Bay Planning Coalition

Sea Level Rise Policy Implications for Bay Area Industry

Council of Richmond Industries

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Executive Director

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The mission of the Bay Planning Coalition is to ensure that commerce, recreation and the environment thrive in the San Francisco Bay-Delta region.
www.bayplanningcoalition.org
BPC celebrating 25 years of leadership
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Presentation Outline

- How fast is the sea rising?
- Why need to address sea level rise?
- Who should set policy and regulate?
- How do we still build and operate in a sustainable manner today?

The Context of Climate Change

- Climate: Greek word Klma-mat=slope of ground, region; a region considered with reference to its atmospheric condition or its weather; the prevailing atmospheric phenomena and conditions of temperature, humidity, wind of a region
- Eustasy: a uniform worldwide change of sea level
- Climate is what you expect; weather is what you get: Mark Twain

Historical Perspective

- Human civilizations have risen, prospered and deteriorated by their ability to anticipate and mitigate variability in many aspects of their climate—especially floods and droughts
- Planet earth is really Planet water
- Recent climate research has documented global warming during 20th Century and predicted either continued or accelerated global warming for 21st (IPCC 2007) One impact of global arming is continued or accelerated rise of global mean sea level.

Other factors driving local sea level change

- **Geologic**—vertical land movement can occur due to tectonics (earthquakes, regional subsidence, uplift, compaction of sedimentary strata
- **Atmospheric** – can affect local or regional water levels. Decadal-scale phenomena include El Nino-Southern Oscillation (ENSO) in the Pacific and NAO in the Atlantic. Climate change may alter the frequency and severity of tropical storms
- **Historic trends in local Mean Sea Level are best determined from tide gauge records**.

Sea Level Rise Projection Chronology

1987 Responding to Changes in Sea Level, Engineering Implications, National Research Council

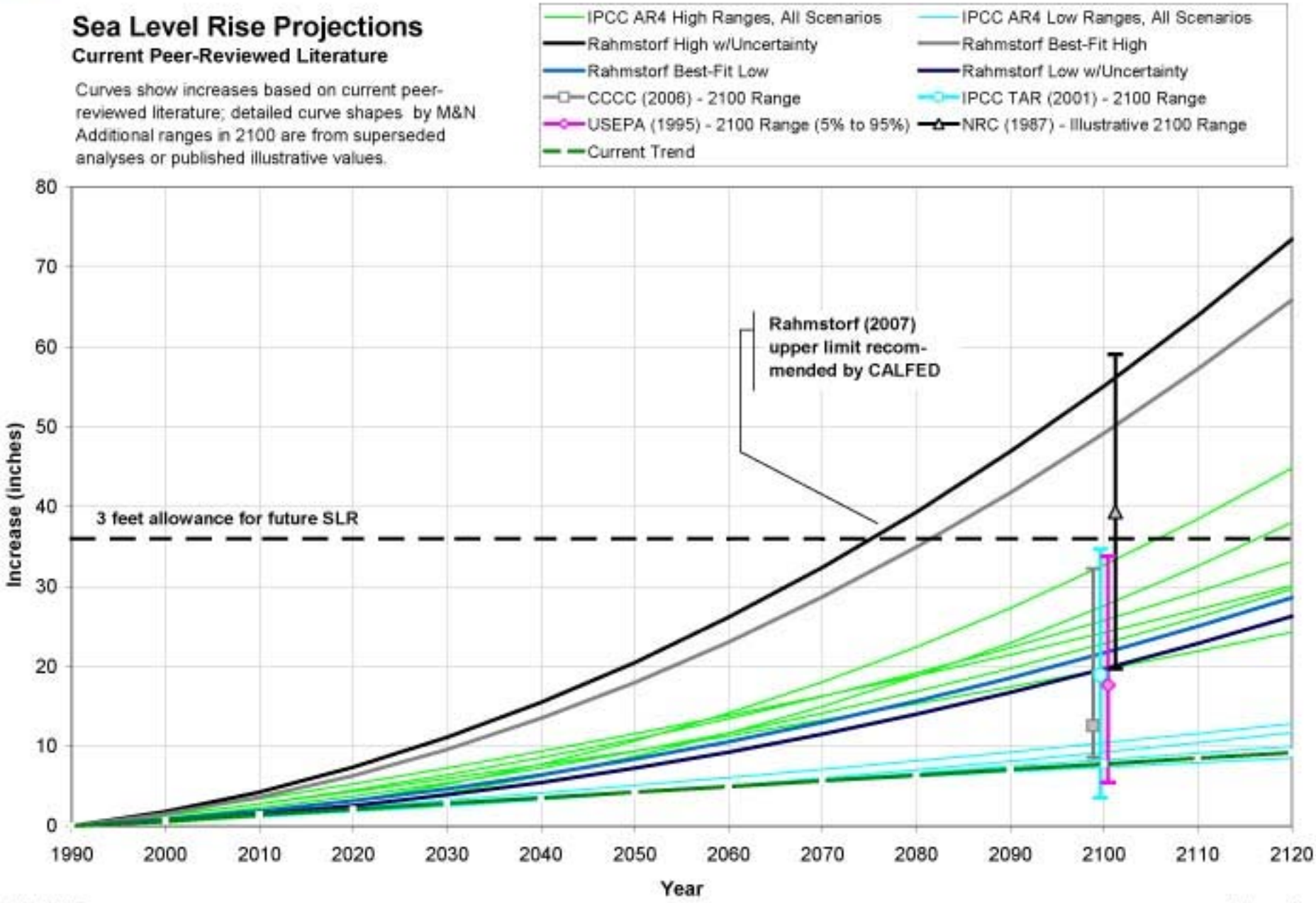
- U. S. Environmental Protection Agency, 1995
- Intergovernmental Panel on Climate Change (IPCC), 2001 Third Assessment Report (TAR)
- California Climate Change Center, 2006
- Rahmstorf, 2007
- Intergovernmental Panel On Climate Change, 2007 (AR 4) Fourth Assessment Report
- CALFED Bay-Delta Program, 2007
- U. S. Army Corps of Engineers, Engineering Circular No. 1165-2-211, July 1, 2009

MOFFATT & NICHOL

Sea Level Rise Projections

Current Peer-Reviewed Literature

Curves show increases based on current peer-reviewed literature; detailed curve shapes by M&N
Additional ranges in 2100 are from superseded analyses or published illustrative values.



7/3/2008

Figure 1

Responding to Changes in Sea Level Engineering Implications, 1987, National Research Council

- Relative mean sea level (vs eustatic sea level) is rising at majority of tide gauge stations on continental coasts around the world. The density of the ocean and hence the sea level does not rise uniformly. Local geologic processes (uplift and subsidence) affect the rate of sea level rise relative to the land.
- **It's where you are standing**!
- No projections, but adopts 3 plausible conditions of **20, 39 and 59 inches by 2100.**
- Responses: Stabilization or Retreat

U. S. Environmental Protection Agency, 1995

- Probability estimates of different sea level rise for the 21st century
- Model depending on IPCC projections of sea level rise on 35 major uncertainties
- Thermal expansion together with ice melt
- Global average of between **5-34 inches between 1990 and 2100.**

IPCC 2001 Third Assessment Report (TAR)

- Synthesis of peer-reviewed science
- Identified uncertainty for dynamic ice sheet instability
- Projects a rise of **4 – 35 inches between 1990-2100.**

California Climate Change Center, 2006

- Scripps, Cal Energy Commission, UC San Diego and UC Berkeley
- Projected eustatic sea level rise of **8 – 31 inches between 2000 and 2100** and are similar to AR 4 report.
- Superseded by AR Report

IPCC, 2007 (AR4)

- Projects **7 -23 inches for sea level rise in the 21st century.**
- Second set of projections for scaled-up ice discharge term: 7-30 inches.
- Uncertainty derives from different greenhouse gas emission scenarios (6)
- Compared to 2001, the AR4 is more conservative and narrower in the science sense, but no so in an engineering or planning sense.

Rahmstorf, 2007

- Stefan Rahmstorf, Potsdam Institute for Climate Impact Research, a semi-empirical approach to predict SLR. Rate of SLR is proportional to the increase in temperature relative to a previous equilibrium temperature. **28-39 inches bwt. 1990 and 2100.**

CALFED Bay-Delta Program, 2007

- Being widely quoted as a basis for flood planning in the S. F. Bay area
- 3 approaches to incorporate sea level rise uncertainty: Use empirical models for short term: 28-39 inches to 2100 (these do include dynamic instability of ice sheets); design a system that both withstands a sea level rise, but also minimizes damage; use higher than expected rates in long term infrastructure planning and design—these are favored over fixed targets

U.S. Army Corps Eng. Circular 1165-2-211, July, 2009

- Regional sea-level change rates should be evaluated as well as rates of local sea level change and global sea level change. Regional are expected to be close to global.
- For USACE activities, analysts shall consider what effect higher relative sea-level rise rates could have on design alternatives, economic and environmental evaluation, and risk.
- The analysis shall include a low rate, which shall be based on an extrapolation of the historical rate, and intermediate and high rates, which include future acceleration of sea level rise.
- Since 1987 NRC study, the IPCC has produced four editions of its projections. All five are useful in estimating future changes in local Mean Sea Level.

20 years--do we have enough data

- No, because of decadal-scale variations in climate, such as the NAO and the PDO, tend to mask long term changes in global temperature and sea level
- Projections typically show an acceleration in sea level rise through 21st century—the differences do not begin to be significant until mid-century.
- Understanding the Tides research at NOAA's National Ocean Service

Estimating SLR--some considerations and other factors

- The historic rate of relative sea-level change at relevant local tide stations are being used for the low rate analysis.
- Recognizing that science progresses, more recent projections should be given more weight—
- Increase in sea level of 3 feet around 2075 is the most aggressive projection
- Inflow from watershed
- Regional sea-level change rates should be evaluated as well as rates of local sea level change.

Setting policy, regulations—who decides?

- S. F. Bay Conservation and Development Commission, (BCDC) Living with a Rising Bay; Proposed Bay Plan Amendments
- Governor Schwarzenegger's Climate Change Executive Order Sept. 2008
- Federal Emergency Management Authority (FEMA) Flood Plain Mapping

BCDC

- Living with a Rising Bay publishes its SLR projections: 16 inches 2050; 55 inches by 2100
- Permit applicants must address these SLR projections in engineering for maintenance and development on shoreline
- "When designing a shoreline project, a risk assessment should be prepared based on the 100-yr. flood level "
- Prescribes the conditions limiting what types of development should be authorized in low lying areas
- Any public access provided as a condition of development should be required to remain viable in the event of future sea level rise.

San Francisco Bay Scenario for Sea Level Rise
San Francisco Bay

San Francisco Bay
1 m sea level rise

bcdc

Map is based on USGS elevation data and NAIP imagery. Map is illustrative and depicts a potential inundation scenario in 2100. Limitations in the geospatial data available may affect accuracy. Map should not be used for planning purposes.

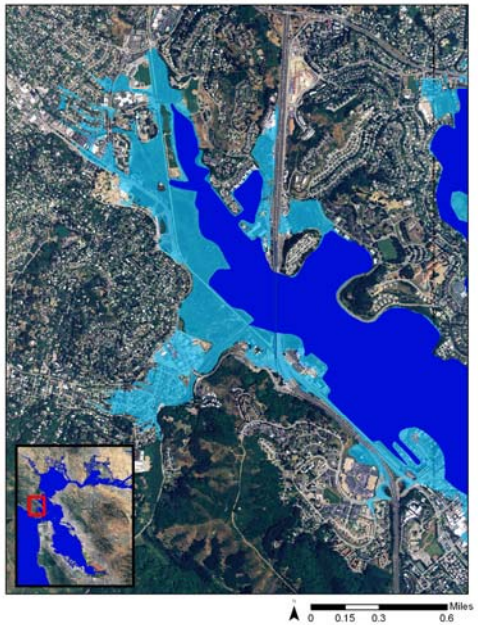
San Francisco Bay Scenario for Sea Level Rise
SFO

San Francisco Bay
1 m sea level rise

bcdc

Map is based on USGS elevation data and NAIP imagery. Map is illustrative and depicts a potential inundation scenario in 2100. Limitations in the geospatial data available may affect accuracy. Map should not be used for planning purposes.

San Francisco Bay Scenario for Sea Level Rise
Richardson Bay



San Francisco Bay
1 m sea level rise

bcdc

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Business, industry, local public works response

- SLR values represent an overly prescriptive approach for worse case scenario rather than a more rational middle of the road expected outcome
- Not clear whether BCDC has considered existing shoreline protection
- Emphasis should be on incremental steps in estimating
- Rational and adaptive management strategies are needed to fit specific local circumstances given wide temporal and spatial variability at shoreline locations around the Bay.
- Eustatic or Global average value versus local sea level rise can greatly differ due to local variation.

Business, industry, local public works response

- Local public works and industry has to make hard investment choices, e.g. risk management
- Do not want a big stick approach; use sub-regional forums, e.g. South S. F. Bay Shoreline Study, Bay Area Flood Managers Group
- Moffatt & Nichol analysis for Treasure Island and Hunter's Point proposed development.
  - Estimates of SLR over next 100 years ranges from historical 8 inches to 33 inches (IPCC maximum) (Rahmstorf suggest 55 inches as high, but plausible value.
  - Existing grades combined with shoreline improvements may disallow flood plain;
  - **an allowance of 3 feet plus 6 inches is recommended**

California's Climate Action Strategy

- November, 2008 Exec. Order directs state agencies to plan for SLR
- Requests Nat'l Academy of Sciences to establish an expert panel to inform state planning
- Issue interim guidance in designated flood plain areas for new projects
- Report on critical infrastructure vulnerability

California's Climate Action Report

- Adaptation Strategy: responses to combat impacts of climate change to minimize harm or take advantage of opportunities
- Communities should amend general plans to avoid potential climate impacts
- Alter water use patterns; achieve a statewide 20% reduction in per capita water use by 2020.
- Identify key land, aquatic habitats and species that could become extinct
- Calif Energy Commission, Caltrans, and Ocean Protection Council are studying SLR

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Open Notebook

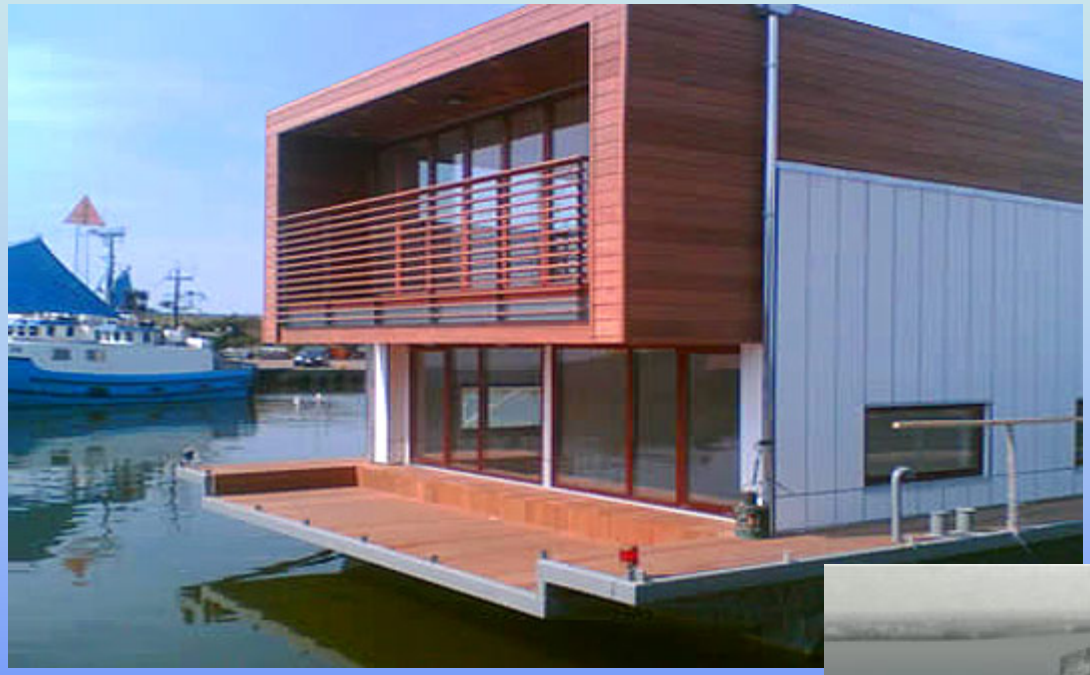
Redwood Shores Flood Control Project

- To comply with FEMA flood protection requirements, as of March 1, 2010, the City of Redwood City, South Bayside System Authority, San Mateo County will have to raise and strengthen about five miles of existing perimeter levee protecting Redwood Shores Peninsula.
- Five different approaches will be used:
  - raising the levee 6-inches;
  - creating a 2.5 foot-high earthen berm on bayward edge;
  - installing a five foot high vinyl sheet pile wall;
  - installing a one-foot high concrete wall; and
  - temporarily deployed a water-filled rubber bladder, during 50-100 year storm events.

Sustainable Practices

- Monitoring; Learn more, e.g. Understanding the Tides; connectivity bwt the bay and the ocean
- Continuing collaborative discussion
- Uncertainty of planning horizons of 40-90 years;
- Consider a broad range of possible future SLR scenarios and discussion of the risks associated with each of them
- Risk management; not solely risk averse
- These should include a flood/storm damage, environmental and an investment strategy perspective

The Dutch Philosophy



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Questions and Discussion