

How climate change may influence stormwater runoff

Insights from the Puget Sound Stormwater Heatmap

Christian Nilsen
September 10, 2020

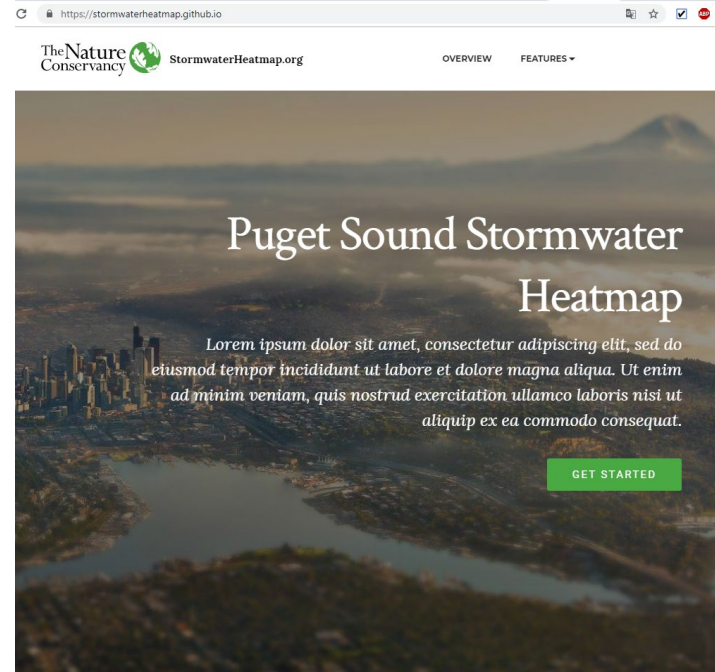
Geosyntec 
consultants



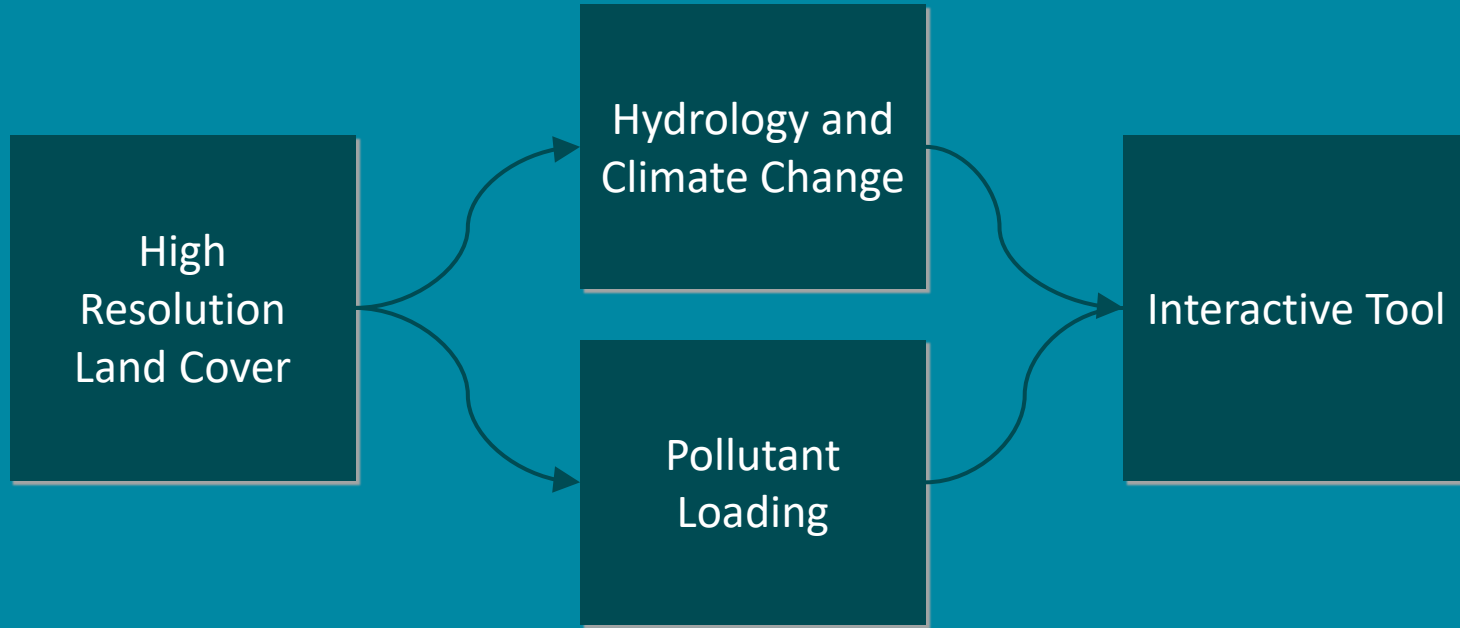
The Puget Sound Stormwater Heatmap

Goals and motivation

- Get the best science and tools in the hands of decision makers
- Lower the costs for effective decision making and planning
- Improve Puget Sound water quality and recover ecosystem health



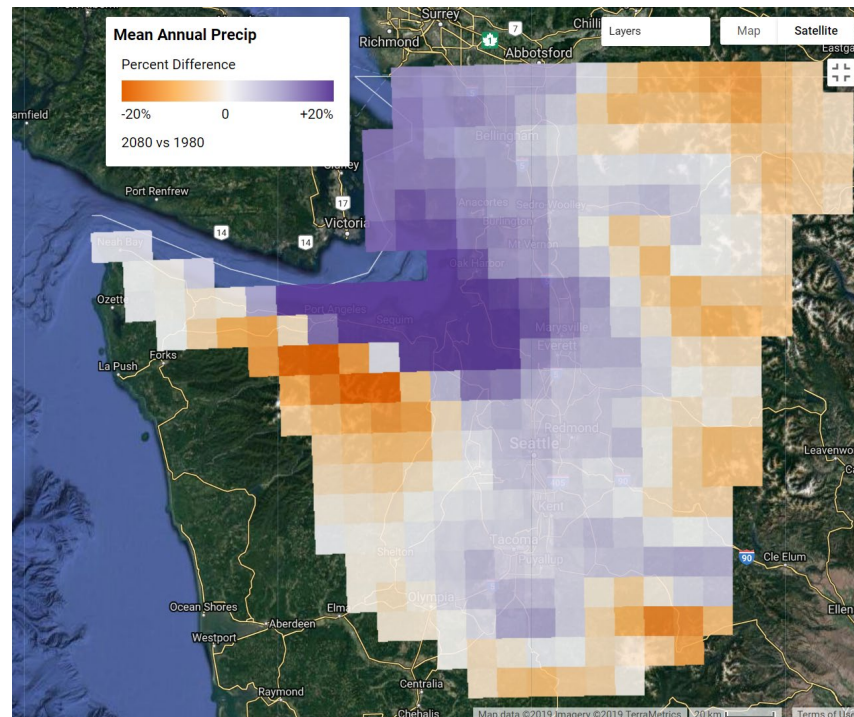
Components and products



- Downscaled from GFDL CM3. RCP 8.5 (High emissions) "High-High"
- Hourly precipitation developed through application of regional weather model (Weather Research and Forecasting WRF, Skamarock et al. 2005)

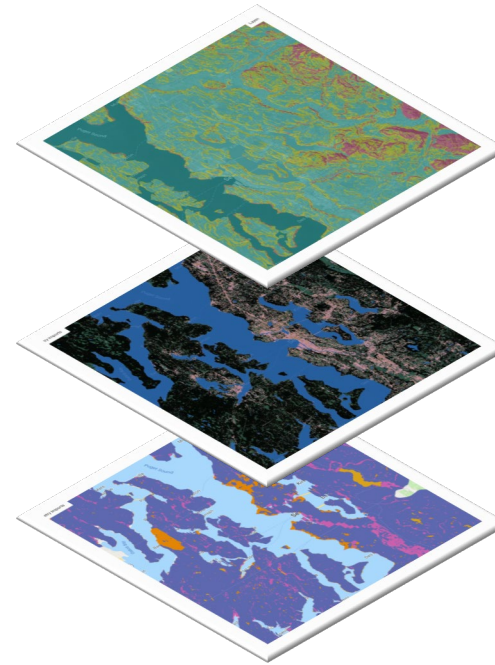
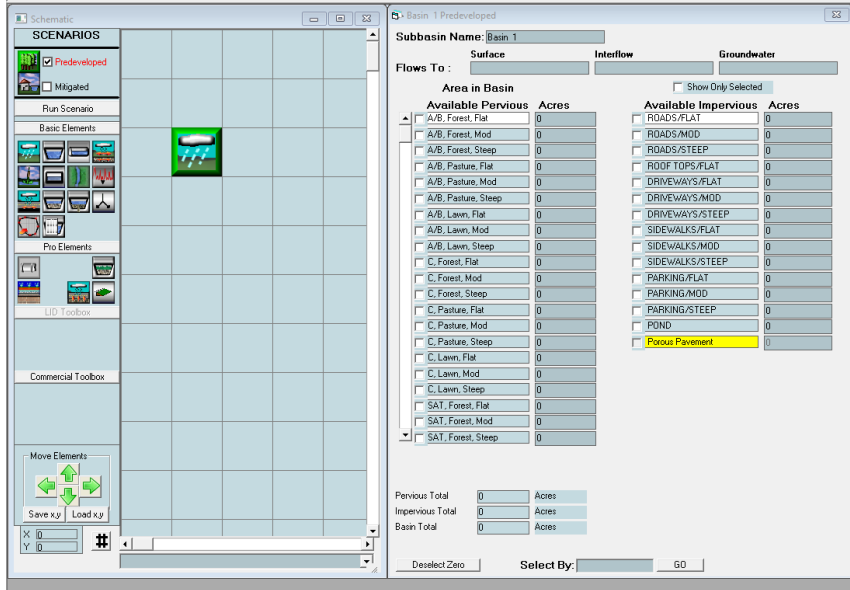


Mauger, G.S., J.S. Won, K. Hegewisch, C. Lynch, R. Lorente Plazas, E. P. Salathé Jr., 2018. New Projections of Changing Heavy Precipitation in King County. Report prepared for the King County Department of Natural Resources. Climate Impacts Group, University of Washington, Seattle.



HYDROLOGIC RESPONSE UNITS

30 HRUs – Precalibrated factors



3 Slope
Categories Types

5 Land Cover
Types

3 Soils Categories

Western Washington Hydrology Model

Runoff Simulation Workflow

Python



GFDL 8.5
Hourly
Precip



Potential
Evaporation

Gridded
Meteorology

HSPY

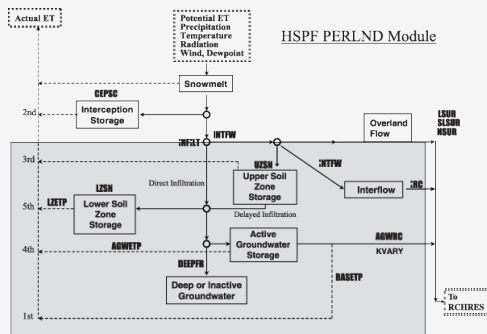


Table info

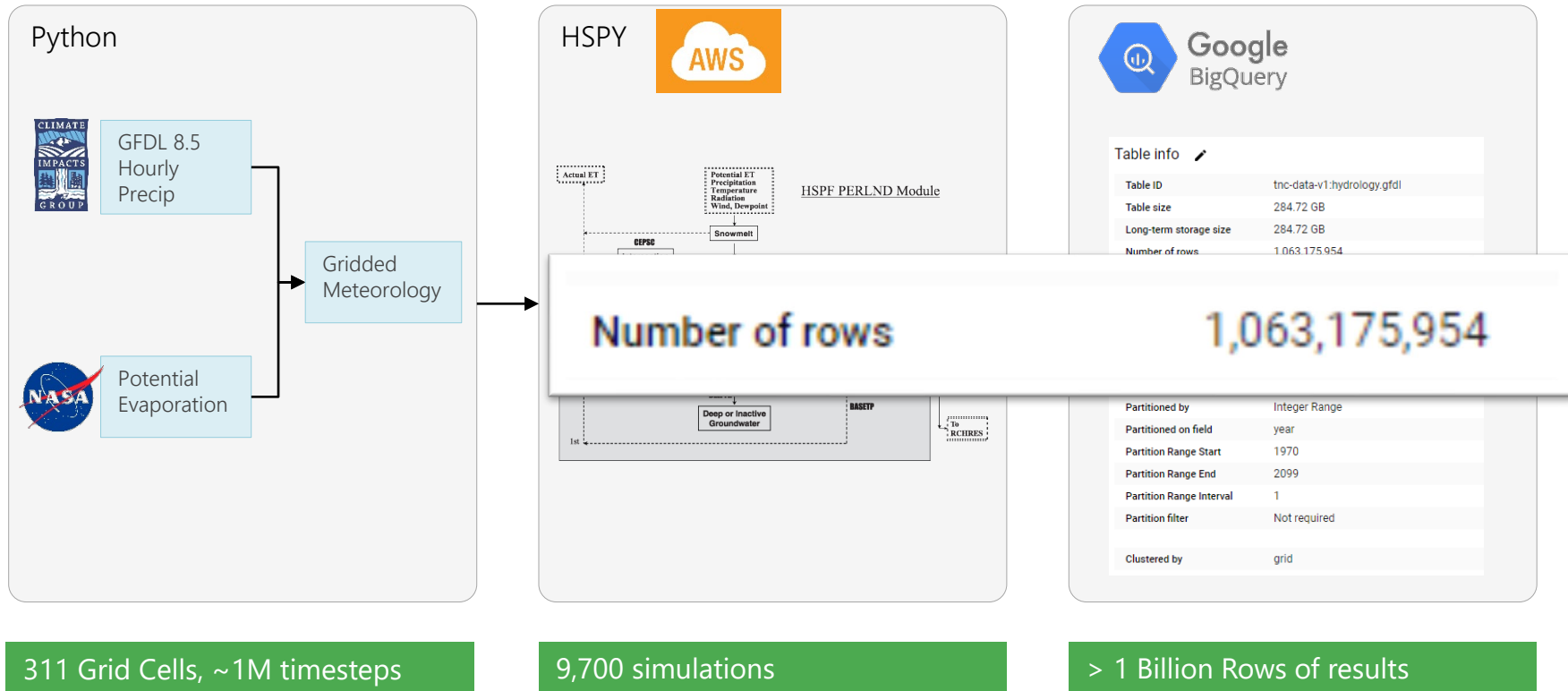
Table ID	tnc-data-v1:hydrology.gfdl
Table size	284.72 GB
Long-term storage size	284.72 GB
Number of rows	1,063,175,954
Created	May 6, 2020, 8:58:43 AM
Table expiration	Never
Last modified	May 6, 2020, 8:58:43 AM
Data location	US
Table type	Partitioned
Partitioned by	Integer Range
Partitioned on field	year
Partition Range Start	1970
Partition Range End	2099
Partition Range Interval	1
Partition filter	Not required
Clustered by	grid

311 Grid Cells, ~1M timesteps

9,700 simulations

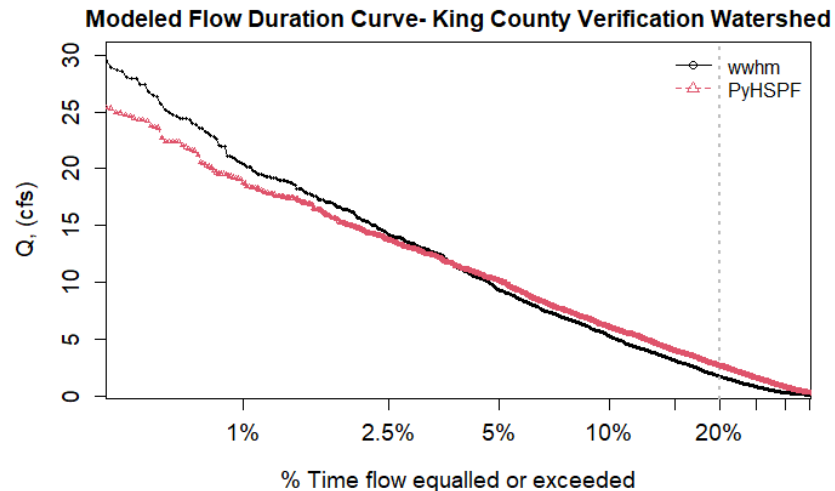
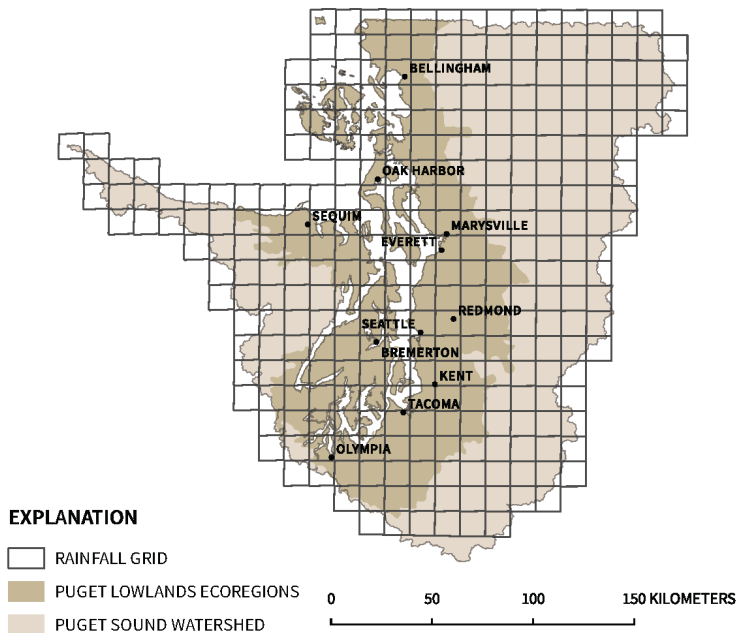
> 1 Billion Rows of results

Runoff Simulation Workflow




Verification against WWHM

Madsen Creek Watershed, King County



Client Libraries



Google BigQuery

Query editor

```
1 SELECT artist_name,  
2        artist_gender,  
3        artist_area,  
4        ARRAY(SELECT artist_credit_name_name  
5              FROM UNNEST(recordings_by_artists_dataflow_nested.artist_recordings)) AS artist_credit_name_name,  
6        ARRAY(SELECT recording_name  
7              FROM UNNEST(recordings_by_artists_dataflow_nested.artist_recordings)) AS recording_name  
8 FROM musicbrainz.recordings_by_artists_dataflow_nested  
9 UNNEST(recordings_by_artists_dataflow_nested.artist_recordings) AS artist_recordings_struct  
10 WHERE artist_recordings_struct.recording_name LIKE "%Justin%"  
11 LIMIT 1000;  
12
```

Processing location: US

[Run](#) [Save query](#) [Save view](#) [Schedule query](#) [More](#)

This query will process 663.8 MB when run.

Query results

Query complete (4.2 sec elapsed, 663.8 MB processed)

Job information Results JSON Execution details

Row	artist_name	artist_gender	artist_area	artist_credit_name_name	recording_name
1	Maurizio Bialocchi	null	null	Maurizio Bialocchi	Old Bastard (Justin Imperiale mix)
2	Lee Jefferies	null	null	Lee Jefferies	Drop the Dime (feat. Justin Bourne)
3	Obsolete Systems	null	null	Obsolete Systems	Life With Justin Bailey
4	Frogs in Socks	null	null	Frogs in Socks	Night Kaps (Justin Jay remix)
				Frogs in Socks	Get It On (Didier Morris Got it on remix)
				Frogs in Socks	Get It On
				Frogs in Socks	Night Kaps
				Frogs in Socks	Get It On (Jett remix)



{ **REST:API** }



Sign up:

<https://groups.google.com/d/forum/stormwaterheatmap/join>

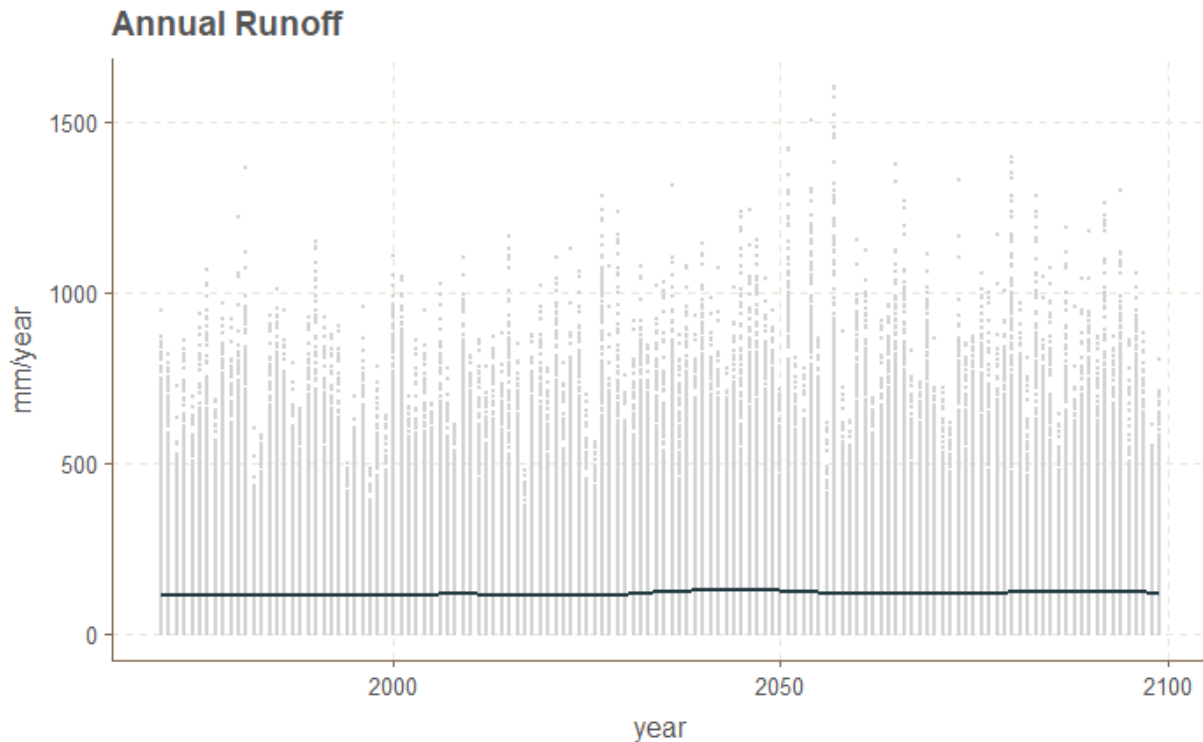


Annual Runoff – All Locations

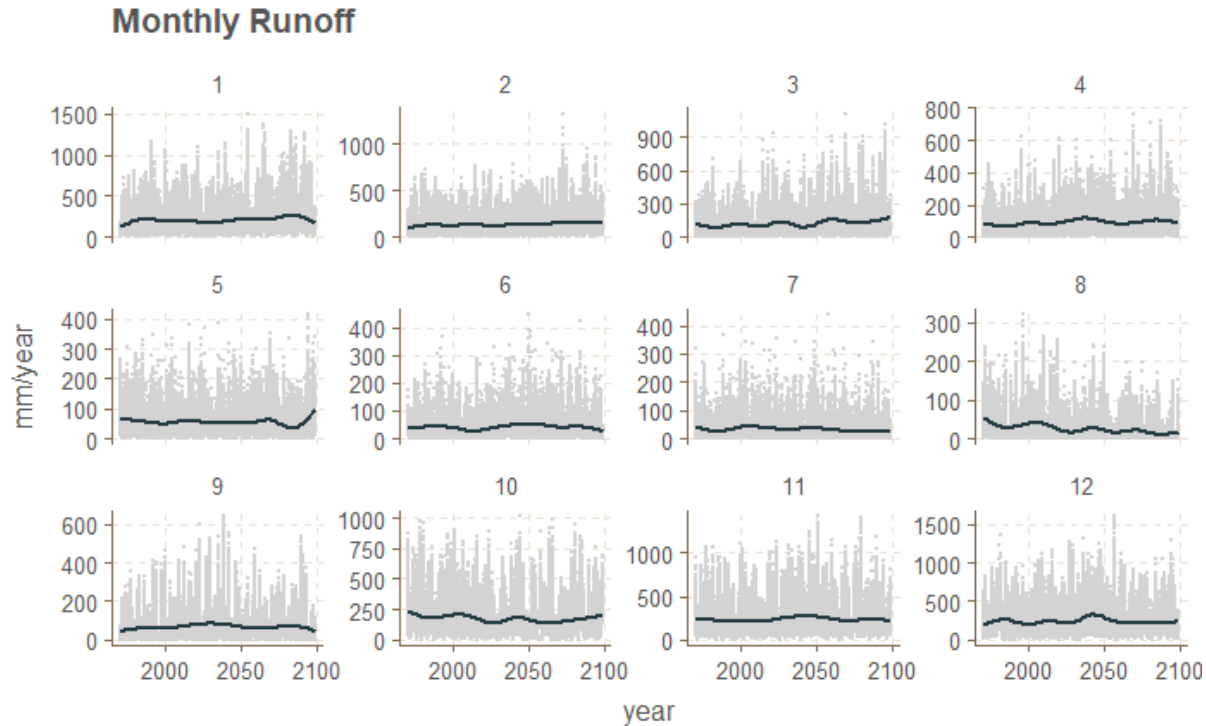
SQL Query

No model required!

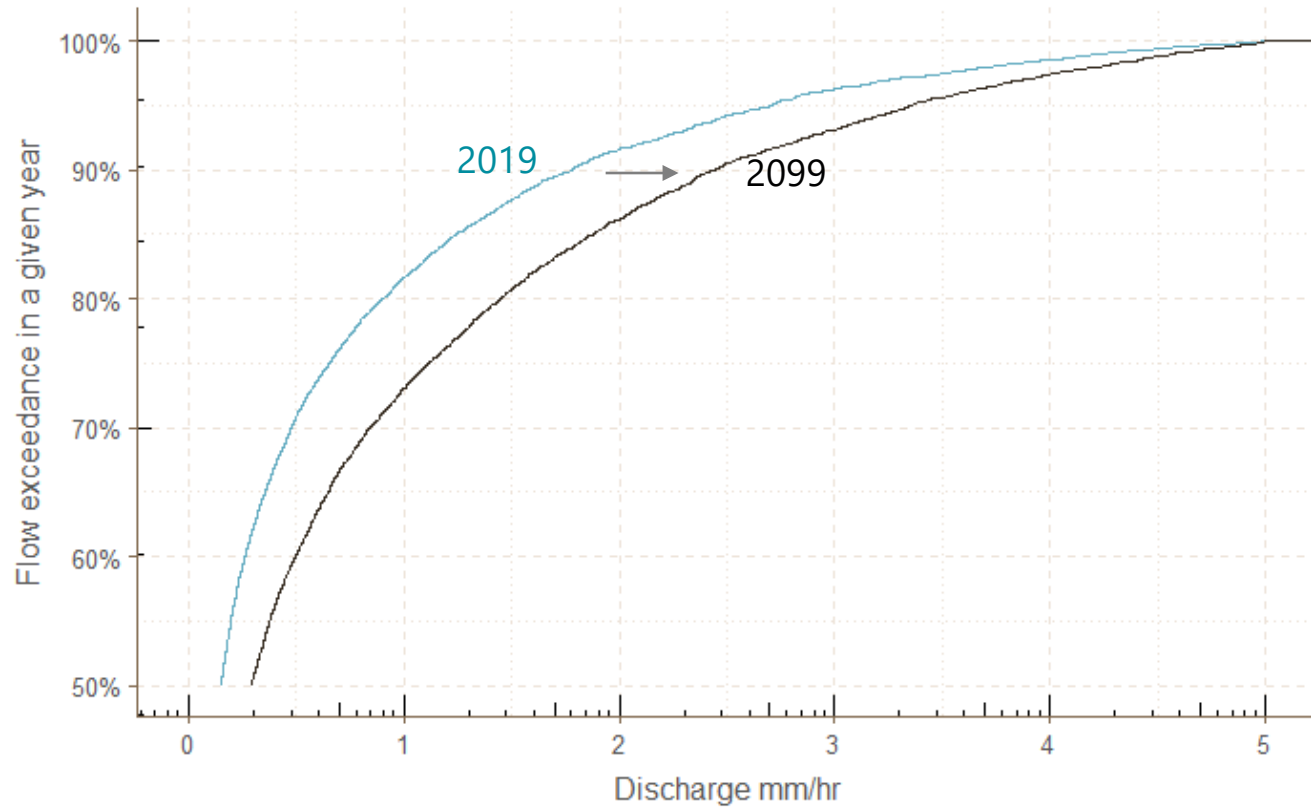
```
SELECT  
    SUM(mm_hr)  
FROM  
    'tnc-data-v1.hydrology.gfdl_longformat'  
WHERE  
    comp IN ('suro',  
            'ifwo')  
GROUP BY  
    hru,  
    grid,  
    year
```



Monthly Runoff – all Locations

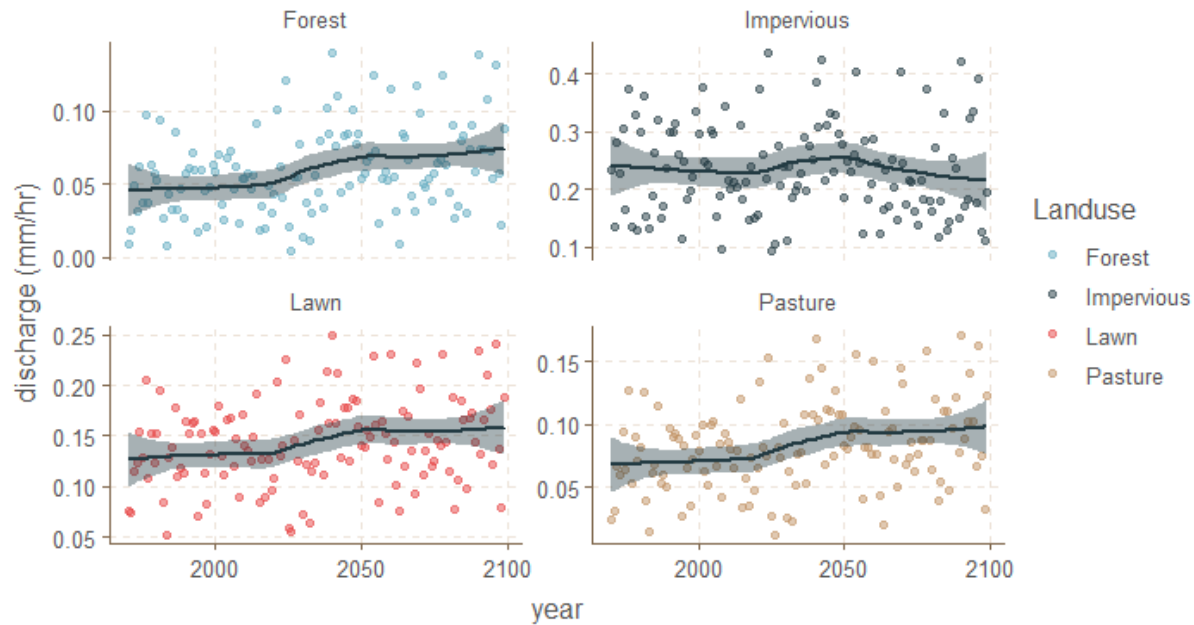


Flow Percentile per Year



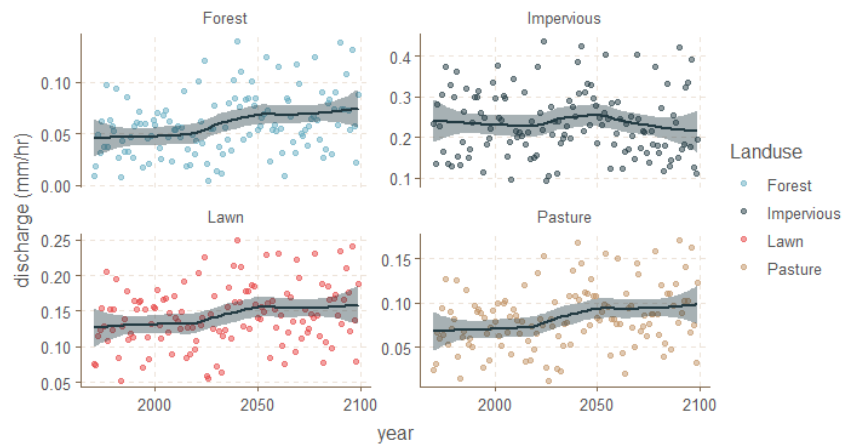
90th Flow Percentile, Issaquah, WA

Till, Moderate Slope



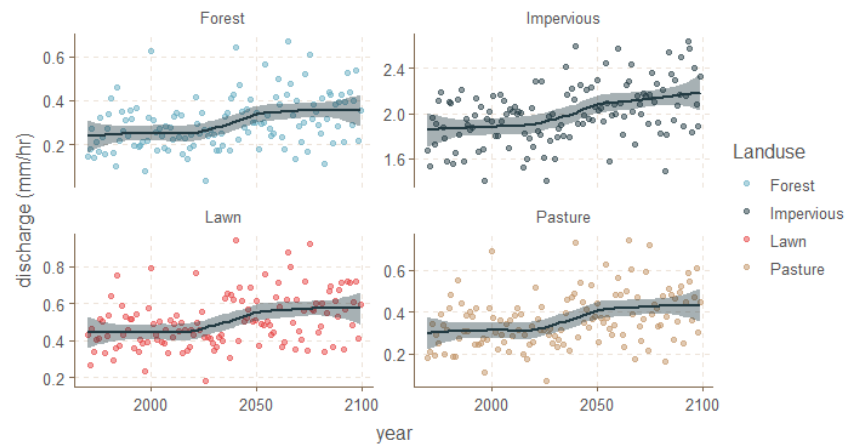
90th Flow Percentile, Issaquah, WA

Till, Moderate Slope



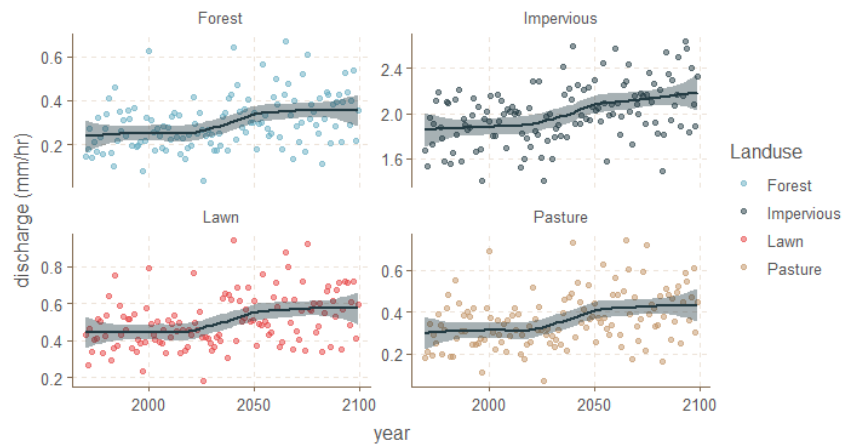
99th Flow Percentile, Issaquah, WA

Till, Moderate Slope



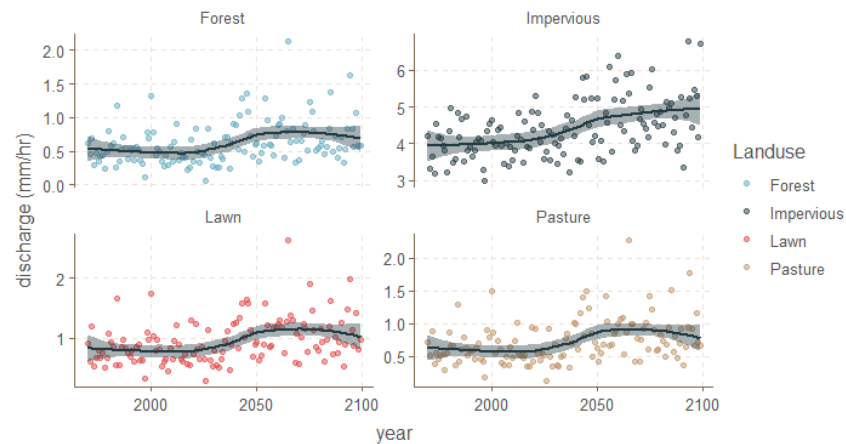
99th Flow Percentile, Issaquah, WA

Till, Moderate Slope



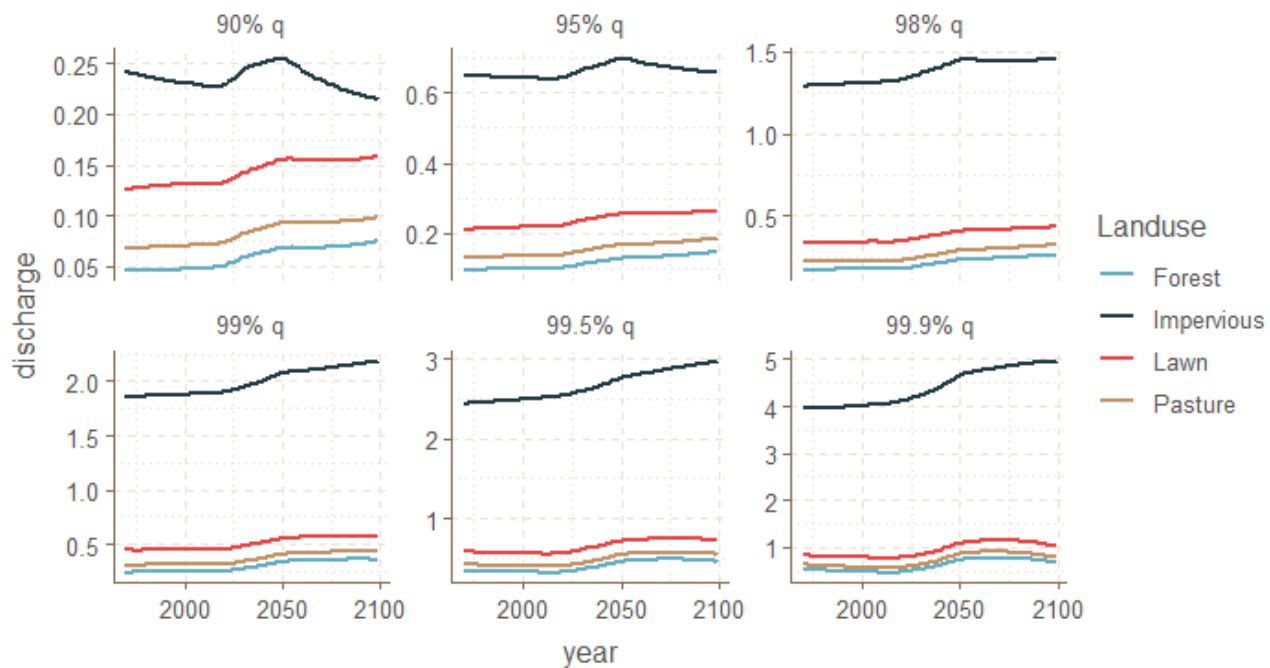
99.9th Flow Percentile, Issaquah, WA

Till, Moderate Slope



Simulated Flow Percentiles, Issaquah, WA

Till Soil, Moderate Slope

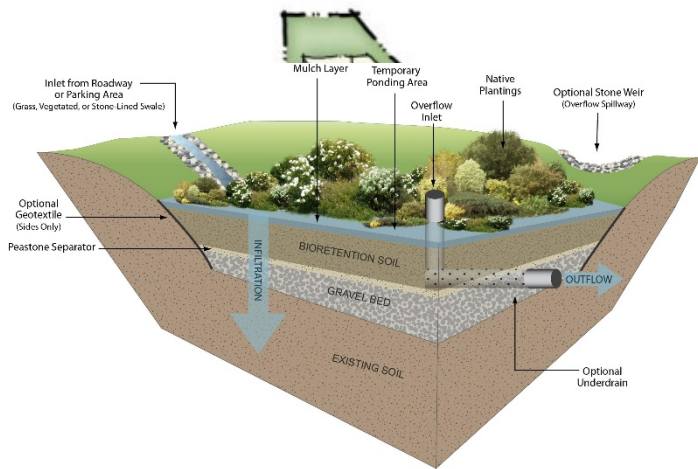


Hypothetical Development

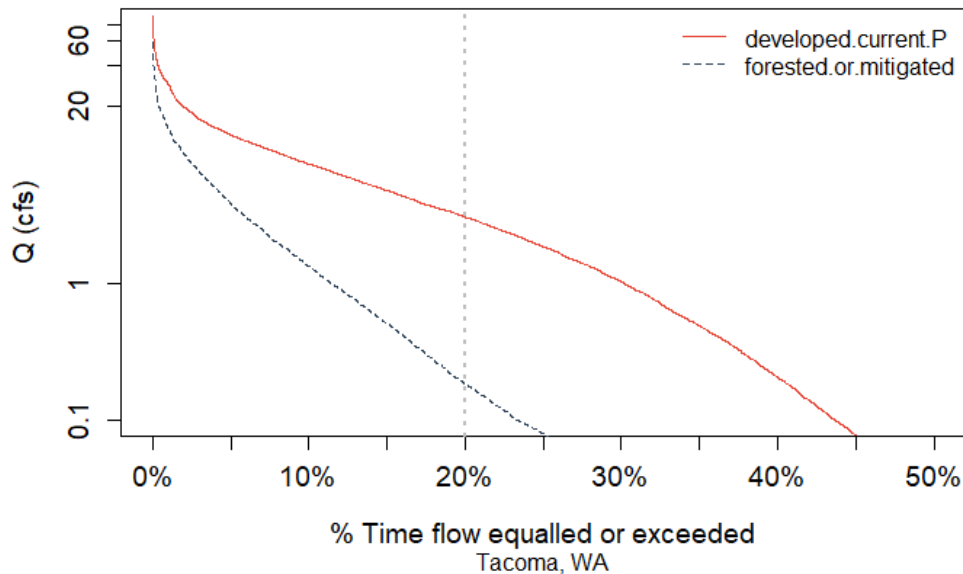
Historic Precipitation

Scenario

Landcover	Acres
Forest	14
Grass	16
Impervious	10



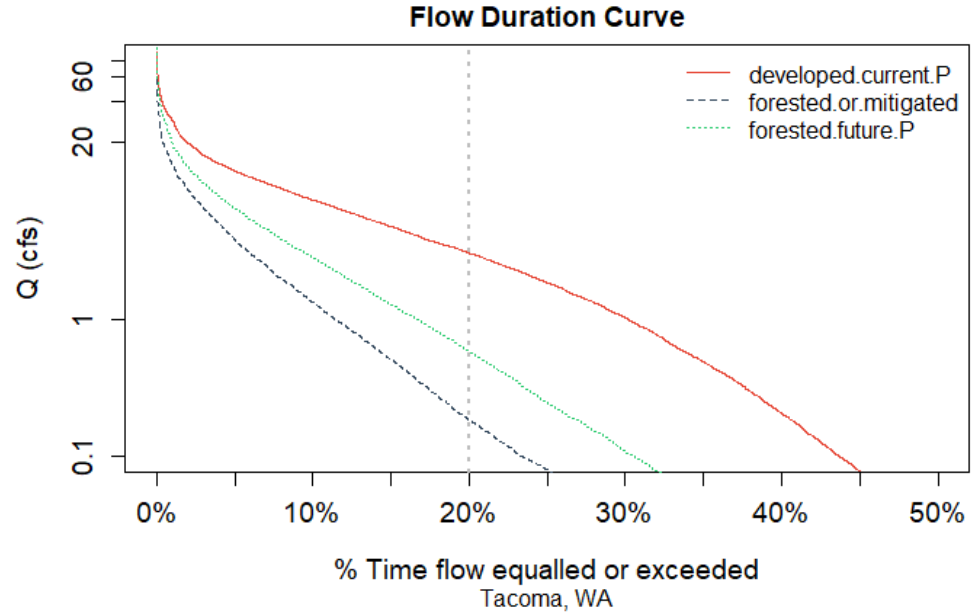
Flow Duration Curve



Hypothetical Development

2080 Precipitation

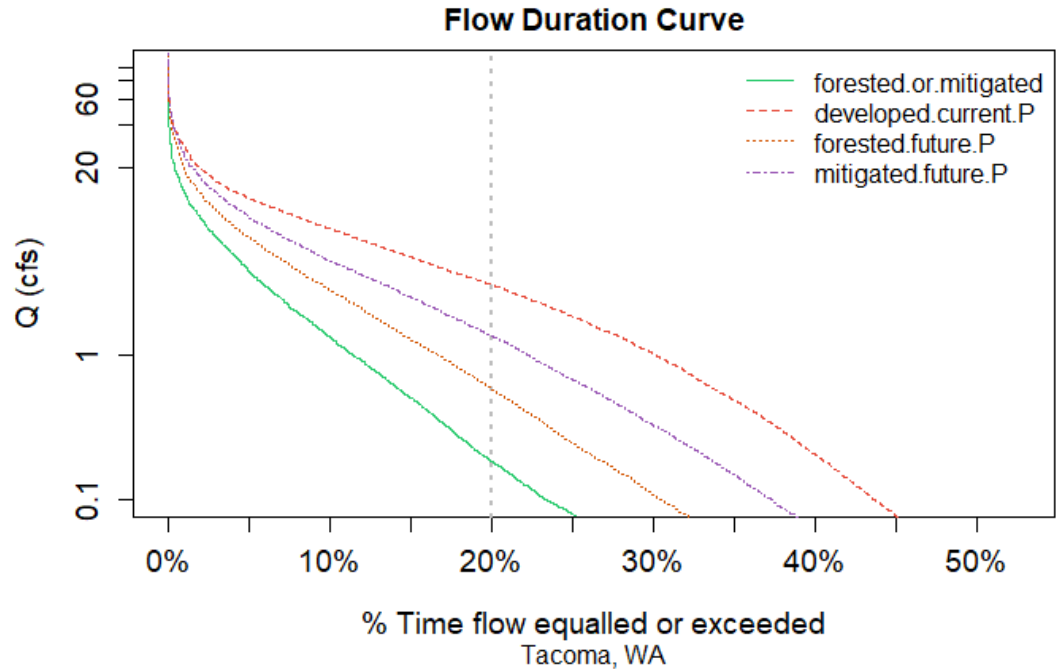
Scenario	
Landcover	Acres
Forest	40
Grass	0
Impervious	0

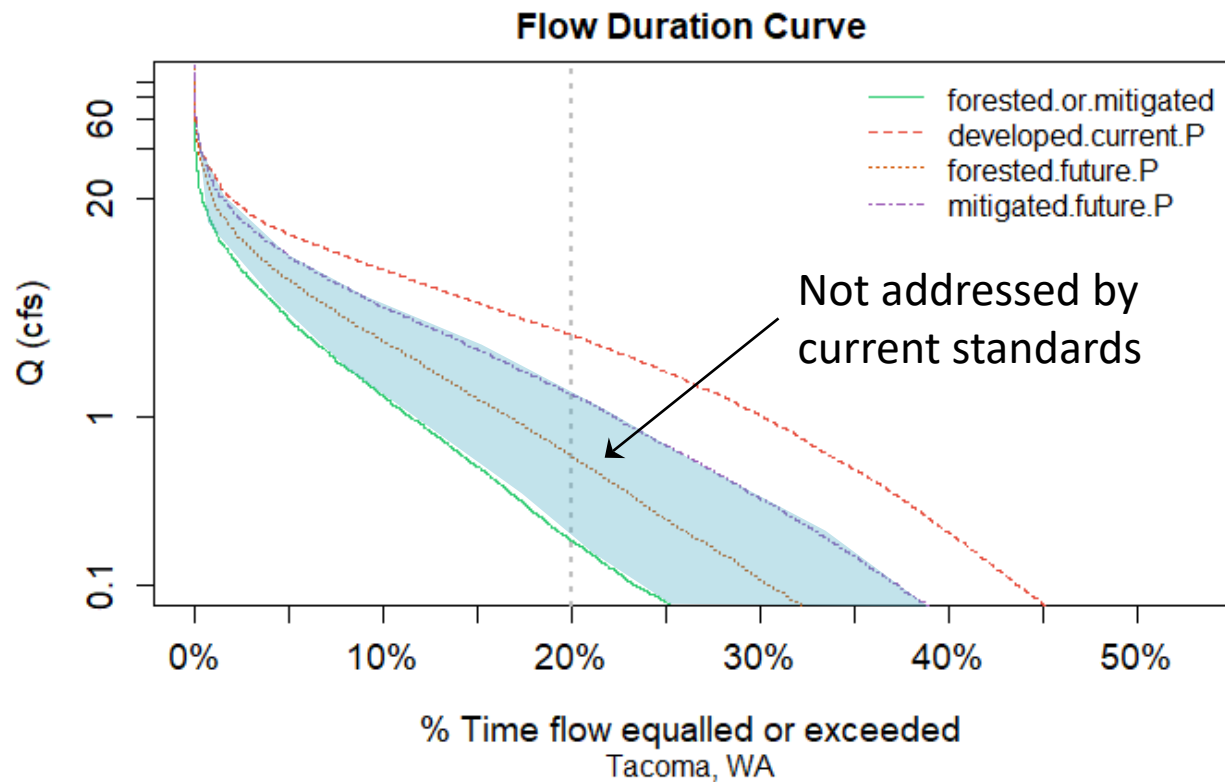


Hypothetical Development

2080 Precipitation

Scenario	
Landcover	Acres
Forest	24
Grass	16
Impervious	0





Conclusions

What we can say about potential climate change effects

- All the caveats everybody has already mentioned
- Different responses based on soil type, and land cover
- Somewhat consistent responses across Puget Sound
 - Pervious land uses more affected by smaller storms
 - Impervious land uses more affected by larger storms
 - Saturated and Till soils show largest responses
- Current flow control standards may not be protective under future climate scenarios



Thank you

Geosyntec[®]
consultants

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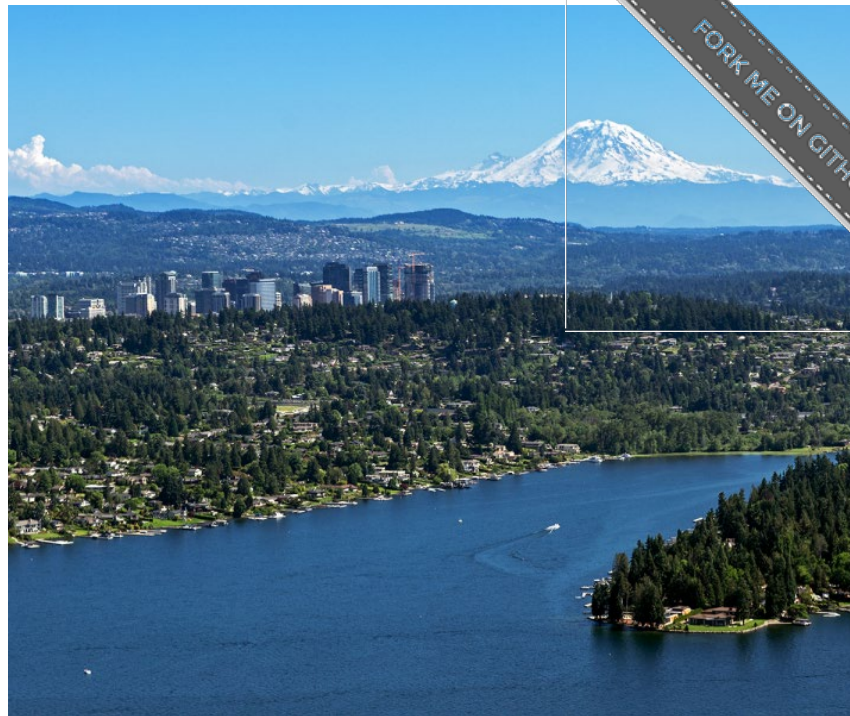
Collaborators



The Nature
Conservancy



Funding and in-kind support from:



github.com/stormwaterheatmap