Equitable-access flood modeling for timely & just adaptation in the near and long term

Katharine (Katie) J. Mach

Professor of Environmental Science & Policy, University of Miami Rosenstiel School & Abess Center

Brett F. Sanders

Professor of Civil & Environmental Engineering & Urban Planning & Public Policy, University of California, Irvine

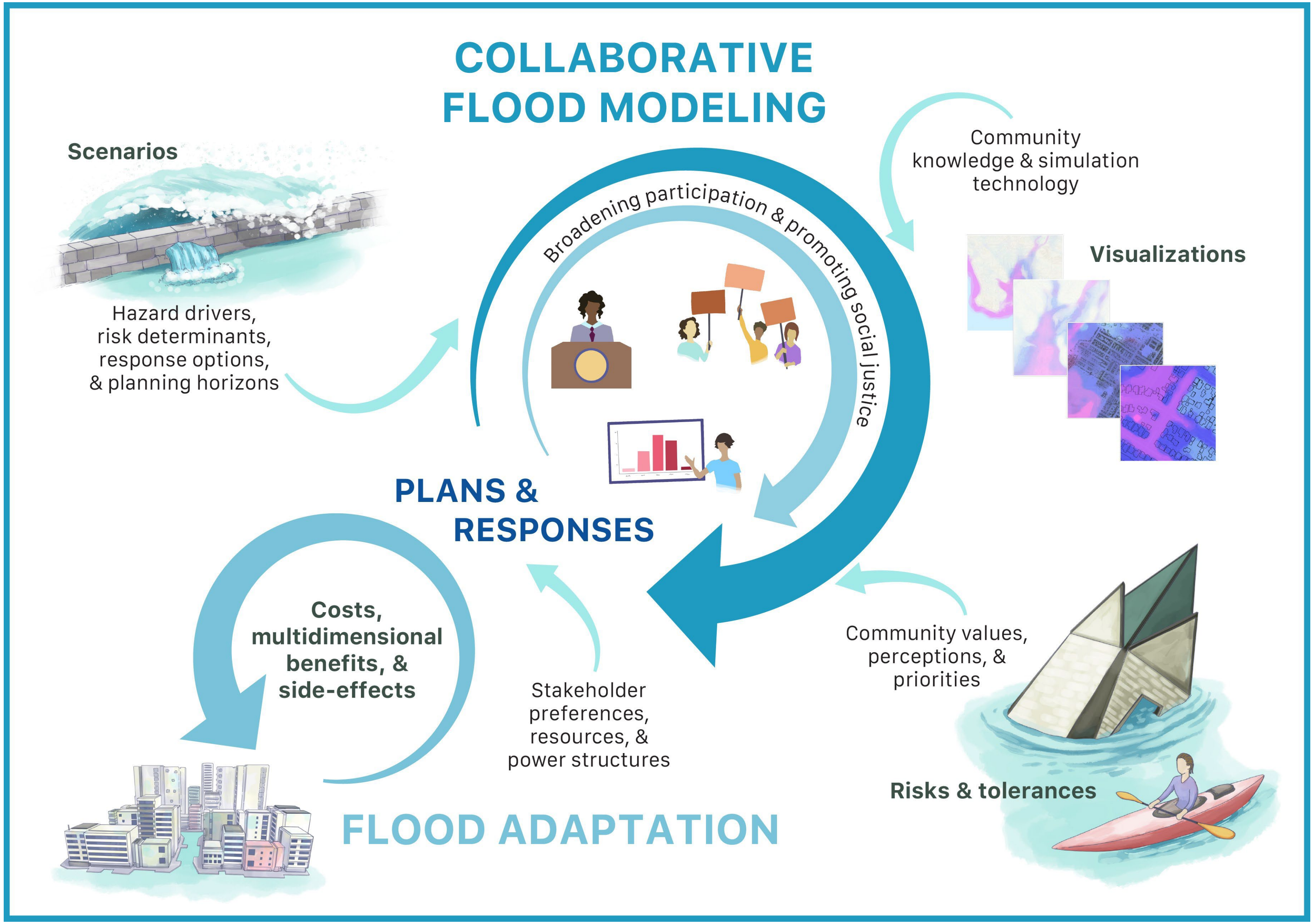
Research Team: J.E. Schubert, J. Niemann, K.K. Larson Mohr, D. Amini Baghbadorani, & E. Hamill

FloodRISE Miami

Motivation

- Resident & stakeholder participation is crucial to effective, equitable flood adaptation, yet extremely time intensive & challenging
- Most simulation software is too slow to support wide exploration of risks and coordination of responses
- New technology (e.g., PRIMo, SFINCS) enabling rapid fine-scale urban flood modeling may be transformational for equitable risk exploration & adaptation

FloodRISE Miami

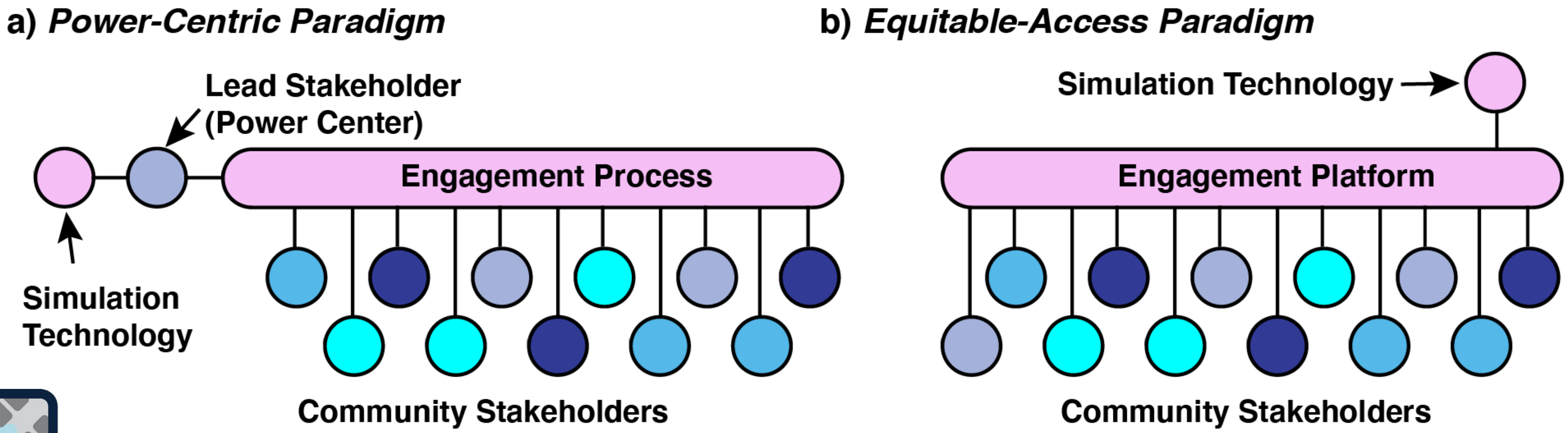


FloodRISE Miami

Mach et al. (2022).

Hypothesis

Shifting control over flood modeling will change the outcomes of adaptation



FloodRISE Miami

Theory of Change

	Task 1	Task 2	Task 3
	overcoming barriers to participation/representation	fast-response, interactive flood simulation	testing equitable-access paradigm
Activities	• baseline survey of MDC residents: flood awareness; preferences about responses and responsibility for them; perceptions of barriers/conflicts, engagement, and scenarios for flood adaptation • in-person collaborative flood modeling (CFM) by group, repeating survey and comparing to baseline	• PRIMo-Infrastructure development • CitizenLab simulation/engagement platform set up and pilot	• collaborative site selection • testing synchronous in-person CFM (targeted engagement) • testing asynchronous remote CFM (widespread engagement)
Assumptions	• residents and community stakeholders want to be engaged in flood adaptation • residents and community stakeholders desire capacity to explore potential flood adaptation solutions (i.e., propose ideas, see them tested) • fine-scale, rapid/interactive flood simulation is a technological gap (in representing local infrastructure and enabling interactivity) that limits flood adaptation • comparing baseline resident survey with CFM-participant survey is robust/meaningful		
Outputs	• baseline survey results • comparison with in-person CFM by group	• PRIMo updated (flood drivers, structures) and validated for MDC context, including analysis of flood risk changes under different interventions • CitizenLab platform functioning and refined for CFM	• site selected • synchronous in-person CFM (targeted engagement) evaluated, compared to baseline survey • asynchronous remote CFM (widespread engagement) evaluated, compared to baseline survey
Outcomes – Near-term (within 1-3 years)	• resident and professional perspectives about flood adaptation priorities, processes, and outcomes better understood—in their alignments/disagreements, including what motivates participation or not • potential for CFM versus existing local flood adaptation efforts preliminarily assessed (for improving shared awareness and shaping response preferences)	• understanding of user experiences with responsive, interactive flood simulation platform (i.e., user knowledge of flood hazards/risks/responses, consistency of user judgments informed by preferences, soundness of user inferences, platform limitations) • interactive flood simulation platform available for CFM at neighborhood to regional scale	• improved understanding of different forms of CFM (i.e., how in-person v. remote CFM reveals, changes, and balances preferences for flood adaptation across public/private sector and civil society)
Outcomes – Medium-term (within 3-5 years)	• support for implementation of tasks 2 and 3 • increased understanding of barriers to participation/representation in MDC	• support for implementation of task 3 • improved user experiences with flood simulation in task 3 • increased awareness of the potential for fast-response, interactive flood simulation for adaptation planning	• time- and resource-efficient identification of flood adaptation response options and pathways • flood adaptation responses better reflecting priorities and preferences esp. for underserved stakeholder groups • improved participant experiences in flood adaptation planning (e.g., inclusiveness, fairness, and transparency) • increased risk reduction and co-benefits and reduced side-effects for flood adaptation responses
Aims/Impacts	• regional flood adaptation planning processes become more time-efficient and empower underserved residents and professionals • participation in flood adaptation planning increases and is sustained • regional flood adaptation plans are effective in risk reduction, with more benefits for other priorities and fewer side-effects • equitable-access paradigm piloted at MDC community scale replicated elsewhere (nationally, internationally)		

Theory of Change

	Task 1	Task 2	Task 3
	overcoming barriers to participation/representation	fast-response, interactive flood simulation	testing equitable-access paradigm
Activities	• baseline survey of MDC residents: flood awareness; preferences about responses and responsibility for them; perceptions of barriers/conflicts, engagement, and scenarios for flood adaptation • in-person collaborative flood modeling (CFM) by group, repeating survey and comparing to baseline	• PRIMo-Infrastructure development • CitizenLab simulation/engagement platform set up and pilot	• collaborative site selection • testing synchronous in-person CFM (targeted engagement) • testing asynchronous remote CFM (widespread engagement)

Long-term aims:

- more time-efficient flood adaptation planning, empowering underserved residents & professionals
- increased participation in flood adaptation planning
- flood adaptation effective in risk reduction, with more benefits for other priorities
- transferable equitable-access paradigm

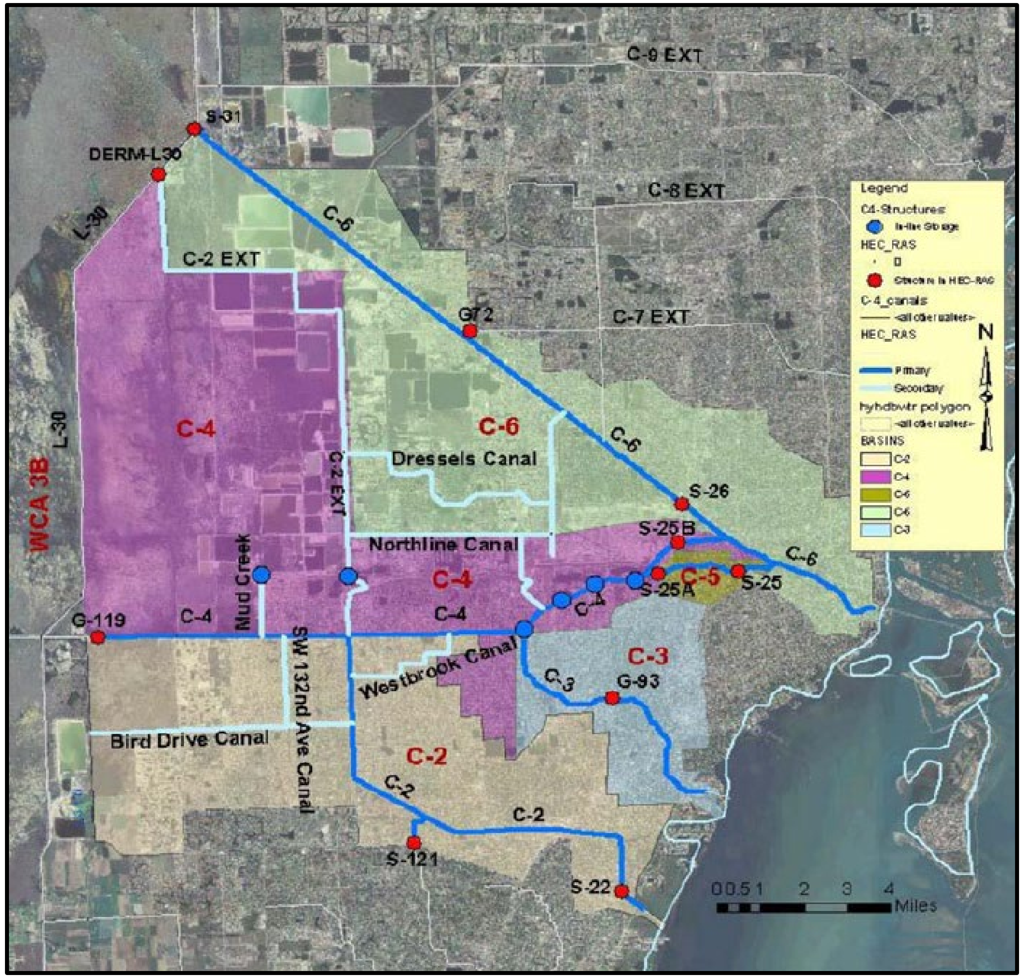
Evaluating experiences of all participants to support course corrections

		Task 1	Task 2	Task 3
Outcomes		awareness and shaping response preferences)	neighborhood to regional scale	
	Medium-term (within 3-5 years)	• support for implementation of tasks 2 and 3 • increased understanding of barriers to participation/representation in MDC	• support for implementation of task 3 • improved user experiences with flood simulation in task 3 • increased awareness of the potential for fast-response, interactive flood simulation for adaptation planning	• time- and resource-efficient identification of flood adaptation response options and pathways • flood adaptation responses better reflecting priorities and preferences esp. for underserved stakeholder groups • improved participant experiences in flood adaptation planning (e.g., inclusiveness, fairness, and transparency) • increased risk reduction and co-benefits and reduced side-effects for flood adaptation responses

Aims/Impacts

- regional flood adaptation planning processes become more time-efficient and empower underserved residents and professionals
- participation in flood adaptation planning increases and is sustained
- regional flood adaptation plans are effective in risk reduction, with more benefits for other priorities and fewer side-effects
- equitable-access paradigm piloted at MDC community scale replicated elsewhere (nationally, internationally)

Identification of project focus area with partners

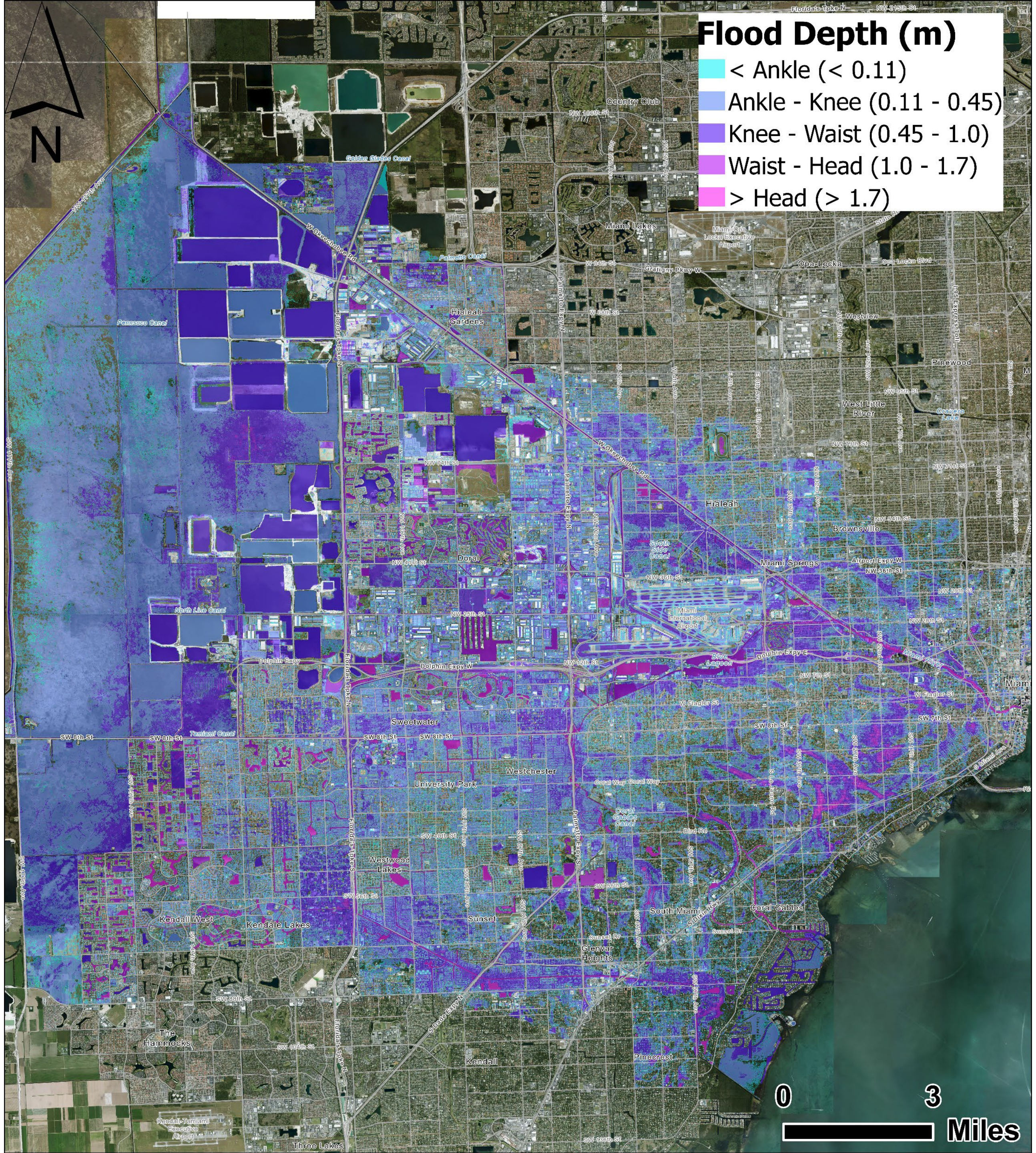


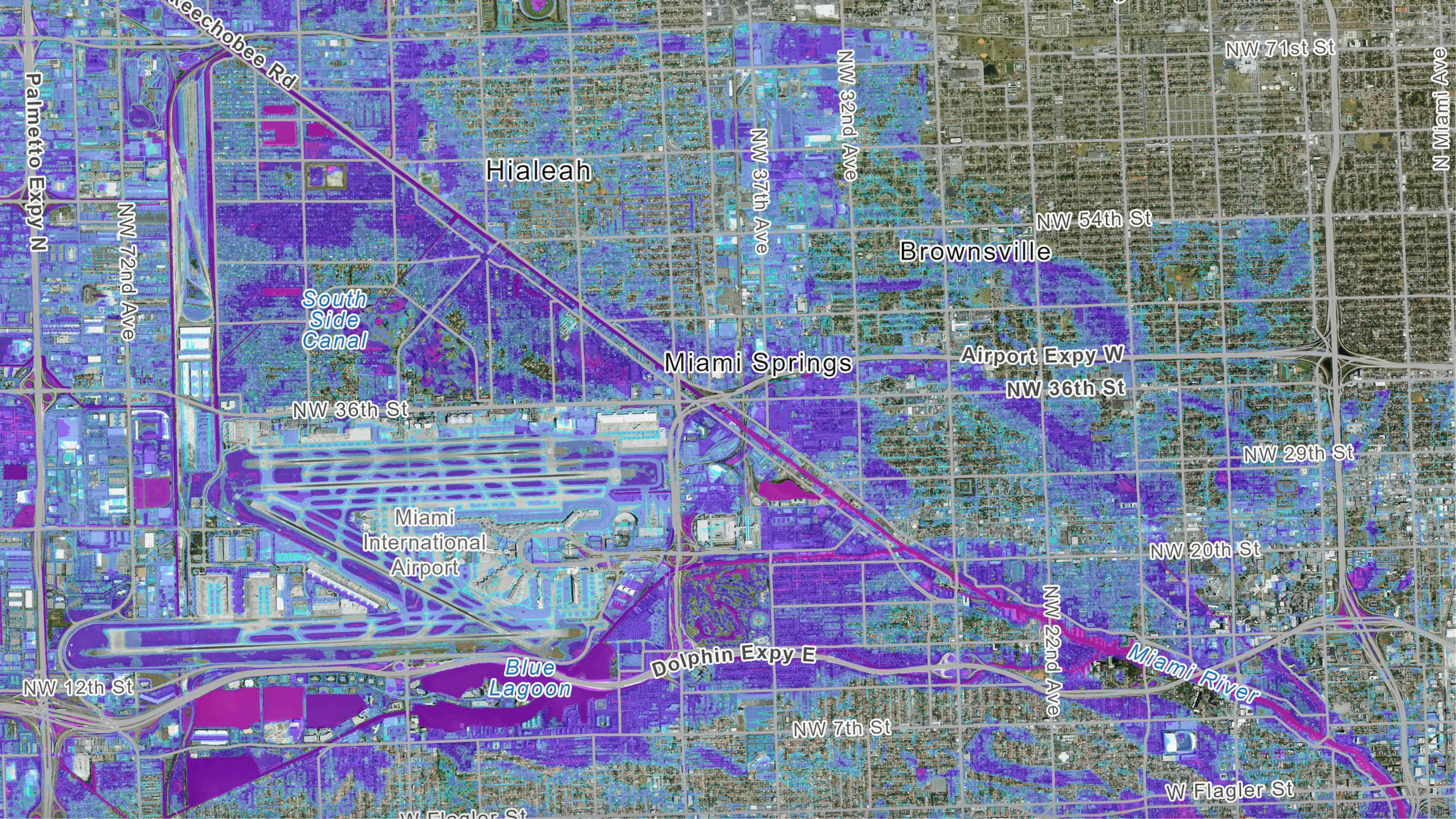
PRIMo model simulation & validation

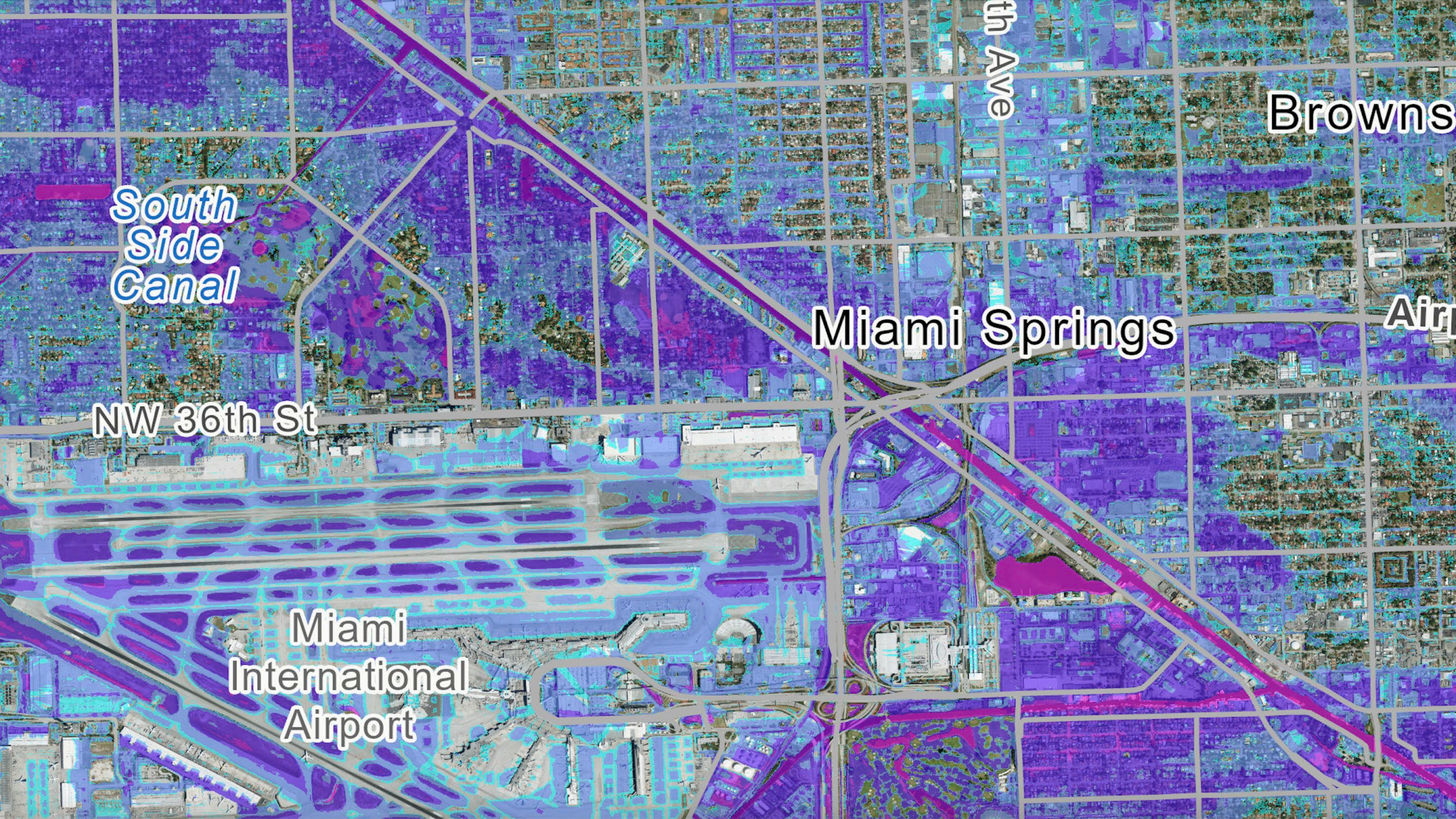
here: 24 hr spatially uniform rainfall depth of 378 mm (14.8 inches) across C2-C6 region. Coastal boundary condition is MHHW.

24 hr simulation at 1.5 m resolution in 20 minutes

validation underway: comparisons to gage data and other models; refinement of model structure (e.g., the inclusion of canal gates, pumps, & exfiltration trenches)




Okeechobee Rd
Palmetto Expy N
NW 72nd Ave
Hialeah
NW 37th Ave
NW 32nd Ave
NW 71st St
N Miami Ave
NW 54th St
Brownsville
South Side Canal
Miami Springs
Airport Expy W
NW 36th St
NW 36th St
NW 29th St
Miami International Airport
NW 20th St
NW 22nd Ave
Miami River
Dolphin Expy E
Blue Lagoon
NW 12th St
NW 7th St
W Flagler St
W Flagler St



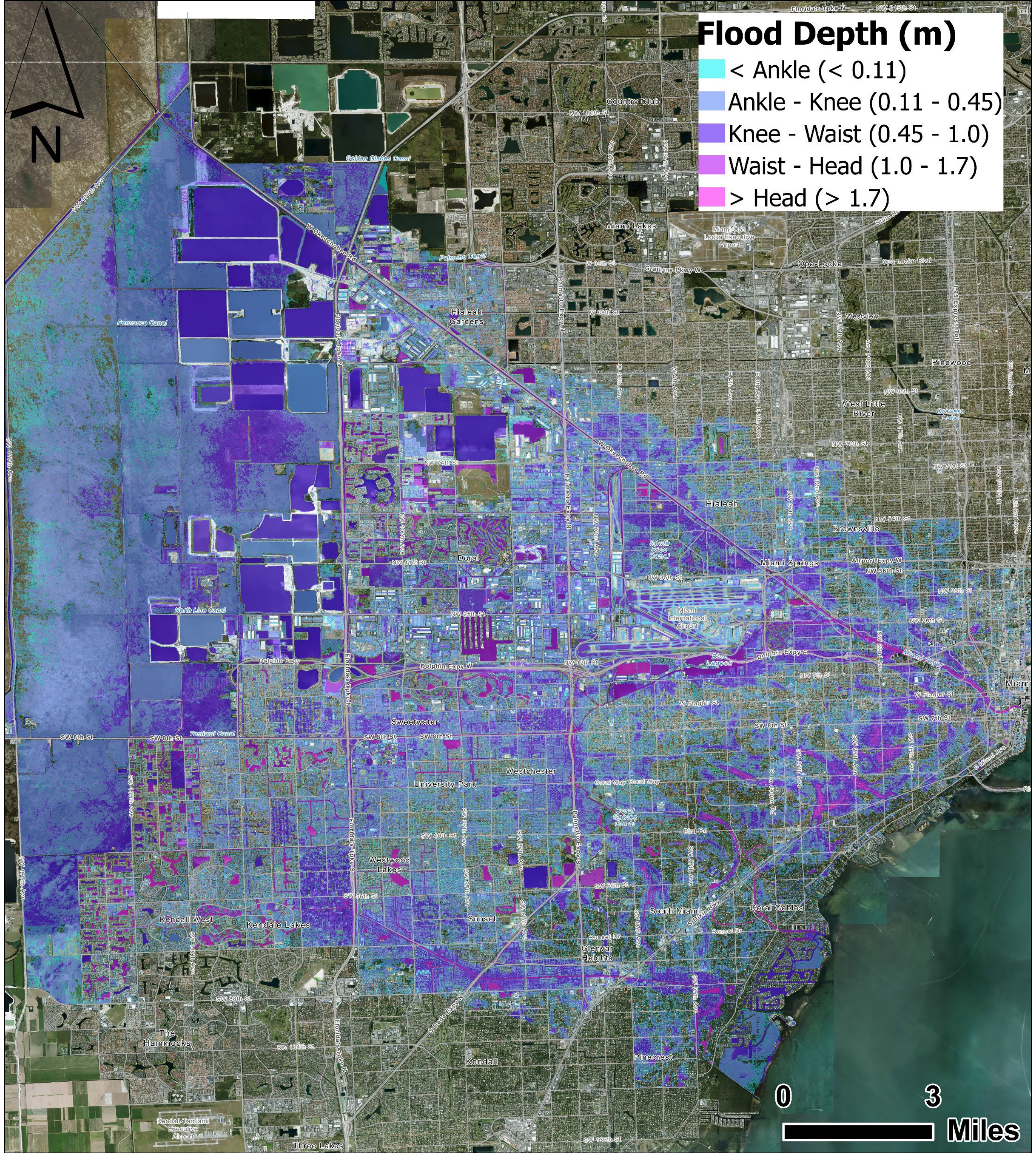
South Side Canal
NW 36th St
Miami Springs
Miami International Airport

PRIMo model simulation & validation

here: 24 hr spatially uniform rainfall depth of 378 mm (14.8 inches) across C2-C6 region. Coastal boundary condition is MHHW.

24 hr simulation at 1.5 m resolution in 20 minutes

validation underway: comparisons to gage data and other models; refinement of model structure (e.g., the inclusion of canal gates, pumps, & exfiltration trenches)

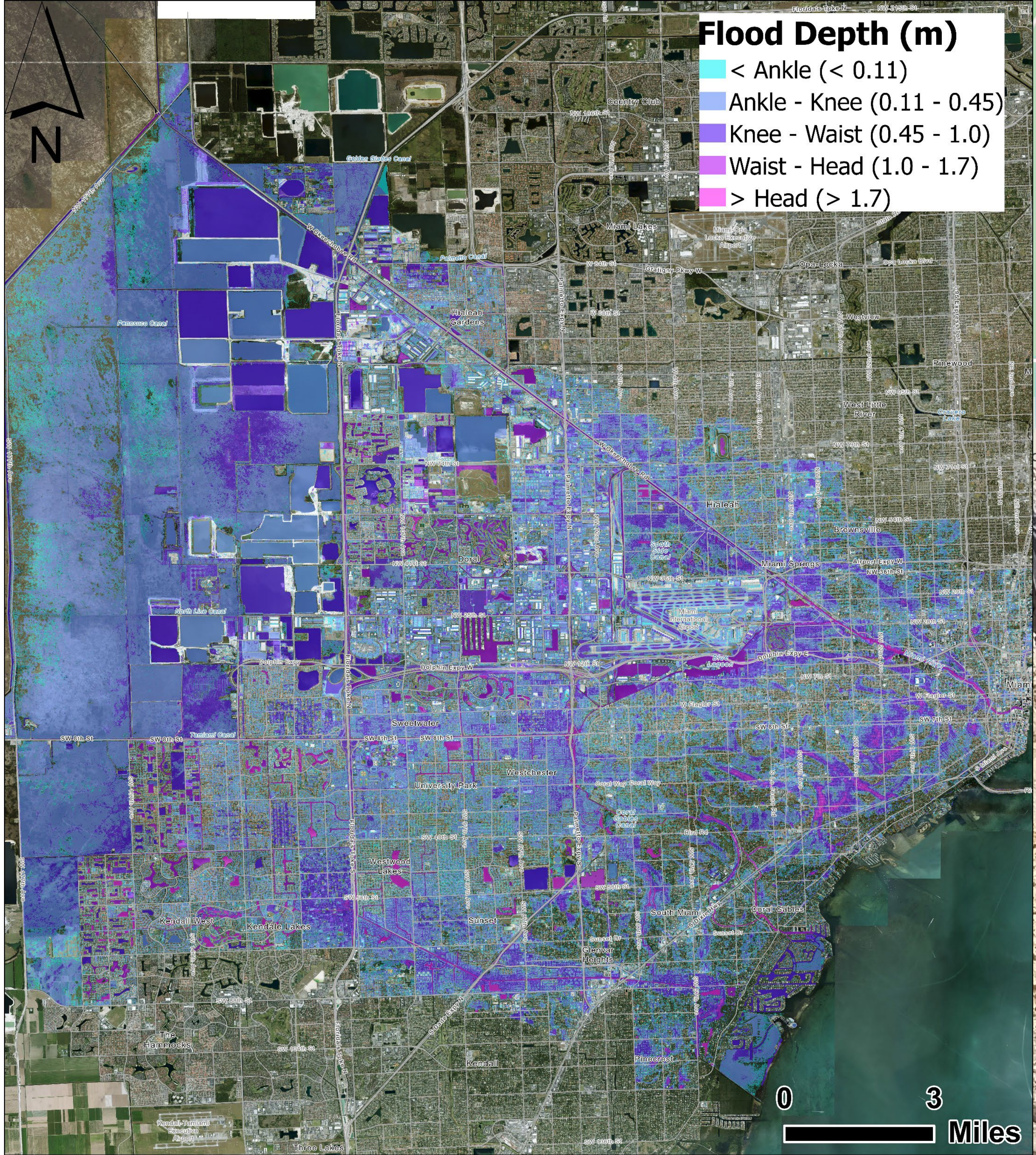


Preliminary PRIMo model simulations

what if?:

more injection wells & exfiltration trenches result in ***10% less runoff***

future work will consider routing of infiltration & exfiltration flows to canals using PRIMo



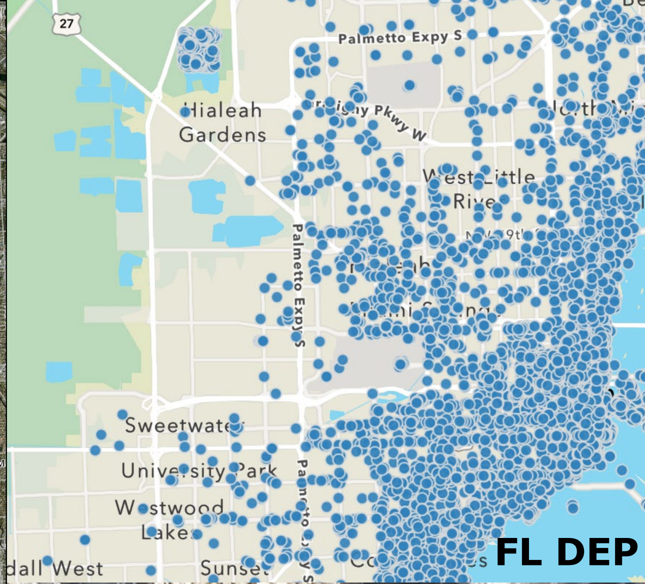


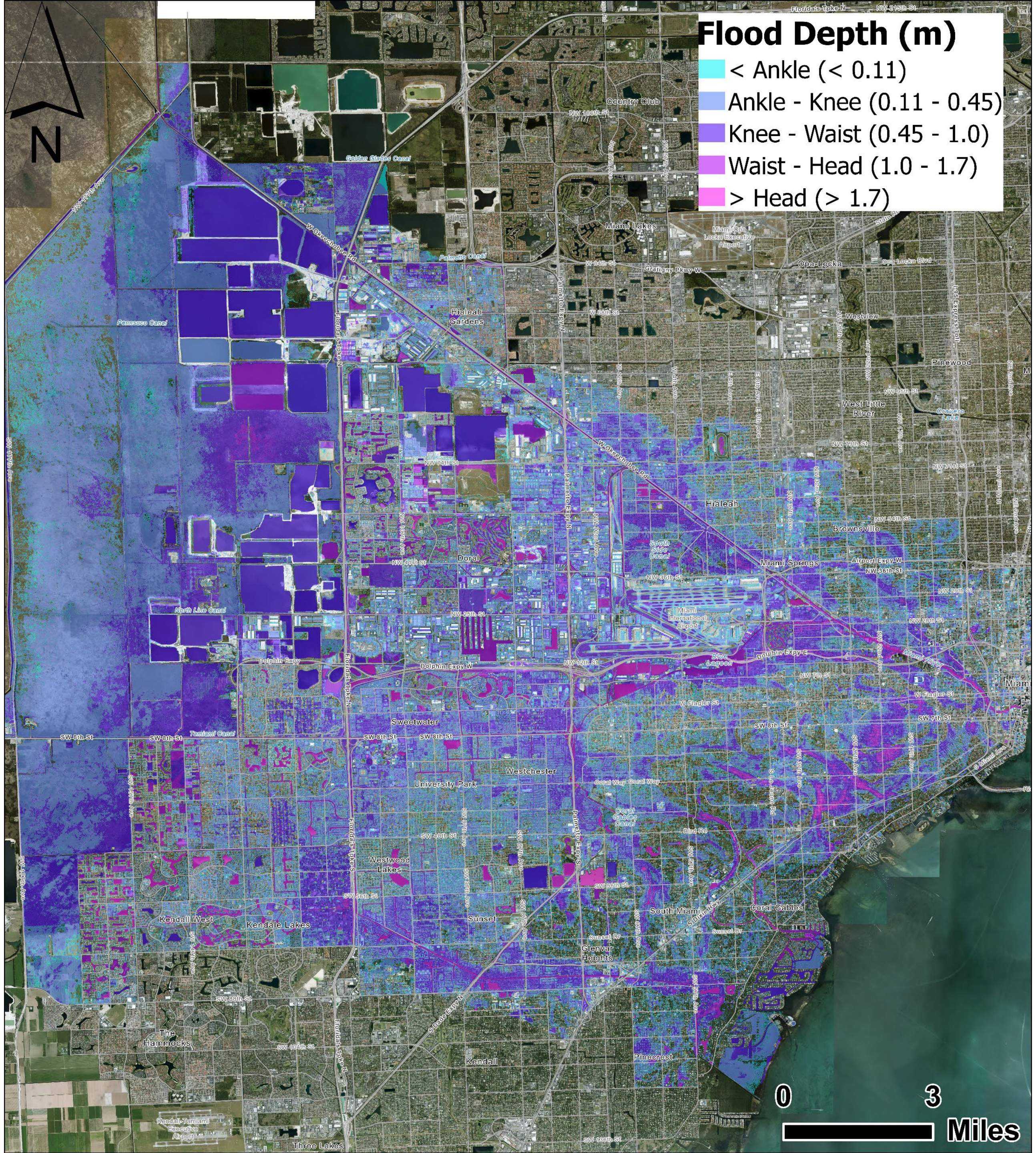
Photo: M. Sukop

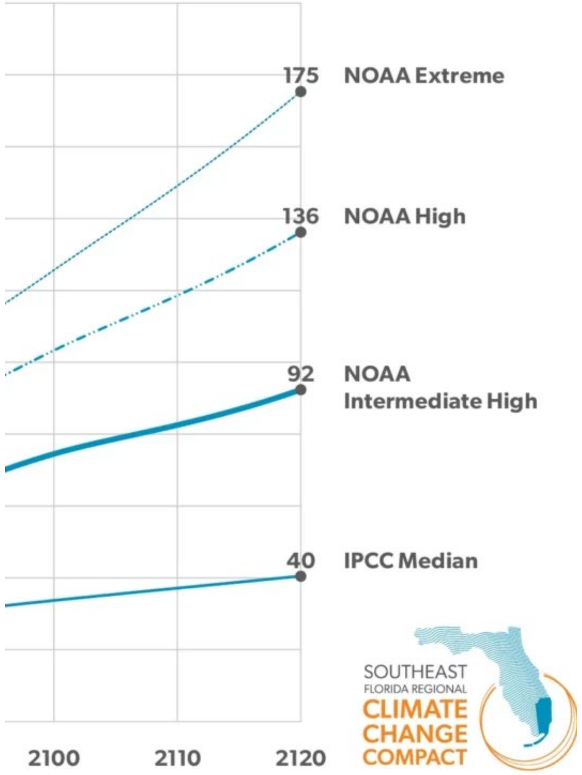
Preliminary PRIMo model simulations

what if?:

higher future groundwater levels result in ***10% more runoff***

future work will consider resolving the effect of a changing groundwater table on PRIMo simulated runoff

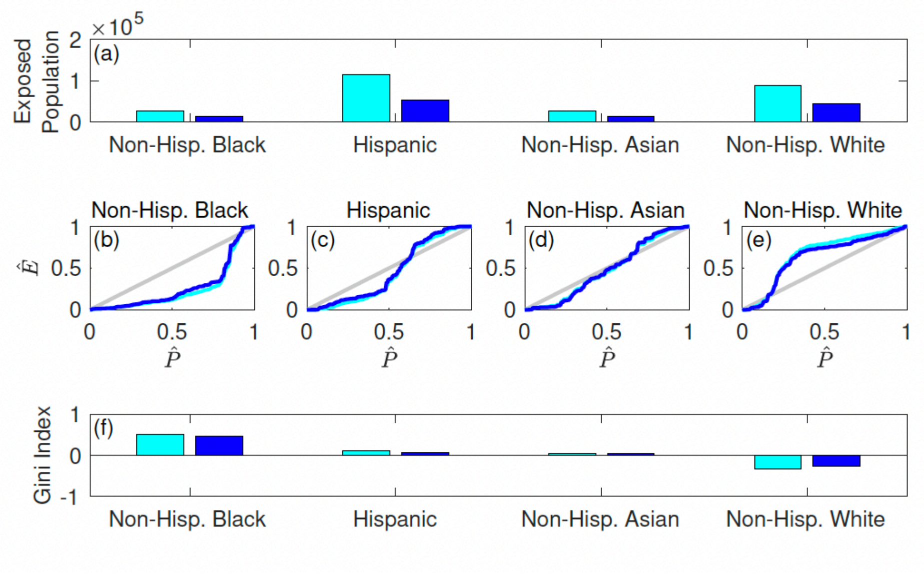


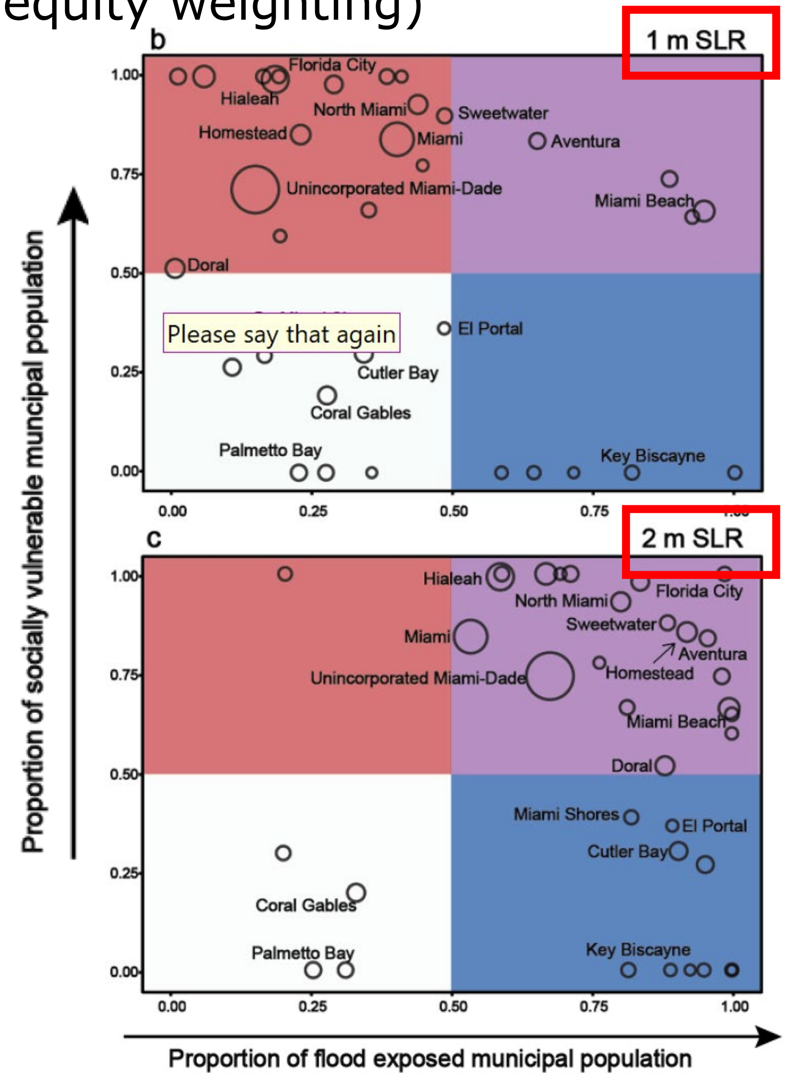


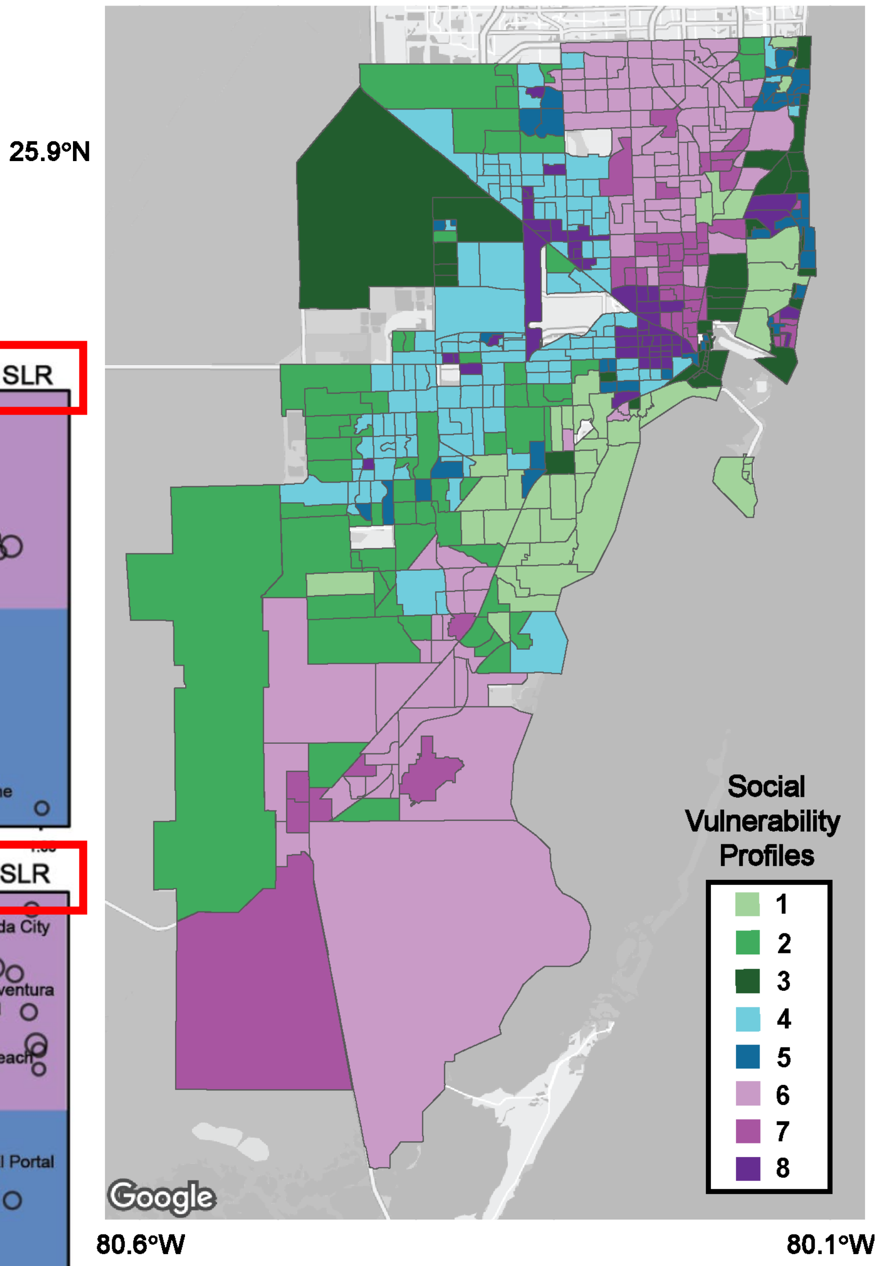
Estimating flood risks with PRIMo & testing solutions

- Exposed population (with equity measures)
- Exposed properties (with & without equity weighting)
- Exposed critical assets
- Exposed roadways
- Municipal exposures

- *Exploring use of Delft-FIAT*

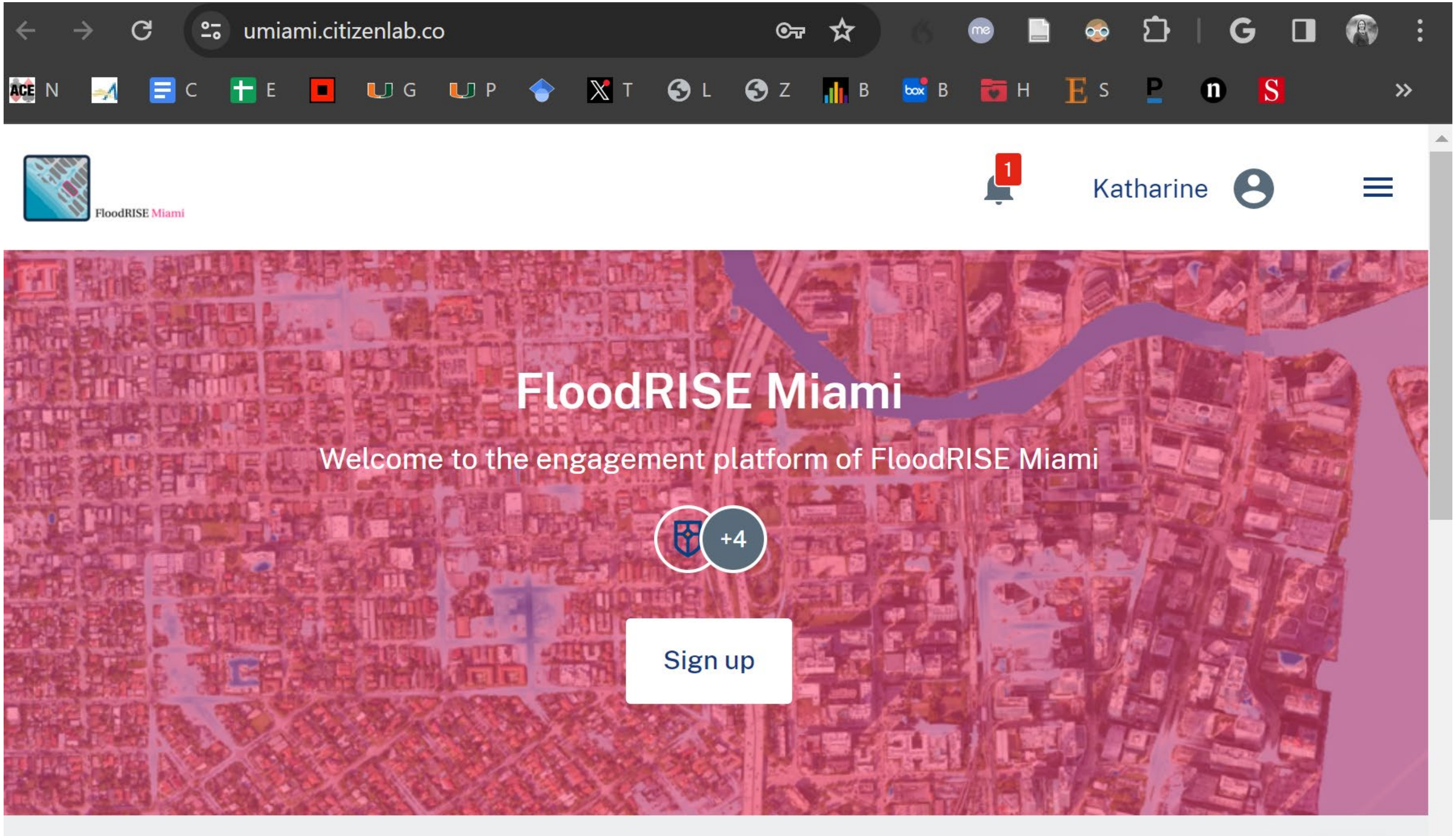






Sanders et al. (2022) *Nature Sustainability*, Seeteram et al. (2023) *ERL* & *CRM*

Interactive platform for collaborative flood modeling



Establishing a baseline for testing effects of collaborative flood modeling

Miami-Dade County flood risk/response representative survey (via Ipsos)

Question areas:

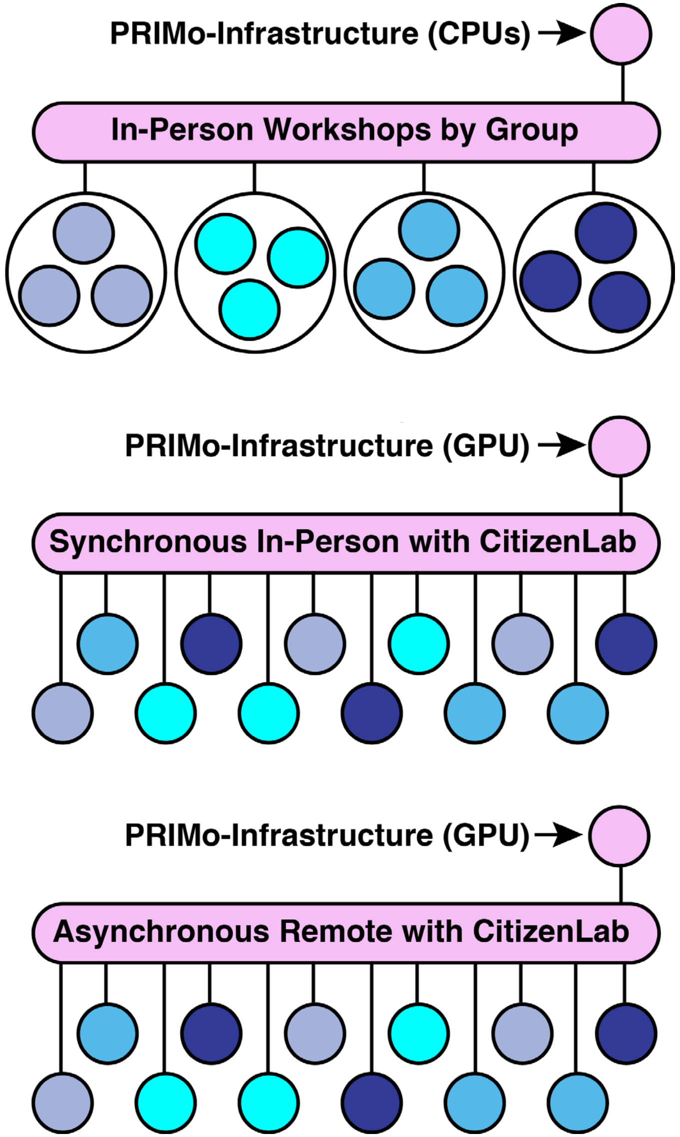
- Flood risk perceptions
  - likelihood and consequences across flood drivers and spatial scales
  - changes through time
- Flood preparedness
  - household and community perceptions and actions
  - level of engagement/participation
  - perceptions of responsibilities (public, private, civil society)
  - perceptions of effectiveness and trust of government
  - preferred responses
- Information sources

Putting these pieces together to test collaborative flood modeling

- Piloting collaborative flood modeling & comparing outcomes to baseline
- Testing collaborative flood modeling at scale (***in-person*** and ***digital*** engagement)

Can fast-response, equitable-access flood simulation…

- shorten adaptation planning <u>timelines</u>?
- improve resident and stakeholder <u>experiences</u>?
- enhance project <u>outcomes</u> in near & long term?



FloodRISE Miami