Assessing Urban Flood Risk in a Changing Climate

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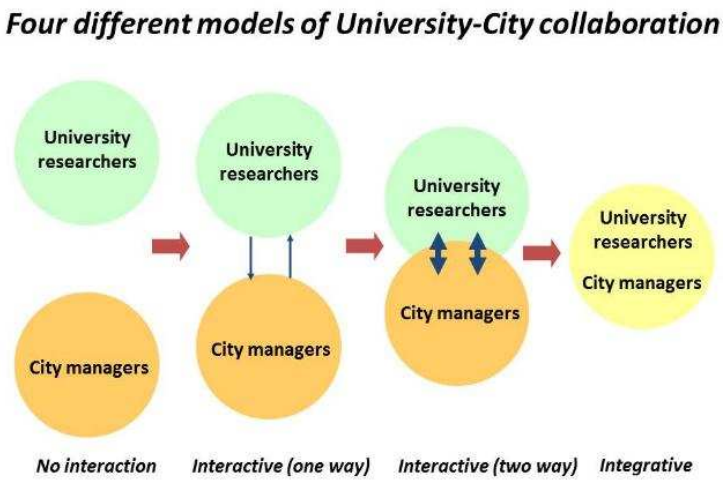
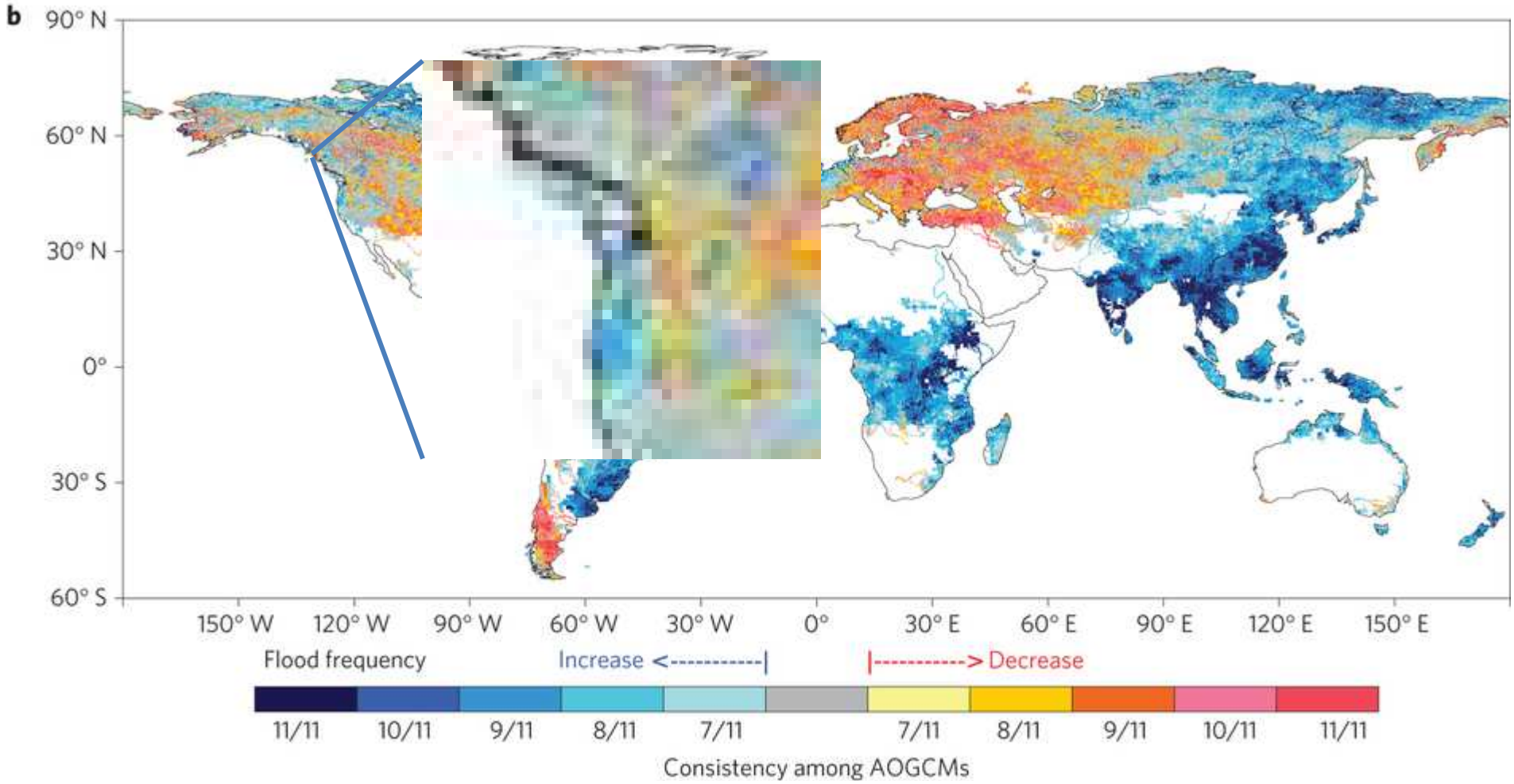
PROJECT BACKGROUND

City interest	PSU interest
Climate Action Plan (2015)	Interdisciplinary Climate Res.
Interest in regional sustainability	Ongoing study in the Willamette
BES modeling efforts	Hydrologic and hydraulic modeling
Future climate impacts	Vulnerability analysis



CHANGE IN FLOOD FREQUENCY



Source: IPCC 5th assessment report (2014)

CHANGES IN SEA LEVEL RISE (SRL)

Changes in Regional SLR will exacerbate flow increases

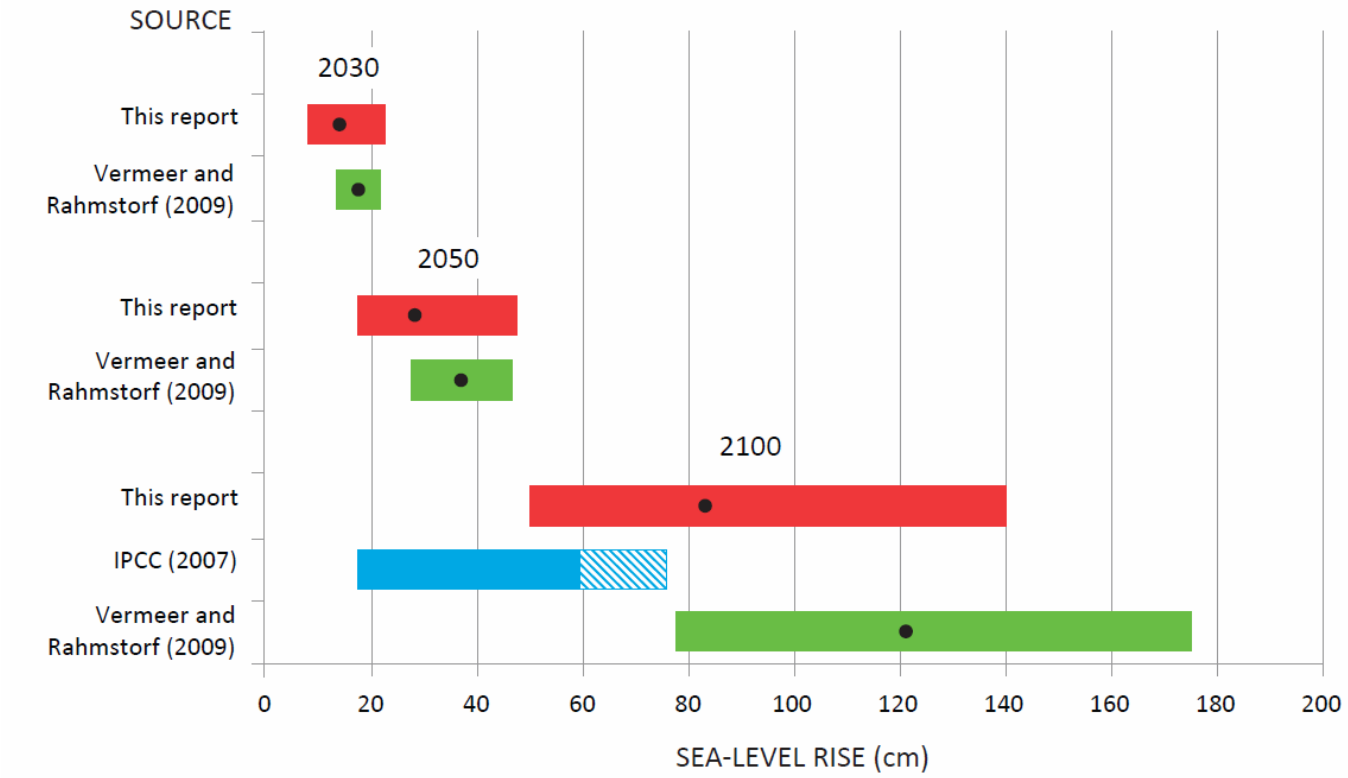
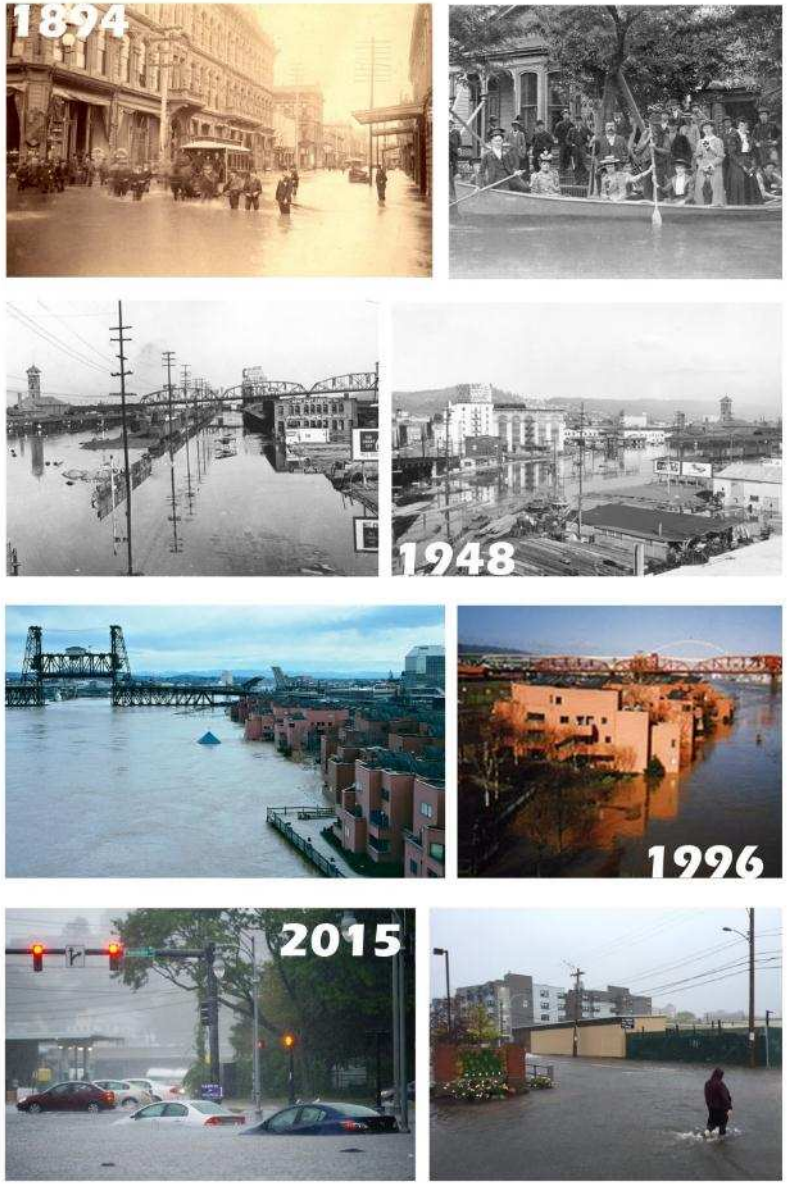


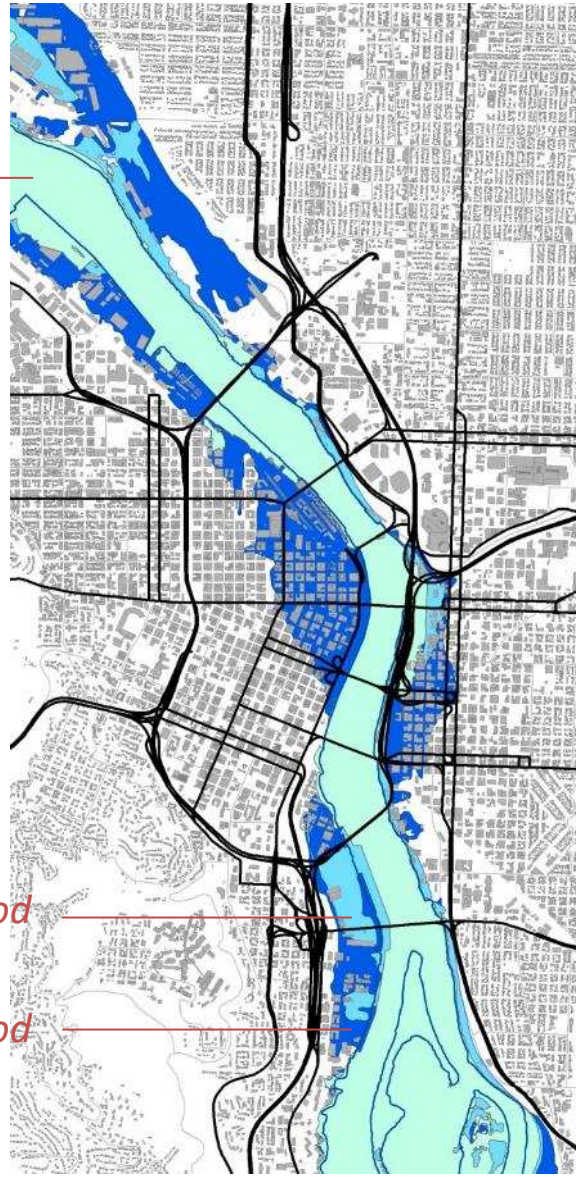
FIGURE 5.6 Global sea-level rise for 2030, 2050, and 2100 projected by this committee (red), Vermeer and Rahmstorf (2009; green), and IPCC (2007; blue). The dots are the projected values and the colored bars are the ranges. The IPCC value includes the sea-level projection (blue) plus the scaled-up ice sheet discharge component (blue diagonal lines).

Source: *National Research Council,*[2012]

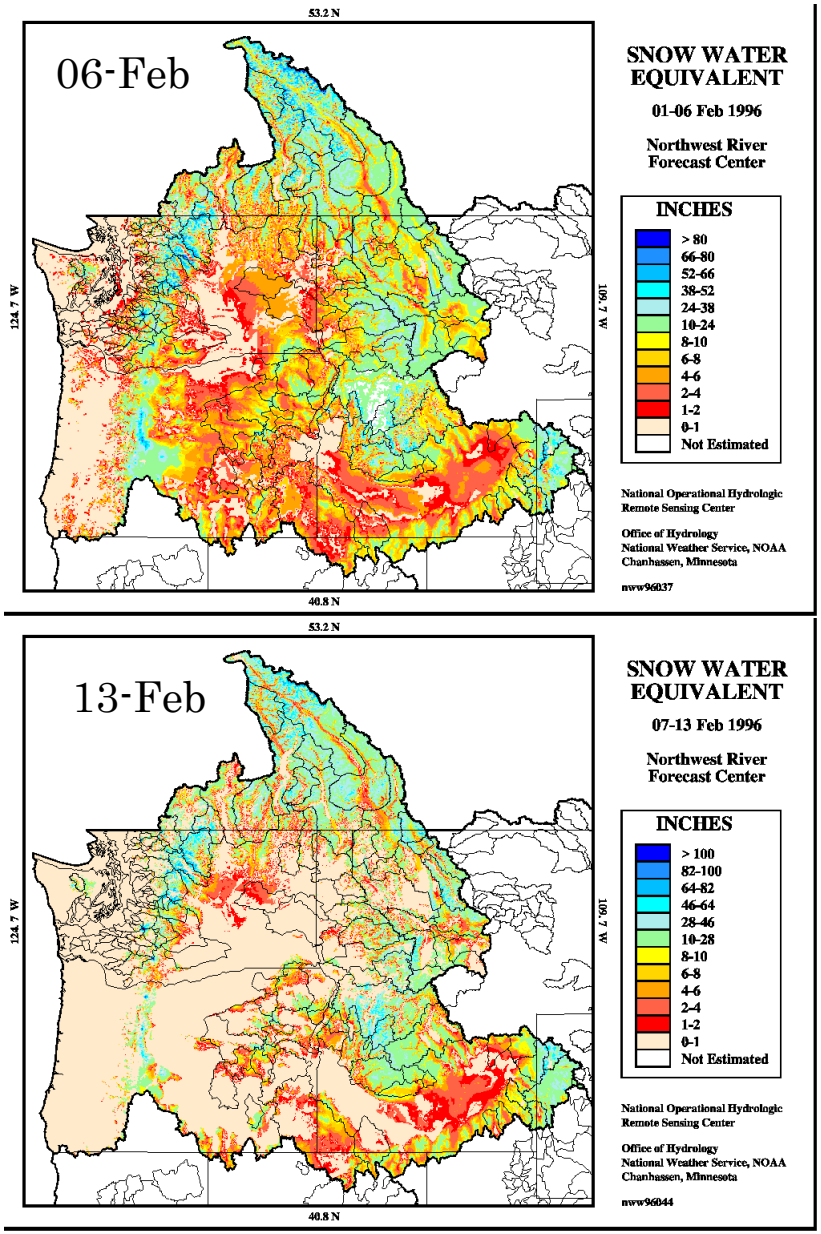
NRC used as a guideline for future SLR estimates

HISTORICAL FLOODS IN PORTLAND





FEBRUARY 1996 FLOODS



http://www.nwrfc.noaa.gov/rfc/

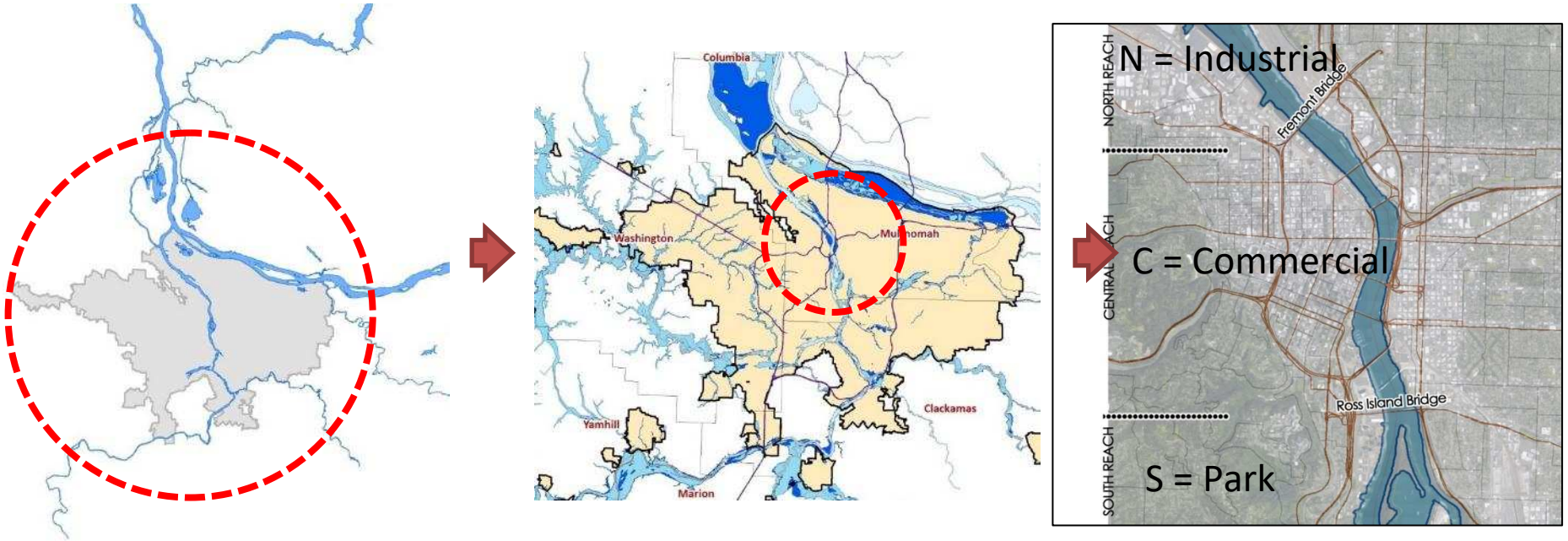
Rain-on-snow event produced disastrous flooding

Between 06-Feb and13-Feb most of the snowpack melted to streamflow

https://upload.wikimedia.org/wikipedia/commons/9/97/Flood_in_Portland_Feb_1996_-_area_NW_of_Steel_Bridge.jpg

RESEARCH OBJECTIVE

To assess flood risk along the *mainstem* of the Willamette River within the City of Portland, Oregon under different upstream flow change and sea level rise scenarios



RESEARCH QUESTIONS

1. What is the current vulnerability of flood risk along the mainstem of the Willamette River?

2. How do the flood water level and spatial extent of floods shift under different flow and sea level rise scenarios?

3. Where are the hotspots of vulnerability and how many buildings will be affected under different scenarios?

METHODS

Literature Review

Identification of Indicators

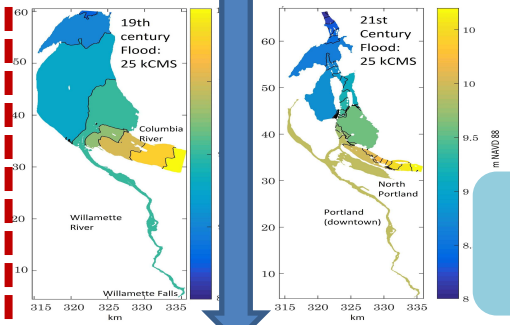
qualtrics

Expert Survey

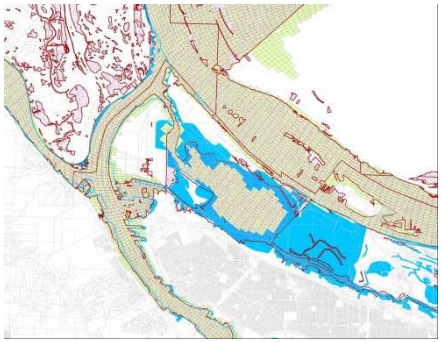
Stakeholder Consultation

Vulnerability analysis

Flood area Mapping

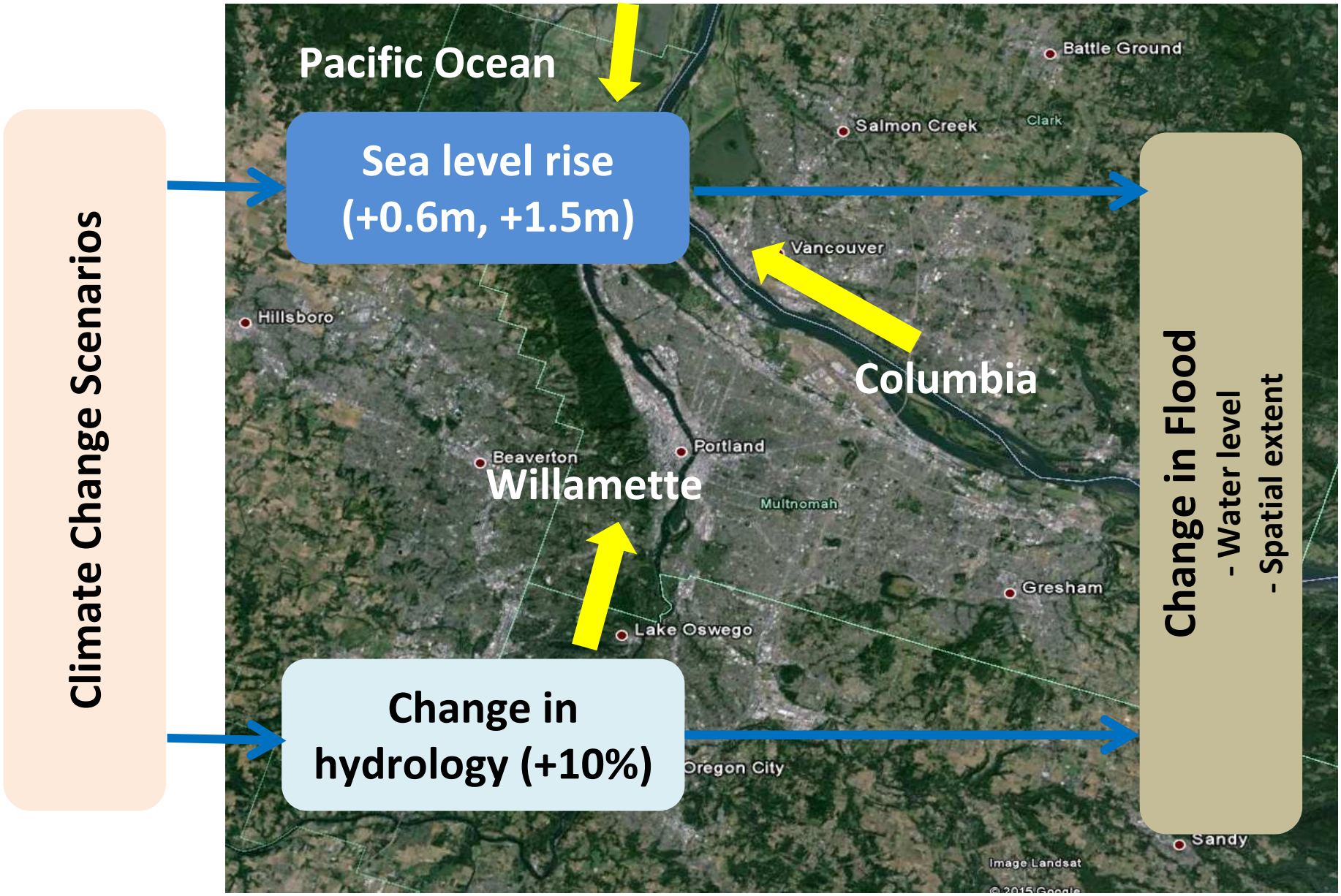


Scenario analysis



Hydraulic modeling

MODELING - SCENARIO ANALYSIS



SYNTHETIC SCENARIOS

Flow Increase (%)

A – no increase

B – 10% projected increase

Sea Level Rise (m)

0 – no change

1 - 0.6m rise

2 - 1.5m rise

Source: Cooley and Chang (2017)

http://media.oregonlive.com/pacific-northwest-news/photo/columbia-bonnevillejpg-91b4bb9af02dff5f.jpg

Source: IPCC (2014)

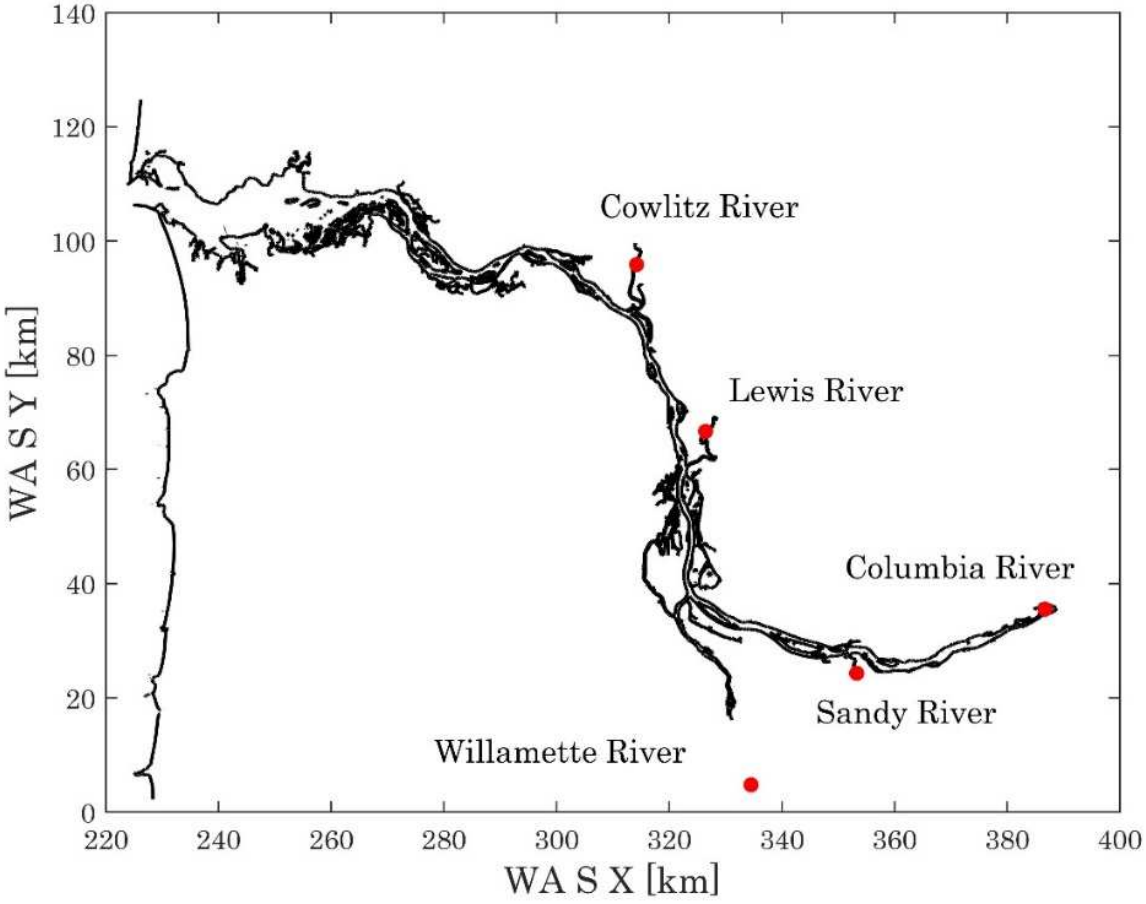
http://i.bnet.com/blogs/rising-sea-level1.jpg

1996 WILLAMETTE FLOOD SIMULATION

Model Sources

Tides

- OSU Tidal Prediction Software
- No change in tidal constituents with SLR



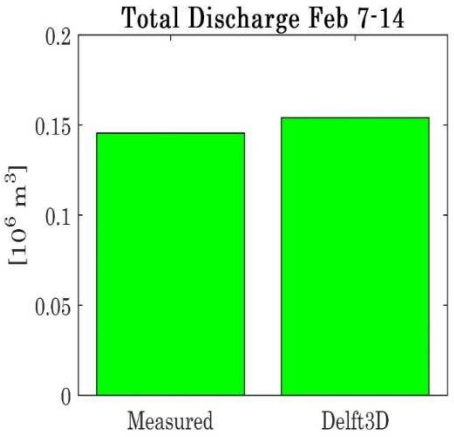
Discharge

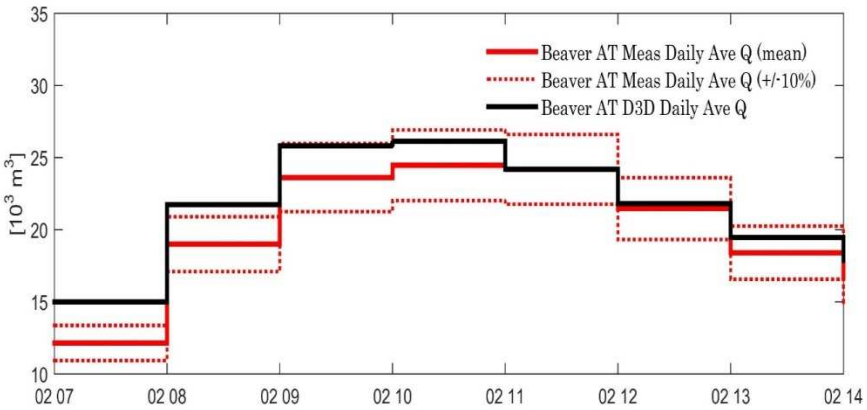
Columbia River Inputs

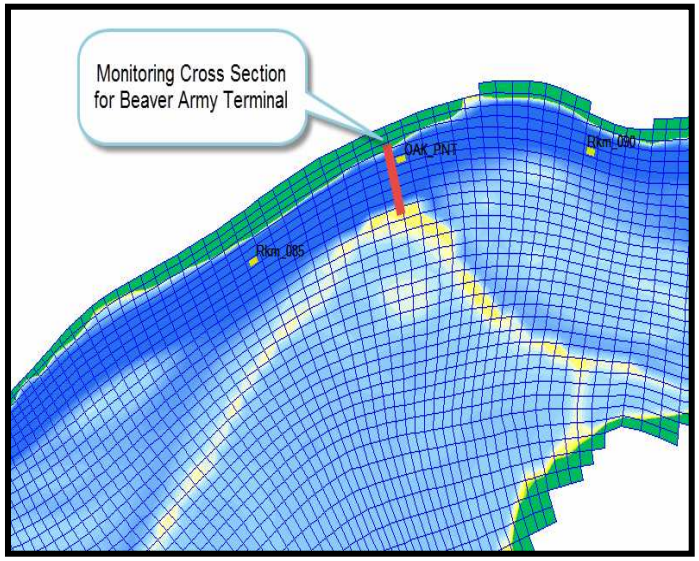
+ Willamette River inputs

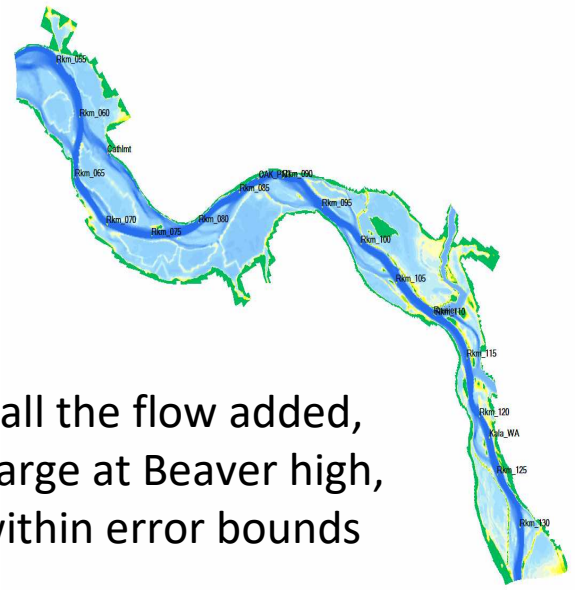
DELFT 3D MODELED VS. OBSERVED DISCHARGE

Model discharge monitored at Beaver Army Terminal and compared to measured discharge





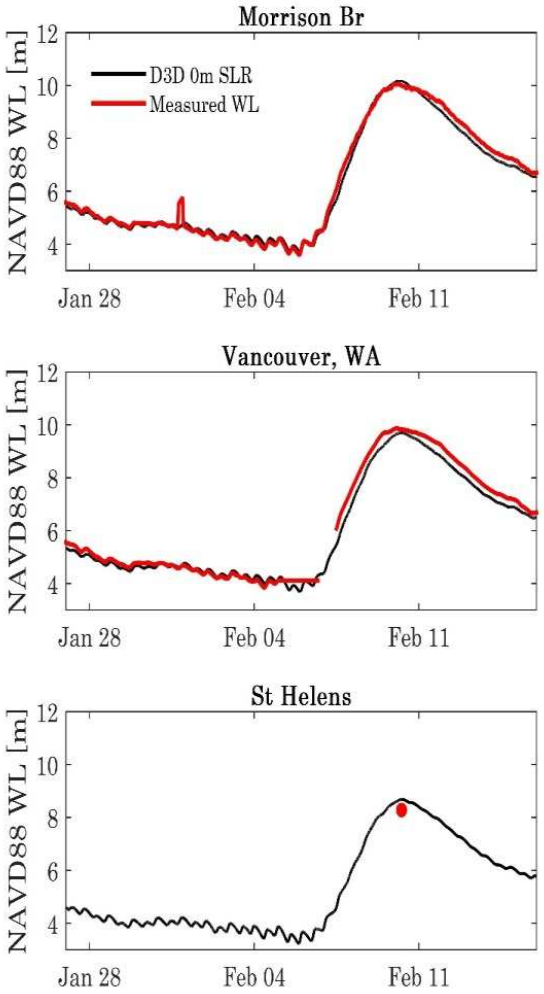




With all the flow added, discharge at Beaver high, but within error bounds

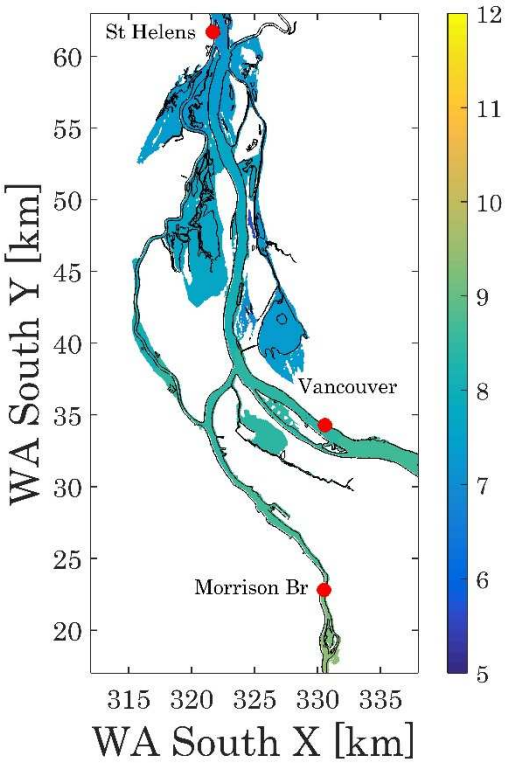
MODELED VS. SIMULATED WATER LEVEL & INUNDATION

Water Level



Inundation

Delft3D 0m SLR

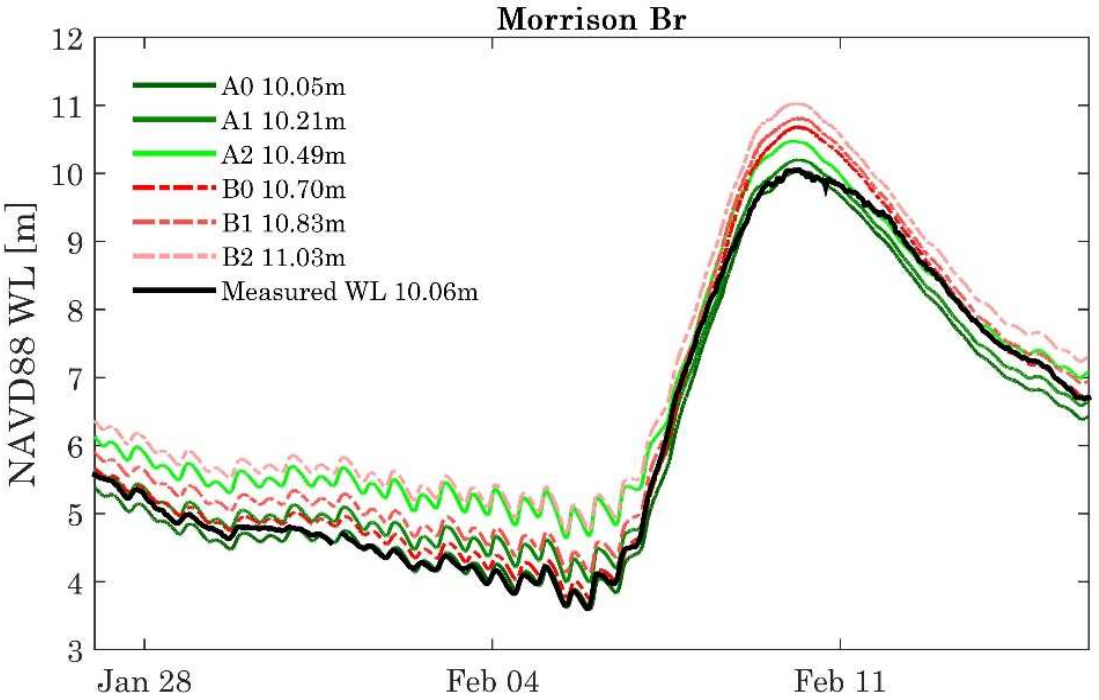


Landsat 11 Feb 1996

SCENARIO RESULTS: CHANGE IN WATER LEVEL

Water levels steadily increase under sea level rise and flow increase scenarios

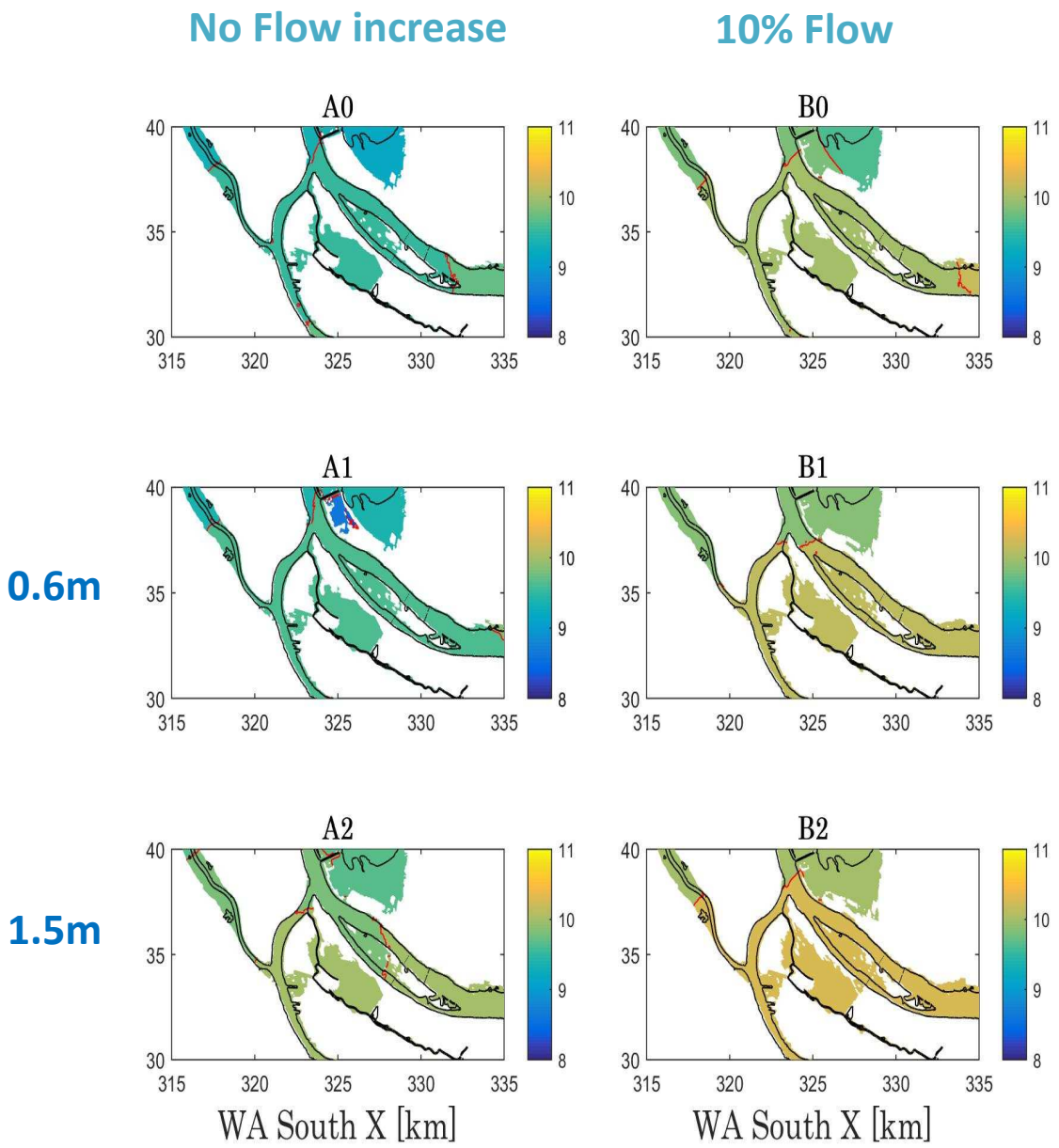
Flow \ SLR	0	1	2
A	10.05	10.21	10.49
B	10.70	10.83	11.03



Difference between measured and simulated = 1 cm

SCENARIO RESULTS: CHANGE IN INUNDATION

There is a progressive increase in inundation under these Sea Level Rise and Flow increase scenarios

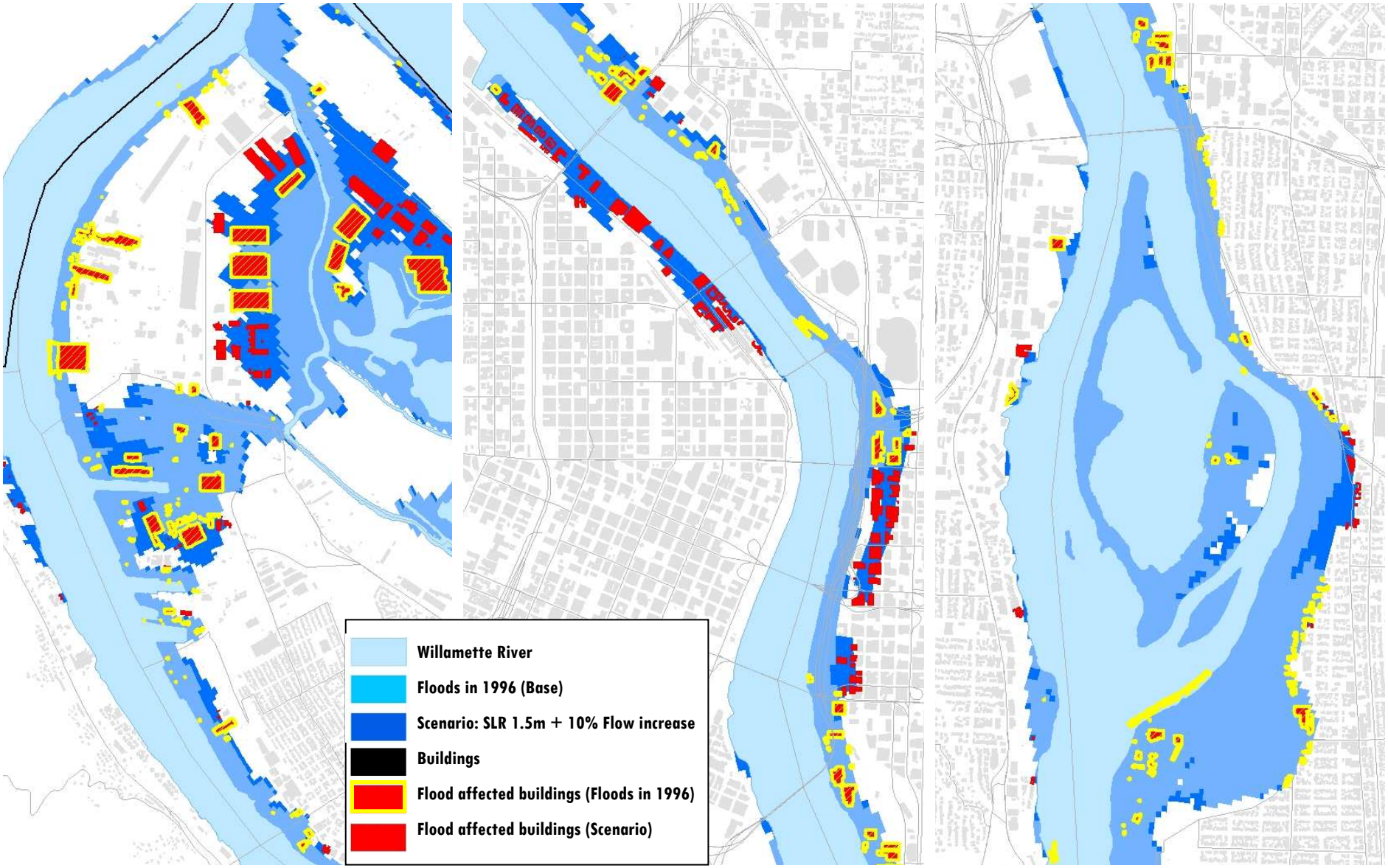


AFFECTED BUILDINGS UNDER THE EXTREME SCENARIO

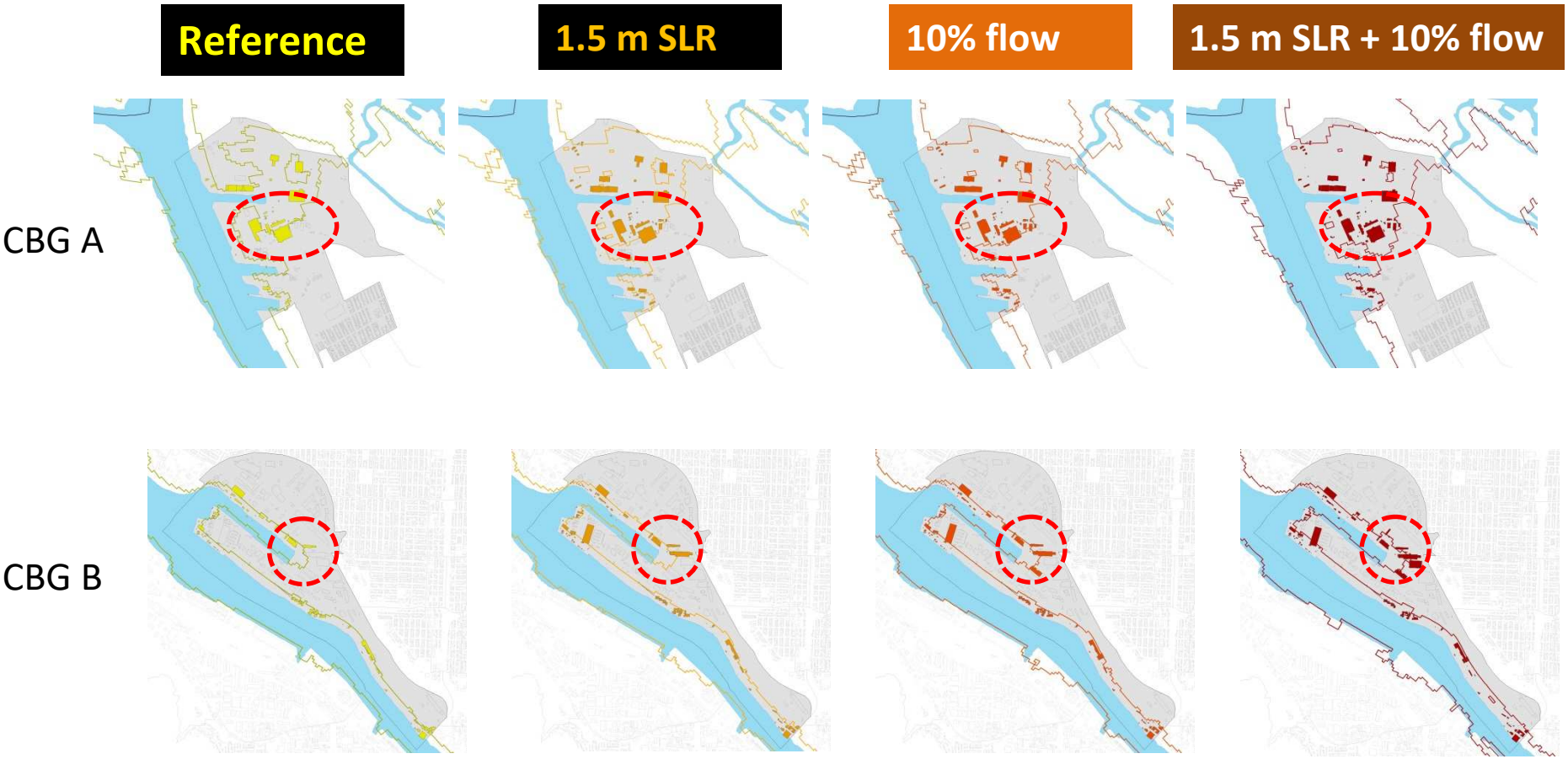
NORTH

CENTRAL

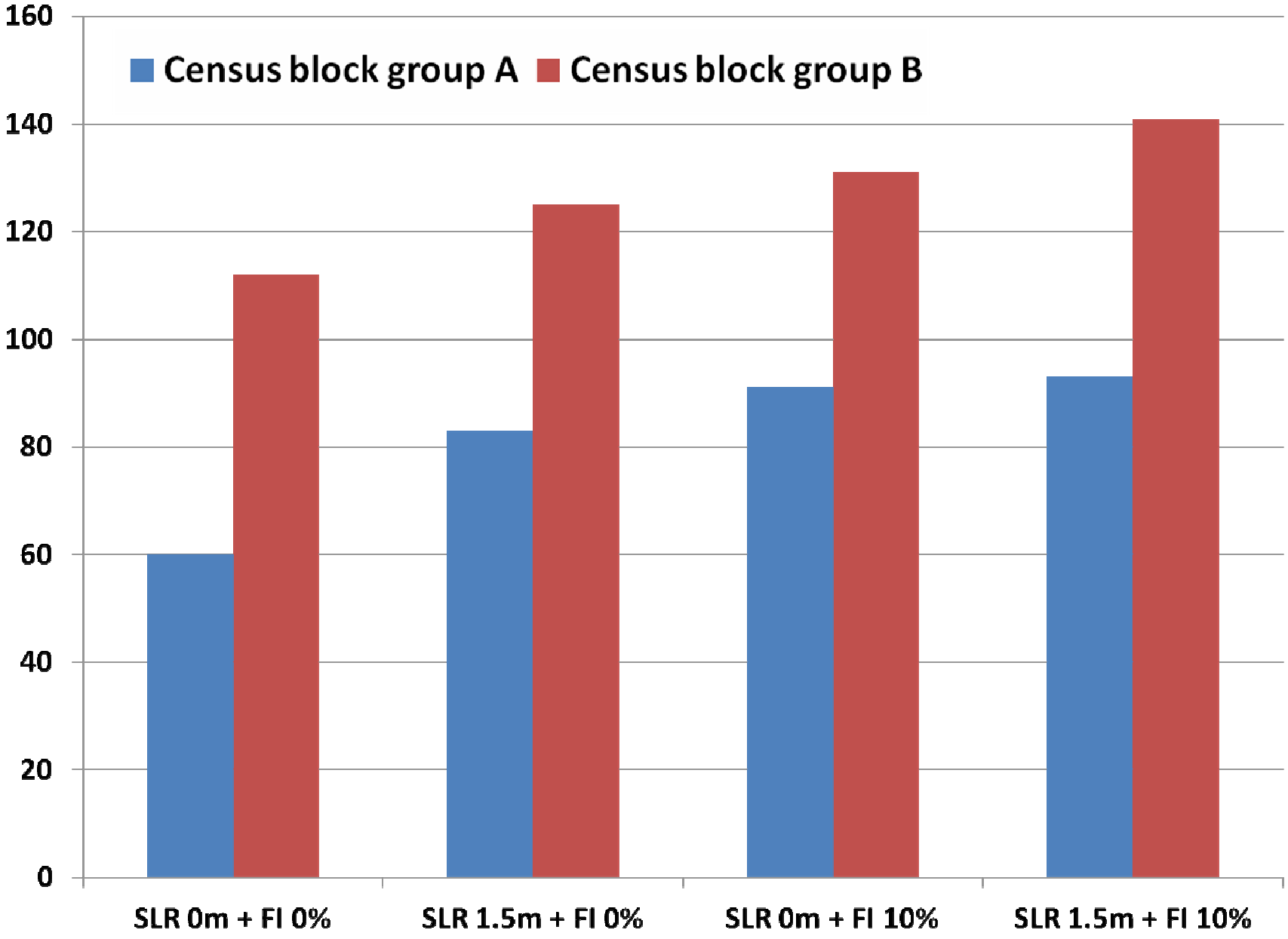
SOUTH



AFFECTED BUILDINGS UNDER SCENARIOS



NUMBER OF BUILDINGS AFFECTED UNDER SCENARIOS



Conclusions

1. The Delft 3D hydraulic model simulates the observed water level well (1cm difference) at the Morrison Bridge.
2. Water levels are more sensitive to highest flow increase (10% flow) than the highest sea level rise (SLR) (+1.5m) scenarios.
3. There is a progressive increase in inundation area under these SLR and flow increase scenarios.
4. The north section of the Willamette has higher vulnerable areas and buildings than the central and south sections.

Thank you!

Questions or Comments:
Contact Heejun Chang at changh@pdx.edu

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