Using Decadal Climate Prediction to Characterize and Manage Changing Flood Risks in Colorado

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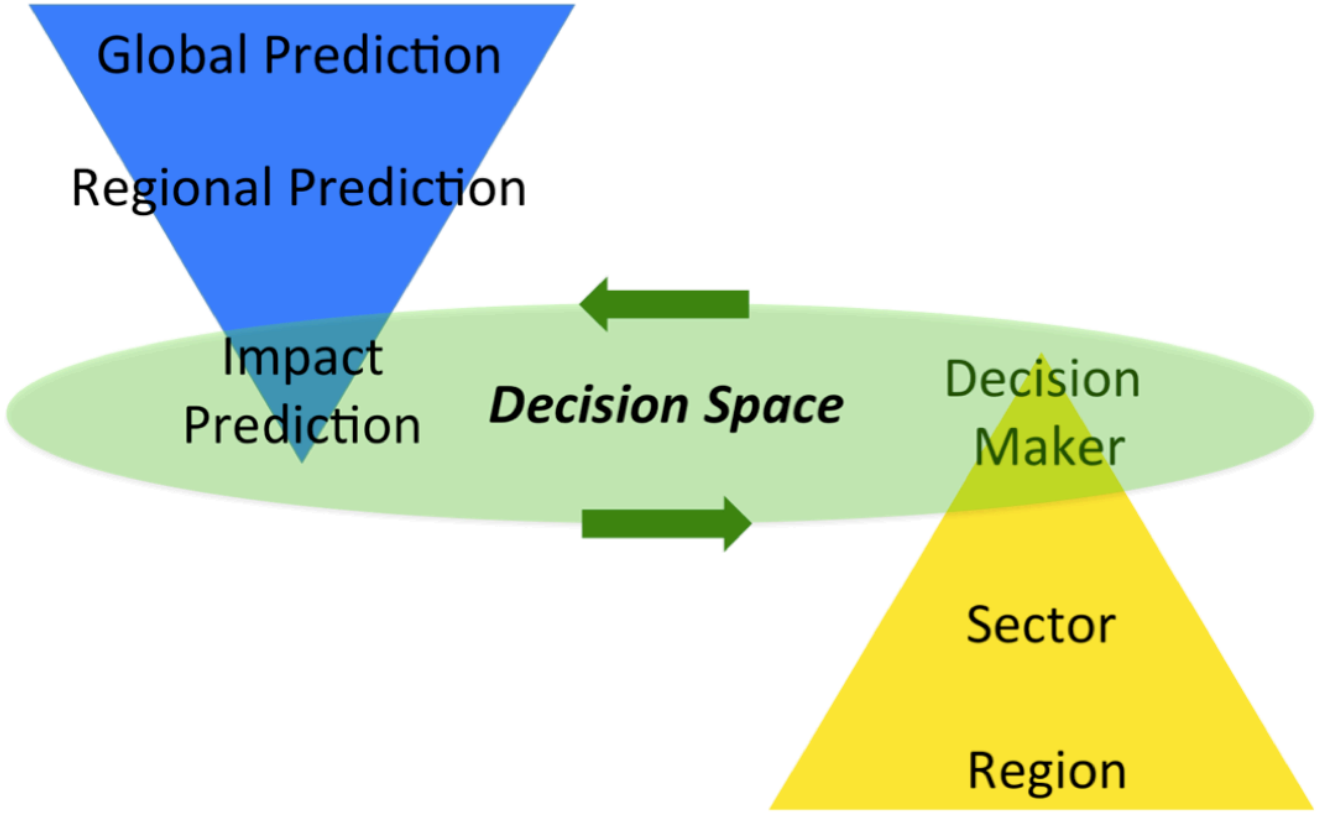
Understanding Decision-Climate Interactions on Decadal Scales

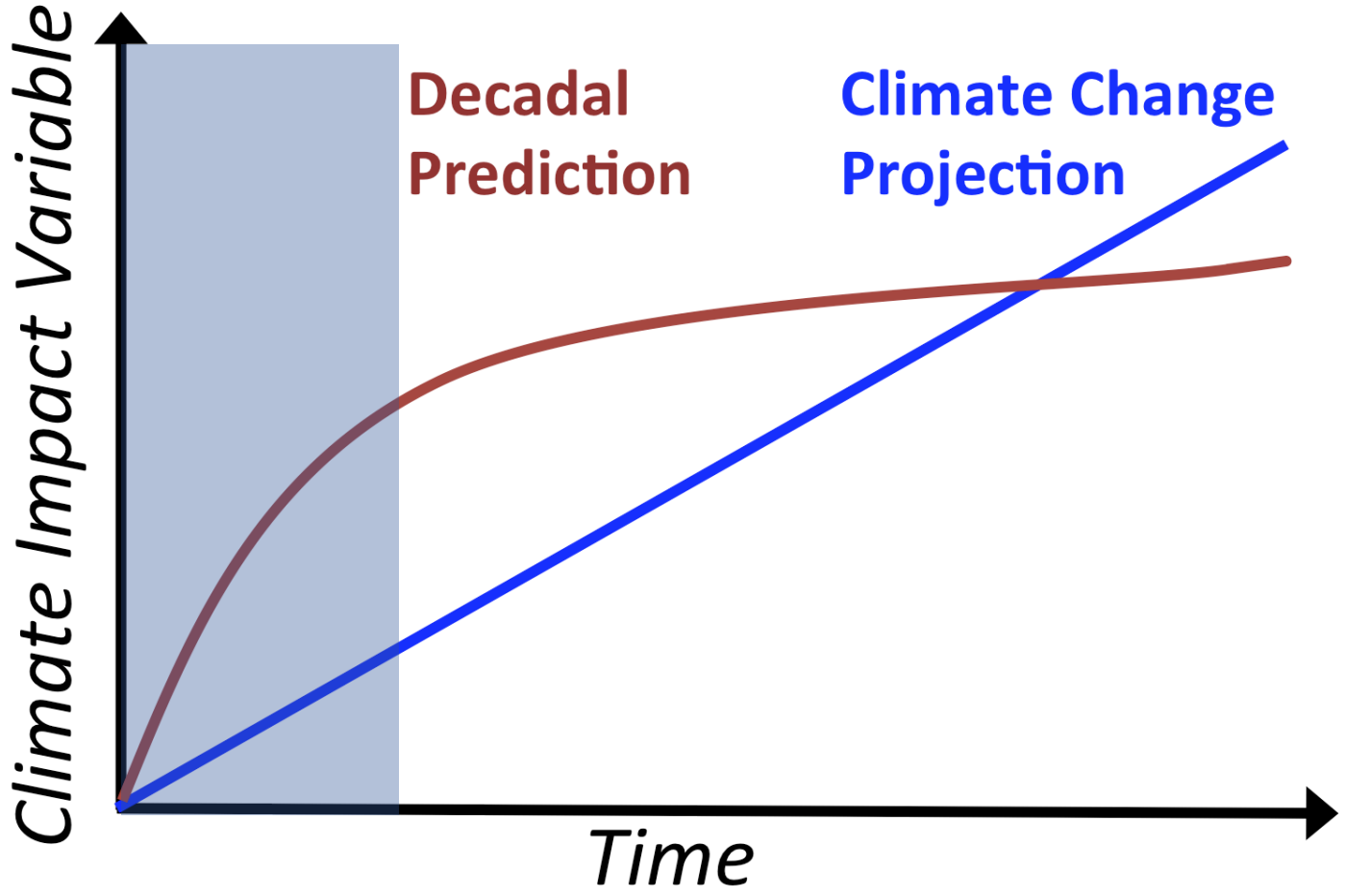
Part 1: Understand climate information needs and use

Part 2: Build predictive capacity for the needed information



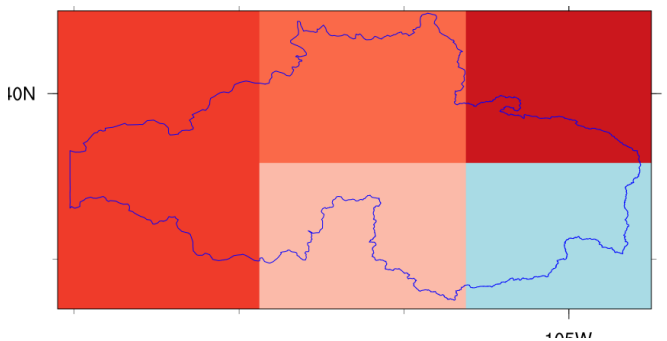
Motivation

From a public official: "*We're all sort of wondering when the next big one is going to come, and knowing that it's inevitable but not knowing particularly when, because it could be next year or it could be in 50 or 100 years.*" - Morss et al. (2015)

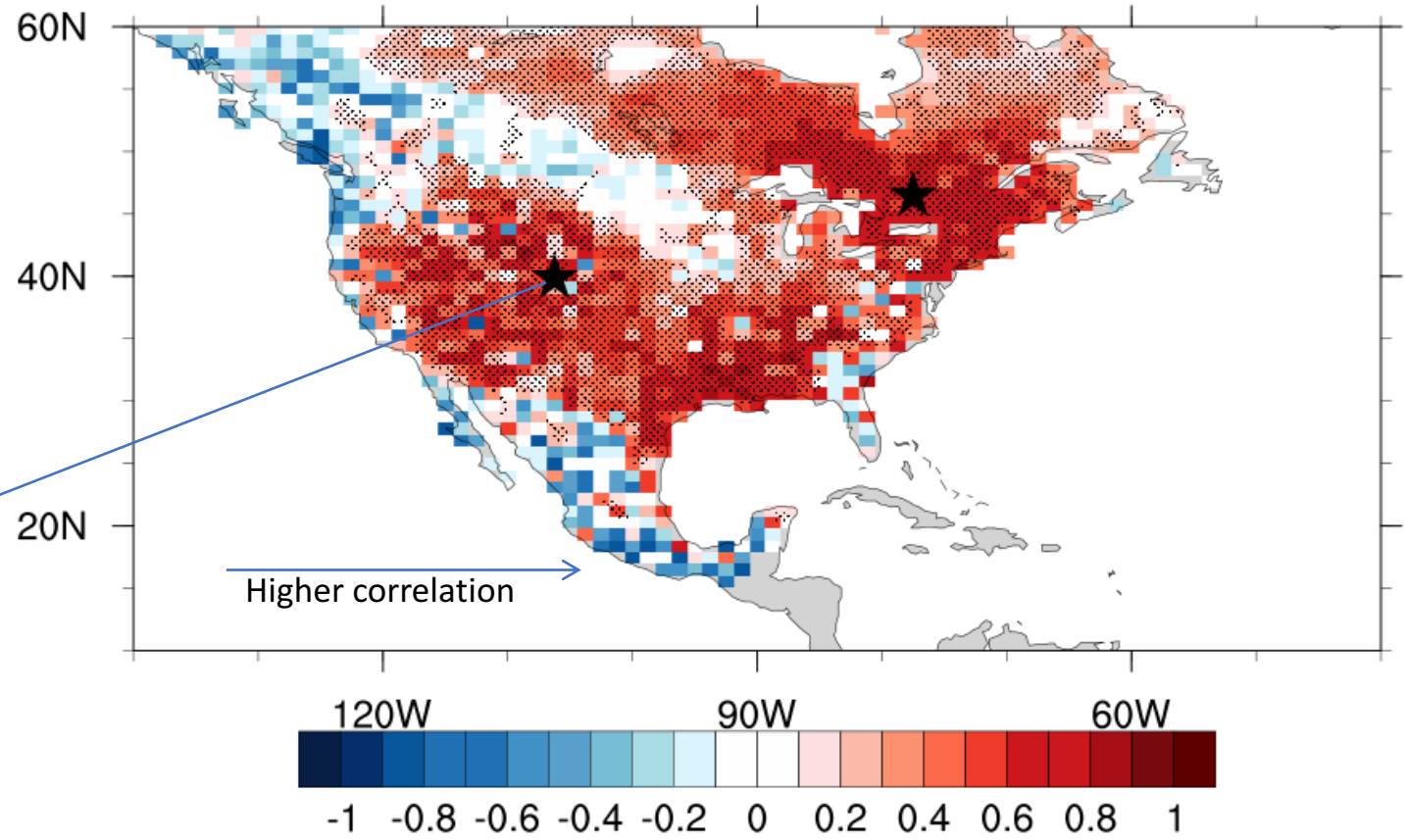


Predictive capacity for temperature

Anomaly Correlation (ACC): Temperature hindcasts for years 1-5 are skillful over much of the U.S.



Colorado Watershed
(ACC = 0.37)



Source: Towler et al. Forthcoming. Towards the Application of Decadal Climate Predictions. Journal of Applied Meteorology and Climatology

Study methodology (for Part 1)

- Interviews with flood managers within the area overseen by the Urban Drainage and Flood Control District
  - Interviewees represent a range of decision makers working in rural and urban settings
- 15 individual and group interviews with 24 experts
  - Purposive, snowball sampling strategy
- Semi-structured interview design
  - What sort of relevant decisions do people make?
  - How do people use weather and climate information?
  - What are people's priorities related to flood management?
- Interviews were recorded, transcribed, and analyzed

In order to anonymize the data, direct quotes are refer to transcript number and all individual, city, and landmark names have been removed or changed.

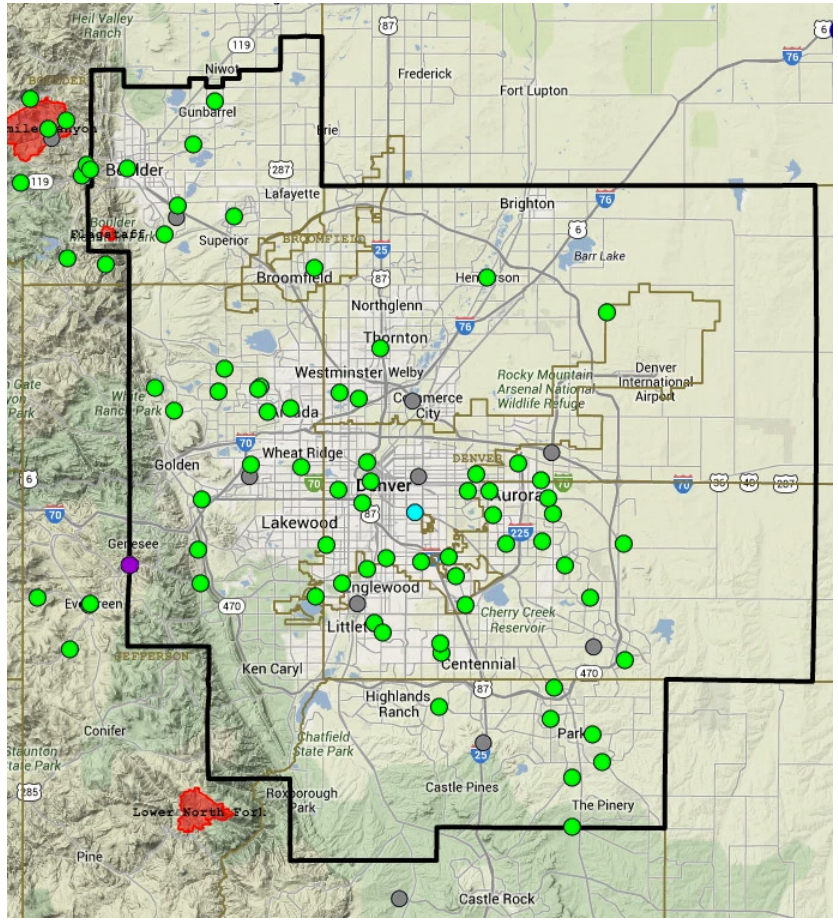
Flood context

"[Trappers] were the only white inhabitants of Colorado. So they identified that there was a flood when they were out here doing their trapping…[O]ne of the things that I was looking at – you know, when I look at the [historical floods] and at when it rains…I want to be able to tell our operations people when to be aware of the flooding and when not to be." (T10)

Hwy 119, Colorado, September 2013

Urban Drainage and Flood Control District

- Established 1969
- 40 local governments
- Data collection
  - ~200 rain gauges
  - ~100 stream gauges
- Colorado Urban Hydrograph Program
- Emergency ALERT system
  - Daily precipitation outlook
- Master planning for 100 year storm
- Fund >50% capital projects
- “We’re the one that kind of holds the glue together really.” (T4)



Emergency alerts and management

"If the extremes are going to be more frequent, then we got to just recognize that we got to be on our toes and alert in kind of a different way, just expect it and deal with it when it comes, and that's kind of my world. **So I'm going to deal with it whether it comes or doesn't."** (T3)

Master planning

“We like to say that our masterplans have about a 20 to 30-year shelf-life.” (T4)

“Or 100 years. Sometimes a hundred-year design is a design life too, for concrete structures.” (T10)

Vegetation and wildfire

"We, in the past, did a very much of an engineered solution, and within the last ten, especially the last five years, we´re really evolving into how to use as much of the natural, beneficial functions of the streams and **re-introduce some more natural processes into the design, so it can be more self-healing**." (T1)

"All of their watersheds start up in the mountains, and it's a more fire prone area…we really bump up the clogging factor on culverts and bridges." (T4)

Hydrograph data

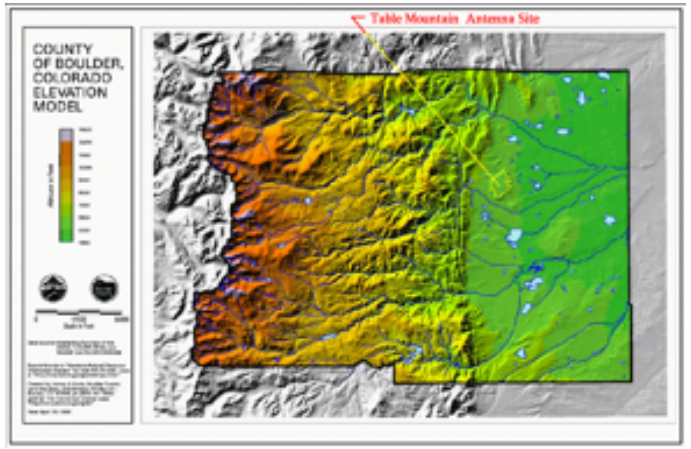
“We utilize the rainfall curves that Urban Drainage has provided us. And Urban Drainage is also recalibrating the Colorado Urban Hydrograph Program ….to reflect the last 30 years of rain data and gauge data and creeks and stuff to make that program probably a little bit more accurate…. Then something happens like the 2013 event and we say, ‘Wow, this not only exceeded our rainfall criteria we use to design things, but we have all of these other observations around it.’ And it’s one event; you really can’t make a complete decision about that, but it certainly makes it worthwhile to go back and visit that. **But one part of that that relates to your study is how valid is our frequency analysis for hind casting on a data set that’s shifting over time?**…[T]he actual distribution we’re using might not be the right distribution for rainfall… And so we may have more big events and we’re just not interpreting it correctly.” (T10)

What matters? Intensity or duration or location

"Folks think that we're gonna get a heck of a lot more frequent, big thunderstorms. That's one thing. If they think, "No, we're not gonna get as many of those, for whatever reason. But we might get more of these storm systems that come in and set up and are stationary and dump a ton of water. That's a whole 'nother thing." Not all rainstorms are the same…. So should we be looking at different kinds of initiated storm events? (T12)

"[G]reen infrastructure has a huge effect on the small frequent storms, what we would call the minor storm, the two-year storm, five-year storm. It'll have as much as 8% impact on the runoff rate. In the 100-year storm, the major storm, negligible." (T6)

"If that storm cell in 2013 had happened on the Clearmountain Watershed, this area would look like Katrina." (T6)



Considerations for decadal information

“[Decadal climate information] would affect what the local governments do. We focus on the major streams. But it would be good information for the local governments to know that you are going to have more intense smaller storms more frequently so that they can maybe consider increasing their minor storm infrastructure. So that doesn’t necessarily affect us, but it would affect what we say in our criteria manual for that kind of stuff for the local governments.” (T4)

“If our design storm, that the 100-year design storm, [was] switching to be something that was lower intensity and longer duration, higher volume that would be a concern, because that’s not what we’re planning for right now.” (T4)

Considerations for decadal information

“Don’t forget this is a regional country where these kinds of storms happen, not often, maybe on a decadal basis or a 20 year or a 30-year basis [but] a lot of what we build today as engineers is based on the data that we’ve collected to date. It’s not based on the data projecting what it’s going to look like 20 years from now.” (T3)

“[W]e have droughts and we have times when it’s very rainy, and being able to identify those better …would help us quite a bit. Because then we could say, you know, “Yeah, it hasn’t rained in 30 years, but the reason it hasn’t is because we’re in this dry period.” (T11)

“I think it will be relevant…because if we’re designing facilities that we intend to last for the typical design life, like 50 years into the future, then does it make sense to be hind casting to a data set that’s 50 years old?” (T10)

Considerations for decadal information

“It absolutely should not be a line on the map. And some day I think it won´t be a line on the map. Someday it´ll be shades of grey and shades of risk.” (T2)

“And at least providing maybe additional buffer between drainage ways and development, and maybe have us look at providing a little more conservatism or maybe even redundancy in some of our drainage design.” (T8)

Potential utility of decadal climate information

- Storm type, duration, and frequency
  - Prioritize near-term investments
  - Explain variability
  - Local government responsibilities for runoff from smaller storms
- Vegetation
  - Temperature
  - Drought and wildfire
- Demographic changes
  - Public opinion
  - Population growth

Thank you!

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www.mmm.ucar.edu/udecide

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Mutiple project partners: