UNDERSTANDING COASTAL FLOODING IN THE SAN FRANCISCO BAY DELTA
HOW CAN MODELLING HELP?

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As the climate continues to change, shifts in oceanic and atmospheric conditions result in higher sea levels and altered rainfall regimes.

Changing sea levels, in combination with changing land elevations, will result in more frequent coastal flooding of low-lying areas adjacent to rivers, delta’s, estuaries and bays.

This past winter has demonstrated the flood potential associated with Atmospheric River events, while past coastal storms coincident with high tides, reveal the vulnerability of infrastructure and assets situated on low-lying land.
In estuaries and delta’s, coastal flooding is influenced by river runoff, tidal regimes, changes in mean sea level and vertical land motion.

Understanding how these processes interact and affect water levels throughout complex systems like the San Francisco Bay Delta is vital for making informed planning decisions, such as defend, adapt, or retreat.

While a multitude of data is collected throughout the region, it is difficult to unpick the processes which dominate coastal flooding at each location from these observations alone.
CHALLENGE

To better understand the potential impact river runoff, sea level rise, and tidal processes have on coastal flooding across the San Francisco Bay Delta, we conducted numerical experiments, to explore the effect different scenarios have on water levels throughout the San Francisco Bay/Delta region.
PROCESSES OF INTEREST

- TIDES
- RIVER DISCHARGE
- SEA LEVEL RISE
- VERTICAL LAND MOTION
Circulation is driven:
• Tidal forcing at the open ocean boundary
• River discharge at upstream locations, and
• Atmospheric forcing from ERA 5
Our preliminary modelling experiments demonstrate that interactions between tidal processes and riverine processes, are complex and non-linear.

Water levels in upper bay and delta areas are most affected by high riverine discharge, however higher runoff conditions affect sea levels in the lower bay, potentially reducing maximum water levels.

Similarly, interactions between tides and sea level rise invoke a non-linear response in this system.

While most of the system experiences an increase in maximum water level due to SLR, formerly non-tidal water bodies and riverine areas, appear to experience a slight decrease in maximum water level.

The combination of Megaflood conditions and SLR resulted in higher maximum water levels throughout the entire system.
FUTURE WORK

We have utilized results from 70-year simulations (Kees et al., 2021) to estimate how far into the future nuisance flooding events will occur daily.

This preliminary assessment assumed a linear increase in water level based upon estimated sea level rise from the San Francisco Bay tidal gauge.

The modelling experiments discussed here indicate that the relationship between water levels and sea level rise is non-linear and spatially variable, and thus this more complicated relationship may alter such projected timeframes.

Given the high variability of vertical land motion in this region, our future experiments will explore methods by which we can account for changes in both land elevation and sea level rise.
HOW WILL VERTICAL LAND MOTION AFFECT FUTURE WATER LEVELS?

Land Subsidence in the Delta
Delta Area reprinted 1985

1m SLR: Jan-Feb 2017 Maximum Water Level (m)

-0.8  -0.4  0    0.4  0.8  1.2  1.6  2.0  2.4  2.8  3.2  3.6  4.0 (m)
THANK YOU

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