR



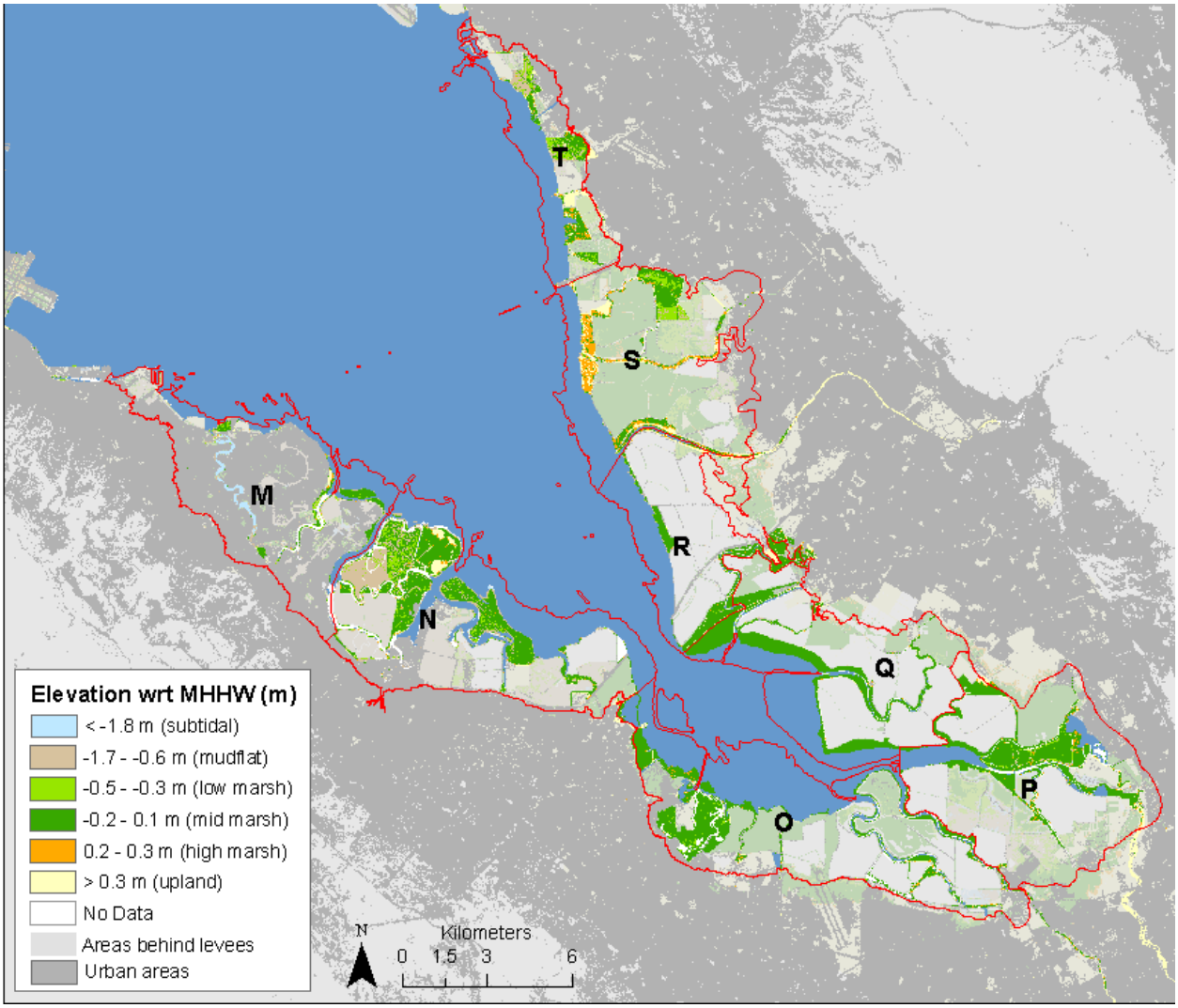
South Bay: 2030 Sed Low/ SLR Low



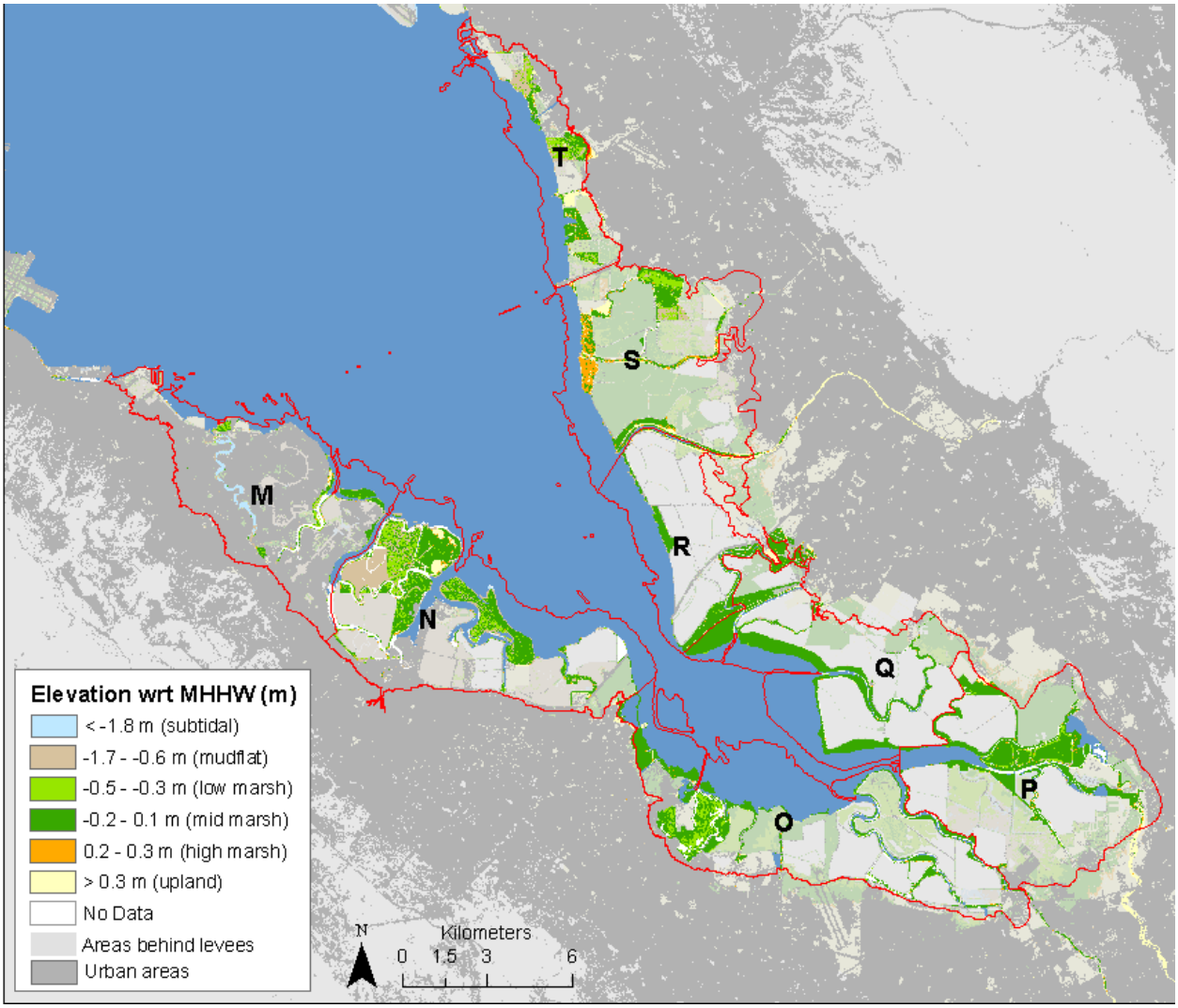
South Bay: 2030 Sed Low/ SLR High



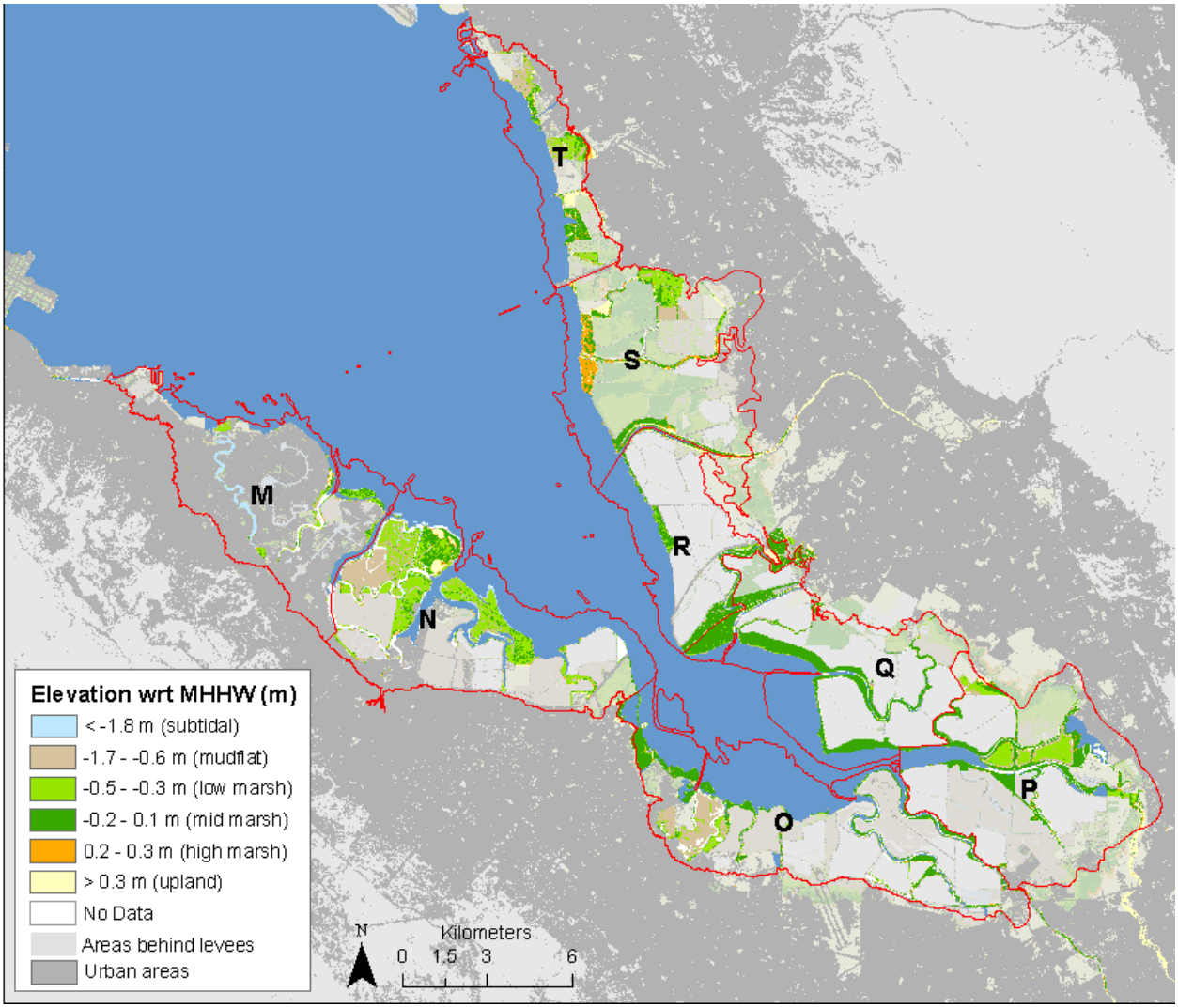
South Bay: 2030 Sed High/ SLR Low



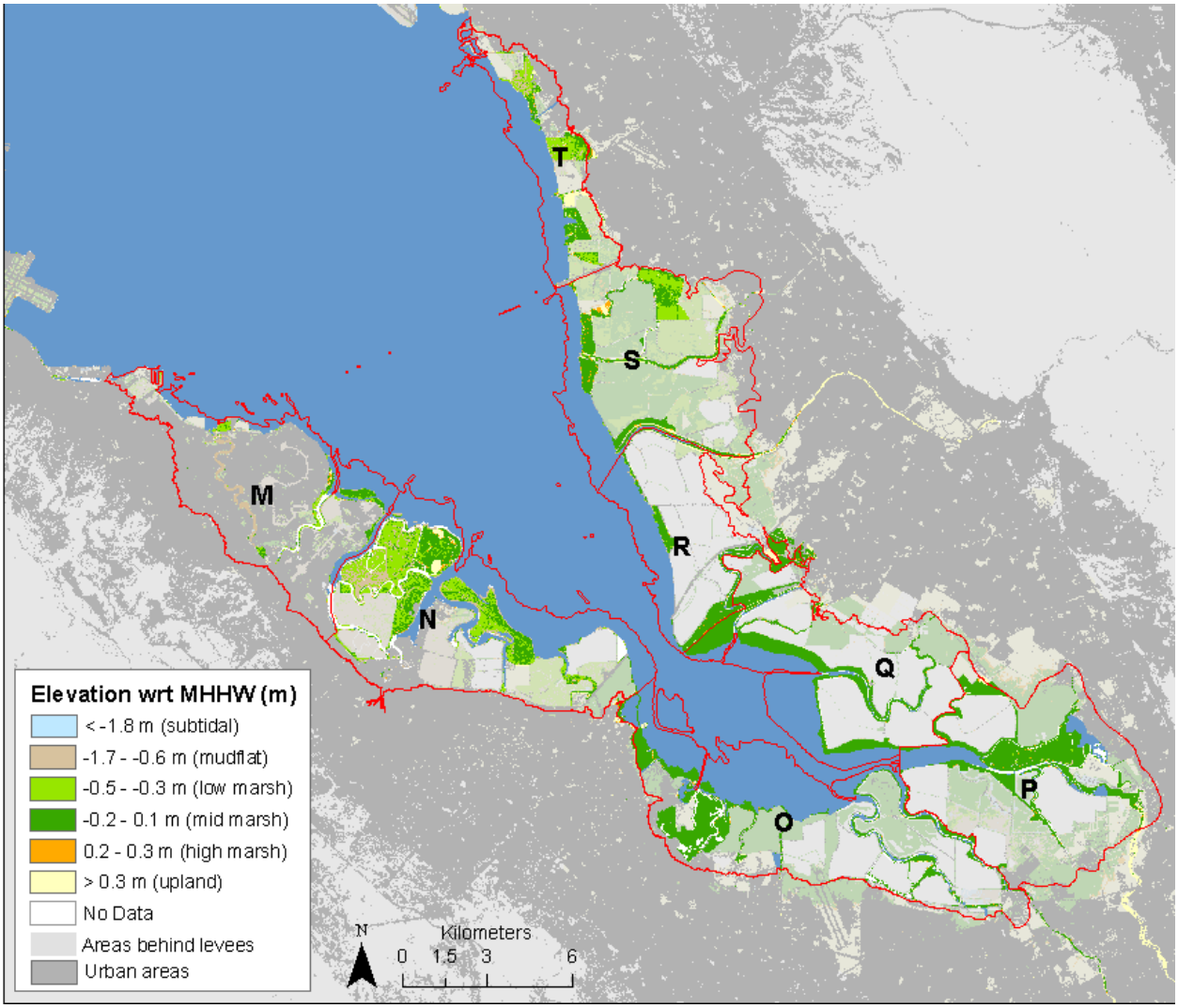
South Bay: 2030 Sed High/SLR High



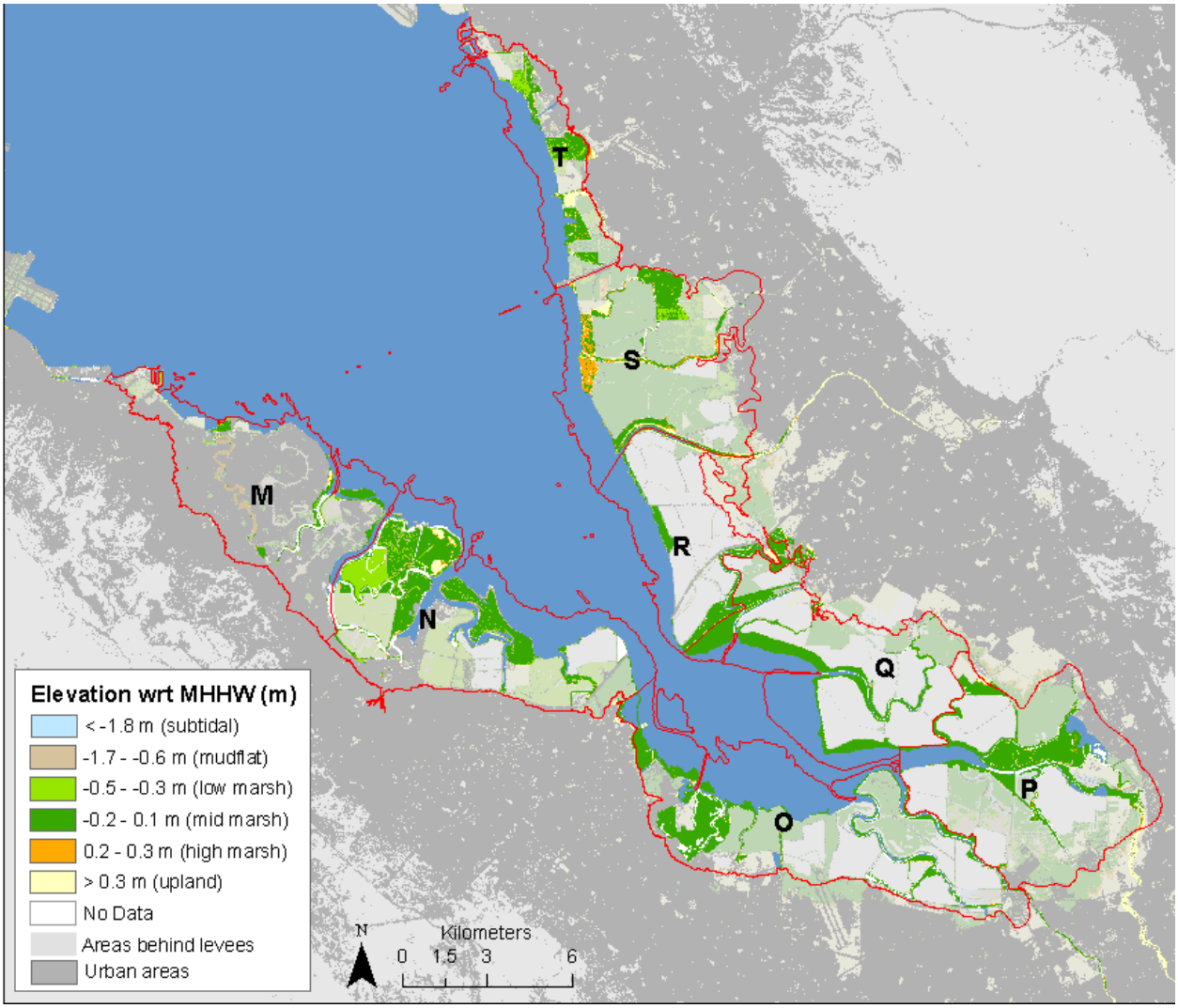
South Bay: 2050 Sed Low/ SLR Low



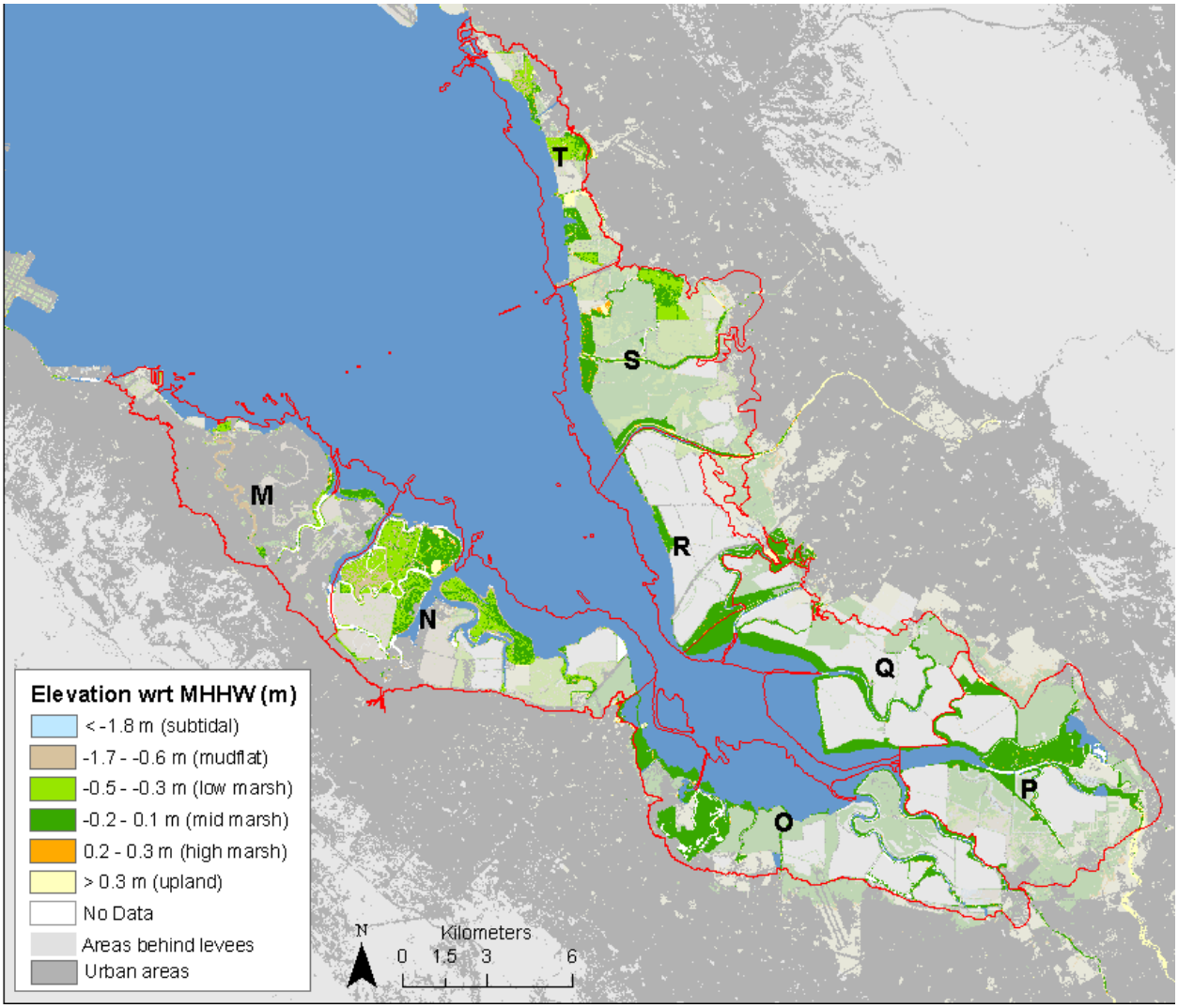
South Bay: 2050 Sed Low/ SLR High



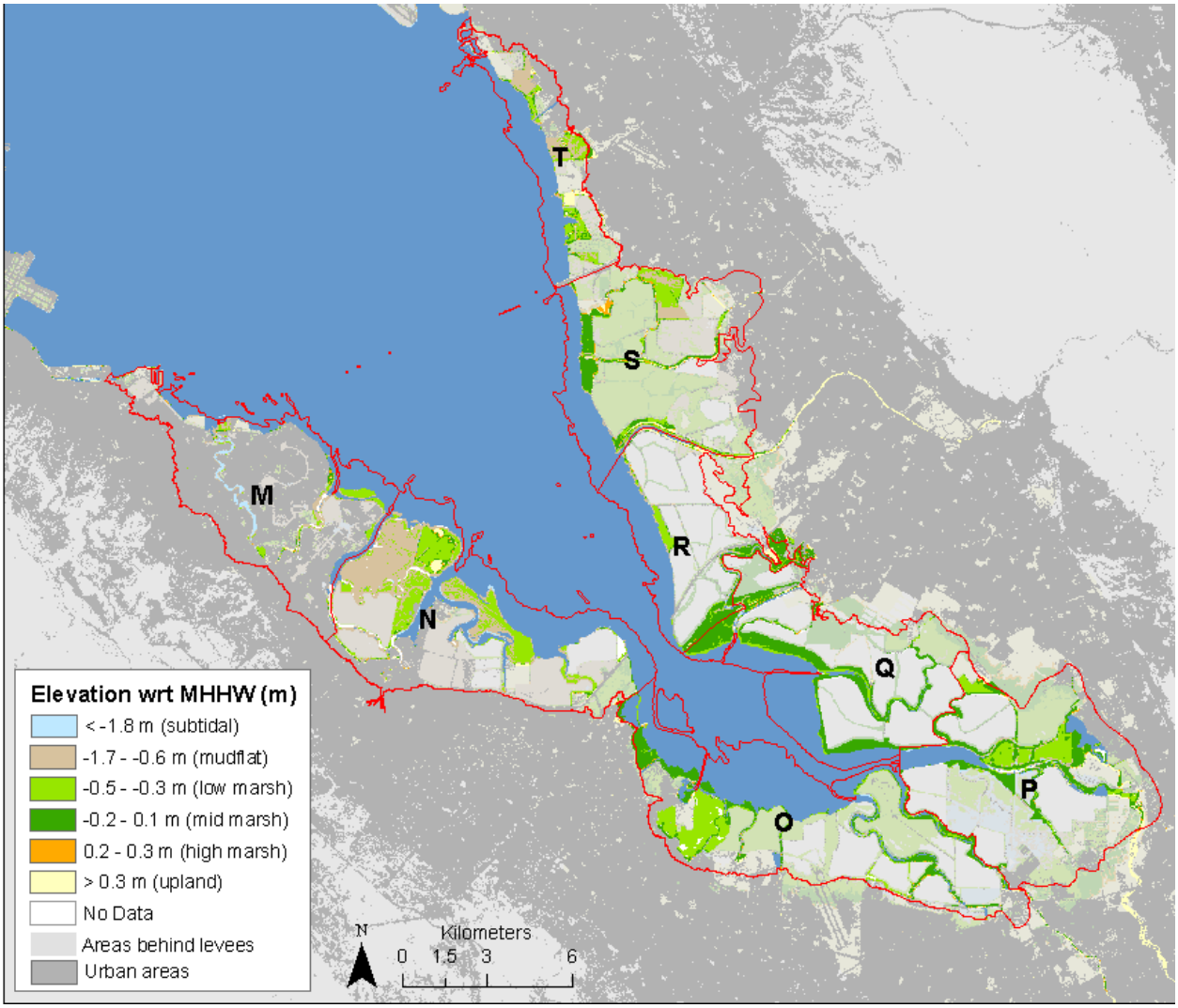
South Bay: 2050 Sed High/ SLR Low



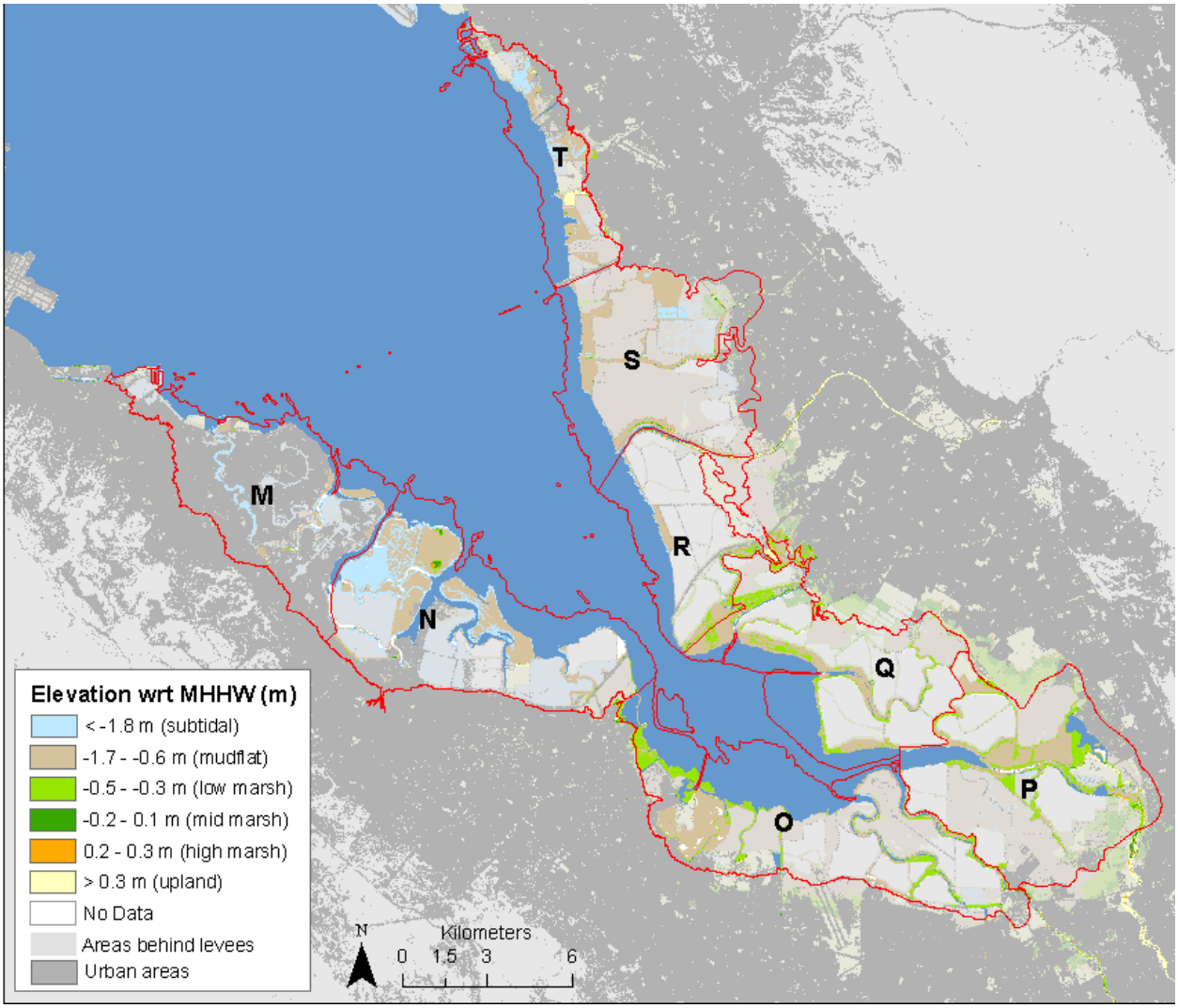
South Bay: 2050 Sed High/ SLR High



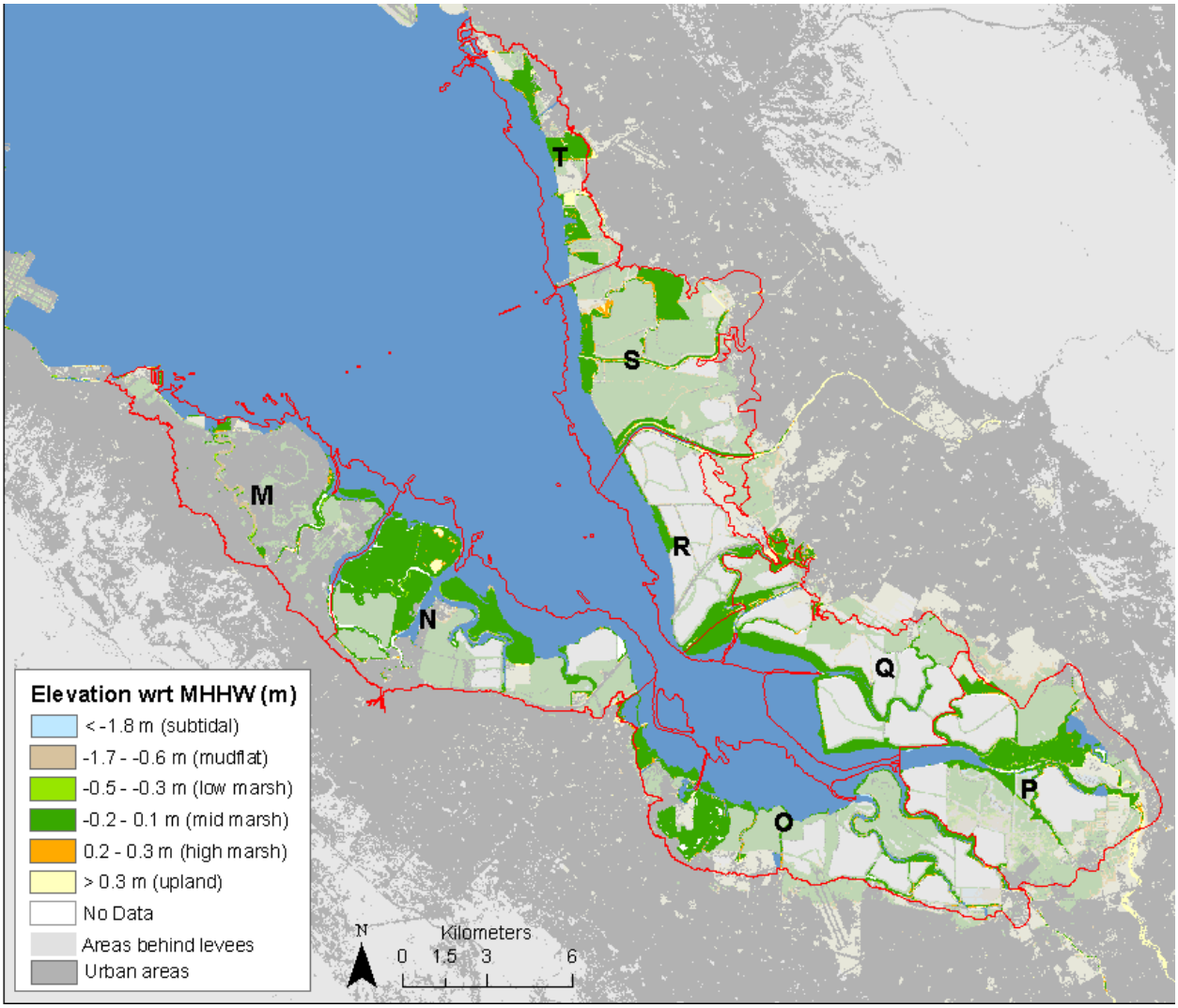
South Bay: 2110 Sed Low/SLR Low



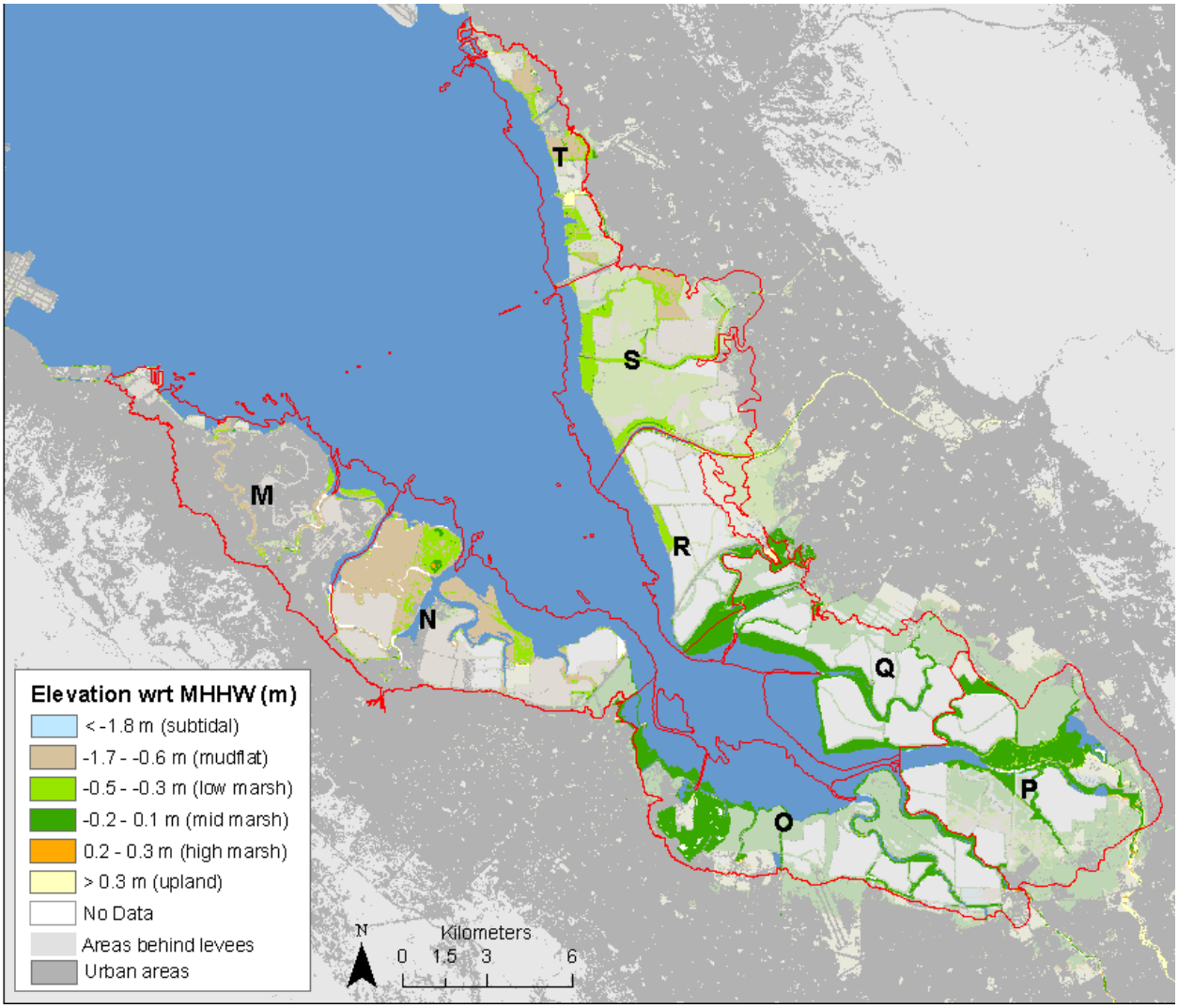
South Bay: 2110 Sed Low/ SLR High



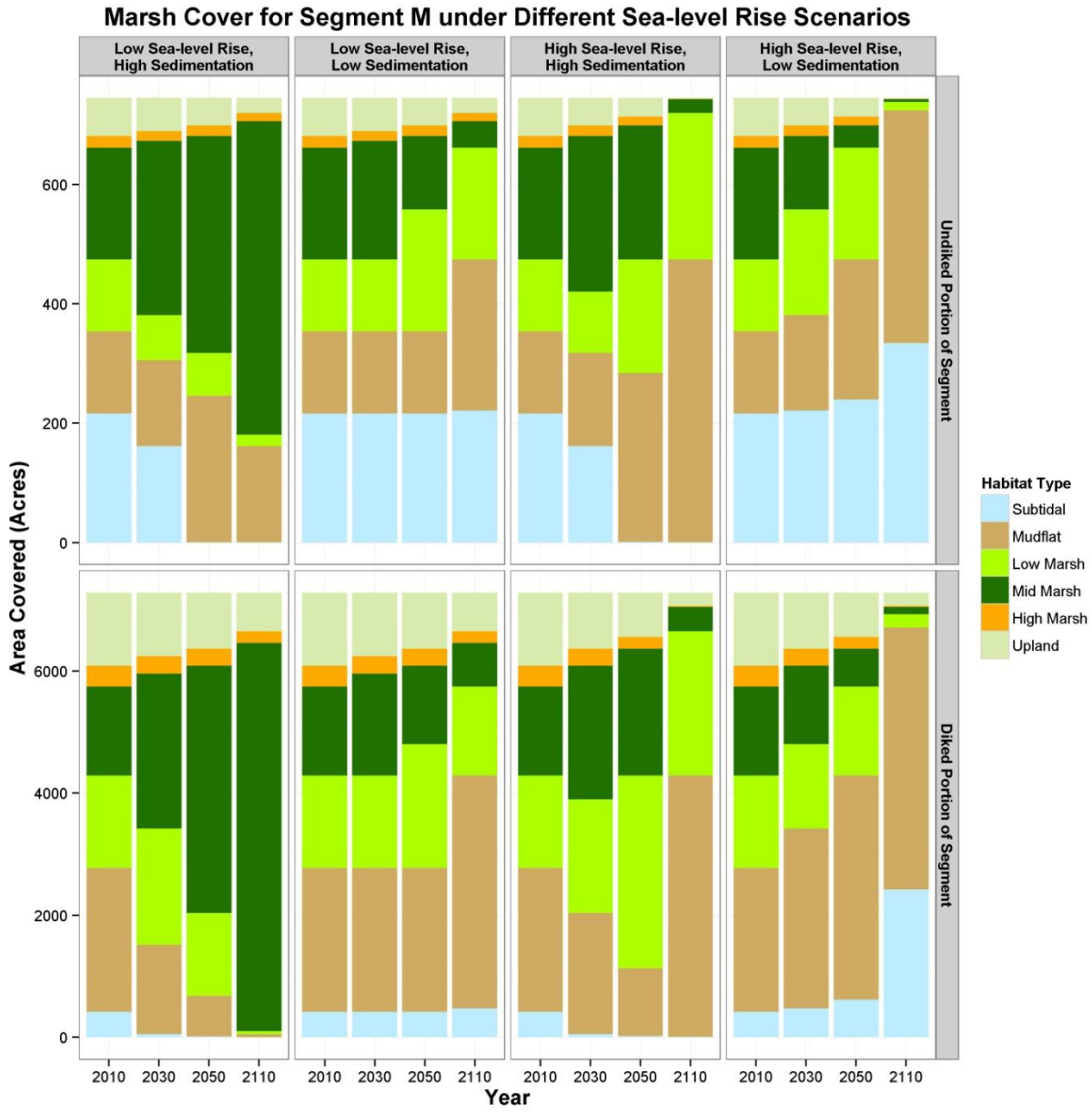
South Bay: 2110 Sed High/ SLR Low



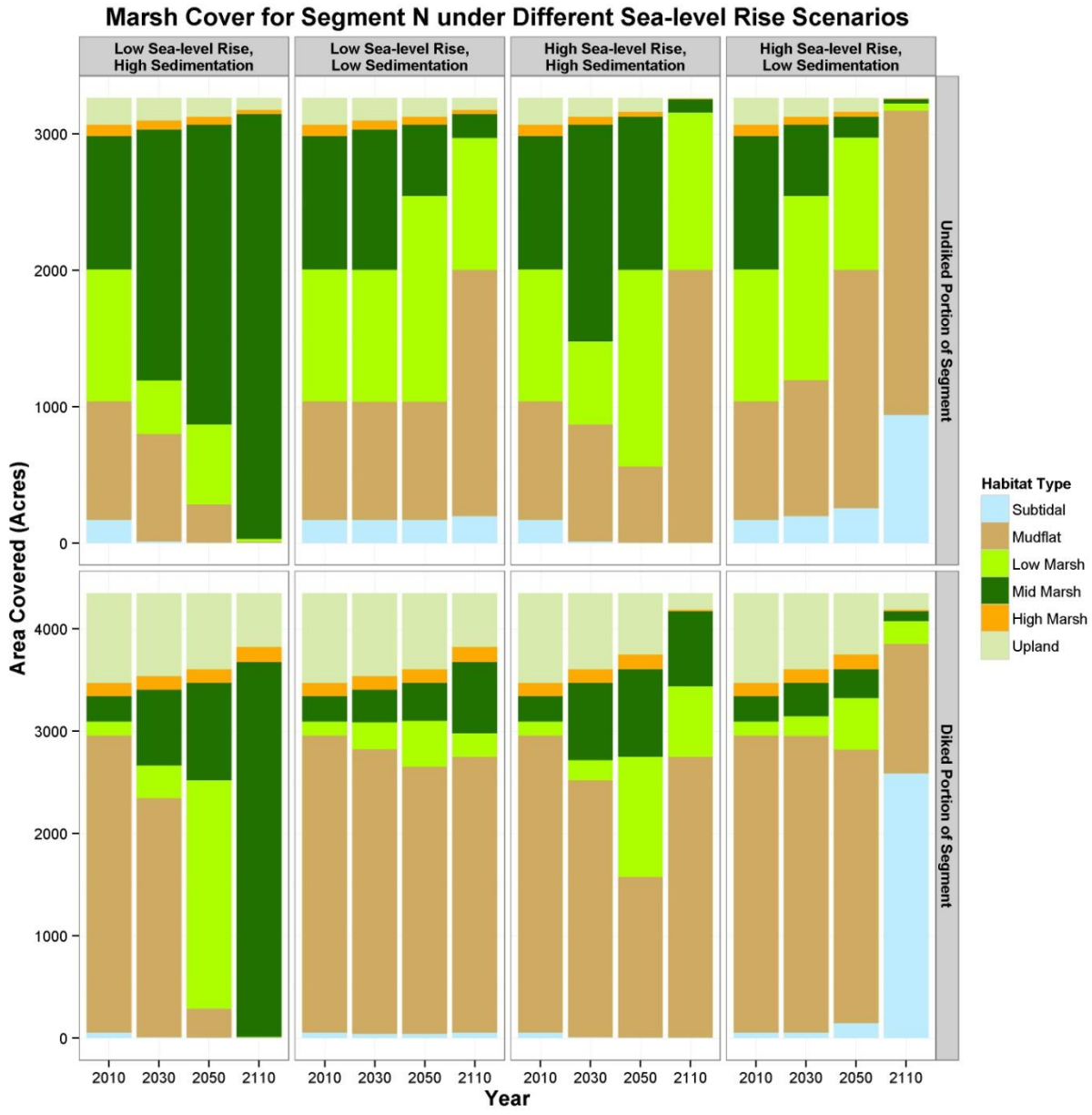
South Bay: 2110 Sed High/ SLR High



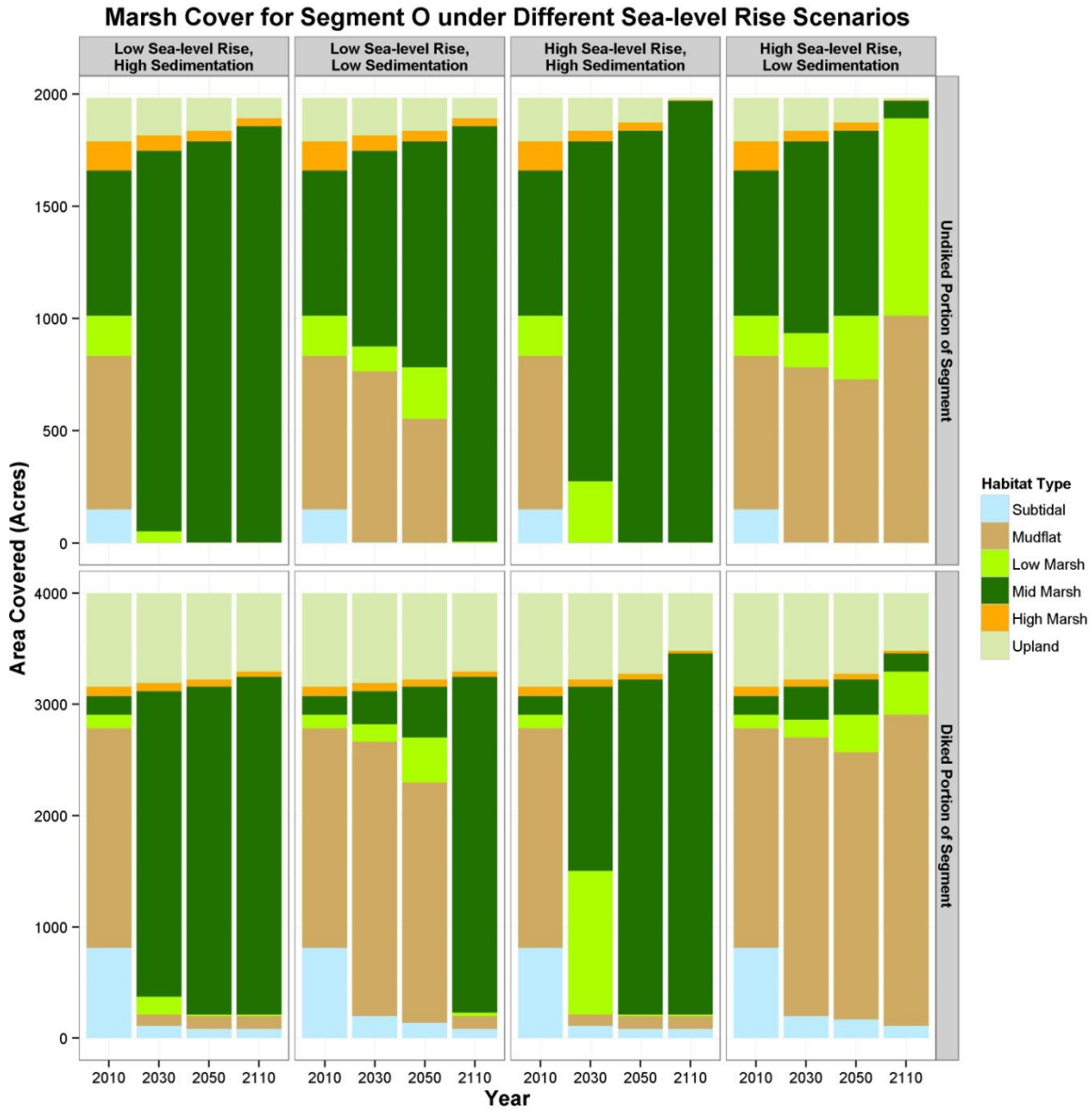
South Bay: Segment M


Marsh Cover for Segment M under Different Sea-level Rise Scenarios
Low Sea-level Rise, High Sedimentation
Low Sea-level Rise, Low Sedimentation
High Sea-level Rise, High Sedimentation
High Sea-level Rise, Low Sedimentation
Undiked Portion of Segment
Diked Portion of Segment
Area Covered (Acres)
0
200
400
600
2000
4000
6000
2010
2030
2050
2110
Year
Habitat Type
Subtidal
Mudflat
Low Marsh
Mid Marsh
High Marsh
Upland

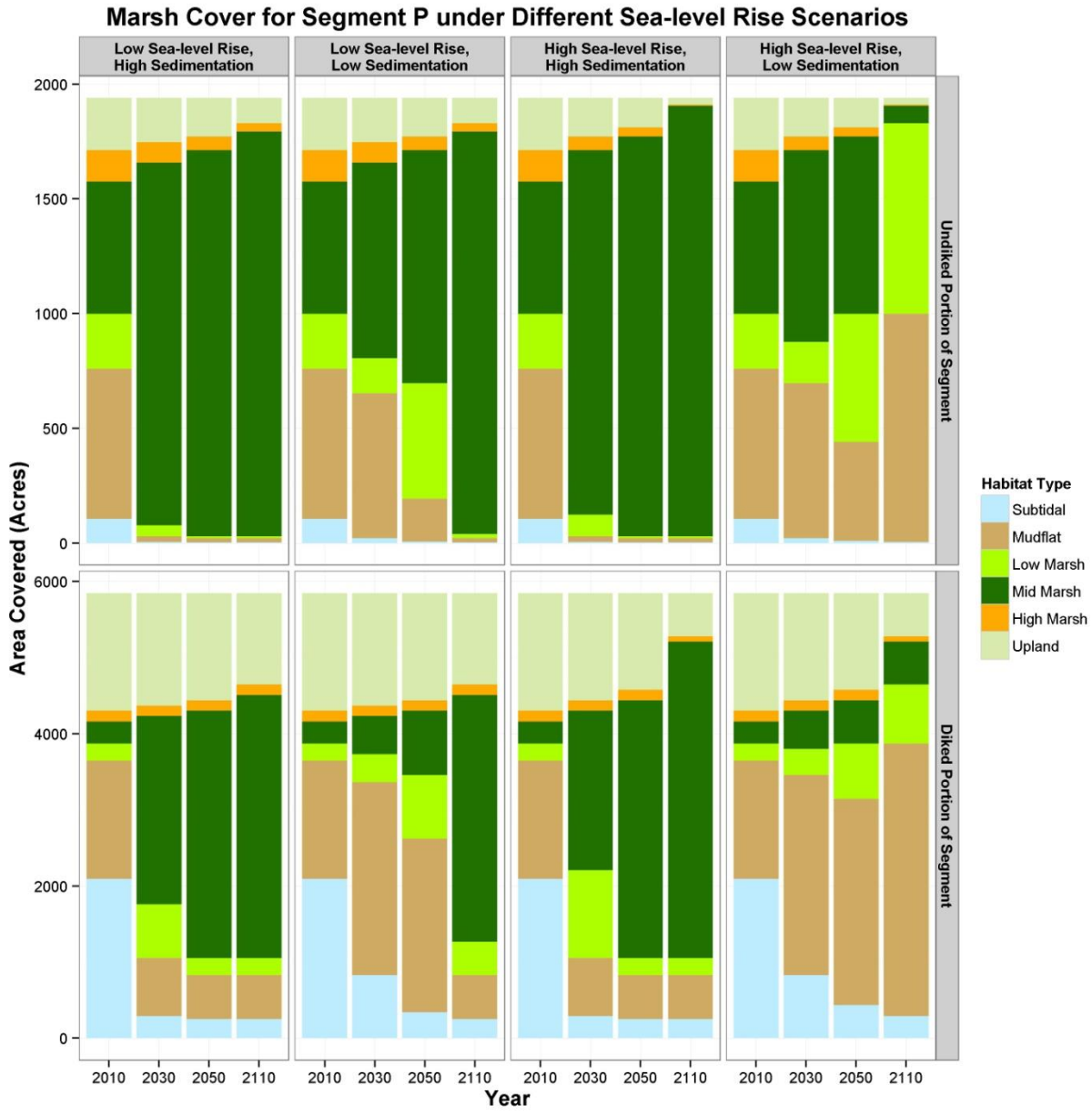
South Bay: Segment N



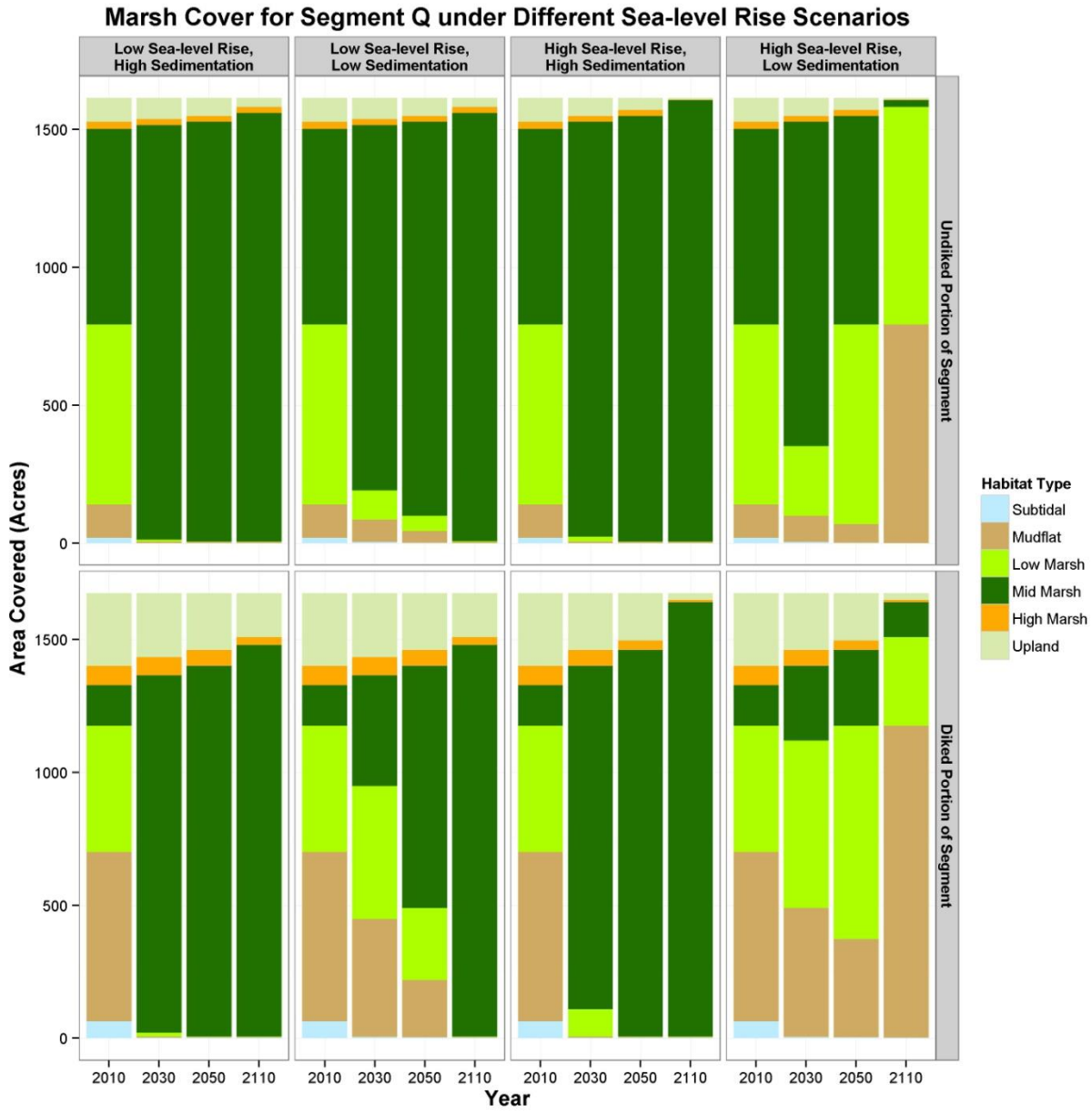
South Bay: Segment O



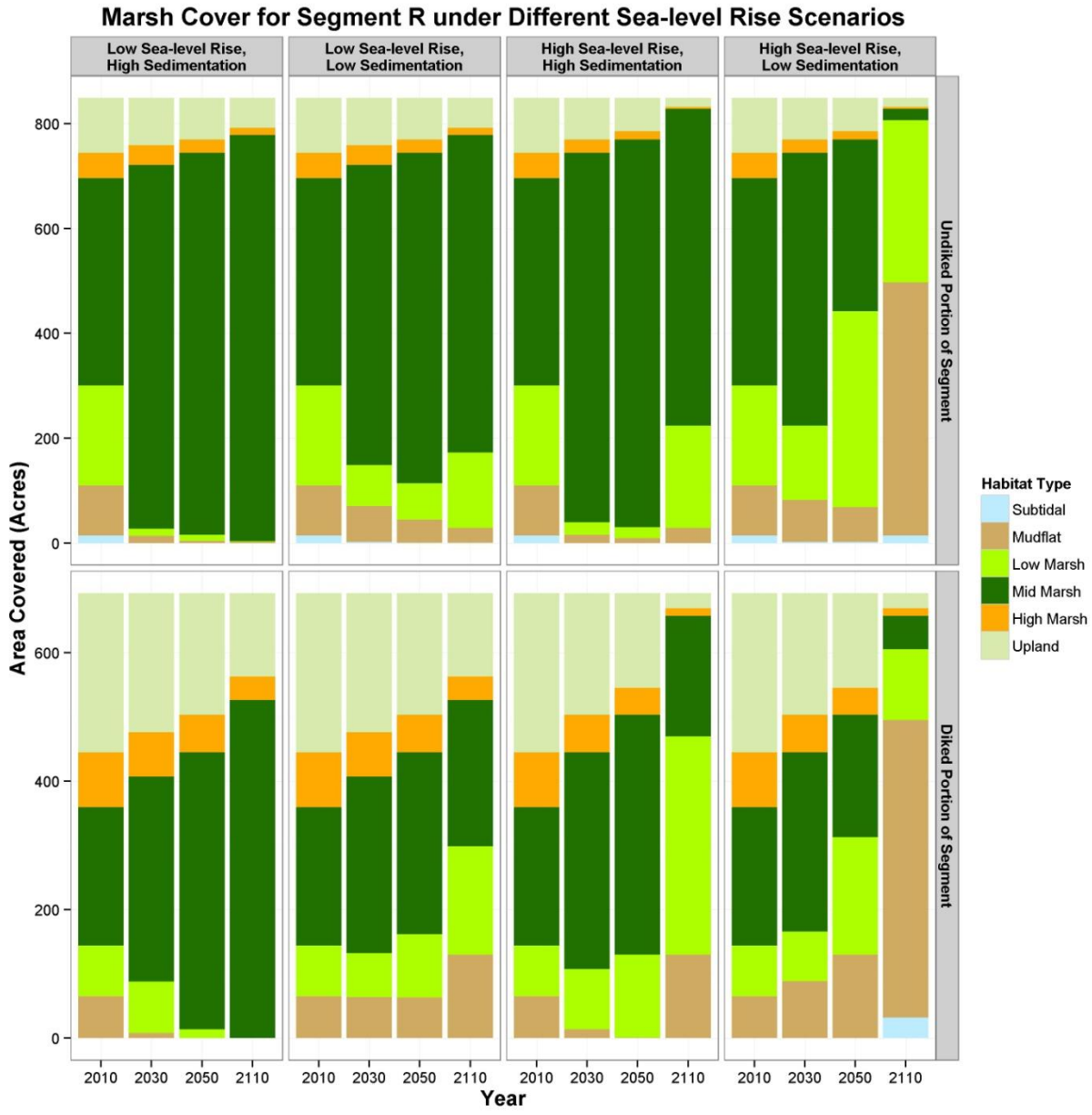
South Bay: Segment P



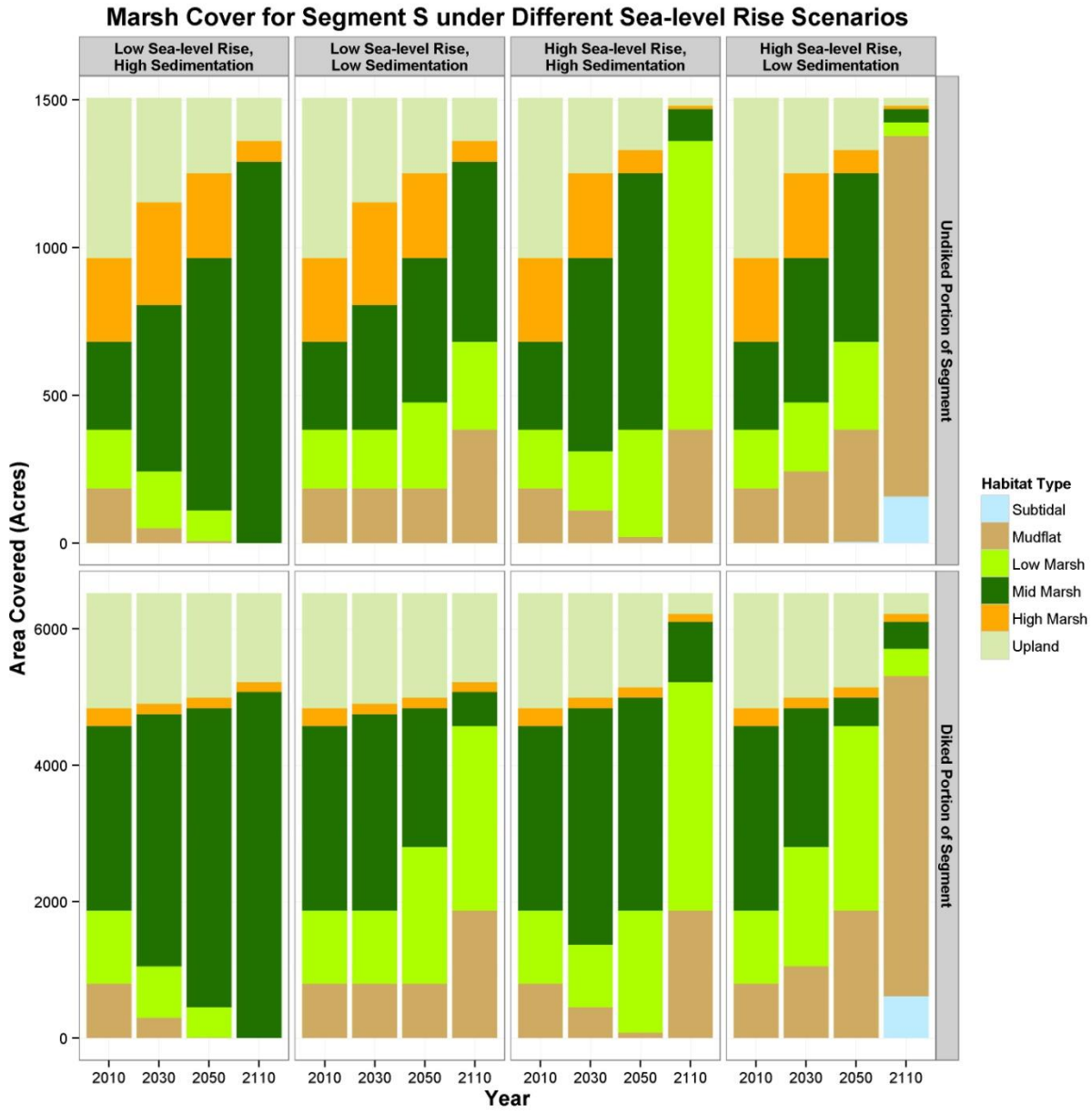
South Bay: Segment Q



South Bay: Segment R



South Bay: Segment S



South Bay: Segment T