

Evaluating climate risks and opportunities: operational and strategic considerations

Amy Snover, PhD

Assistant Dean, Applied Research
College of the Environment
Director, Climate Impacts Group
University of Washington

Executive Forum on Business & Climate
5 November 2013

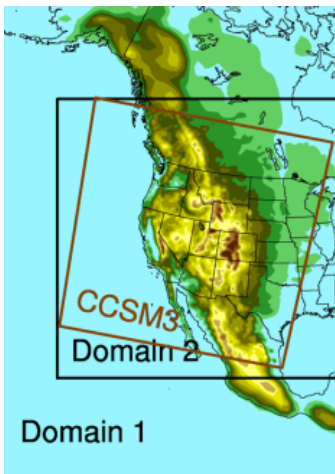


*Climate Science in the
Public Interest*

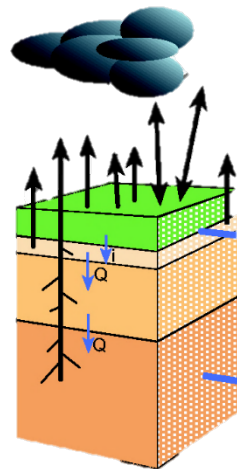


The Climate Impacts Group

An integrated research and stakeholder engagement team linking climate science and decision making to build climate resilience.



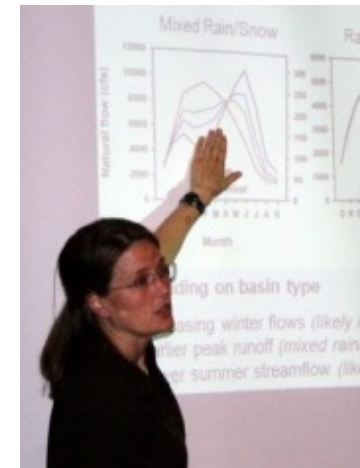
Downscaling global climate models



Macro and fine-scale hydrologic modeling



Impacts assessments



Adaptation planning and outreach

Working since 1995 with a focus on:

- U.S. Pacific Northwest, Western U.S., Pacific Rim
- Water, forests, fish, coasts, energy, human health, urban areas
- Stakeholders: Private, public & non-governmental actors involved in climate-sensitive policymaking, planning and decision making



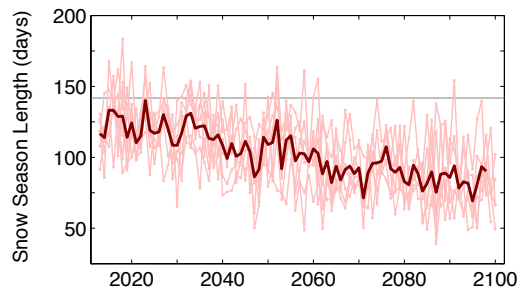
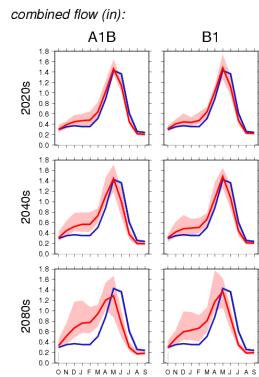
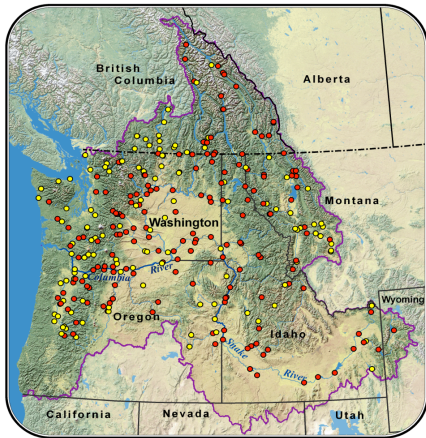
Develop



Apply

Science / Projections / Data

Interpretation / Guidance





Identifying climate risks & vulnerabilities

Desire for:

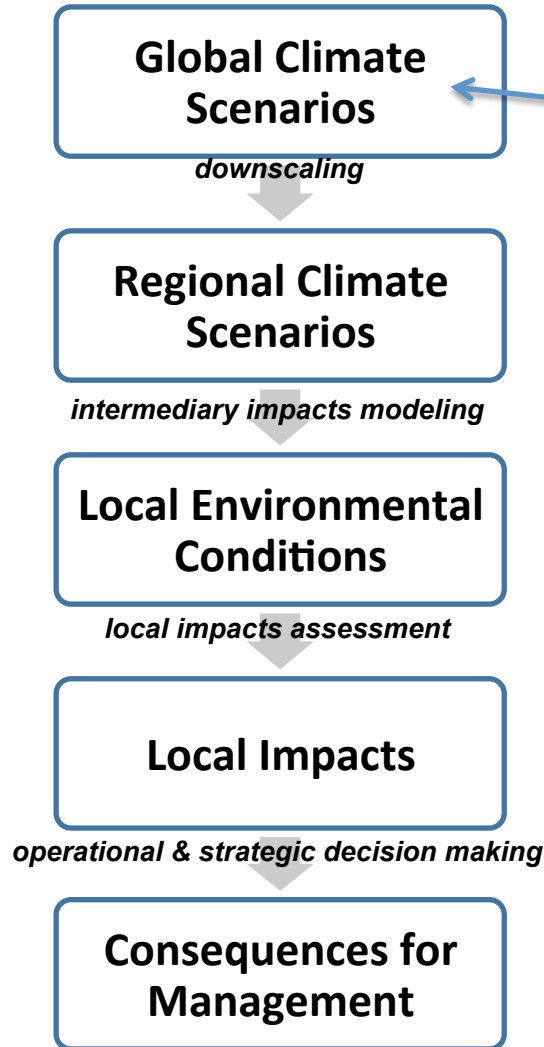
- greater granularity
- watershed-specific streamflow projections
- information about extreme events

Questions about how to engage with:

- climate uncertainty
- the skeptical/disengaged parts of the enterprise
- “pushing” information/risk assessment out to diverse divisions
- Interactions between public & private sector



But first: Where should we start?

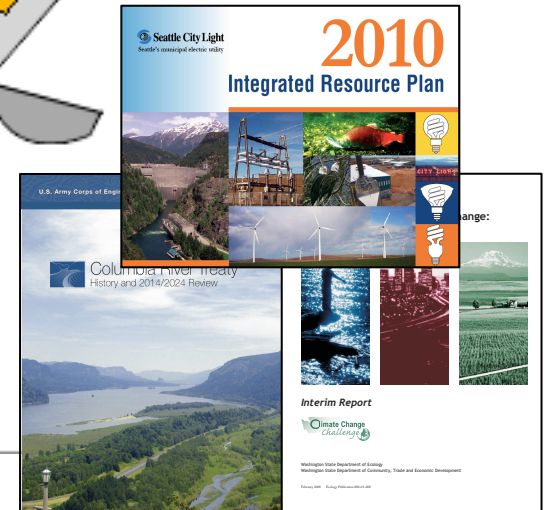
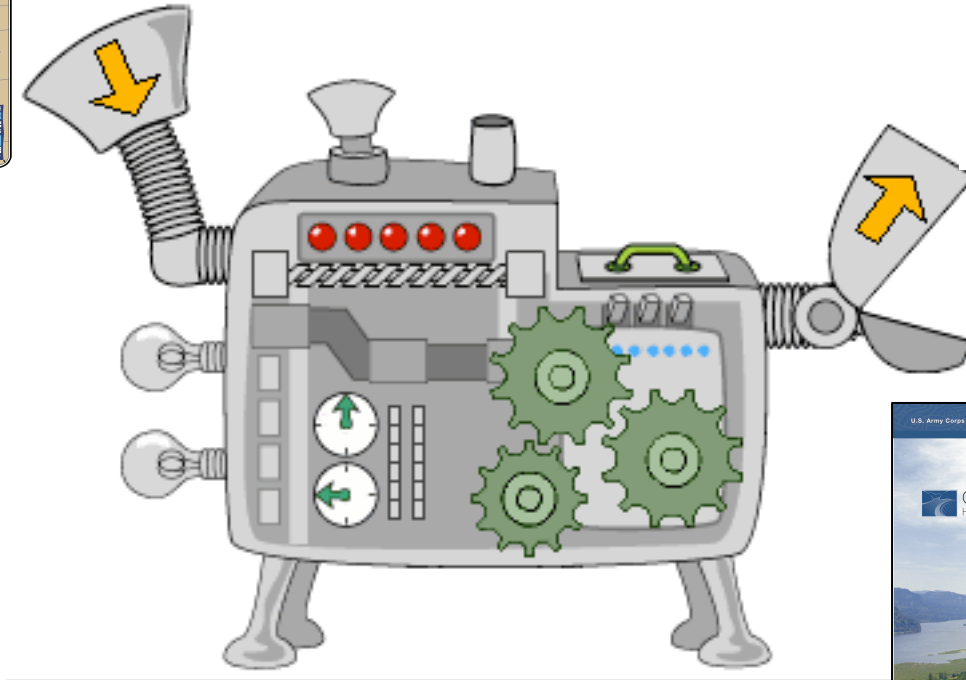
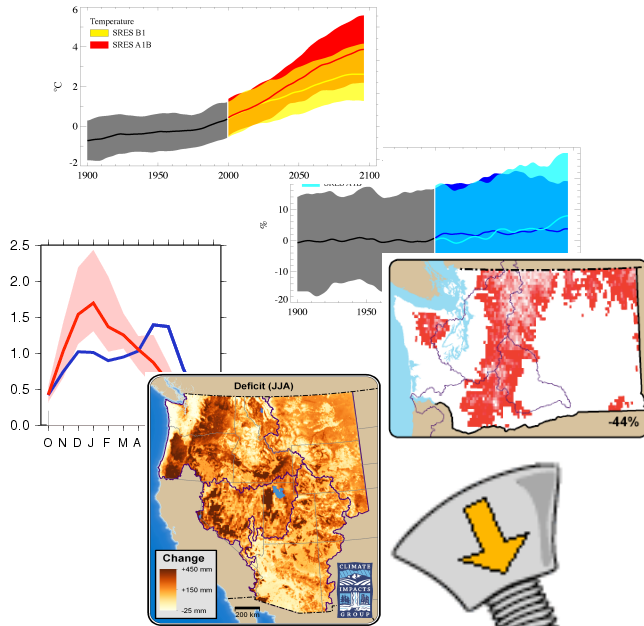


Uncertainty from:
GCMs, emissions
scenarios, climate
variability

Key question: where/how is
climate projected to change
& what will the impacts be?

Key hazards/impacts
Coastal flooding
Inland flooding & drought
Wildfire
Storms

Wishful thinking...





Take Two: Where should we start?

Areas of business to examine:

- planning
- operations (incl. supply chains)
- properties, facilities and physical assets
- connectivity
- employees
- customers
- communities
- overall resiliency

Scoping the assessment

1. *Vulnerability of what?* ...
Identify the outcome variables of concern
2. *Vulnerability to what?* ...
Identify drivers of concern
3. *Vulnerability when?* ...
Specify the time period of assessment

Identify outcome variables of concern by considering system aspects such as:

- planning areas
- business lines
- management objectives
- reporting responsibilities
- facilities & operations
- geographic zones

For more examples, and step-by-step guidance, see *Preparing for Climate Change*, Chapter 7.





Climate Adaptation/Risk Assessment/ Resilience requires ... *Three streams of expertise*

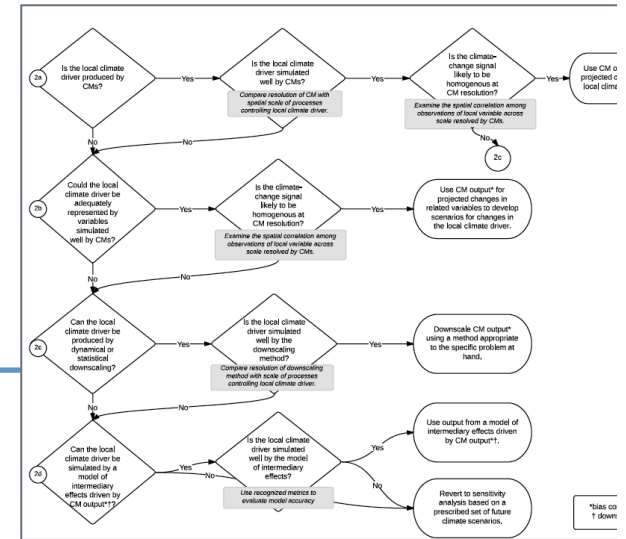
Information / Context

1. **Climate sensitivity**
Variables of concern
System sensitivity to changes in environmental conditions
2. **Climate change**
Ability to project changes
Appropriate data sources
(GCMs, downscaling, impacts models)
Variability vs. trends

Expertise

Subject matter expert

Climate science
Climate impacts science



*To support
NOAA/NMFS'
ESA decision
making*



Climate Adaptation/Risk Assessment/Resilience requires ...

Three streams of expertise

Information / Context

1.

Climate sensitivity

Variables of concern
System sensitivity to changes in environmental conditions

2.

Climate change

Ability to project changes
Appropriate data sources (GCMs, downscaling, impacts models)
Variability vs. trends

3.

Risk management

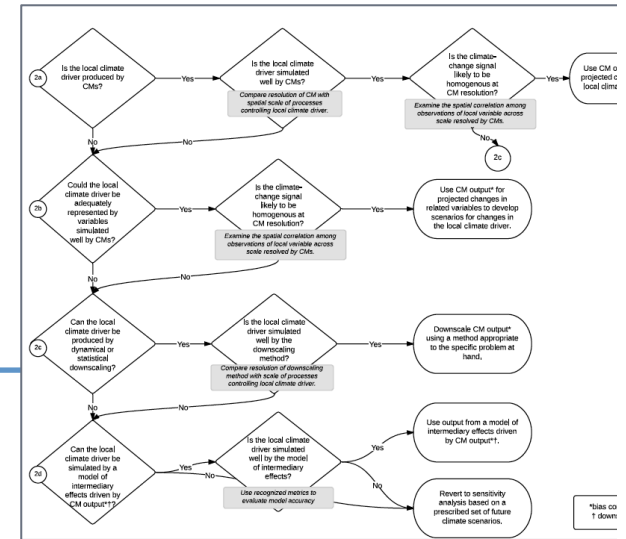
Scenario & time horizon selection
Best vs. worst case

Expertise

Subject matter expert

Climate science
Climate impacts science

Policymaker
Risk assessment



To support NOAA/NMFS' ESA decision making



Choose scenarios to match risk management approach

Risk averse:

identify worst case scenarios

Risk tolerant:

plan for best/middle, adjust response if necessary

Risk spreading:

develop strategies robust to uncertainty by planning for a range of possible outcomes, e.g., best & worst case scenarios



Examples

Locally-specific projections of hydrologic changes (Columbia River basin scenarios)

Combining climate change projections with distributed technical knowledge to assess vulnerability of diverse transportation network (WSDOT)

Comprehensive impacts assessment across climate drivers, affected sectors, time horizons, levels of certainty (Swinomish)

Consider:

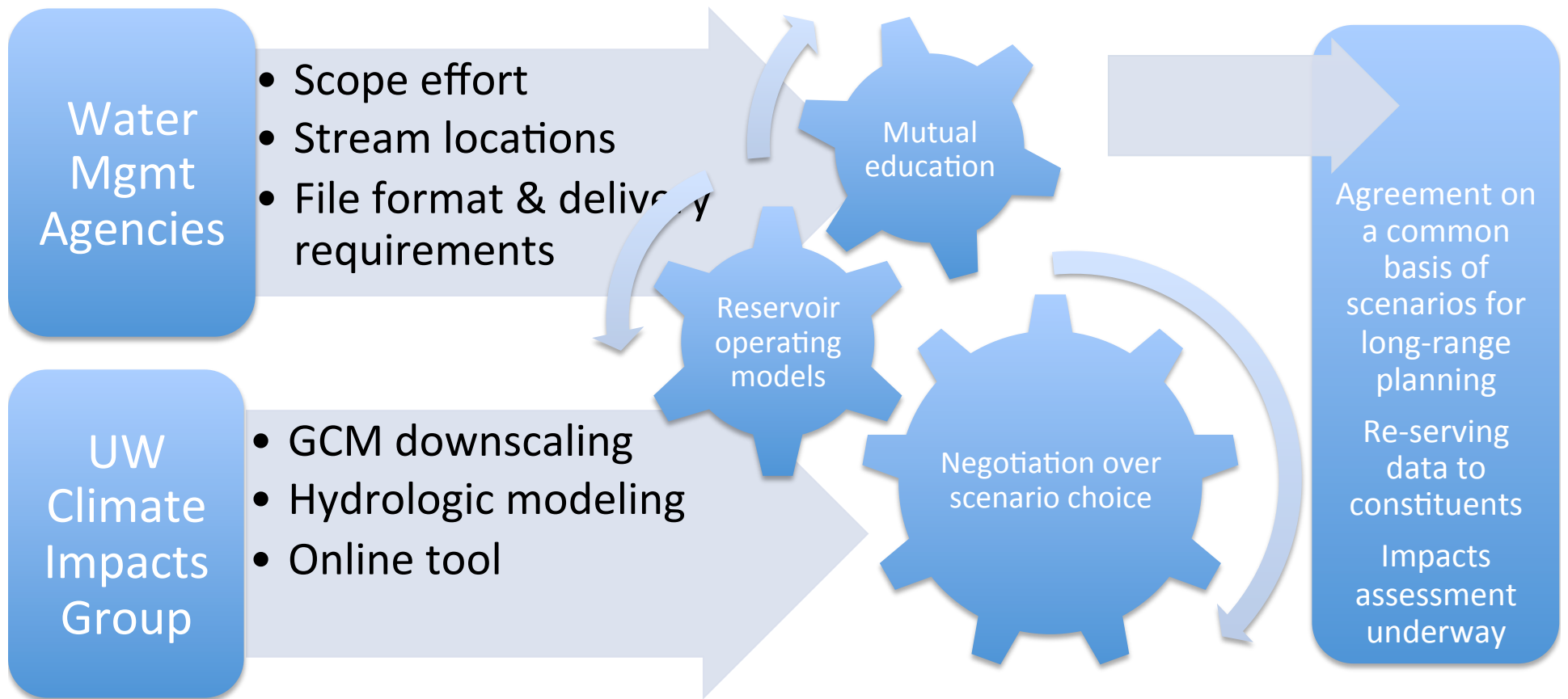
- Multiple interacting streams of input
- Process/approach (data, partnerships, treatment of uncertainty) more than findings

EX1: Climate change impacts on Columbia River basin water resources management

Project Scope	Columbia Basin federal water resources management
Vulnerability of <i>what?</i>	Columbia River basin water resources management objectives
<i>To what?</i>	Warming, precipitation changes
<i>When?</i>	2020s, 2040s, 2080s

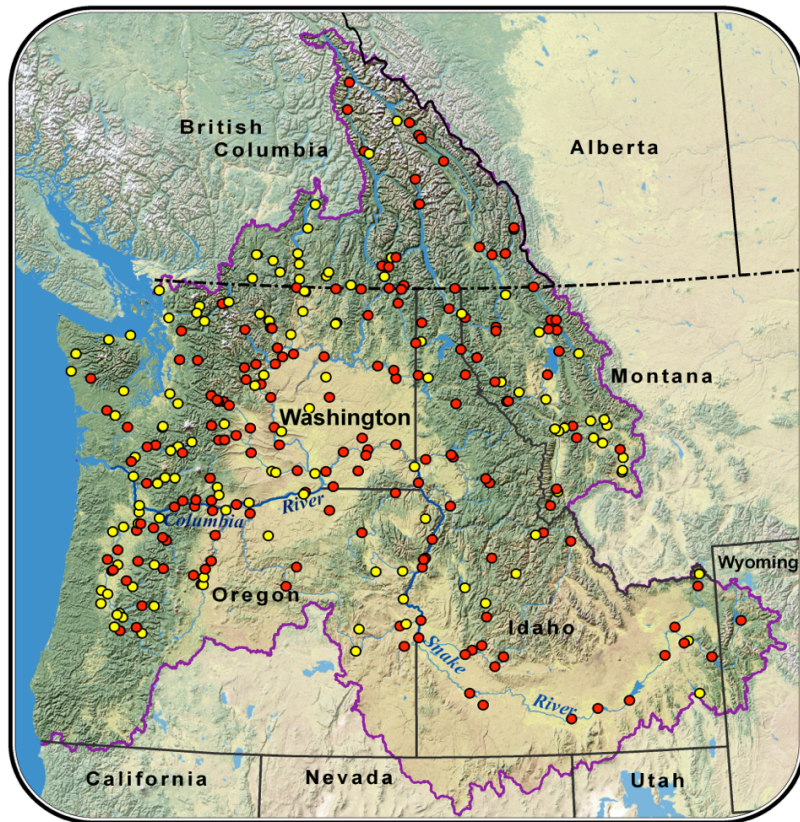
Requires information about future streamflow at specific river locations

Climate change impacts on Columbia River basin water resources management





Columbia Basin Climate Change Scenarios Project



A comprehensive online suite of 21st century hydro/climate scenarios, including data for:

- Temperature
- Precipitation
- Snowpack
- Streamflow
- Floods & extreme low flows
- Evapotranspiration (water demand)
- Soil moisture

<http://warm.atmos.washington.edu/2860/>

Supported by Ecology (HB2860), BPA, NWPCC, ODWR, BC Ministry of Enviro

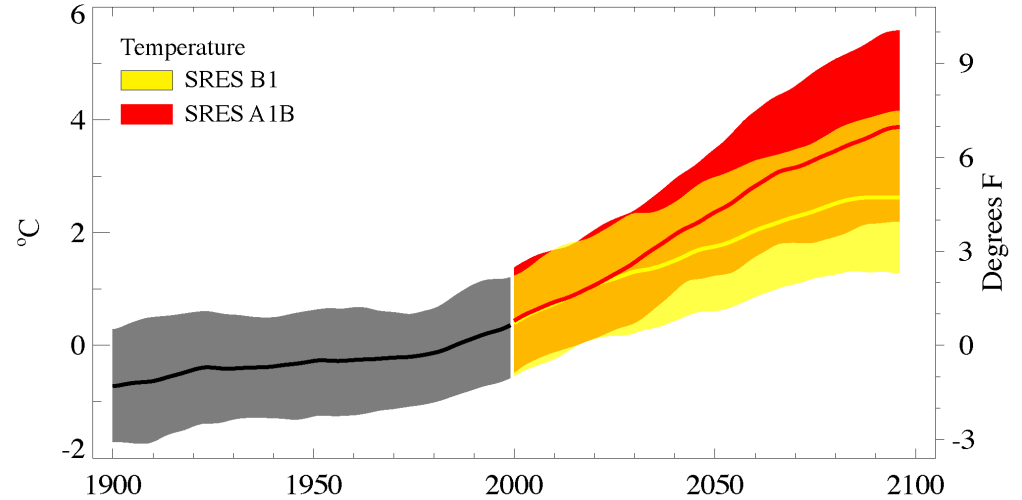


PNW Climate Change

Warmer

2020s	+2.0°F (1.1-3.4°F)
2040s	+3.2°F (1.6-5.2°F)
2080s	+5.3°F (2.8-9.7°F)

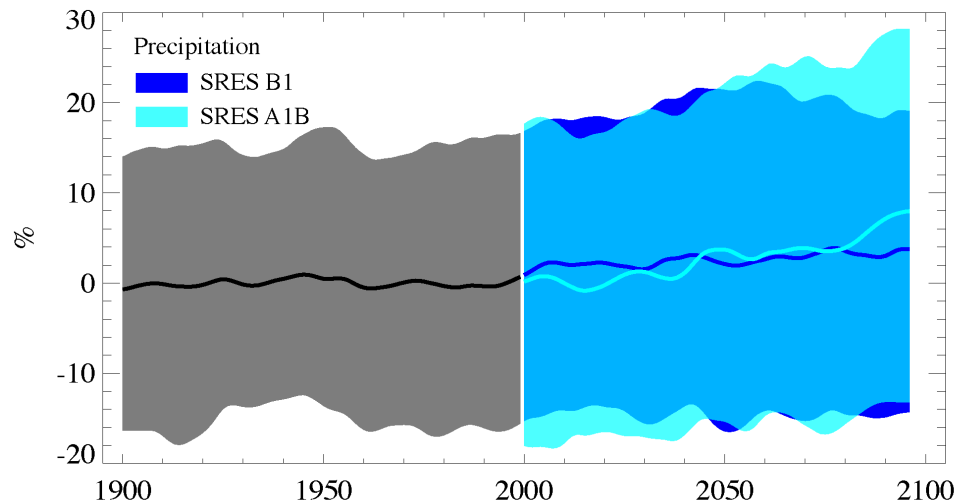
More hot days. Fewer cold days.



Wetter

2020s	+1% (-9 to 12%)
2040s	+2% (-11 to +12%)
2080s	+4% (-10 to +20%)

Wetter falls/winters/springs; drier summers.
Potential increases in extreme precipitation.



Example of site-specific products

Climate Impacts Group - Site Specific Data - 2005

South Fork, Boise River | My F-S... x Boîte de réception (9) - gmauge... x Climate Impacts Group - Site Sp... x +

warm.atmos.washington.edu/2860/products/sites/?site=2005

cig scl report

CLIMATE IMPACTS GROUP

Site Specific Data

Use the pull-down menu or map links to access data and summary figures for individual streamflow locations.

[Join Project's Listserve](#)

[Project Home](#)

[Introduction for New Users](#)

[Project Report](#)

[Citations and Contacts](#)

[Project Updates](#)

[Climate Scenarios](#)

[Site-specific Data](#)

[Primary Data](#)

[Reservoir Model Input Data](#)

[Research Site Data Spreadsheet](#)

Site:

PEND OREILLE RIVER AT ALBENI FALLS DAM

Site Info: **ALBEN (2005)**

USGS Id: [12395500](#)

Latitude (DMS): 48 10 56

Longitude (DMS): 117 02 00

Latitude (Decimal): 48.1822

Longitude (Decimal): -117.0333

Area: 24200 miles²

Nash Sutcliffe Efficiency = N/A

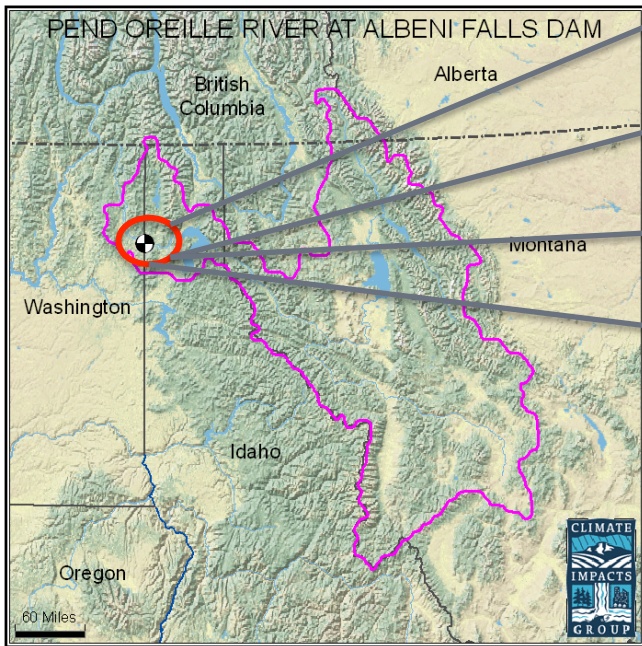
[General FTP directory](#)

warm.atmos.washington.edu/2860/products/sites/r7climate/subbasin_summaries/2005/map_lg.png

<http://warm.atmos.washington.edu/2860>



Example of site-specific products

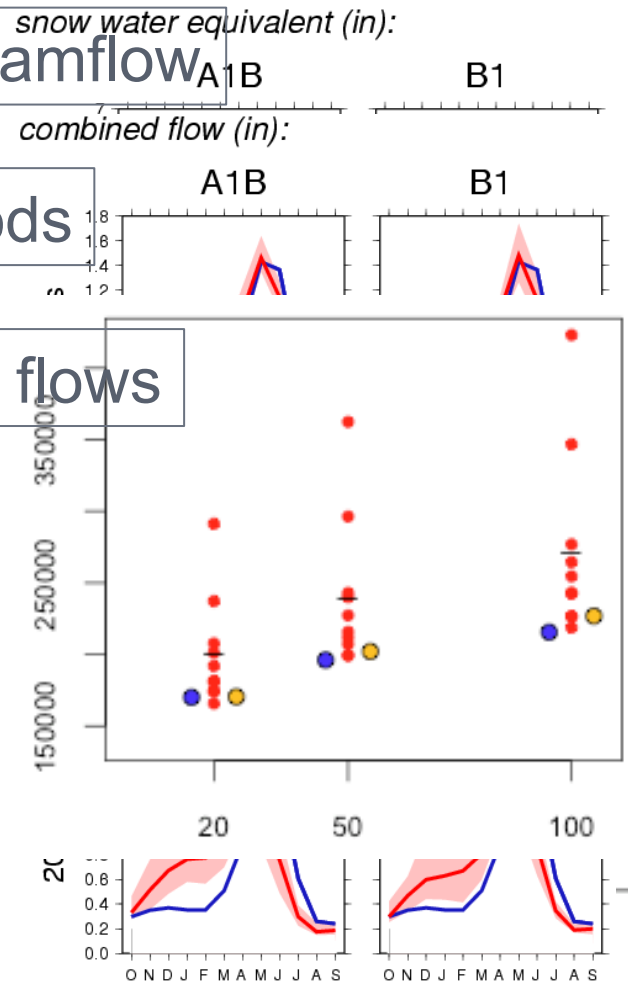


Snowpack

Streamflow
snow water equivalent (in):
 A1B B1

Floods

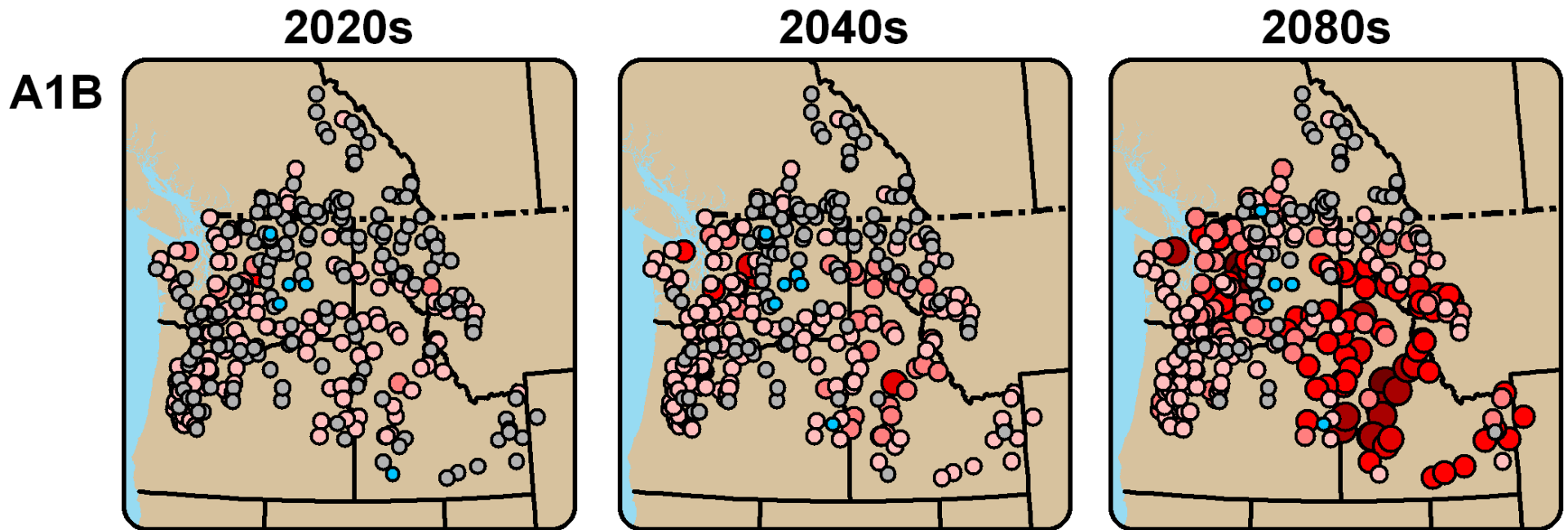
Low flows





Enables local- and regional assessment

Ratio of 100-year Flood Statistics (21st Century ÷ 20th Century)



EX2: Washington State DOT's Vulnerability Assessment: *Asking the "Climate Question"*



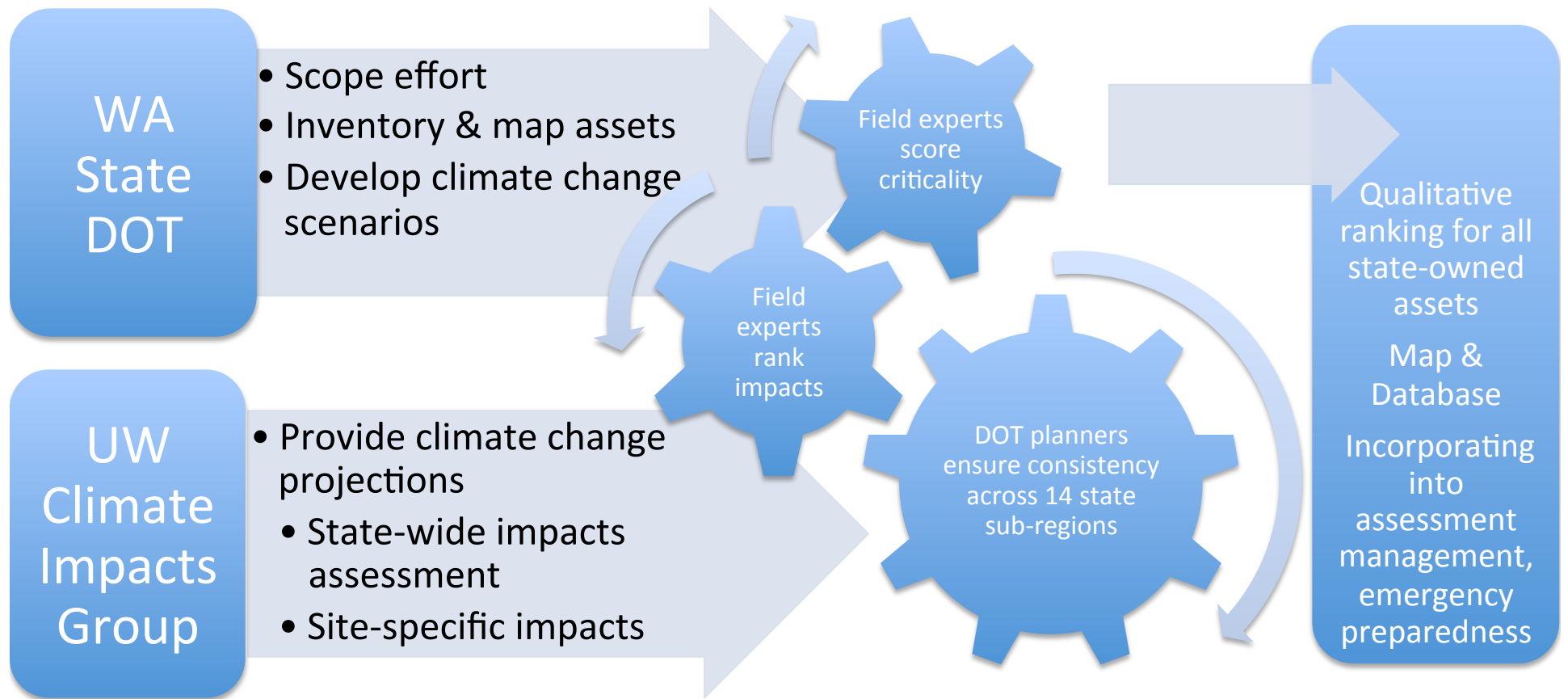
Slide courtesy of Carol Lee Roalkvam
WSDOT Environmental Policy Branch Manager

Climate Vulnerability of Washington State's Transportation Infrastructure

Project Scope	WA State DOT
Vulnerability of what?	State-owned transportation infrastructure
To what?	Warming, precipitation changes, sea level rise, increased risk of flooding, landslides, inundation, wildfire
When?	2040s (temp, precipitation) 2', 4', 6' sea level rise

“What does climate change mean for WSDOT infrastructure and operations?”




Climate Vulnerability of Washington State's Transportation Infrastructure



SLR estimated along coast and Puget Sound



Step 1 – Group defines character of each asset

Very low to low				Moderate		Critical to Very Critical			
1	2	3	4	5	6	7	8	9	10
Criticality of asset									
<p>Notice that along with the qualitative terms there is an associated scale of 1 to 10, this is to serve as a facilitation tool for some people who may find it useful to think in terms of a numerical scale – although the scoring by each individual is of course subjective. The scale is a generic scale of criticality where “1” is very low (least critical) and “10” is very critical.</p>									
									
<p>Typically involves: non-NHS low AADT alternate routes available</p>				<p>Typically involves: some NHS non-NHS low to medium AADT serves as an alternative for other state routes</p>		<p>Typically involves: Interstate Lifeline some NHS sole access no alternate routes</p>			

Record Impact Score

10
9
8
7
6
5
4
3
2
1



Complete Catastrophic Failure

Results in total loss or ruin of asset. Asset *may* be available for *limited* use after at least 60 days and would require major repair or rebuild over extended period of time. "Complete and/or catastrophic failure" typically involves:

- Immediate road closure;
- Disruptions to travel;
- Vehicles forced to re-route to other roads;
- Reduced commerce in affected areas;
- Reduces or eliminates access to some destinations;
- May sever some utilities located within right-of-way;
- May damage drainage conveyance or storage systems.



Temporary Operational Failure

Results in minor damage and/or disruption to asset. Asset would be available with either full or limited use within 60 days and may have immediate limited use still available.

"Temporary Operational Failure" typically involves:

- Temporary road closure, hours to weeks;
- Reduced access to destinations served by the asset;
- Stranded vehicles;
- Possible temporary utility failures.



Reduced capacity

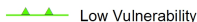
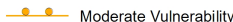
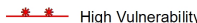
Results in little or negligible impact to asset. Asset would be available with full use within 10 days and has immediate limited use still available. "Reduced capacity" typically involves:

- Less convenient travel;
- Occasional/ brief lane closures, but roads remain open;
- A few vehicles may move to alternate routes;



Figure 2.1 Photo Depictions of Qualitatively Assessed Climate Change Consequences

Climate Impacts Vulnerability Assessment Statewide Results



State Routes

-  Low Vulnerability
-  Moderate Vulnerability
-  High Vulnerability

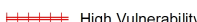
State Airports

-  Low Vulnerability
-  Moderate Vulnerability

State Ferry

-  Low Vulnerability
-  High Vulnerability

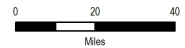
State Rail

-  High Vulnerability

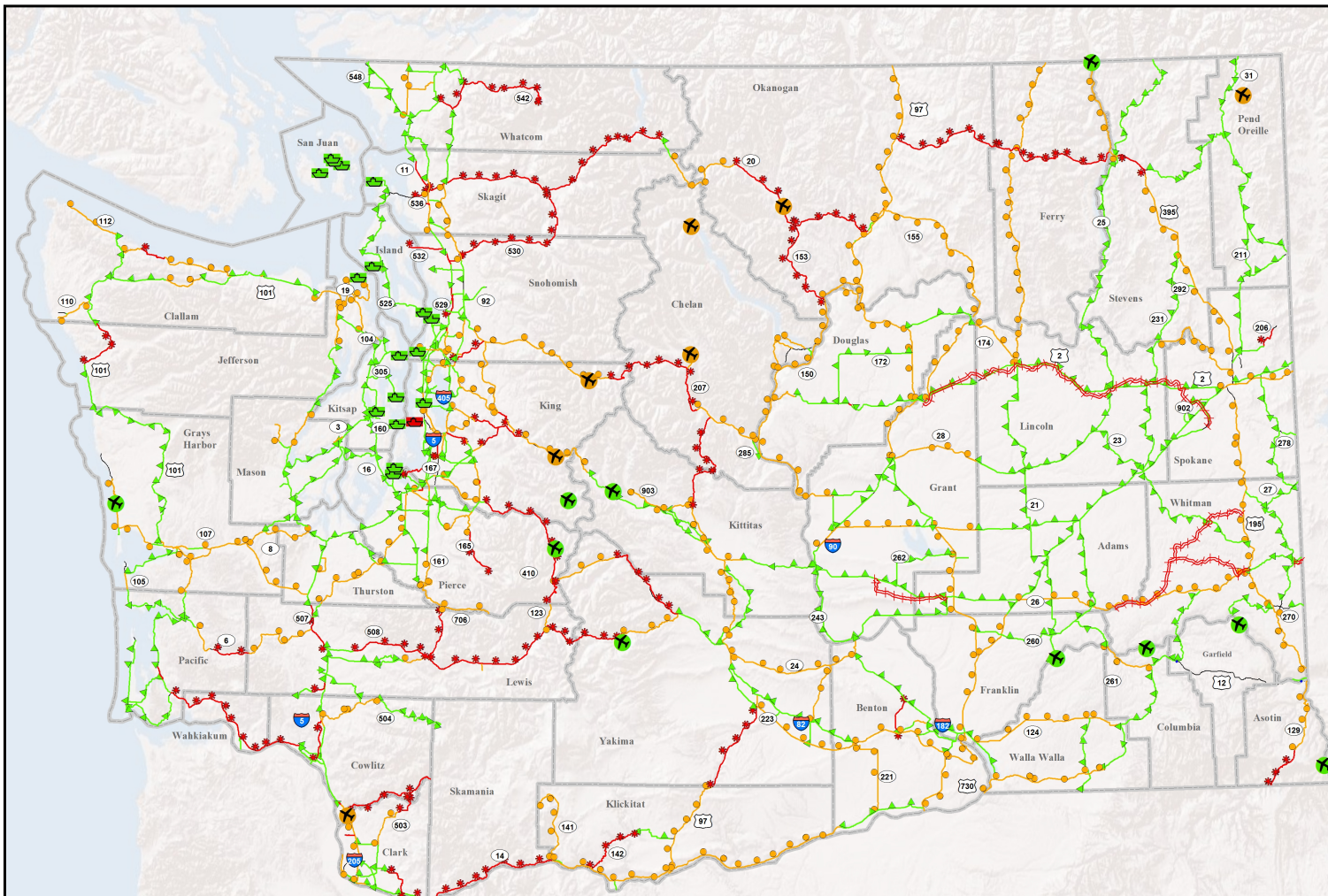
November 30, 2011

Data Source: Climate Impacts Vulnerability Assessment from WSDOT Internal Scenario-based Planning Workshops Conducted March - October 2011; State Routes from WSDOT at scale of 1:24K; County Boundaries from WSDOT at scale of 1:500K

NOTE: Statewide results assess 2-foot Sea Level Rise (see Appendix E for 4-foot and 6-foot)



sq\2011\climatechange\stateimpact11x17.mxd



DRAFT

FOR PLANNING ONLY
Not suitable for site specific use

What did we find?

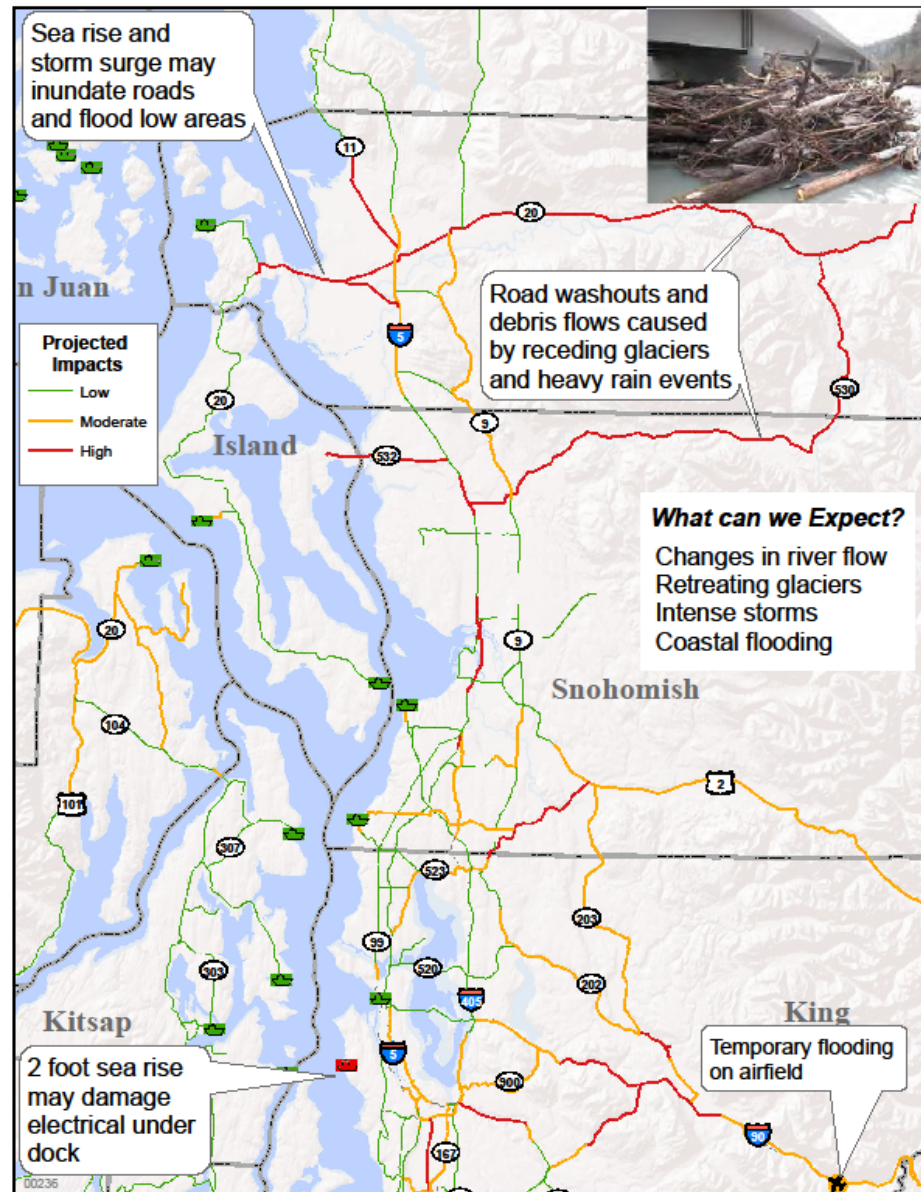
Climate change will intensify known threats.

The study reinforces value of our current maintenance and retrofit programs.

Some surprises:

- Bridges safer than their approaches
- Maintenance facilities at risk

It was a unique way to capture knowledge of field staff





EX2b: Sound Transit Climate Risk Reduction Project



EX3: Comprehensive impacts assessment across climate drivers, affected sectors, time horizons, levels of certainty



Shelter Bay, source: http://www.goskagit.com/home/article/shelter_bay_residents_bracing_for_increase/



Swinomish Indian Tribal Community: Climate Change Initiative

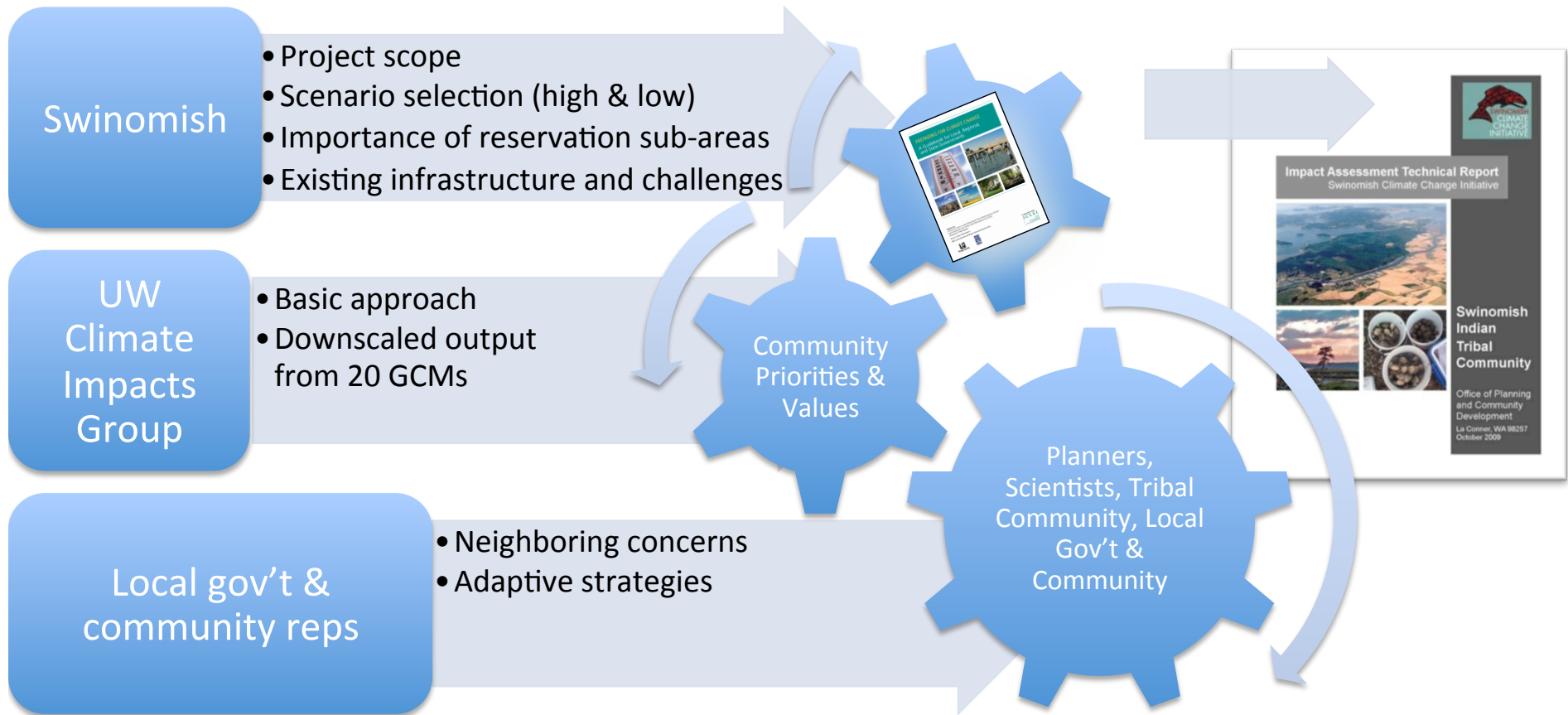
Project Scope	WA State DOT
Vulnerability of <i>what?</i>	Swinomish Indian Reservation community assets, vital infrastructure, natural resources, cultural areas, economic development areas, and community health
<i>To what?</i>	all currently understood local impacts of climate change (temp, precipitation, sea level rise, hydrologic response, wildfire risk, flooding, inundation, erosion, public health, etc)
<i>When?</i>	“near” (20-50) and “long” (50-100) term



Shelter Bay, source: http://www.goskagit.com/home/article/shelter_bay_residents_bracing_for_increase/



Swinomish Indian Tribal Community: Climate Change Initiative





Swinomish Indian Tribal Community: Climate Change Initiative

- **Impact Analysis:** at-risk areas (zones), range/probability of impacts by planning sector, based on local projections

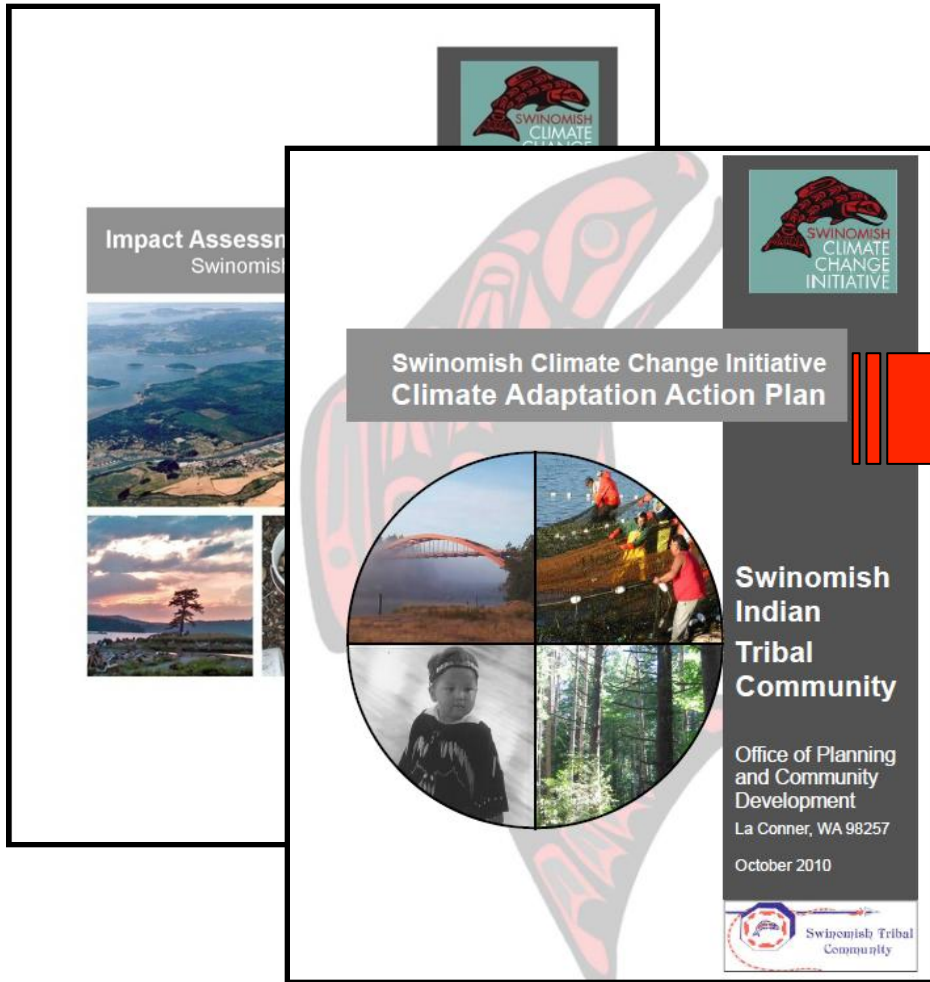
- **Vulnerability Assessment:** inventory risk zones, sensitivity/adaptive capacity
- **Risk Analysis:** value of at-risk assets; vulnerability X probability = risk

POTENTIAL CLIMATE CHANGE IMPACTS BY POLICY SECTORS		20 - 50 YR PROBABILITY:	HIGH <---> POSSIBLE	(UNSHADED: NOT LIKELY/NOT APPLICABLE)
SWINOMISH INDIAN RESERVATION VICINITY		50-100 YR PROBABILITY:	HIGH <---> POSSIBLE	(UNSHADED: NOT LIKELY/NOT APPLICABLE)
SECTION/ELEMENT	Element	High	Possible	Not Likely/Not Applicable
NATURAL SYSTEMS				
Shoreline/Beaches				
Tribal Lands				
Habitat				
Salmon				
Forage fish				
Waterfowl/Birds				
Wetlands				
Groundwater				
Wetlands				
Forest resources				
Air Quality				
HUMAN/BUILT SYSTEMS				
Land use:				
Near-shore development				
Residential				
Agriculture				
Recreation				
Public/Private Utilities:				
Communications				
Energy/Power				
Waste management/disposal				
Fire				
Other emergency response				
Human Health				
Transportation:				
Bridges				
Public transit				
Marine/port facilities				
Cultural Resources				

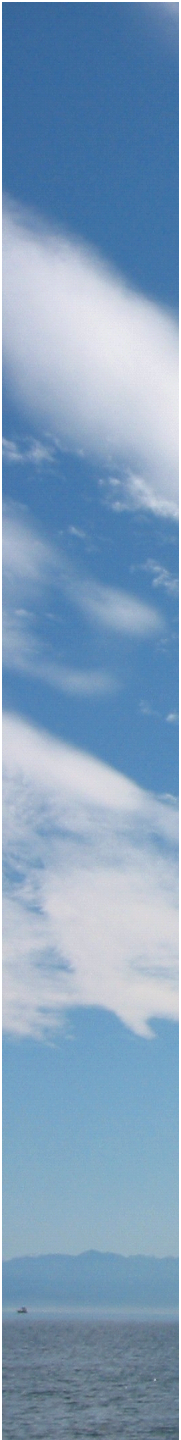




Implementing Action Plan Priorities



- Coastal zone measures (\$\$)
- Dike maintenance/repair (\$\$\$\$)
- Preservation of access (\$\$\$\$\$)
- Wildfire control (\$)
- Emergency planning (\$)



*Climate Science in the
Public Interest*

UW Climate Impacts Group
www.cses.washington.edu/cig



COLLEGE OF THE ENVIRONMENT
UNIVERSITY *of* WASHINGTON