Potential Climate Change Impacts on Stormwater Management in WRIA 9

EPA Puget Sound Watershed Management Assistance Program FY2009

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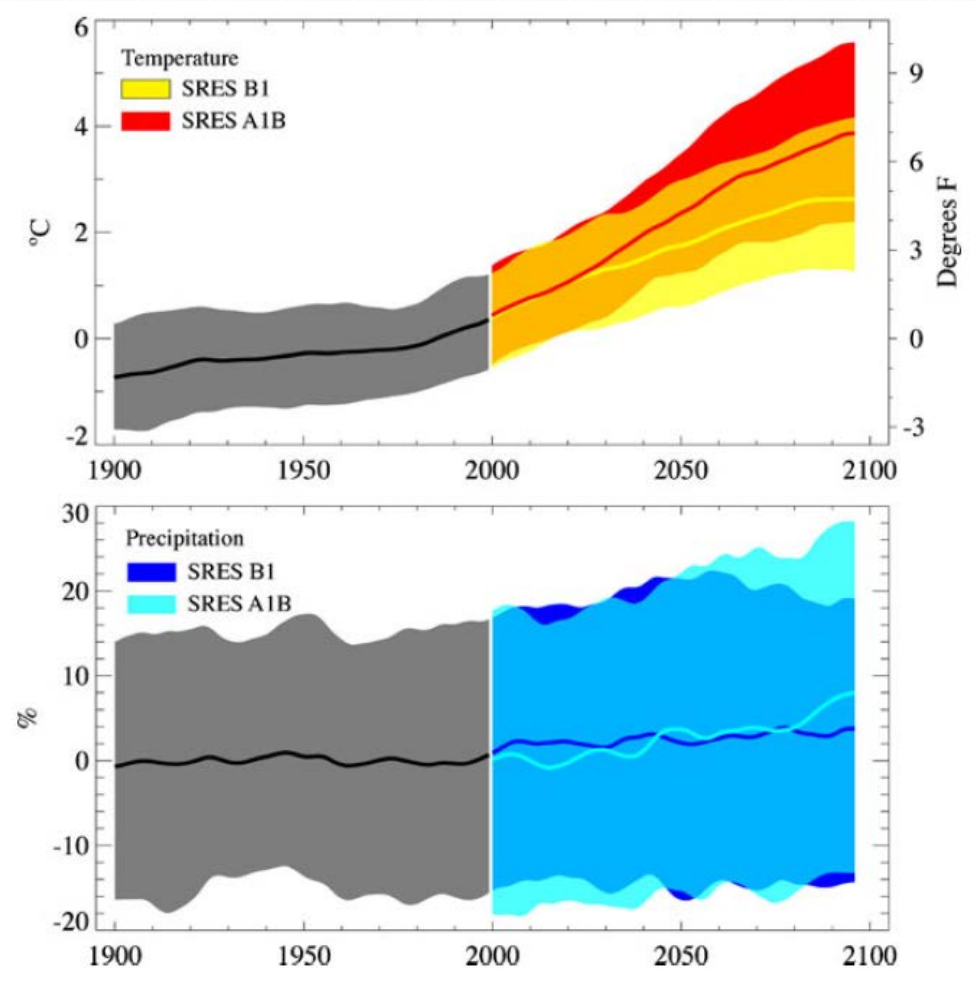
Goal

- Inform stormwater agencies of what might be coming as a consequence of projected changes in local rainfall

Objectives

- Leverage previous climate change studies as much as possible
- Characterize conditions as *locally* as possible
- Quantify possible impacts on stormwater infrastructure and streams

Climate Modeling



Source: Mote and Salathe 2010

- GCM's
  - consistent for temperature modeling
  - consistent for snow pack and water supply
  - Variable for rainfall

Climate Models Used

GSM	Emission	Downscale	Time step	Source
CGMCM 3.1 T47	A1B	BCSD	Daily	Cuo et al., 2010
CGMCM 3.1 T63				
CNRM_CM3				
ECHAM5				
HADCM				
HADGEM1				
IPSL_CM4				
BCCR				
CCSM3				
CSIRO_3_5				
ECHO_G				
FGOALS_0_G				
GFDL_CM2_0				
GFDL_CM2_1				
GISS_AOM				
GISS_ER				
INMCM3_0				
MIROC_3.2				
MIROC_3.2_HI				
PCM1				
ECHAM5[1]		WRF + BCSD	1-hour	Rosenberg et al., 2010
CCSM3[2]	A2			

Method of Analyses

Compare using Relative Percent Difference

$$RPD = \frac{(Future\ - Historical)}{Historical} * 100$$

1. Rainfall patterns using annual maximum daily rainfall (all modeling scenarios)
2. Stormwater ponds using detention volumes (Rosenberg)
3. Flashiness using High Pulse Counts (Rosenberg)

Results (1) Rainfall

- 20 GCMs (Cuo)
  - +14% avg
  - -7% to +56%
  - Storm sizes generally increase
- 2 GCMs (Rosenberg)
  - Small storms get smaller, big storms get bigger (A1B)
  - A2, all storms get bigger (+18% avg)

	Rosenberg		Cuo (A1B)		
Statistic	ECHAM5 | A1B	CCSM3 | A2	Avg	Min	Max
Mean	4%	18%	11%	-1%	29%
100%	6%	53%	24%	-8%	68%
99%	7%	48%	20%	-9%	51%
95%	10%	29%	14%	-7%	56%
90%	-6%	20%	12%	-5%	63%
75%	8%	11%	3%	-10%	19%
50%	8%	17%	13%	3%	22%
25%	2%	12%	18%	6%	32%
10%	-9%	22%	19%	7%	41%
5%	-17%	25%	12%	-2%	24%
1%	-14%	40%	5%	-16%	19%
0%	-10%	46%	4%	-21%	19%

Results (2) Stormwater Pond Volumes

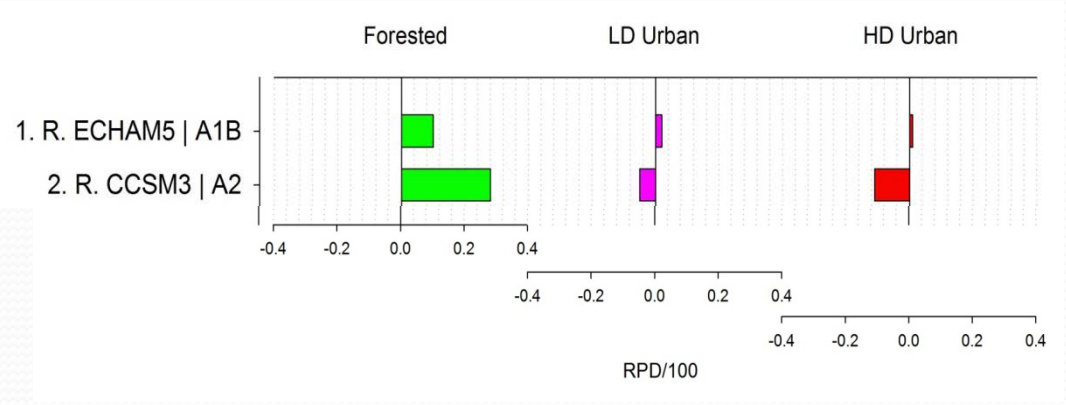
LD Residential Land Use Distribution,

Level 2 Flow Control Targets

- Modeling Scenario (ECHAM5 |A1B)
  - <1% increase
- Modeling Scenario (CCSM3 | A2)
  - +11% increase

Results (3) Flashiness (HPCs)

- Forested HPCs increase
- Developed landscapes may see little or no increase in frequency, just bigger storms



Uncertainties

- Cuo's 20 GCM ensemble was based on a single moderate emission scenario (A1B), other emission scenarios will produce different results
- Only one climate modeling scenario using pessimistic emissions (A2) was downscaled, but it's based on a GCM that is among top 4 GCMs producing storm runoff (using Cuo's 20 GCMs and A1B)
- Impacts from climate change could be more or less when evaluating for a wider range of flow control targets (e.g., LID, Level 3), emission scenarios, and flashiness metrics
- Method of downscaling GCMs influences results

- A whole new suite of emission scenarios have recently become available (IPCC AR5) and that will generate new modeling scenarios

Summary

- Storm volumes generally increase, but are wide ranging from
  - -21% to + 68%, depending on the size of the storm and modeling scenario
- A single balanced climate scenario (ECHAM5 | A1B) marginally increases stormwater pond size (< +1%)
- A pessimistic emission scenario (A2) coupled with a GCM producing larger than ensemble average storms (CCSM3) increases stormwater pond volumes +11% (**LD Residential**)
- Stream flashiness increases for forested conditions
- Landscapes that are already flashy may not see an increase in frequency of flashiness

Conclusion

- Based on a time horizon of 2020 to 2050, we can't say with certainty that it's a good investment right now, but for planning purposes we feel that incorporating this upper range of impact is an imperfect but good, pre-cautionary approach
- When new downscaled climate modeling scenarios become available, this should be revisited

Round Table Questions

- Lots of variability in results, how useful is this?
- New climate scenarios are underway, should we revisit at a later date?
- Because forested conditions become more flashy in the future, what should be the targets?