



SHAPING COASTAL RESILIENT CITY

\$137,879 MILLION

ECONOMIC LOSSES &

57545 ha

EXPOSURE AREA

WITHIN 2100 SEA LEVEL RISE &

200 YEARS STORM SURGE

16% LAND AT RISK

OVER 80 YEARS



LEGEND

- other city around GuangZhou
- 2100 slr+200-year storm surge in GuangZhou
- 2100 slr+200-year storm surge in other cities



Country / City	China/Guangzhou
University / School	South China Agricultural University/School of Forestry and Landscape Architecture
Academic year	Fall 2019
Title of the project	Shaping coastal resilient city
Authors	Jin huang; Peilin Liao; Ziling Hu; Jialiang Lu; Chuyi Huang; Xinying Chen; Linqian Wu.



TECHNICAL DOSSIER

Title of the project	Shaping coastal resilient city
Authors	Jin huang; Peilin Liao; Ziling Hu; Jialiang Lu; Chuyi Huang; Xinying Chen; Linqian Wu.
Title of the course	Landscape Design Studio III
Academic year	Fall 2019
Teaching Staff	Chongxian Chen, Yu Xia
Department/Section/Program of belonging	Landscape Architecture
University/School	South China Agricultural University/School of Forestry and Landscape Architecture



Guangzhou, located in the Pearl River Delta, is a highly populated and densely developed city. However, as one of the most vulnerable cities to climate change and rising seas, Guangzhou is facing the most urgent problem: how to manage the risk of sea-level rise (SLR) and storm surge in such complex urban systems?

Since 2017, cooperating with the government, engineers and local residents, the planning team has established new resilient visions to adapt the risk brought by the SLR. After accomplishing vulnerability assessment in different time scales (2030,2050,2100) with Source-Pathway-Receptor-Consequence (SPRC) model, the team proposes the toolkits for each vulnerable system including residential, transportation, industrial, commercial & public, agriculture, and wetland & urban park, as one part of perspective urban planning. It is based on three resilient strategies: retreat, defend, adapt. Focusing on providing paradigm in planning for SLR, Shaping coastal resilient city proposes that the most effective solution is creating resilient space for each urban system to grow over time with SLR, considering economic, ecological and cultural values, rather than simply hardening the edge.

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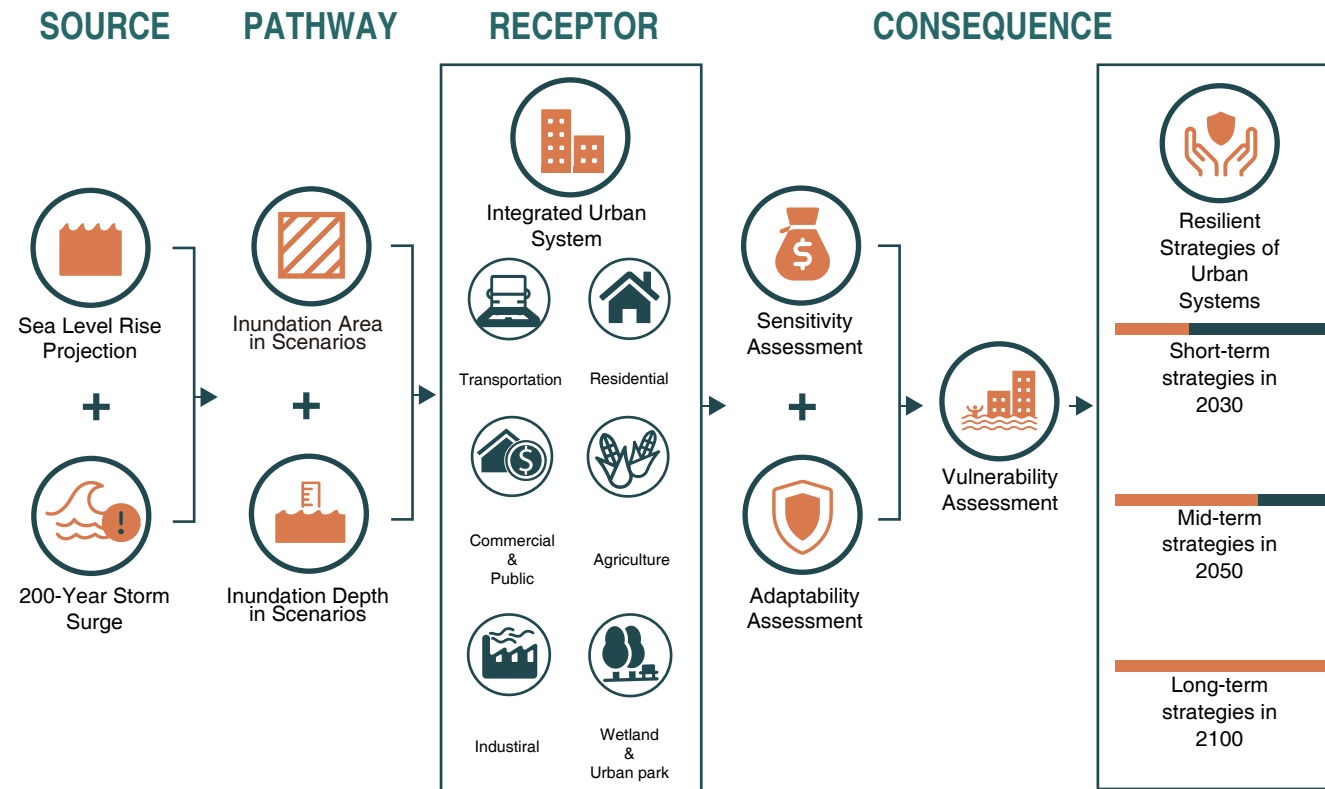
CLIMATE CHANGE AGAIN

11th International Biennial Landscape Barcelona

Barcelona September 2020
SCHOOL PRIZE

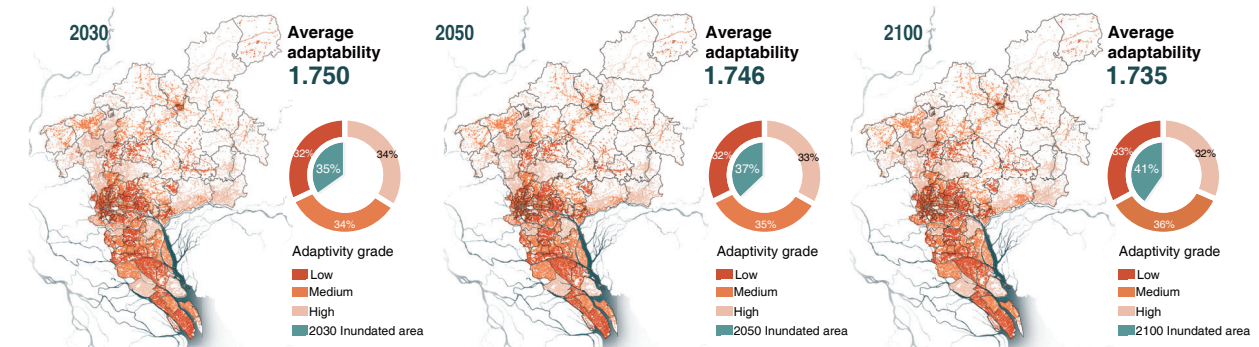


METHOD OF PROJECT

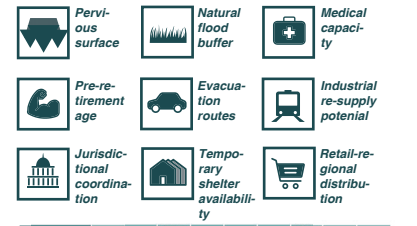
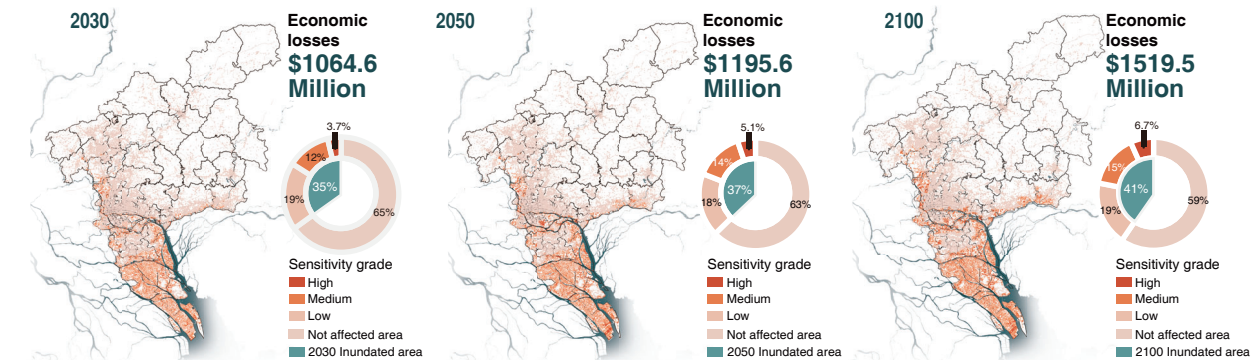


ADAPTABILITY & SENSITIVITY ASSESSMENT

ADAPTABILITY ASSESSMENT



SENSITIVITY ASSESSMENT

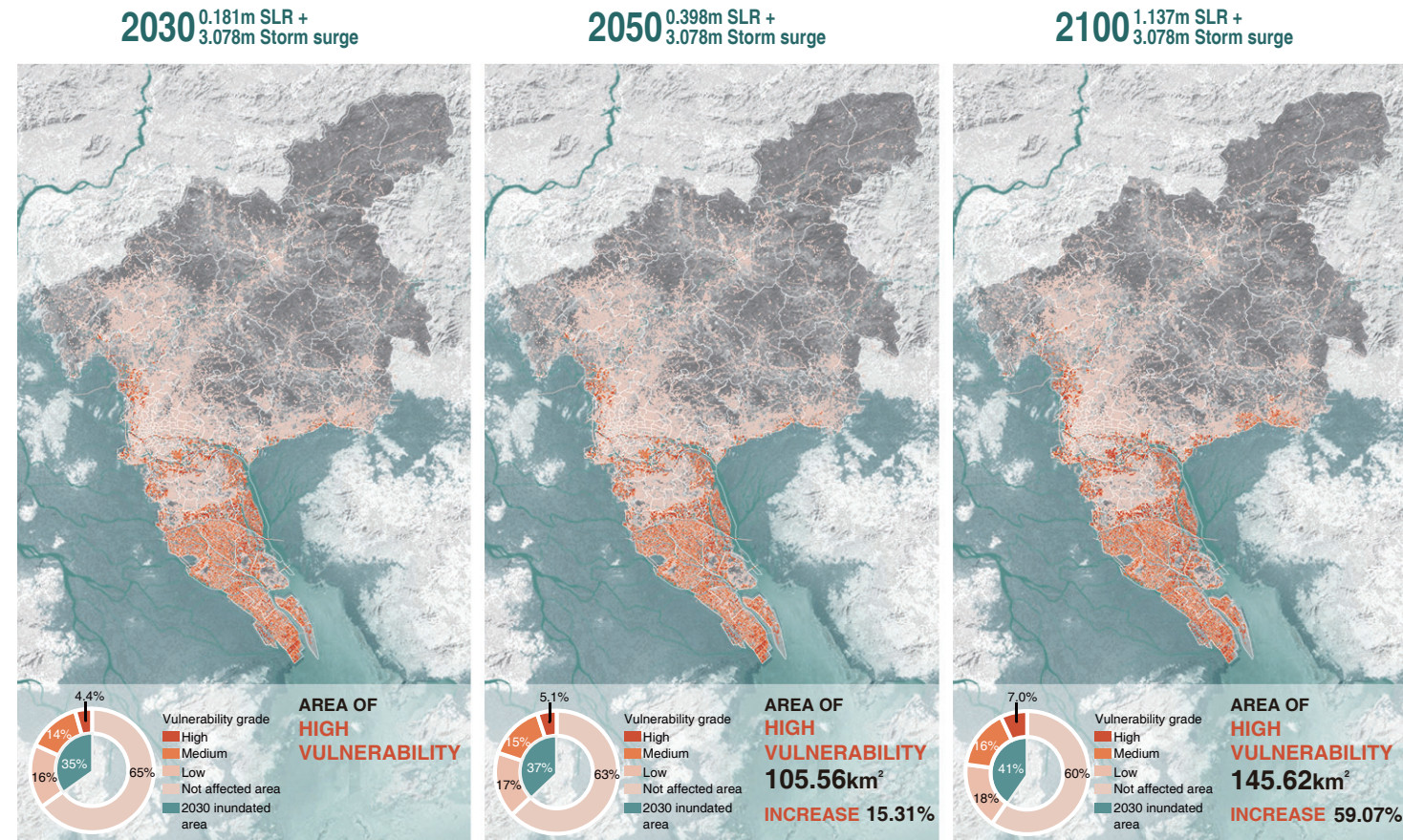


Receptor type	Pervious surface	Natural flood buffer	Medical capacity	Pre-retirement age	Evacuation routes	Industrial re-supply potential	Jurisdictional coordination	Temporary shelter availability	Retail-regional distribution
0.5	0	0	36	36	36	0	0	36	36
1.5	0	0	54	54	54	0	0	54	54
2	0	0	72	72	72	0	0	72	72
3	0	0	90	90	90	0	0	90	90
4	0	0	108	108	108	0	0	108	108
5	0	0	126	126	126	0	0	126	126
6	0	0	144	144	144	0	0	144	144

	Residential Economic losses \$151.6 Million		Commercial & public Economic losses \$700.2 Million
	Transportation Economic losses \$142.0 Million		Agriculture Economic losses \$16.29 Million
	Industrial Economic losses \$503.4 Million		Wetland & Urban park Economic losses \$60.5 Million

System type	Residential	Commercial & Public	Industrial	Agriculture	Transportation	Wetland & Urban park
1	0.5	30	36	28	14	56
2	1.5	48	54	42	21	84
3	2	60	72	56	28	112
4	3	90	108	84	42	168
5	4	120	144	112	56	224
6	5	150	180	140	70	280

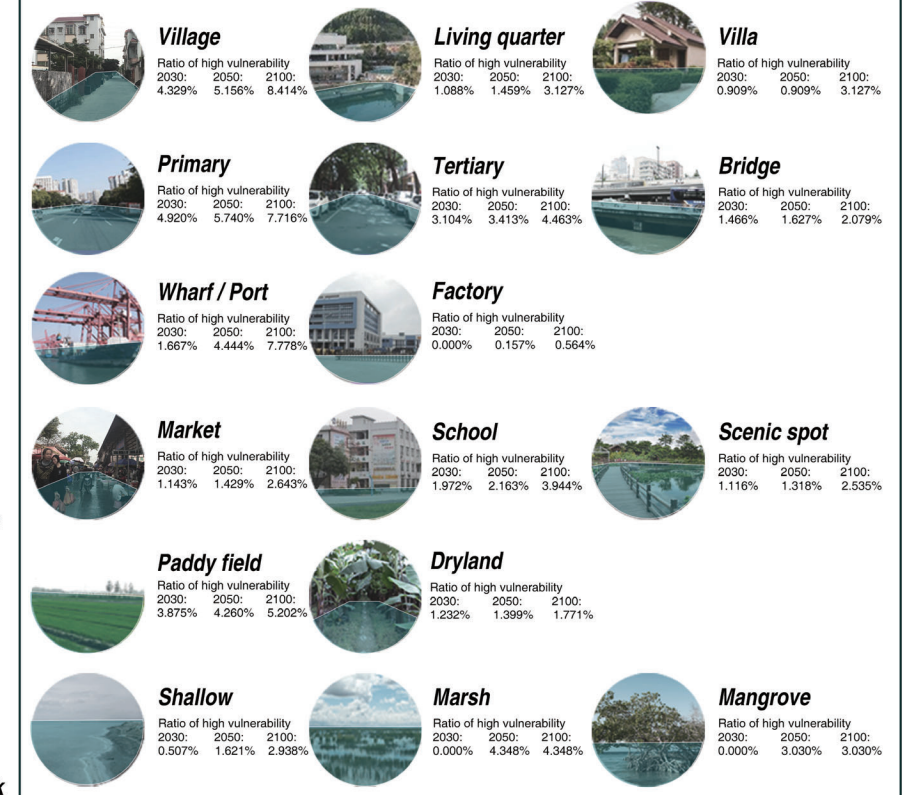
VULNERABILITY ASSESSMENT



URBAN SYSTEMS

- Residential
- Transportation
- Industrial
- Commercial & Public
- Agriculture
- Wetland & Urban park

SYSTEMS OF HIGH VULNERABILITY



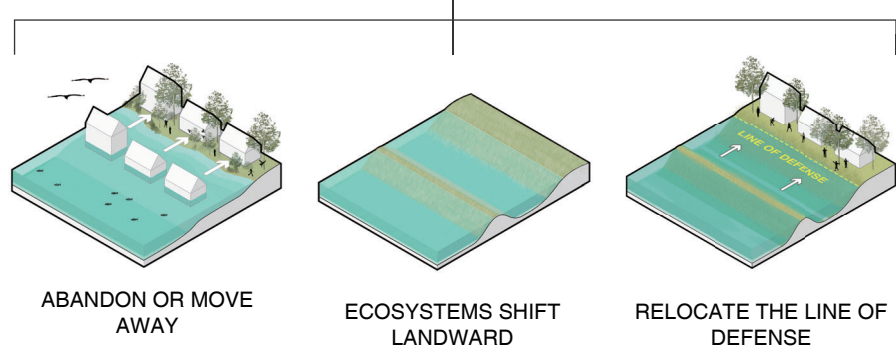
Ratio of high vulnerability of system(%)	Time stages		
	2030	2050	2100
System			
Residential			
Living quarter	1.088	1.459	3.127
Apartment	0.304	0.304	0.304
Villa	0.909	0.909	0.909
Village	4.329	5.156	6.414
Transportation			
Primary	4.920	5.704	7.176
Bridge	1.466	1.627	2.079
Motoway	1.118	1.241	1.619
Viaduct	0.527	0.608	0.729
Tertiary	3.104	3.413	4.463
Secondary	1.239	1.622	2.342
Gas station	1.081	1.216	1.757
Industrial			
Industrial park	0.000	0.000	0.000
Factory	0.000	0.157	0.564
Wharf / Port	1.997	3.444	7.778
Commercial & Public			
Hotel	0.298	0.352	1.056
Market	1.143	1.429	2.643
Restaurant	0.991	1.140	2.264
Maroon	0.455	0.700	1.959
Scenic spot	1.116	1.318	2.535
Hospital	1.045	1.241	2.221
Colleges	0.616	0.780	2.300
School	1.972	2.163	3.944
Agriculture			
Paddy field	3.875	4.260	5.202
Dryland	1.232	1.399	1.771
Wetland & Urban park			
Mangrove	0.000	3.030	3.030
Marsh	0.000	4.348	4.348
Urban park	0.000	0.000	0.366
Shallow	0.507	1.821	2.938



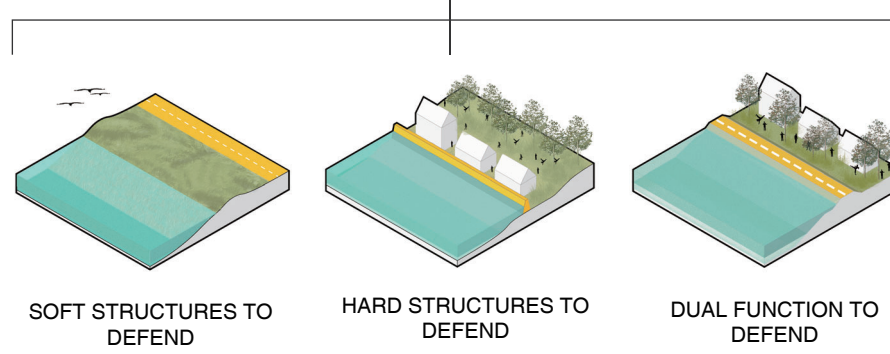
WHAT ARE THE OPTIONS



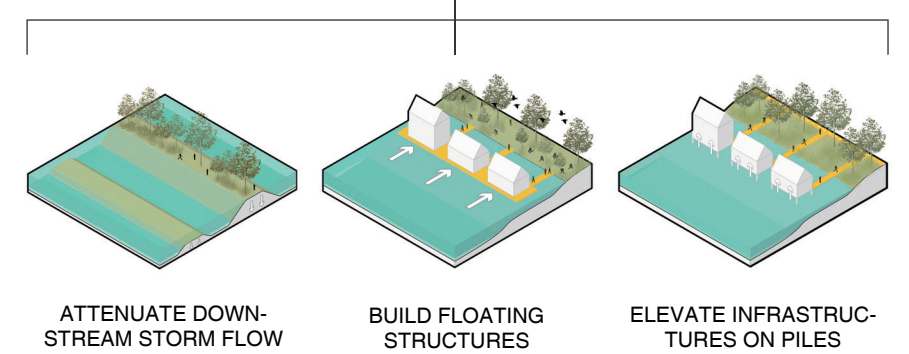
RETREAT MOVE TO HIGHER GROUND



DEFEND KEEP WATER OUT

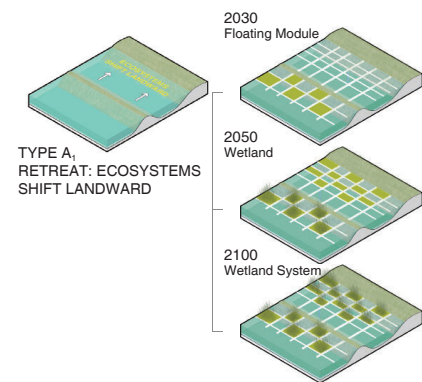


ADAPT LIVE WITH WATER

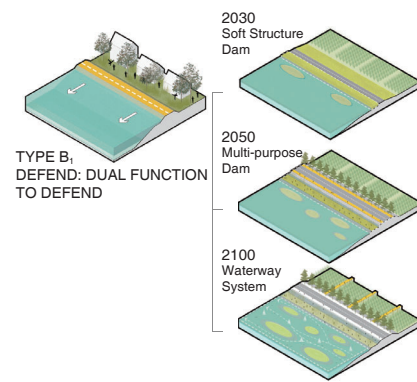


APPROACHES TO IMPROVE RESILIENCE

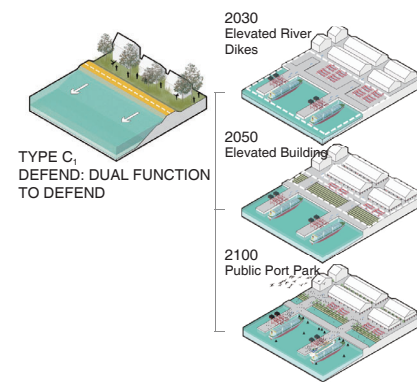
A. Weland & Urban Park



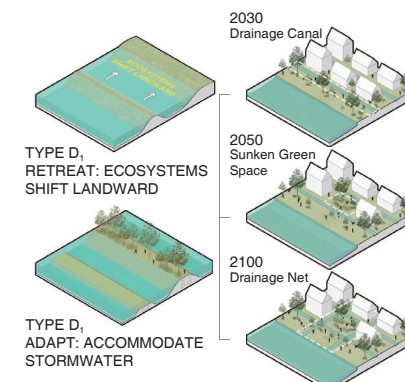
B. Transportation



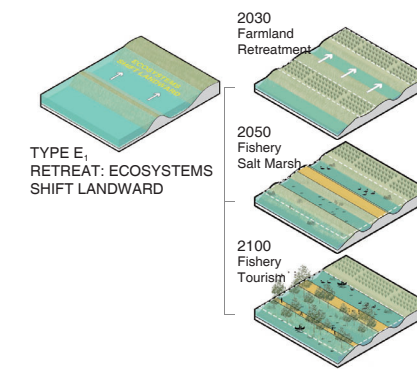
C. Industrial



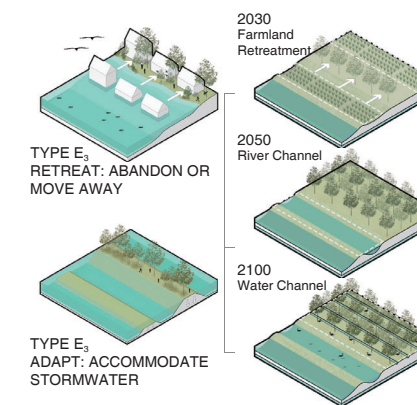
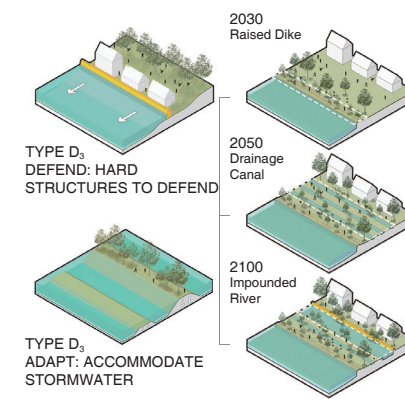
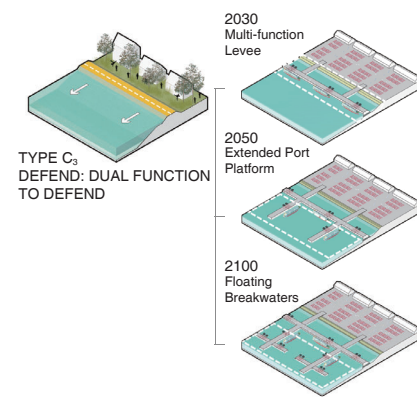
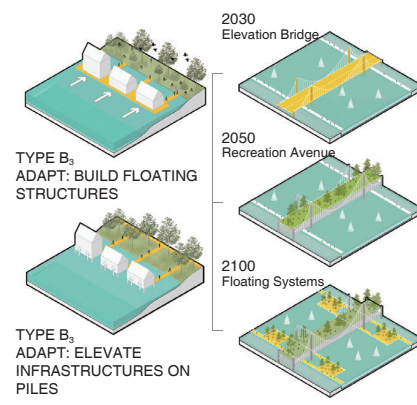
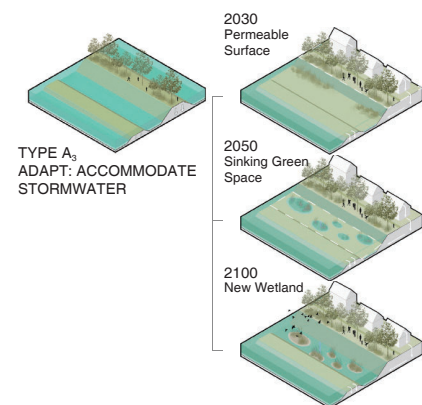
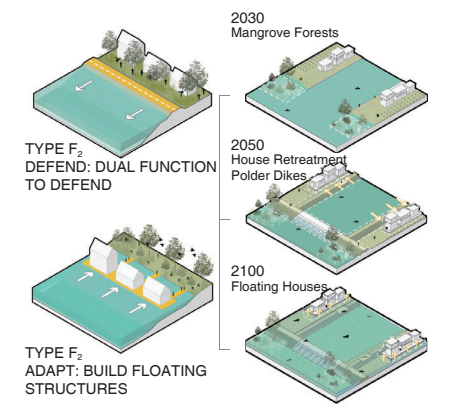
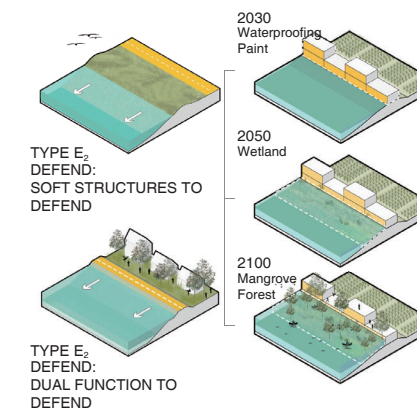
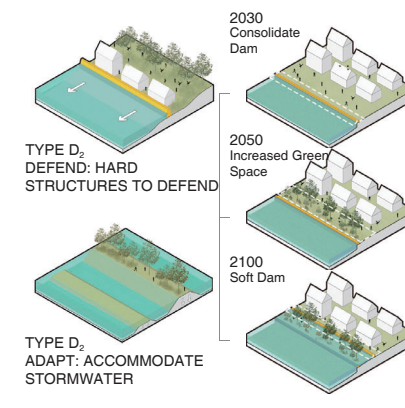
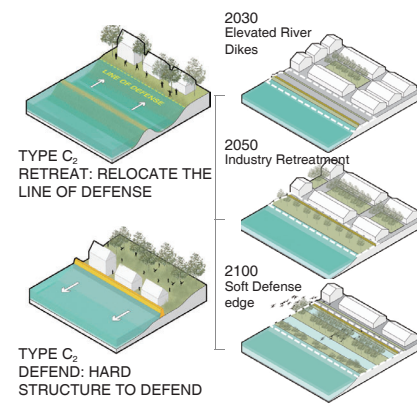
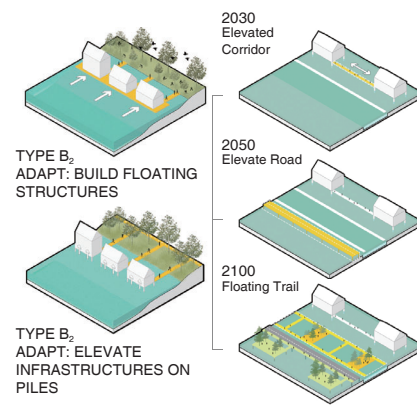
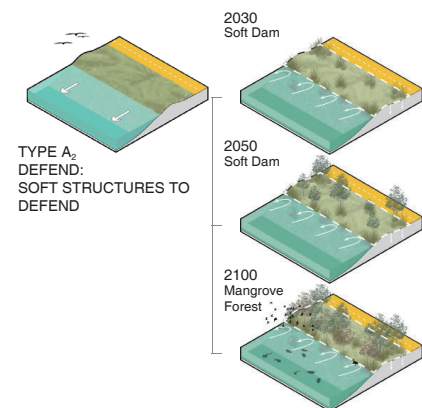
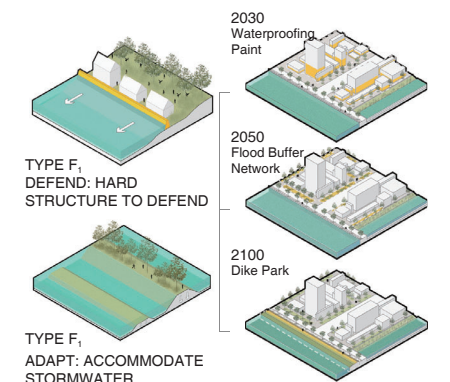
D. Commercial & Public



E. Agriculture



F. Residential





WETLAND & URBAN PARK SYSTEM—RETREAT

Island system
Through the sediment deposition of mangrove, island system will be established to perform as new coastal buffer.

2100 SLR+STORM SURGE
Establishing an island system as a new coastal buffer through the sediment deposition of mangrove.

2050 SLR+STORM SURGE
Connecting the urban park and new islands through the construction of plank road to provide more public space.

2030 SLR+STORM SURGE
Transforming the existing hard surface of coastal space and planting mangrove.

2100 SLR
2100 SLR+STORM SURGE

Permeability Coefficient:
only 5%~10% of runoff remain (5.7×10^{-10} m/s)
only 35%~40% of runoff remain (1.16×10^{-11} ~ 5.78×10^{-11} m/s)

Plant species: *Clasopharyngodon affinis*, *Cypripur calcar*, *Myriophyllum spicatum*, *Cinnamomum camphora*, *Avicennia marina*, *Ecovandora spicata*, *Albizia reticulata*, *Sonneratia caseolaris*

Impair flooding: *Clasopharyngodon affinis*, *Cypripur calcar*, *Myriophyllum spicatum*, *Cinnamomum camphora*

TRANSPORTATION SYSTEM—DEFEND

Waterway System
With the help of land reclamation, the waterway system will be formed.

2100 SLR+STORM SURGE
Providing habitats for animals and connecting people with nature through the waterway systems and wetland.

2030 SLR+STORM SURGE
Establishing a wetland system as resilient buffer to protect the existing transportation system and accelerating the situation by wetland.

2050 SLR+STORM SURGE
Building a multi-functional transportation system of 5-meter-high that will support the operation of traffic and provide public recreation space.

2100 SLR
2100 SLR+STORM SURGE

Permeability Coefficient:
only 40%~50% of runoff remain (5.78×10^{-11} ~ 1.16×10^{-10} m/s)
only 10%~20% of runoff remain (5.7×10^{-12} m/s)

Plant species: *Acacia salicina*, *Ecovandora spicata*, *Ulmus chinensis*, *Gardenia jasminoides*, *Cornus spicata*, *Albizia reticulata*

INDUSTRIAL SYSTEM—DEFEND

Mangrove Forest
The sedimentation of the mangrove will continuously increase the elevation of the edge to defend the storm surge.

2030 SLR+STORM SURGE
Decomposing the existing edge of port extending higher wetland apron, establishing mangrove system.

2050 SLR+STORM SURGE
Combining the tidal power plant with the new wetland apron to transform the risk of SLR into electricity resources.

2100 SLR+STORM SURGE
Developing the mangrove system and oyster breeding to strengthen the resilience buffer.

2100 SLR
2100 SLR+STORM SURGE

Permeability Coefficient:
only 10%~20% of runoff remain (5.7×10^{-11} m/s)
only 8%~45% of runoff remain (5.78×10^{-11} ~ 1.6×10^{-10} m/s)

Plant species: *Acacia salicina*, *Ecovandora spicata*, *Ulmus chinensis*, *Gardenia jasminoides*, *Cornus spicata*, *Albizia reticulata*

Benefits:
• Reduce the transportation time and cost
• A growing dam
• Wave impact reduction
• Water purification
• Annual output value: \$1.05x10⁶
• Daily power output: 354600KW-h
• Sedimentation reduction
• The accelerated discharge of water secured the seabed help to reduce the deposition
• Floating Breakwater
• Wave impact reduction: 90%
• Oyster shell
• Enriched hazardous substance
• Habitat for life

COMMERCIAL & PUBLIC SYSTEM—DEFEND + ADAPT

Drainage Canal
Humid plants help to increase retention capacity.

2030 SLR+STORM SURGE
Decomposing part of hard edge and reusing the concrete in the seabed to create new habitats for animals and aquatic plants.

2050 SLR+STORM SURGE
Improving rain and flood bearing capacity through expanding drainage system and using permeable pavements.

2100 SLR+STORM SURGE
Transforming some canals into the impounded river to adapt to storm surges while increasing biodiversity and creating new recreational spaces.

2100 SLR
2100 SLR+STORM SURGE

Permeability Coefficient:
only 10%~20% of runoff remain (5.7×10^{-11} m/s)
only 8%~45% of runoff remain (5.78×10^{-11} ~ 1.6×10^{-10} m/s)

Plant species: *Acacia salicina*, *Ecovandora spicata*, *Ulmus chinensis*, *Gardenia jasminoides*, *Cornus spicata*, *Albizia reticulata*

AGRICULTURE SYSTEM—RETREAT

Farmland
Use the floating grids as working spaces and plant saline-tolerant plants.

2100 SLR+STORM SURGE
Replacing salt marsh with mangrove while utilizing the floating working platforms to attract visitors and develop tourism.

2030 SLR+STORM SURGE
Retreating existing farmland that responds to seawater inundation and developing aquaculture.

2050 SLR+STORM SURGE
Planting salt marsh and reviving aquaculture after harvesting salt marsh.

2100 SLR
2100 SLR+STORM SURGE

Permeability Coefficient:
only 10%~20% of runoff remain (5.7×10^{-11} m/s)
only 8%~45% of runoff remain (5.78×10^{-11} ~ 1.6×10^{-10} m/s)

Plant species: *Acacia salicina*, *Ecovandora spicata*, *Ulmus chinensis*, *Gardenia jasminoides*, *Cornus spicata*, *Albizia reticulata*

Aquaculture: *Penaeus chinensis*, *Penaeus monodon*, *Penaeus vannamei*, *Penaeus chinensis*, *Penaeus monodon*, *Penaeus vannamei*, *Penaeus chinensis*, *Penaeus monodon*, *Penaeus vannamei*

RESIDENTIAL SYSTEM—DEFEND + ADAPT

Polders
The origin of polders lie in the re-vent and diking of individual parcels of land or groups of these, with more and dikes being dug and connected.

Floating House
Residential houses will float when seawater floods through the polder dikes.

Floating Road
Connecting with river dikes and floating house and proving space for infrastructure such as electricity supply, it works when flooding is coming.

2100 SLR+STORM SURGE
Converting some houses into floating structures.

2050 SLR+STORM SURGE
Retreating existing houses along the river, building dikes on the site of relocated houses, building new still houses.

2030 SLR+STORM SURGE
Planting mangrove to protect shoreline from damaging waves and floods.

2100 SLR
2100 SLR+STORM SURGE

Permeability Coefficient:
only 10%~20% of runoff remain (5.7×10^{-11} m/s)
only 8%~45% of runoff remain (5.78×10^{-11} ~ 1.6×10^{-10} m/s)

Plant species: *Acacia salicina*, *Ecovandora spicata*, *Ulmus chinensis*, *Gardenia jasminoides*, *Cornus spicata*, *Albizia reticulata*