Climate Science and Water Resources

Sea Level Rise
&
Changing Hydrology

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Climate Change & Coastal Water Quality

- *Sea level rise*
- *Waves*
- *Winds*
- *Storms*
- *Surface warming*
- *Land runoff*
- *Ocean DO*
- *Ocean pH*

~ absence of evidence does not imply evidence of absence ~

Sea Level Rise

Sea level has risen ~0.2m over past century and projected to rise ~1m over next century.

Some things to think about …

- *Retreat or defend – coastal infrastructure*
- *Salinity intrusion – aquifers & estuaries*
- *Coastal erosion*
- *Beaches & estuary mouth – stratification*
- *Marshes & wetland functions (filter)*

Waves & Winds

Upwelling winds strengthened over past 30yrs.
Largest waves are larger and more frequent.

Some things to think about …

- *Coastal erosion*
- *Beaches & estuary mouth – stratification*
- *Ocean WQ – incr. nutrients, decr. DO, decr. pH*
- *Pollution patterns (ZoI)*
- *Stratification/intrusion & estuary phytoplankton*

Land Runoff

Sierra runoff earlier and stronger.

Coastal watersheds different – no clear projection,
but suggestions of extreme events – local extraction.

Some things to think about …

- *Estuary stratification & mouth state*
- *Estuary loading*
- *Small plume impacts*
- *SFB outflow and plume impacts*
- *Responses to water need – desalination*

Ocean Water Quality

Upwelled waters lower in pH and DO.
Upwelling strengthening.

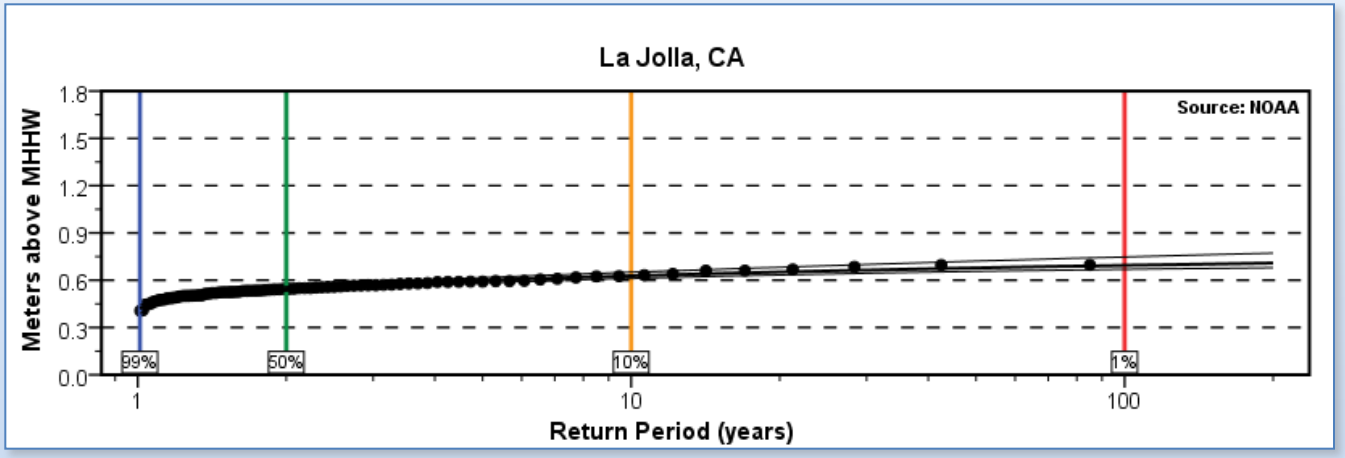
Some things to think about …

- *More acidic, hypoxic, nutrified coastal waters*
- *Intrusion of coastal water into estuaries*
- *Intrusion of coastal water into bays*

Sea Level Rise

SLR is certain, but the rate is uncertain
and unsteady on shorter time scales.

Observed sea level is comprised of a trend plus variability (interdecadal, interannual, seasonal, synoptic, tidal, episodic) … highest levels occur during events, e.g., tsunami/storm/tide.



NOAA projection from historical data … annual max+0.4, occasional max +0.7

Risk assessment … probability * wager …

Probability of "dose" – regional & local effects; level & duration

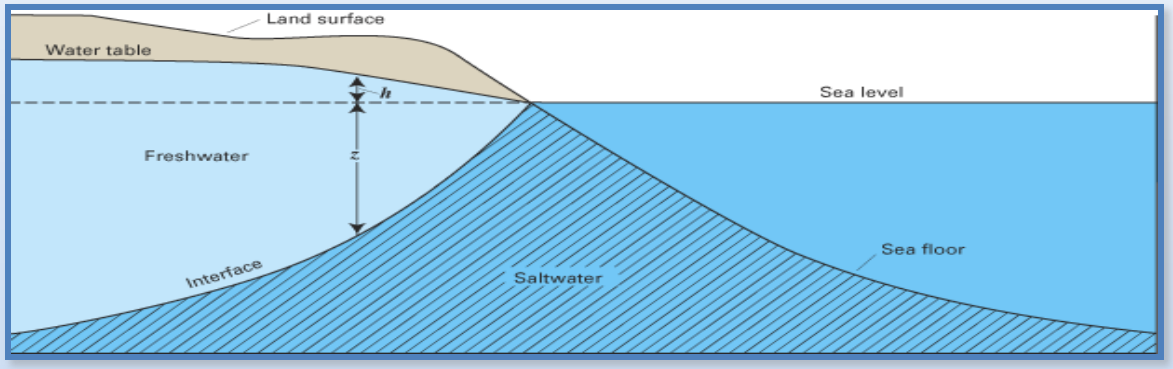
Response to "dose" – inconvenient/reversible vs destructive

Seawater Intrusion

Dense seawater moves into aquifer
– held back & down by freshwater layer.

- Reduced freshwater leads to greater intrusion
- Higher sea level leads to greater intrusion

Note aspect ratio of land/water table: 1m SLR ~ 10km intrusion



Wikipedia (or any textbook)
… $z = (\rho/\Delta\rho).h$

Seawater intrusion will show a lot of local detail – with possible step change, delayed response – depends on nature of aquifer.

Aquifer surveys or develop adaptive water management policy … expt w/o damage?

Desalination

Is it a response to climate change or over-use?

Seems to be a luxury not a right – do it properly!

Small is beautiful … desalination is natural,

but intensity of intake and discharge is not.

Larval entrainment …

Impact on population may be less of an issue than perceived

Larval entrainment in cooling water intakes: spatially explicit models reveal effects on benthic metapopulations and shortcomings of traditional assessments

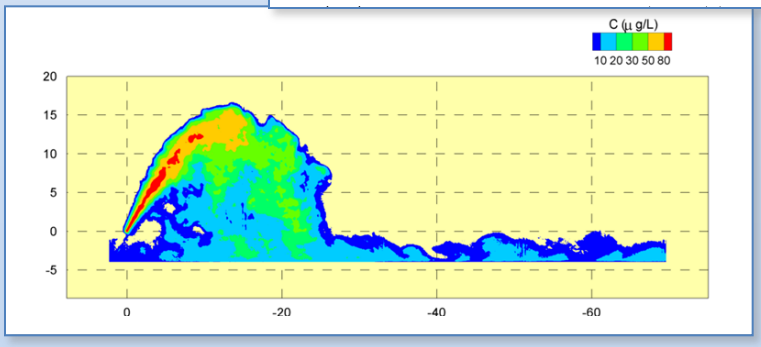
J. Wilson White, Kerry J. Nickols, Linden Clarke, and John L. Largier

Abstract: Spatial management of marine populations typically requires consideration of larval dispersal pathways. When a power plant with a cooling water intake system (CWIS) is present, managers must also account for reductions in larval supply to natural habitats due to larval entrainment in the CWIS. To evaluate the consequences of CWIS entrainment for benthic populations, we coupled a transport model for an idealized coastline to a spatially explicit metapopulation model. CWIS entrainment reduced the probability of dispersal to and from sites near the CWIS. However, the reductions in larval supply due to entrainment generally produced only minor, localized effects on adult population density because of postsettlement density-dependent mortality. Only when population densities were already reduced by other forms of adult or larval mortality did entrainment threaten population persistence. Our simulations suggest that subpopulations several kilometres upstream of CWIS make the greatest contribution to metapopulation persistence by countering the effects of CWIS entrainment, and these locations should be the focus of conservation efforts to enhance larval sources. Finally, we show that traditional statistics used to estimate the demographic effects of CWIS entrainment are generally inaccurate and unreliable because they ignore nonlinearities in population dynamics.

Brine discharge …

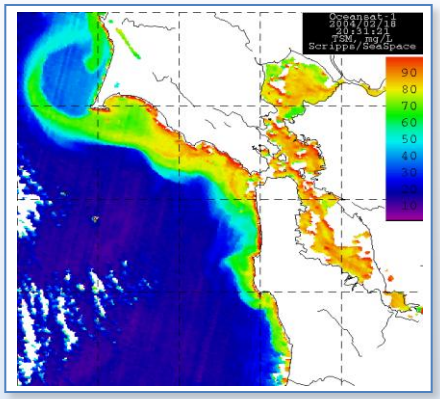
Need to mix (diffusers)

Avoid sump locations

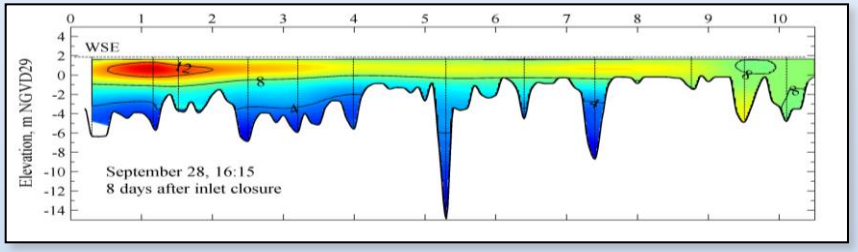


Estuaries & Plumes

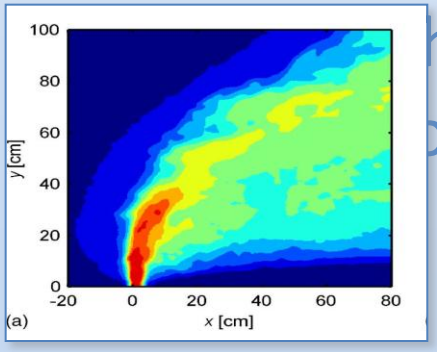
Policy challenges … recognizing interplay between policy realism & complexity of nature.



- ASBS – local versus remote sources
- Estuary WQ (nutrients, turbidity, DO)
  - Level vs input vs impact
  - One size fits all?
  - Natural extreme conditions



- Zone of Impact – haracteristic spatial pattern of pollution or given source – can define & monitor



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