Climate Impacts to Restoration Practices & BMPs

Joint Meeting of the Urban Stormwater Workgroup, Modeling Workgroup, and Climate Resiliency Workgroup

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with support from:

The future is not certain, even with good understanding of physics

- Global climate models (GCMs) disagree on details of local climate, even with good understanding of physics
- Understanding of local watershed responses requires spatial downscaling, but the downscaling methods introduce further variability.
- What the future will look like depends on political and economic responses in addition to physics

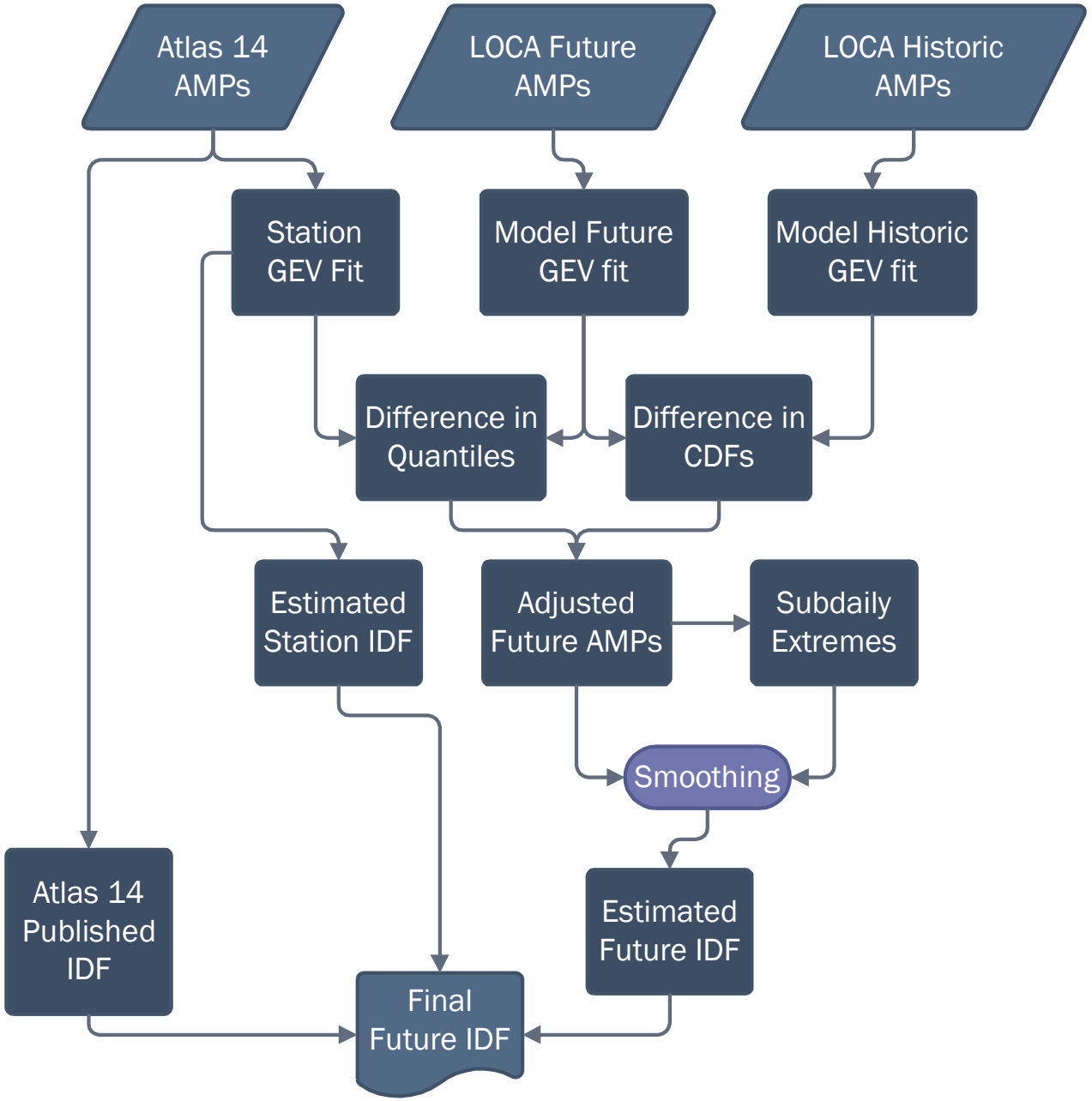
We need:

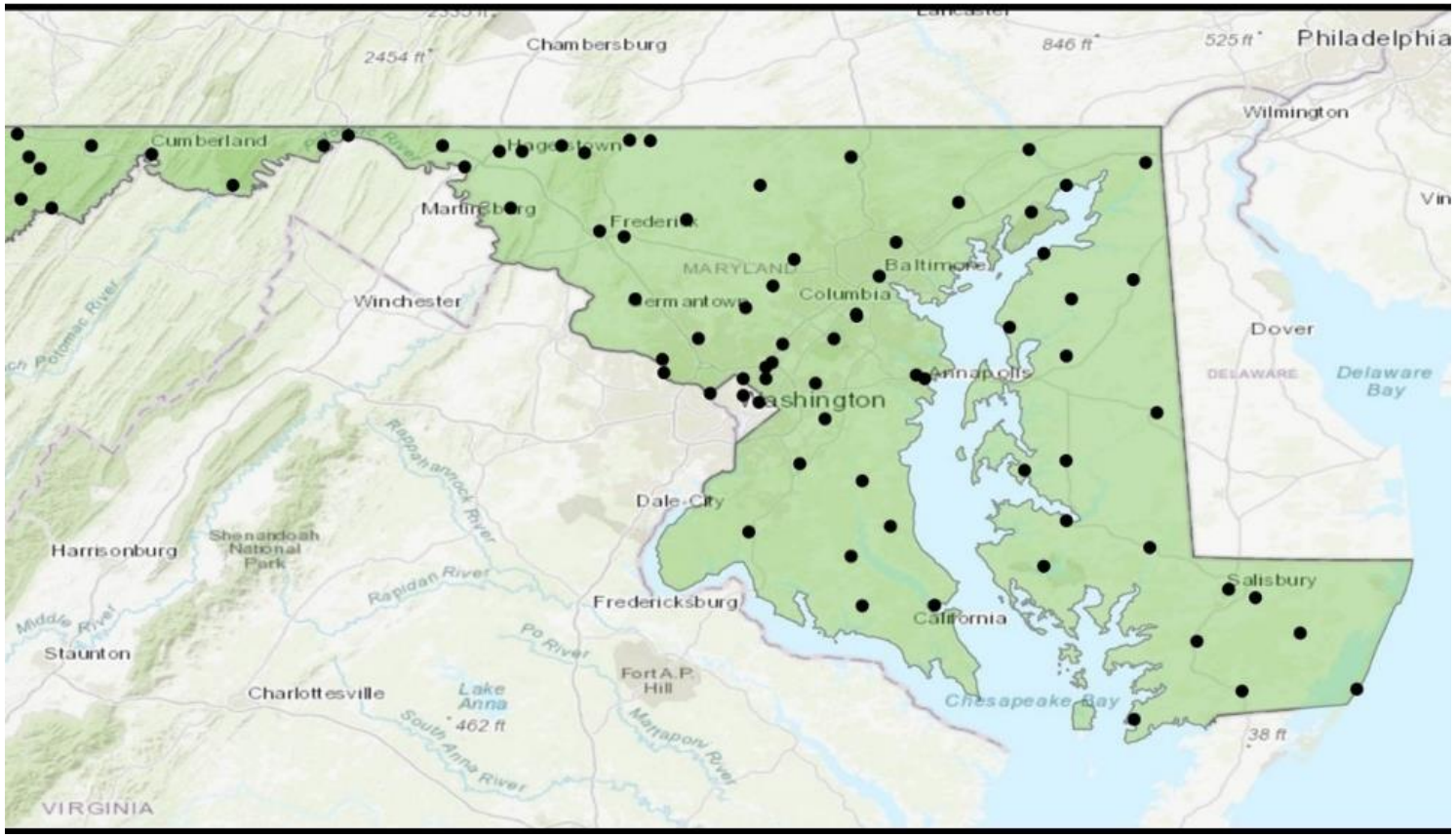
- Analyses that present the range of reasonably possible future events to which adaptation may be needed
- Methods to rapidly ingest new climate projections (e.g., CMIP6 experiments, new dynamical downscaling results) so that results are not tied to a limited set of experiments
- Conversion of storm-event precipitation to runoff time series that will determine success of BMPs

Technical Approach

- Our approach differs from many other IDF efforts
  - Don’t rely directly on GCM or RCM-based prediction of extreme events
  - Replicate NOAA Atlas 14 IDF methods (AMP-based)
  - Use LOCA statistically downscaled daily GCM output
  - Map relative change in AMP distribution functions between historic and future conditions in downscaled GCM output to NOAA maxima series using EQM and recalculate IDF
  - Map changes by quantiles with correction for changes in shape of cumulative distribution function over time

IDF Updating

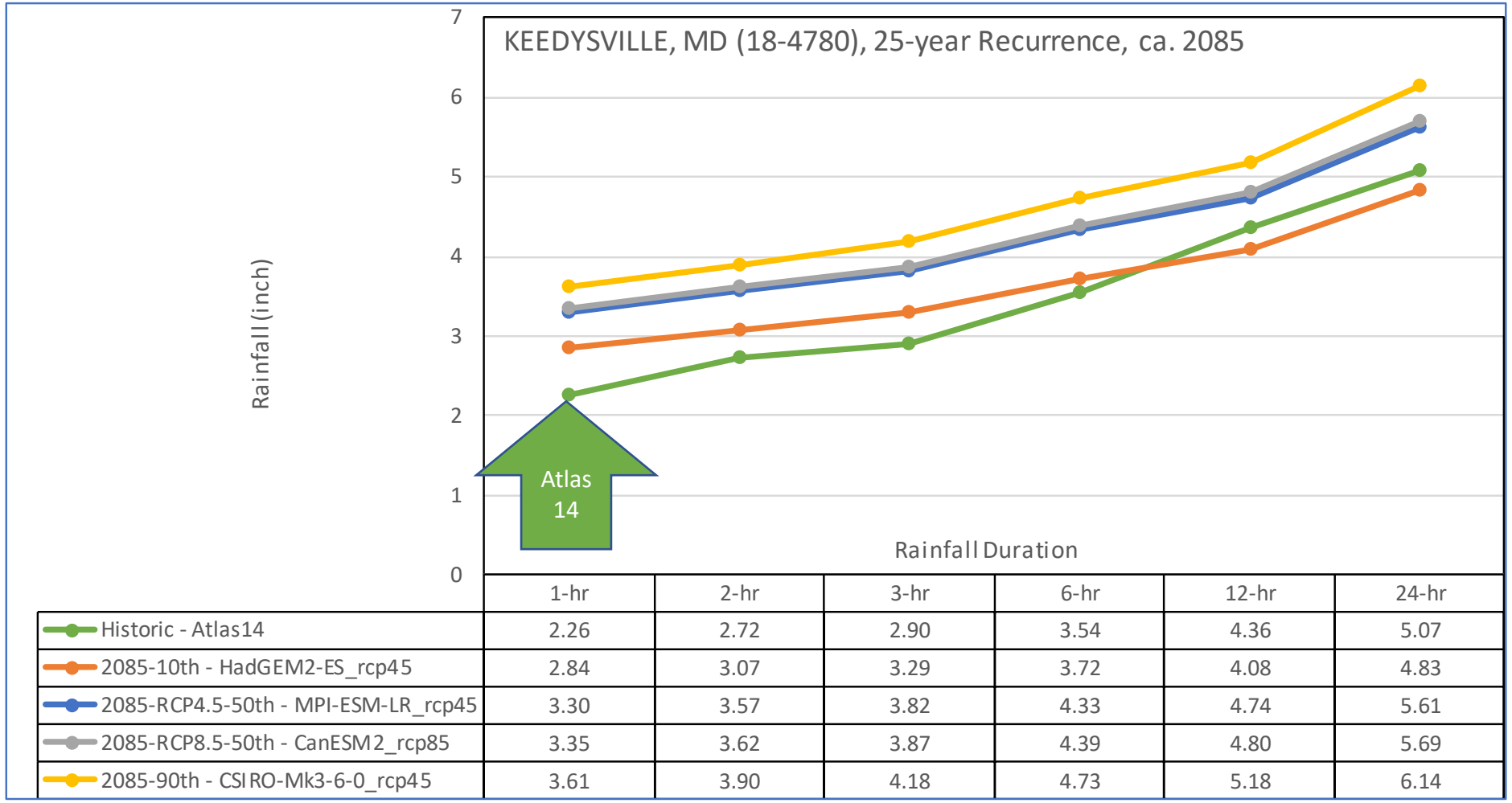




Efficient Methods Enable Estimates of Precipitation and Runoff throughout MD

- Statistical approach to update NOAA Atlas 14 IDF curves based on change in climate models (EQM)
- Application of SWMM5 to convert rainfall to runoff and simulate BMP performance
- Estimate range of futures to which adaptation may be needed
- Database of results for 79 MD stations, mid and late century

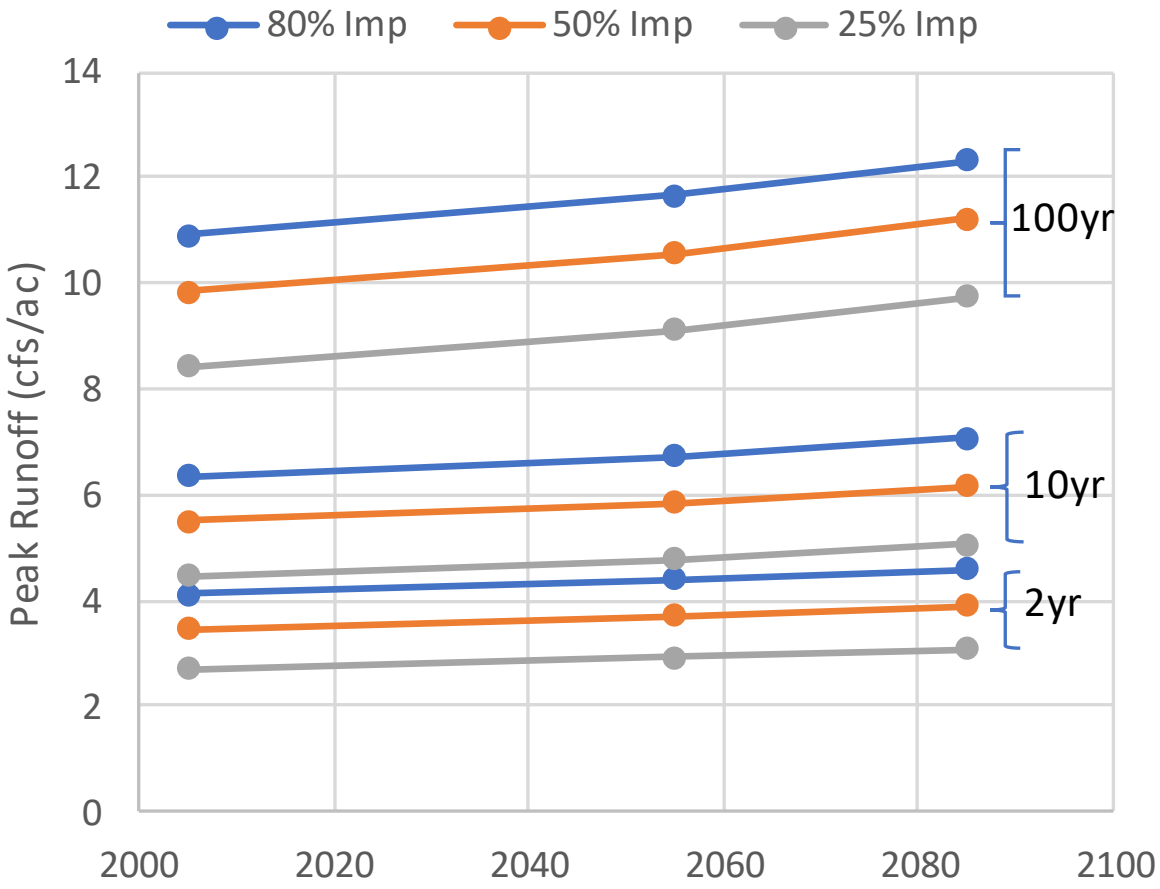
Future IDF Curves Show a Range of Possible Conditions, with a Tendency toward More Intense Storms



	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr
Historic - Atlas14	2.26	2.72	2.90	3.54	4.36	5.07
2085-10th - HadGEM2-ES_rcp45	2.84	3.07	3.29	3.72	4.08	4.83
2085-RCP4.5-50th - MPI-ESM-LR_rcp45	3.30	3.57	3.82	4.33	4.74	5.61
2085-RCP8.5-50th - CanESM2_rcp85	3.35	3.62	3.87	4.39	4.80	5.69
2085-90th - CSIRO-Mk3-6-0_rcp45	3.61	3.90	4.18	4.73	5.18	6.14

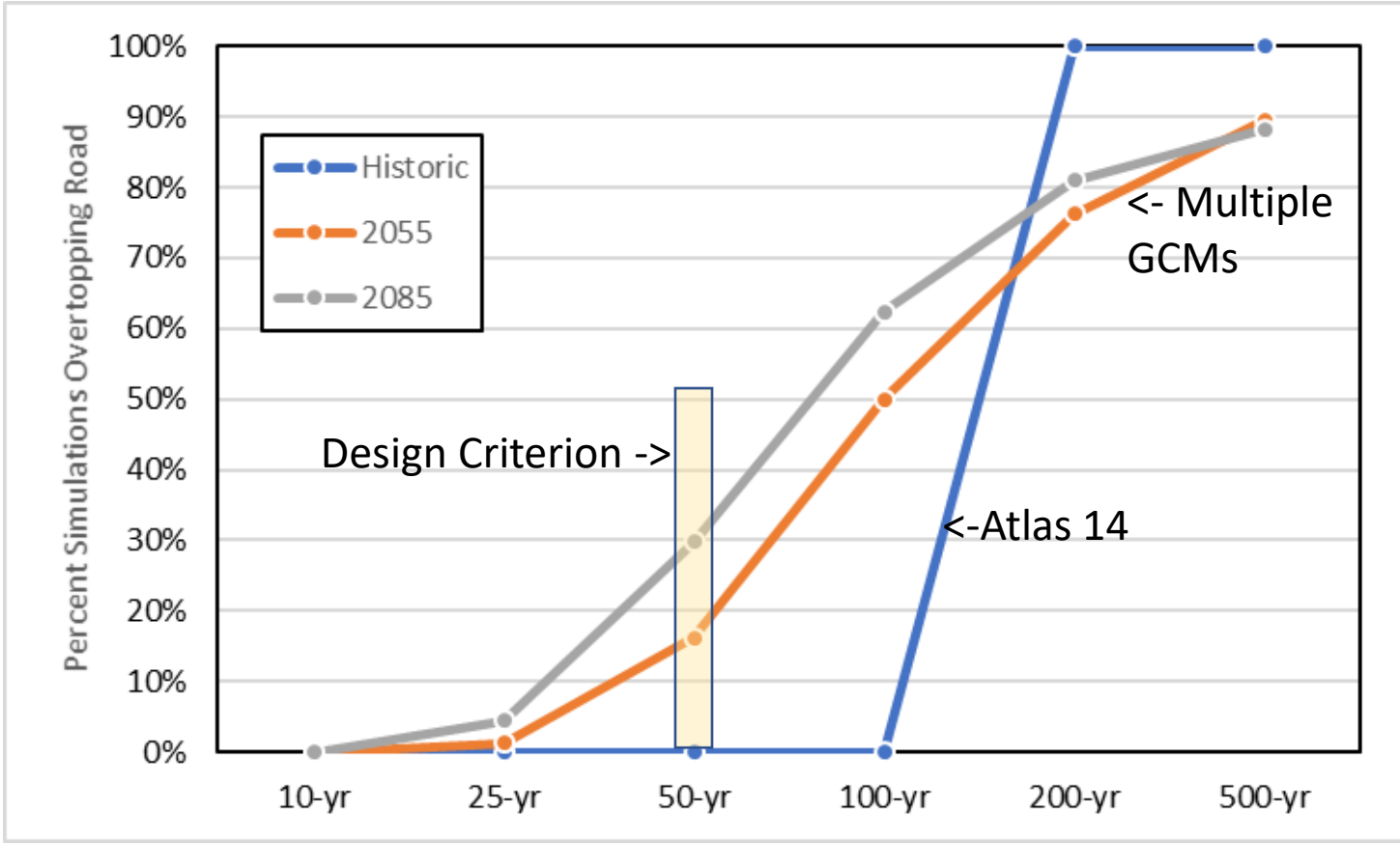
Runoff Depends on Rainfall and Site Conditions – but the General Trend is Up

- Averages over 20,576 combinations of sites, GCMs, recurrence intervals, imperviousness
- ~14% increase in storm peak runoff rates by late century
- Larger increases for more extreme events



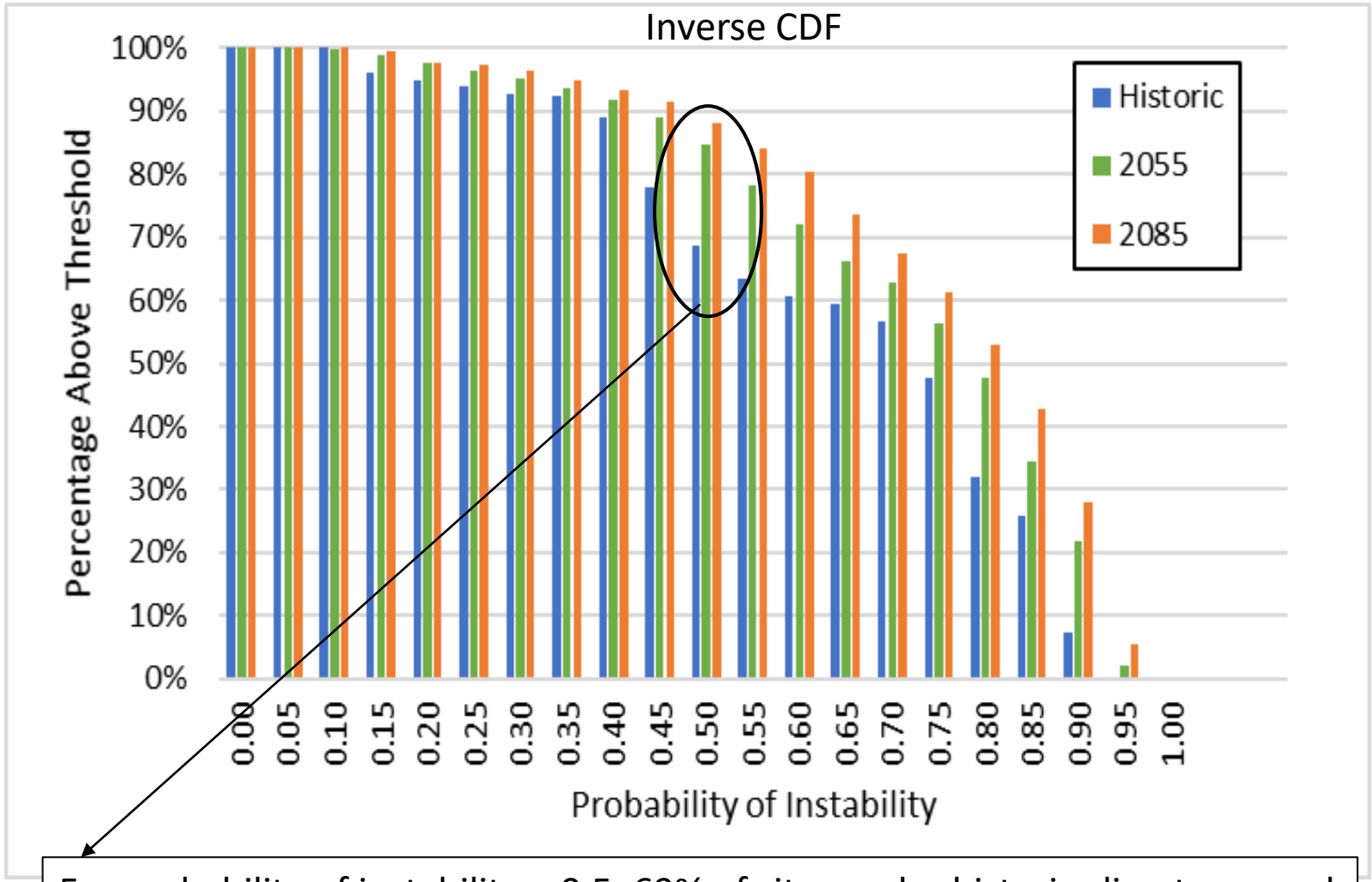
Increasing Flood Risk for Current Designs

- Road culvert designed to pass runoff from 50-year 24-hr storm (minor arterial road)
- Large potential increases in low-recurrence events = greater flood risk



1% slope, 100 ft round culvert, 4.5 ft diameter, 200 cfs design flow, 2 ft freeboard at design flow (matches FHWA Design Guideline 1)

Predicted Probability of Channel Instability at 25% Imperviousness for Runoff from a 1 Acre Site with $S/\sqrt{d_{50}}$ = 1.75 using the Logistic Regression of Bledsoe and Watson (2001)



For probability of instability = 0.5, 69% of sites under historic climate exceed threshold; increasing to 85% and 88% under mid and late-century climate

Channel Stability

- Depends on site-specific factors such as slope and grain size
- Risk of crossing threshold for instability is likely to increase
- Restoration designs should consider resilience

Maryland Environmental Site Design

- Based on matching runoff from forest in good condition for 1-year storm
- Relatively minor changes in runoff for events ≤ 1-year recurrence
- ESD is likely to continue to continue to perform well
- Pollutant removal functions of most BMPs likely to be maintained

All results are conditional on the data and methods used

SUMMARY

- LOCA statistically downscaled climate scenarios
- Statistical update to NOAA IDF curves via extreme value distribution
- Suggests potential range to which adaptations may be needed – but does not predict a specific outcome

➢Seek resilient solutions in which adaptations provide co-benefits (e.g., green space, urban heat island mitigation, carbon sequestration) even if the future turns out different than projected by models