Considering Climate Change Impacts in Selection and Design of Sediment Remedies

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Barry Kellems, P.E.

integral consulting inc.

U.S. Climate Change Impacts

- 2014 National Climate Assessment http://nca2014.globalchange.gov
- Summarizes the impacts of climate change on the United States, now and in the future
- 300 experts guided by a 60-member committee
- 3 critical impacts
  - Increased temperature
  - Sea level rise (SLR)
  - Greater storm intensity and frequency

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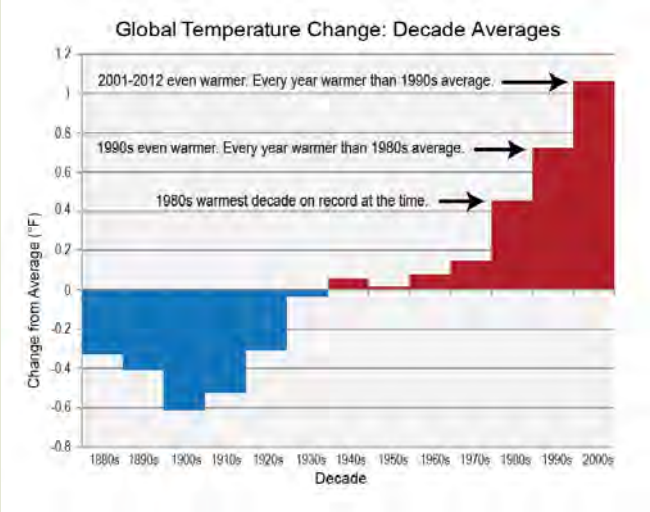
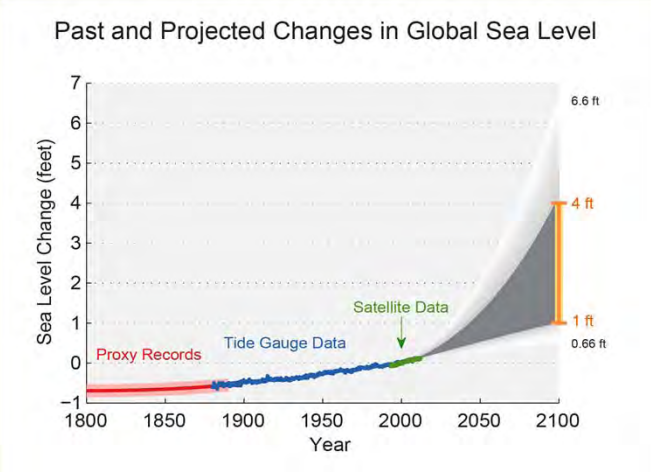
Increased Temperature



The last five decades have seen a progressive rise in the Earth's average surface temperature

Source: 2014 National Climate Assessment

Sea Level Rise

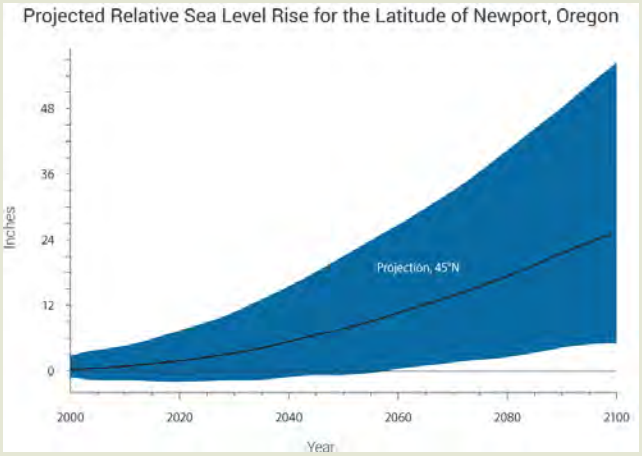


The future SLR scenarios range from 0.66 feet to 6.6 feet in 2100. Recent work suggests that 4 feet is plausible.

Source: 2014 National Climate Assessment

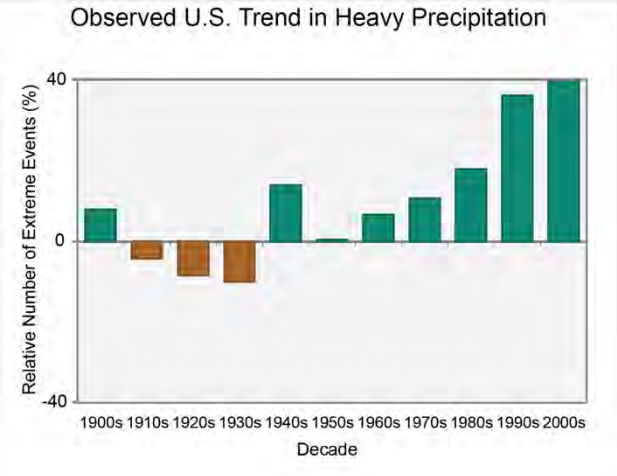
Northwest Sea Level Rise

Sea level is projected to rise in Washington, increasing by +4 to +56 inches by 2100, relative to 2000



Source: 2014 National Climate Assessment

Greater Storm Intensity and Frequency

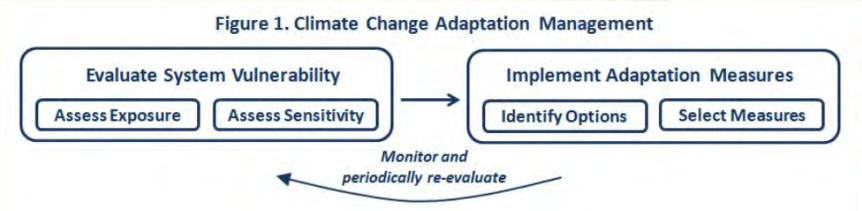


Frequency of 2-day, once every 5-year storms, compared to the period 1901–1960

For Puget Sound, +24 inches of sea level rise will result in a 100-year flood event every year

Source: 2014 National Climate Assessment

EPA's Climate Change Adaptation Process



Source: EPA's Climate Change Adaptation Technical Fact Sheet: Contaminated Sediment Remedies (April 2015)

Consistent with EPA sediment guidance:
"Project managers are encouraged to use an adaptive management approach, especially at complex sediment sites to provide additional certainty of information to support decisions."
Source: Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (December 2005)

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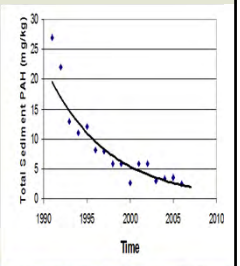
Sediment Remedy Vulnerabilities

- Changes to the bathymetry and patterns of erosion and sediment deposition, affecting MNR or ENR
- Potential for physical damage to:
  - Habitat layer, armor layer, amendment, geotextile or isolation layer in an *in situ* cap
  - Clean sediment layer overlaying contaminated sediment, as part of MNR or ENR
  - Bank stabilization structures and floodplain caps
  - In-water equipment, CAD, CDF, and upland processing facilities
- Alteration or loss of wetland or riparian vegetation used for treatment or local buffering



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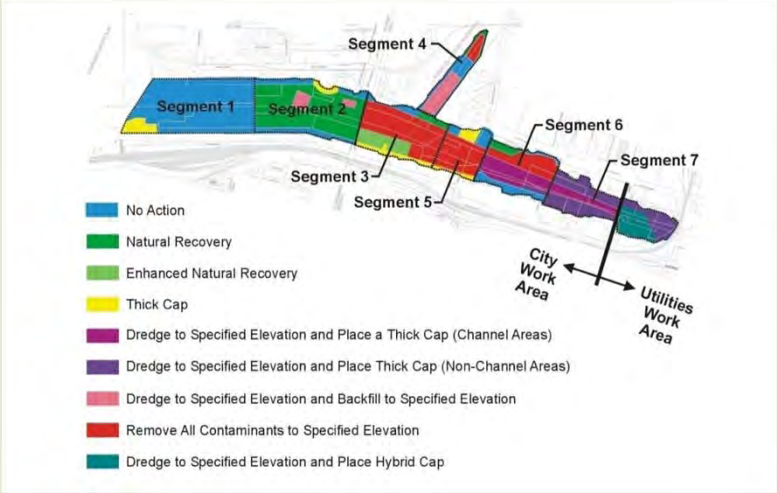
Presumption of Dredging/Offsite Disposal?

"Climate change considerations are particularly important in designs and associated modeling for in situ capping, MNR, and EMNR remedies anticipated to operate for 30 years or longer. If an area is predicted to experience increasingly frequent flooding or storm surge activity or be subject to rising sea levels, disposal of contaminated sediment offsite in an area not subject to these problems may be an option."

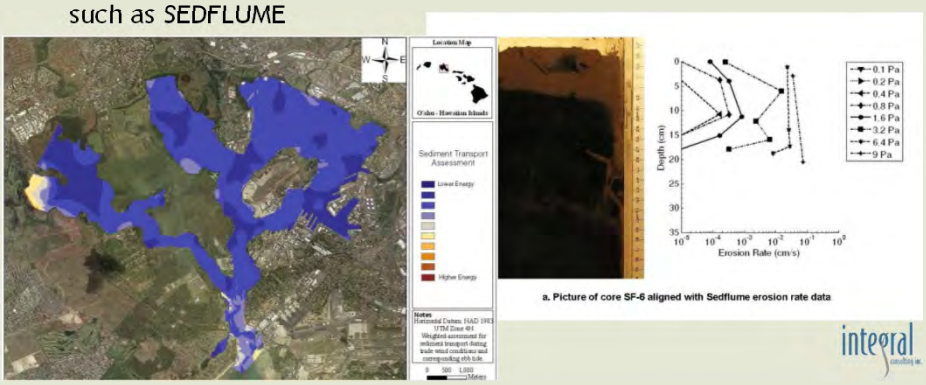
—Climate Change Adaptation Technical Fact Sheet: Contaminated Sediment Remedies (April 2015)

Does Not Allow Cost-Effective "Tool Box" Approach



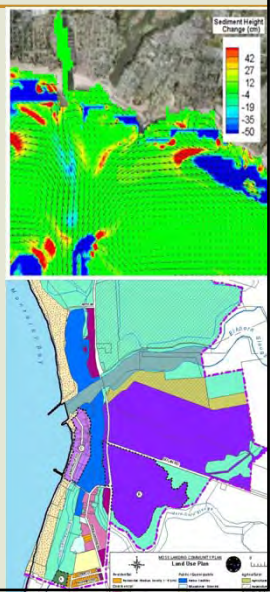
Sediment Remedy Adaptations

- Greater reliance on improved sediment erodibility and deposition assessment (SEDA)
  - http://www.epa.gov/superfund/health/conmedia/sediment/pdfs/SEDA%20final%20ERDC%20TR-14-9.pdf
- Improved data collection tools for measuring sediment erodibility, such as SEDFLUME



Sediment Remedy Adaptations

- Confirm design storm assumptions (will the future 100-year flood differ from the historical 100-year flood and by how much?)
- Evaluate remedial component stability and recontamination potential under design storm conditions
- Armor enhancement for *in situ* caps
- Deposition and hydraulic controls (weirs and dams)
- Flood controls (barriers, stormwater ponds, bioswales)
- Appropriate timing of construction activities (weather windows)
- Adopt proactive (rather than reactive) strategies
- Collaborate with land use agencies



Sediment Remedy Adaptations

- Enhanced bank stabilization
  - Hard: armor and sheet pile
  - Soft: bioengineered barriers
- Coastal hardening
  - Hard: seawall or installing riprap
  - Soft: replenishing sand and/or vegetation
- Opportunity to decrease vulnerability of coastal ecosystems through soft approaches (one-third of the Puget Sound shoreline already cut off through seawalls, bulkheads, and other structures)

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The Risk Management Framework from ISO 31000

- Communication and consultation
- Establishing the context
- Risk assessment
  - Risk identification
  - Risk analysis
  - Risk evaluation
- Risk treatment
  - Selection of risk treatment options
  - Preparing and implementing risk treatment plans
- Monitoring and review

ISO (2009). Risk Management—Principles and Guidelines. ISO 31000:2009 (E)

IEC/ISO (2009). Risk Management—Risk Assessment Techniques. IEC/ISO 31010

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Pine Street Canal Site in Burlington, Vermont

- 38 acre MGP site
- Output from modeling illustrates the site's position in a 100-year floodplain
- A weir at the canal's outlet to Lake Champlain maintains minimum water depth, protecting cap from scour and erosion

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Pine Street Canal Site in Burlington, Vermont

- 2004 remedy consisting of capping 8 acres of contaminated sediment and habitat restoration
- 2010 amended cap (turf reinforcement mat and reactive media) added to address releases of oil and coal tar seeping through portion of cap
- Bank stabilization though anchored cap and revegetation
- All capping components stable following historic 150 year flooding event (Hurricane Irene)

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Grasse River Site in Massena, New York

- 7.2-mile stretch of river with PCB-impacted sediments
- Water surface elevations are controlled by locks within the St. Lawrence Seaway
  - In 2003, a 7-acre pilot-scale cap was damaged due to high flows resulting from a severe ice jam
  - 2013 remedy includes dredging of 109,000 cy sediment and capping of 225 acres, armored in 59 acres prone to ice scour

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Conclusions

- Climate change impacts threaten effectiveness, permanence, and cost of sediment remedies so climate change analysis needs to be incorporated into remedy selection and design
- Because design criteria based on modeling of climate change scenarios will be uncertain, sediment remedies should include:
  - Risk management of impacts
  - Adaptation management
  - Long-term monitoring

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Questions?

Barry Kellems, P.E.

Integral Consulting Inc.
719 2nd Avenue
Suite 700
Seattle, WA 98104

telephone: 206.957.0334
cell: 206.484.2827

bkellems@integral-corp.com