NASA / NOAA / OSTP

Climate data user study/ results

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18F

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Recommendations

1/ Better surface local relevance of data sets.

2/ Recognize and support the critical human expertise that makes climate science actionable.

3/ Pursue an ecosystem approach: Make climate-data websites interoperable, enable audience-specific finding aids, and improve search engine results.

- **3.1** Create a data interchange standard, or a published agreement (among agencies who host climate-change-related data and tools) to publish a machine-readable manifest of what each climate data tool contains.
- **3.2** Agencies should develop role-specific finding aids that use manifests to dynamically generate a catalog of data from other federal sources.
- **3.3** Search engines could also interpret manifests, making it easier for planners to find climate-change data via their own tools.

4/ Consider building a single portal for climate data if it can surface the local relevance of data sets and leverage and facilitate interchange.

- **4.1** A centralized resource of relevant climate information could improve findability for analysts.
- **4.2** However, making such a portal useful and maintainable would be difficult.
- **4.3** We should not rush into building a portal. Climate decision makers can find the tools they need without one; it just takes more time.
- **4.4** Therefore, we suggest implementing recommendations 1 and 2 when considering creating any type of climate-change-data portal.

Proposed next steps: recommendations in action

Introduction

Many groups — including federal agencies, state and municipal governments, private-sector organizations, and educational groups — should use climate-change information in their planning and long-range decision making. In January of 2016 and building on the work of several federal studies[1-3] on climate information, 18F was commissioned to investigate the behaviors and patterns of climate-change planning and make recommendations for how the federal government could make its climate-change data easier to use and act upon.

Executive summary

18F conducted interviews and prototype tests with municipal analysts, science translators, and private-sector planners. We identified ways the federal government could encourage them to incorporate climate change data into their planning processes.

We found:

1. Most analysts' processes contain the same four stages: the motivating event, considering whether to partner with a science translator, either working with a science translator or making do with other resources, and taking action.
2. Most analysts we observed planning for climate change don't rely on federal government data or resources.
3. Analysts need climate-change data tailored to their location and context.
4. Science translators are interested in tools that help them meet the tailored needs of municipal managers.
5. Analysts need a diversity of data sets (and tools to view them), but finding the right one for their needs is hard.

We recommend, first and foremost, to focus on providing locally relevant data sets (and basic tools for accessing them). We also encourage agencies to pursue an ecosystem approach: make climate-data websites interoperable to enable audience-specific finding aids and improve search engine results. We conclude that we should only consider building a single portal for climate data after creating locally relevant tools and enabling data interchange.

Research approach

To better understand how people surface, use, and make decisions based on climate-change data, we needed to gather information from those people about their experiences.

To begin the research process, team members from 18F, the White House's OSTP, OMB, NASA, NOAA, and other organizations gathered for a workshop. During that gathering, and based on an in-depth discussion of the existing work on climate-change data (and related tools), the assembled group reaffirmed the goals of the user study we would undertake: To discover how people surface and use climate-change data, and to make existing data more useful for decision makers.

We conducted a user study, or an exploration of the range of user behaviors and needs, to accomplish this goal. This user study included interviews and prototype tests (described in more detail in the following sections). These methods were ideal in that they did not require any initial assumptions about what users might need and allowed participants to follow up with questions that revealed details about how they use climate change data.

User groups

During our January workshop, we brainstormed a long list of potential user groups to study and selected three groups to focus on: **municipal government analysts, science translators, and private-sector planners**. In this report, the term science translators refers to experts who try to convey actionable climate-change data and information. Similarly, we refer to **analysts**: this term refers to municipal analysts and private-sector planners. To learn more about these groups and how we selected them, please refer to our Methodology Supplement.

Methodologies

We conducted our research in two phases. Our first phase of research, sponsored by NASA, consisted of user interviews, which we kept relatively unstructured.

Phase 1 research questions

Speaking broadly, our user interviews sought to answer these five questions:

1. **What is the context in which local actors recognize the need to plan for climate change?** What are their current circumstances? What are their overarching or longer-term goals?
2. **What do they want?** How would they like to use resources in planning? Who would they like to work with, and how would they communicate their progress?
3. **What do they do?** How do they use these or similar resources in planning? Who do they work with, and how do they communicate to progress their work? How comfortable are they working with raw data?
4. **What should they want and do?** Are these different from what they currently want and do? What resources, data, or other information should they be taking advantage of?
5. **How is the platform being constructed by the Partnership for Resilience and Preparedness matching user goals?** As it's currently being designed, is it enabling users to do what they want to do? Is it enabling users to do what they should do?

We used these five high-level questions to write the more specific questions included in our interview scripts.

Phase 2 hypotheses

Our second phase of research, sponsored by NOAA, consisted of several weeks of prototype testing and analysis. During this phase of research, our goal was to test the concepts embodied in a few hypotheses, uncovered during phase 1, about how we could most improve the experience of analysts and science translators.

During a workshop we held to conclude phase 1, our stakeholders prioritized the following three hypotheses as the most important to investigate. For this reason, we focused our efforts on testing the following:

1. **Integrated displays of data:** A tool that shows projected local climate change for different metrics — and that allows people to use this data alongside their own — may make decision making easier for analysts
2. **A science translation toolkit:** Offering template language and interactive elements that appeal to broad audiences can make it easier for science translators to reach those audiences.
3. **Enhanced navigation between resources:** Resources that promote climate-change awareness should funnel people to resources that facilitate adaptation planning.

To test the concepts embodied in these hypotheses, we designed, built, and tested prototypes with analysts and science translators. Notably, during the workshop we held at the end of phase 1, one additional hypothesis was **not** prioritized for testing. This hypothesis addressed facilitating peers and experts to share knowledge in synchronous and asynchronous ways. Because work in this space is already underway, we chose not to focus on this hypothesis.

For a more detailed account of our research, please consult the Methodology Supplement. There, you'll find research questions, methods, recruitment practices, and protocol for both research phases.

Limitations

We designed our research to investigate our five research questions and our three hypotheses in the most rigorous way we could, given our limited time.

Even so, our results have some limitations, including the following:

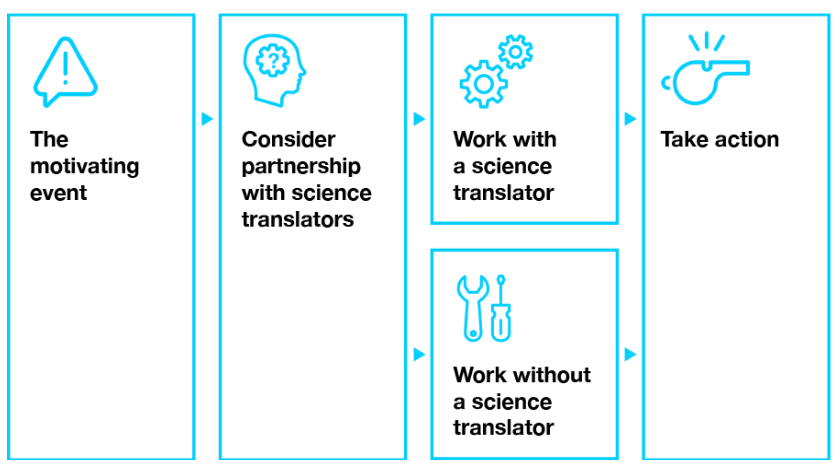
- Although we spoke to a variety of municipal analysts, we did not speak to all types; e.g., we didn't speak with any who focus on transportation planning.
- We spoke to only a few municipal analysts working in rural communities.
- All of our participants believed climate change was happening; we did not speak with any skeptics.
- A sizable portion of the analysts we spoke with were referred through science translators; these existing relationships with science translators likely impacted their processes and outlook.

Findings

1/ The processes of climate-change planning

In order to understand the challenges facing analysts using climate-change data, it's necessary to understand the broader process they use to move from gaining awareness to taking action. From there, we can get a clearer picture of how federal data can fit into their processes.

After interviewing dozens of analysts across the country, we summarized their experience using data for adaptation in the following **journey map**. Most analysts' processes contain the same four stages: the motivating event, considering whether to partner with a science translator, either working with a science translator or making do with other resources, and taking action. Some analysts (and their organizations) are farther along in the journey than others: some are just getting started while others have repeated this process multiple times with different focuses.



1.1 The motivating event

Climate-change planning is usually spurred by a **motivating event** — something that prompts people to move from *thinking about* taking action to doing so. Motivating events vary among analysts. However, some common events include:

- A growing awareness of the local impacts of extreme-weather events
- Legal and regulatory requirements to include climate-change-adaptation planning in broader community-planning efforts
- Executives' (e.g., county managers, city councils, chief executive officers', etc.) excitement about enacting climate-change-adaptation measures
- Comparing oneself to peer organizations and feeling the need to do similar
- The desire to take advantage of available grant funding (often from the state or federal government)

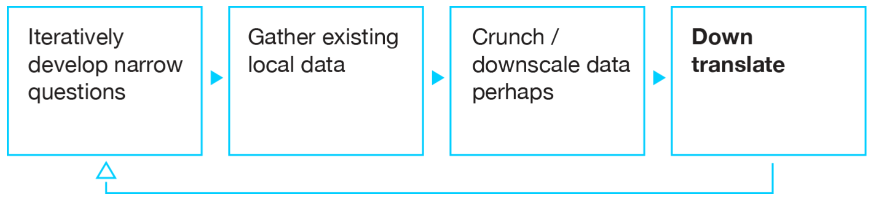
1.2 Considering partnership with science translators

Before they move further in the planning process, analysts consider whom to involve. Science translators can help analysts determine what the science means for them, and at this point in the process, analysts may consult with science translators. Some factors that may influence whether or not an analyst chooses to work with a translator (or not) include:

- The analyst's "bandwidth," or the time and budget they have available for engaging with an external consultant.
- Their existing relationships with science translators (or their lack of existing relationships).
- Their beliefs about whether they need locally tailored information about the effects of climate change.
- Their willingness (or ability) to share their own operational data — for example, a utility company might be hesitant to share their electric demand data with an outside consultant.
- Their inability to find the data and guidance they need from existing websites or other resources.

1.3 Working with a science translator

A number of the analysts we spoke to collaborate with science translators. Those analysts who engage with science translators follow a loosely similar process:



- **The analysts iteratively develop a set of narrow questions for the science translator to investigate.** Analysts often start with broad questions, and science translators help them narrow these to create queries that are answerable using existing scientific literature, existing or newly created data. For example, a science translator might help an analyst narrow the initial question of “Will we overflow our wastewater system?” to the more data-focused “What is the maximum amount of rain (in inches) we expect to receive in the city rain gauge during any 30-minute interval for each year over the next 30 years, and can our system handle it?”

- **Science translators also often gather existing locally produced data** relevant to analysts’ queries. Sometimes this data provides historical background that can help analysts make better-informed decisions. For example, a city might provide the last 30 years’ worth of data collected at their weather station’s rain gauge — data a science translator can use to help frame the current climate-change situation. In other instances, the city gathers operational data to compare with climate projections — for example, municipal planners might compare their log of street flooding complaints with historical rain data to determine when rain starts to cause complaints. Local data becomes an input to climate-model downscaling. One city used their rain gauge data to help a precipitation projection better account for their microclimate.

- **Science translators find or generate projections that answer analysts' questions**. These projections are often the result of "downscaling" global climate-change models. Analysts and science translators describe downscaling as the most technically challenging part of this process.
- **After gathering local data and projections, science translators "translate" their results into answers to analysts' questions.** They use words, graphics, and references that make sense to the analysts' stakeholders.

1.4 Working without a science translator

Likewise, analysts who choose to work without a science translator often employ one or more of the following strategies:

- Using weather forecasts to improve their existing operations' responses to extreme weather events — for example, using weather forecasts to decide when to stage crews to clear clogged storm drains.
- Referring to a particularly challenging year, season, or weather event and then discussing (usually in a meeting or workshop) whether they could handle several such events in close succession.
- Using indicators from regional assessments (and modifying them to include ballpark estimates of relevant local corrections) to inform planning assumptions.
- Using similar nearby organizations (who have data) as proxies while planning — for example, using a nearby larger city's estimates for extreme precipitation frequency.
- Borrowing new zoning codes, ordinances, resilience plans, and others tactics from nearby or similar organizations.
- Gathering possibly locally relevant data from existing tools.

1.5 Taking action

Aftering working with or without a science translator, an analyst may be ready to take action. As they work to adapt to the effects of climate change and communicate their progress or the decisions involved to their communities, an analyst may do one or all of the following:

- Work directly with members of affected communities, helping them understand the tangible impacts of climate change and gathering their input about adaptation options.
- Consider creative, piecemeal alternatives to adaptation that do not require large capital investments — for example, selective greenscaping or targeted drainpipe widening.
- Use cost-benefit analyses to determine which projects would most efficiently benefit others the most.
- Heed constraints imposed by budgets or regulatory bodies.

2 / Most analysts planning for climate change don't rely on federal government resources.

2.1 As they're planning, analysts rarely consult federal websites for climate-change data.

We heard that climate-adaptation work requires data that's applicable (or made applicable) to specific, often small, localities. The analysts we spoke with perceive most federal data to lack the requisite local detail. Instead of using federal data, many analysts seek information through the intermediaries described below. These intermediaries may get their information from federally funded studies and sources.

Predictably, there are exceptions to the above statement: Some municipal planners rely on FEMA flood insurance rate maps to assess flood risk, and many analysts use census data to determine different neighborhoods' risk levels relative to certain events. (Notably, both of these sites offer granular, location-specific data.) Planners may also visit federal websites when they're first learning about climate change, but once they've established awareness of climate-change factors, trends, and impacts, they tend to seek more geographically granular data.

2.2 Most participants perceived federal government data to be inconsistently maintained, hard to use, and scattered among agencies.

One reason analysts rely on intermediaries and other resources is that they perceive federal government data as inconsistently available, hard to use, and scattered among agencies. Participants shared stories of how data that disappeared (or moved) without explanation disrupted their planning process. Others described how, when they found relevant data, the language describing it was so complex that they had to call the publishing agency for help. Many analysts described having to browse through many government websites to find possibly relevant data that seemed scattered amongst agencies.

Climate change data is not just scattered among agencies, but also *within* certain agencies. For example, one participant who frequently uses weather forecast data told us that the information they use is divided among different websites and offices within a single agency.

Despite the fact that resources are often scattered or difficult to find, however, most participants said that they consider these resources credible. Their frustration was not with the credibility of the data, but rather with the process of finding and using it.

2.2 Successful adaptation planning often involves a science translator.

The most successful climate-change-adaptation planners we observed had established relationships with their science translators. In this case, we define success as having extensive, detailed adaptation planning efforts underway. Successful planners, in other words, had not only identified useful data, but had actually begun incorporating it into their planning process.

When we refer to established relationships, we mean high-touch relationships that involve frequent communication. This type of relationship is exemplified by a quote from one of our interviewees, who said, “Whenever I have a question, I just pick up the phone and call <science translation contact>.”

2.3 Analysts also turn to their professional networks for guidance.

The people we spoke to also turn to their professional networks for guidance. Several participants told us they often consult the Urban Sustainability Directors Network, the Water Utility Climate Alliance, regional utility coalitions, extension agent consortiums and other resources before they make decisions.

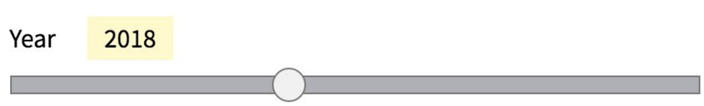
3/ Municipal analysts, private-sector planners, and science translators need climate-change data tailored to their locations and contexts.

3.1 Analysts want data (historical or projected) for the specific local area most relevant to their role.

All of the analysts we spoke to described their need for locally focused data. Though people cited different variables of interest specific to their particular locations, they all shared the need for data particular to their neighborhood, city, county, or other local area. People's roles directly impacted the type of variables most useful to them.

Analysts both want locally focused data and tools that help them view and download it. To them, data and tools to access it go together; without one the other is hard to manage.

Most of the variables analysts want vary by year. They want to be able to input a year or a range of years and see a variable of their choice, with a selector like this one from our prototype testing:



The following table offers a snapshot of the types of information most pertinent to analysts in various roles. It communicates the diversity of local needs, as well as the consensus within some roles about what variables might be useful.

Variables requested by analysts

Type of analyst	Most relevant variable(s)	Frequency	Time horizon	Geographic resolution	Uses
Emergency managers	Projected number of days over a given temperature threshold	Each year	Less than 10-15 years	Entire city, neighborhood	Preparing staffing and budget requests that allow swift response to heat emergencies
Wastewater treatment planners	Projected peak input to stormwater system in any 15-minute interval	Each year	Next 50 to 100 years	Particular rain gauges in a city, block	Predicting whether increasing precipitation will push the drainage system over capacity
Coastal city planners	Projected probability of sea-level rise, storm surge, and nuisance flooding in a given location at a given height; expected depth of flooding or sea-level rise	Each year	Next 50-100 years	Lot or neighborhood	Determining appropriate flood-mitigation measures for a certain lot or neighborhood
Green infrastructure planners	Projected peak temperatures by neighborhood (accounting for local built environment); Projected peak rainfall accumulation during a 15- or 30-minute interval	Each year	Next 50-100 years	Lot or neighborhood	Identifying locations that could benefit most from resilient infrastructure upgrades
Plant agriculture consultants	Projected number of growing degree days for particular crops	Each year	Less than 10 years	County or agricultural district	Deciding which crops to recommend farmers plant

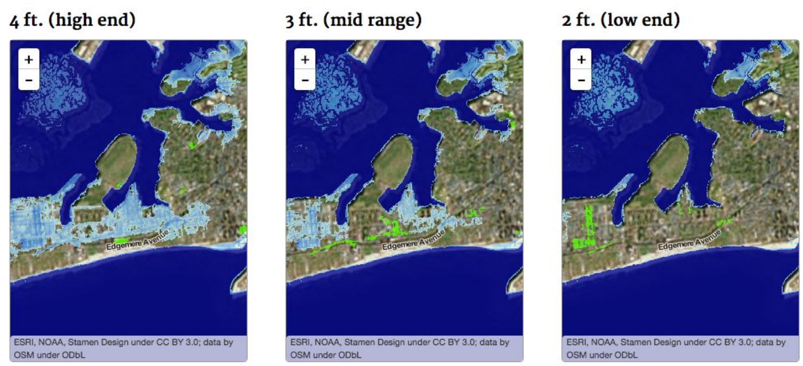
3.2 Analysts want to know how climate-change data acknowledges local context

When they find data, analysts try to determine how it acknowledges local contexts. Because the data are collected and generated by different publishers in different ways, analysts aren't always confident about its ability to reflect geographically specific nuances. For example, one municipal analyst we interviewed wondered whether sea-level-rise projections took into account shifting local tectonic plates. Another wondered whether precipitation predictions acknowledged their mountainous region's microclimate.

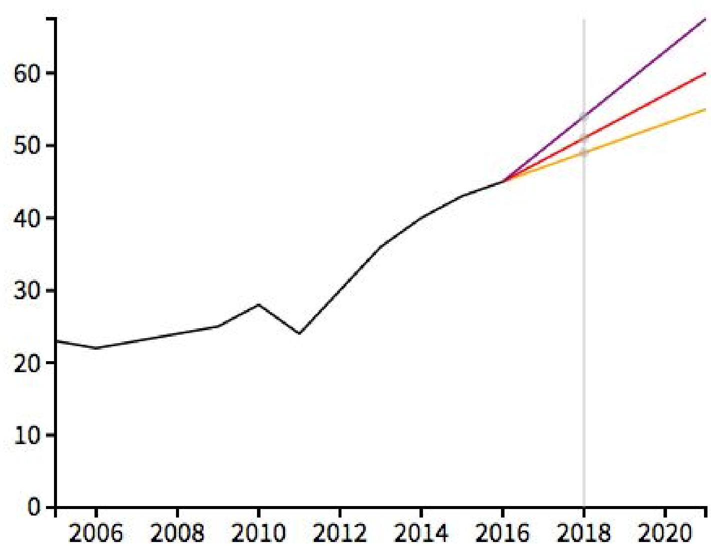
As a result, we heard lots about the importance of making the **source** of the data clear. The simplest way to do this is by including with data sets a statement like, "This data comes from <project>, which includes projections based on <upstream data set>, which makes <assumptions>."

3.3 Analysts understand variability and uncertainty, and they want to see it in projection data.

In addition to their desire to have data acknowledge local factors, analysts are comfortable with projections that include variability and uncertainty. During our prototype tests, they responded positively to tools and data downloads that allowed them to see said uncertainty. For example, analysts appreciated seeing varying sea-level-rise predictions for a given time slice displayed in a series of maps (rather than a single map):



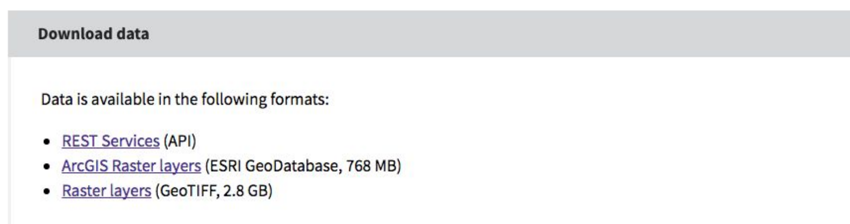
Likewise, they appreciated line graphs that displayed the historic predictions and then the 10th, 50th, and 90th percentile predictions of an ensemble of models:



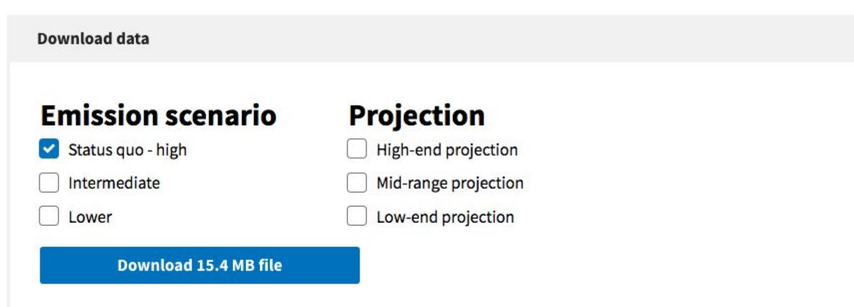
3.4 They look for relevant data in the raw so they can tailor it to their situations.

Most of the analysts we interviewed voiced a preference for being able to download relevant raw data in addition to viewing it through tools. Raw data is more easily manipulable than data only viewable through tools, and many of our analysts expressed their need to generate their own graphs or add their own variables to data from elsewhere.

Equally important to our analysts was the ability to easily download the data relevant to them in a non-proprietary format; nearly everyone we spoke to preferred downloading data sets as CSV and XLS files rather than proprietary CDAT or ArcGIS files. Analysts responded positively to being presented several download options:



Beyond format, people responded to customizing downloads to include different projections and emissions scenarios (depicted in the following screenshot), which again results in more relevant — and more useful — data.



4/ Science translators are interested in tools that help them meet the specific needs of analysts.

4.1 It's hard to convey climate science to municipal analysts and private-sector planners in a way that's both useful and true.

As one science translator told us, "The tradeoffs between good, useful, and used are hard for people that are trained as a scientist." Some science translators received funding to downscale data, but have less support for conveying their results to audiences broader than their original client or publishable research intent. They want to preserve the nuances of their data —particularly the uncertainty inherent to predicting future climate conditions —without doing new work.

4.2 Science translators are interested in tools that help them quickly generate customizable graphics and text that meet the needs of analysts.

The science translators we talked to expressed interest in online tools that help them present data. Science translators expressed particular interest in the parts of our prototype that offered to help them generate graphs or charts based on existing, local data. Although curious about the data source, they were interested in ways of visualizing what might be seen.

Some science translators were also interested in template language that could help them convey the "trickier" parts of climate science. These included ensemble variability and emissions scenarios — two topics difficult for many non-scientists to grasp.

4.3 They also expressed interest in being guided on the "do's and don'ts" of communicating climate-change science.

One of the most popular features of our prototype was a link to "do's and don'ts" for conveying climate-change science. Most science translators said they were interested in best practices for conveying science, particularly those that would help them reach skeptics.

5/ Analysts need a diversity of data sets (and tools to view them), but finding the right one for their needs is hard.

5.1 The possible contexts in which climate change affects long-term planning are diverse.

Because of the variability in analysts' experience levels, roles, and local climate change impacts, no one tool can reasonably be everything to everyone. Multiple tools will always need to exist to serve different needs.

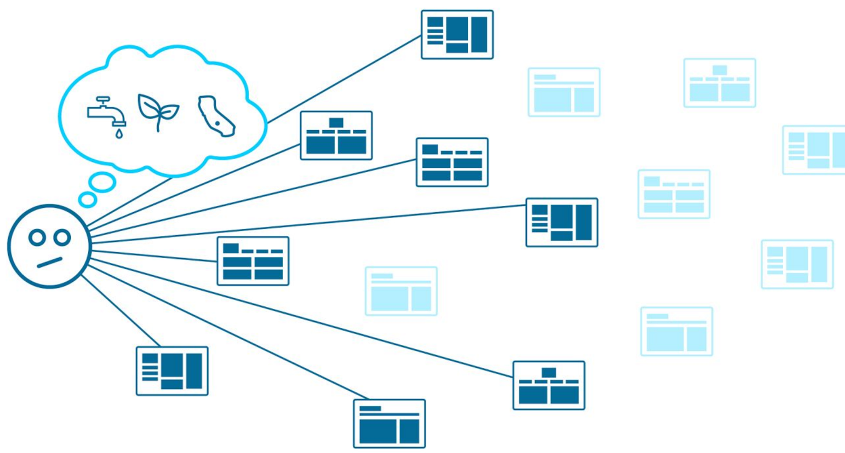
Not surprisingly, we observed that technical aptitude with respect to climate change exists on a broad spectrum. The spectrum features people who are highly climate-data proficient, people who have only a passing understanding of climate's effects (setting aside those who actively disbelieve the science), and everyone in between.

The categories of potential users are even broader than the range of technical aptitude we observed. Our study focused on analysts municipal analysts and had a smaller focus on private-sector planners in the agricultural sector, along with the science translators who help them. Among other people, we met with adaptation planning coordinators; zoning, emergency management, and power utility managers; water and wastewater managers. Members of each group need different data to plan for climate change based on their roles.

As described in finding 3.1, our participants also described highly divergent local contexts. These contexts each contain locally unique factors (for instance, mountainous topography) that may change climate-change-related impacts.

5.2 There are a multitude of climate-change data sets and tools within and outside of government.

As the initial Presidential Innovation Fellow Climate Data Initiative user study[3] noted, there are more than 1,500 federal webpages related to climate change. One of our interview participants put it best when they said, “People are so overwhelmed by the number of clearinghouses and websites. So many studies, so many clearinghouses, so many portals. People have been cranking these out. Here’s the greatest latest tool. They’re drowning.”



5.3 Given their own highly specific needs and the vast array of available data sets and tools, some analysts had trouble finding the right one to use.

We heard questions about which tools are the best to use for specific purposes. For example, one participant wondered, “Do I use NOAA’s sea level rise viewer or surging seas or another tool?" Ultimately, confusion about what site to use for what leads people to feel like this participant: "Local governments don't have time to navigate all these different things.”

We also heard that the adaptation actions eventually undertaken by a city may well end up in court. Some data sets that appear indistinguishable may actually be different, and choosing the “wrong” data may fail to help analysts feel confident that their conclusions will hold legal water.

5.4 Many analysts expressed interest in finding aids that would help them surface the existing tools most relevant to their specific needs.

“Finding aids”—tools that help analysts of all sorts find the most appropriate data and tools for their role and location — would help people across roles, locations, and levels of adeptness. The people we spoke to expressed interest in a tool that does the following:

- Intelligently prioritizes directing people to relevant federal resources over offering general advice.
- Shows data sets, tools, case studies, and other resources relevant to first their geographic region of interest and second their role and the assets they are managing in that role.
- Focuses on curating likely relevant resources instead of cataloguing everything that’s available.

Recommendations

1/ Better surface local relevance of data sets.

In the long term, agencies should invest in generating more downscaled projections that are locally specific. In the short term, we recommend federal websites can improve their existing climate change data sets by doing the following:

- Clearly describe each data set's geographic and time scale granularity, key variables, and assumptions in terms a municipal analysts can understand (as described in finding 3.1).
- Include citations that describe the upstream sources of the data, so analysts can determine how a data set acknowledges local context specific variables (as described in finding 3.2).
- For projections, offer users multiple scenarios to demonstrate the variability and uncertainty inherent in predictions (as described in finding 3.3).
- Offer data for download in the simplest, most open, and most popular possible formats (as described in finding 3.3).

As described in finding 4, we also suggest building tools that will help scientists make use of this data available in the best possible format — that is, the format that's easiest for target users to understand. These tools might include:

- A tool that quickly generates baseline graphics and text that meets the needs of analysts (as described in finding 4.2).
- Guidance on the "do's and don'ts" of communicating climate-change science (as described in finding 4.3).

2/ Recognize and support the critical human expertise that makes climate science actionable.

There is a gap between federal information sources and the ability to effectively plan for climate change. Right now, that gap, where it's bridged, is being bridged largely by scientists and analysts who can together map global climate-projection data to the local area and variables of consequence; without both, adaptation planning is impossible.

Our first recommendation speaks to narrowing the gap. We recognize that a gap will inevitably always exist, and realize too that the human intelligence of experts is necessary to bridge it.

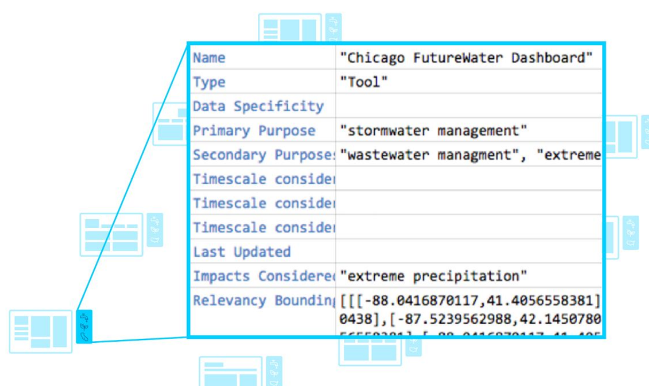
Consider an example: A wastewater utility manager is in charge of planning for a sewer system that includes stormwater drainage. In order to plan successfully for climate-change impacts, the manager must not only have a sense how heavy rain events could be more frequent and intense as a result of climate change (a process that involves downscaling the global models to respect local rain-influencing topographies), but they must also combine this knowledge with historical rain-gauge data for past extreme events, then map *that* information to the throughput of the different parts of the storm drain system. Federal resources will certainly never model the throughput of the storm drain systems of the different municipalities across the country, or map those models to the climate models. Even if the other aspects of this planning were made easier by federal information tools, certain parts of the planning process are inherently local and require local human intelligence.

We generally encourage efforts to connect more analysts with scientists and data experts, the spread of best practices used by successful scientists, experts and analysts, and support groups that promote sharing among government officials, scientists, and analysts.

3/ Pursue an ecosystem approach: Make climate-data websites interoperable, enable audience-specific finding aids, and improve search engine results.

3.1 Create a data interchange standard, or a published agreement (among agencies who host climate-change-related data and tools) to publish a machine-readable manifest of what each climate data tool contains.

At minimum, each manifest would describe the specific areas, locations, types of impacts, variables, data provenance, and underlying data displays the tool shows (for more specific examples, see finding 3.1). A more comprehensive version of the manifest would describe application program interfaces (APIs) that other websites could use to access its data, and the most advanced type of manifest would actually provide APIs that would allow others to access its data and visualizations.



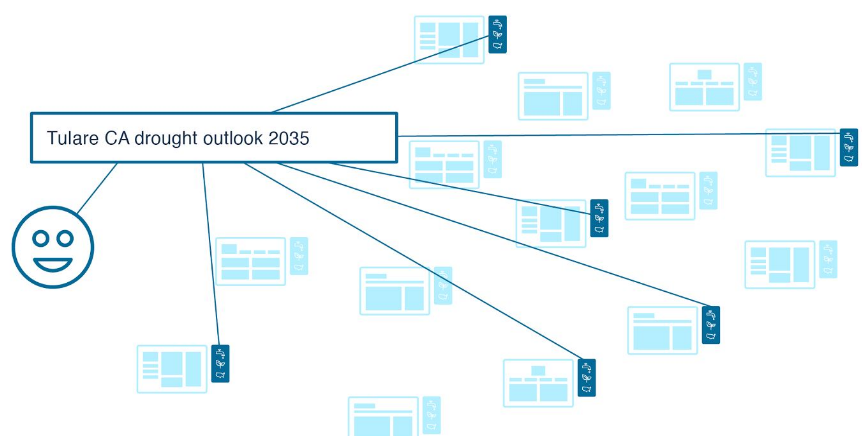
The manifests would help analysts and private-sector planners better find tools in two ways, as described in the following two sections.

3.2 Agencies should develop role-specific finding aids that use manifests to dynamically generate a catalog of data from other federal sources.

For example, the Department of Transportation could create a website that dynamically lists other federal websites offering climate-change-related data and tools that meet the needs of transportation planners. To benefit as many planners as possible, these finding aids should do the following:

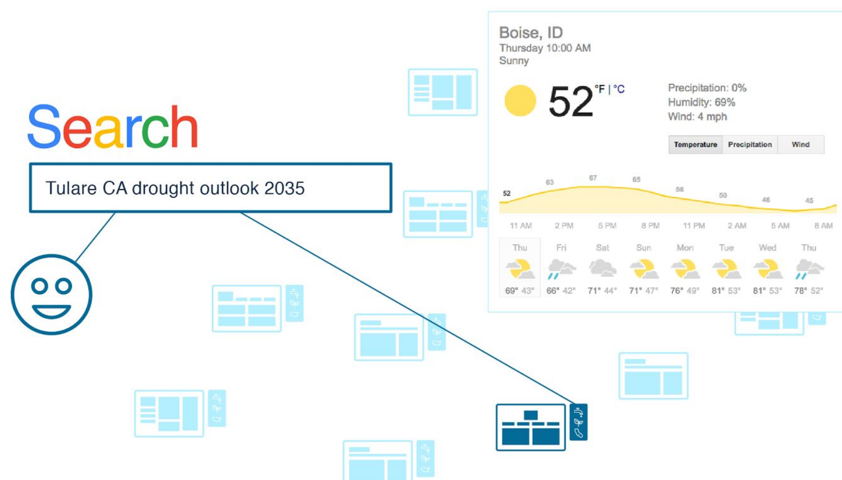
- Intelligently direct people to relevant federal resources over offering general advice.
- Focus on curating resources instead of cataloguing everything that's available. By developing relevance rubrics and making considered editorial decisions about the most likely impacts for different locations, we can help people access **only** the information they need.
- Show tools, case studies, and other resources relevant (first) to a user's **geographic region of interest,** and then (second) to their role and the assets they're managing in that role.

By offering manifest-driven finding aids, agencies can target audiences they regulate and serve, reduce information overload and direct planners to data and tools, ultimately streamlining the decision-making process.



3.3 Search engines could also interpret manifests, making it easier for planners to find climate-change data via their own tools.

In general, the more specific data a site provides search engines about what it offers, the more likely the search engine will show it in relevant search results. Giving search engines specific data about what locations, variables, timescales, and uses data sets might have (in the form of machine-readable manifests) increases the likelihood of those search engines showing the data sets. Additionally, providing specific search engine data access could improve the search experience by showing users previews of what data they will find on a page or providing answers within the search engine.



4/ Consider building a single portal for climate data if it can surface the local relevance of data sets and leverage and facilitate interchange.

4.1 A centralized resource of relevant climate information could improve findability for analysts.

Municipal analysts, private-sector planners, and science translators all complained that the relevant data was scattered among websites (see finding 2). At first glance, this finding suggests that building and publicizing a centralized place for the data they seek (a "portal") could indeed help them by creating a front door for all users to enter.

4.2 However, making such a portal useful and maintainable would be difficult.

Before we steer people toward data and tools, we need data and tools that better fit their needs. Otherwise, we'll largely be pointing interested analysts toward websites that **don't** meet their needs and increase frustration.

We also need to enable the data interchange that makes connecting a large collection of websites easy for users to understand. Without an interchange standard, creating a portal would require large amounts of manual cataloging that would quickly become out of date. Additionally, without a standard, the portal would likely have a poor handoff user experience; users would have to re-enter their location, variables of interest, and other search terms upon arriving at an agency's tool from the portal.

One other note: A single portal that represents all of the data the government offers would require unprecedented (in this sphere) interagency collaboration. Such a portal would have to be curated by a council of agencies and meet the interests of each. This compromise isn't impossible, but is difficult enough to create pause.

4.3 We should not rush into building a portal. Climate decision makers can find the tools they need without one; it just takes more time.

Without a portal, how will people find tools that address local contexts? The same way they do now. Although it is not as easy, people currently use science translators, professional networks, and various search engines (described in finding 1) to find useful tools. Analysts can currently surface relevant tools; it just takes a bit more effort.

4.4 Therefore, we suggest implementing recommendations 1 and 3 when considering creating any type of climate-change-data portal.

We maintain that surfacing the local relevance of data sets and a data-interchange standard would ease the challenges of building a useful data portal.

If, eventually, agencies laid the groundwork described in recommendations one and two, we could see multiple possible useful approaches to a portal. A single, multi-faceted portal could try to meet the needs of the many possible audiences. However, many "mini-portals," each tailored to different audiences and hosted by different agencies, could as well.

Proposed next steps: recommendations in action

1. Support science translators by building a science translation toolkit (through a co-designed, user-centered process) that helps them scale their research.

2. Create a “minimum viable” draft manifest data-interchange standard. We suggest holding a facilitated kickoff workshop with municipal planners, science translators, data/data-tool providers, and other analysts from NOAA, NASA, FEMA, USGS, EPA, and others to come to rough consensus on central elements of this standard. Create a working group representing the same agency that meets on a regular basis to keep it up to date and lightweight. Involve data-standard experts to help facilitate this group.

   At a minimum, the data standard should focus on climate impact, data geographic specificity, data provenance (as a tree back up to parent model), and acknowledgement of any or no local factors taken into account.

3. In conjunction with 2, create simple tools for creating, collecting, and processing the manifests to serve as a proof of concept. To the degree possible, build the tools using open-source or commercial, off-the-shelf data-aggregation tools and use it to test the manifest data standard. Use the data manifests to track citations to understand which data sets are being used and how, or provoking derivative products.

4. Finally, whatever is undertaken should be done with an uncompromising focus on the users. New tools, features, and data sets should be created based on observations of the tool users in the normal context of their work, and should be developed with a user-centered and iterative approach. The usefulness of existing tools and data should be evaluated not simply in terms of user feedback or feature requests; rather, it should also incorporate actual observations of users trying to use the data sets and tools. Testing should take place frequently (weekly or biweekly tests are industry best practice), and test findings should be incorporated into tools on a similar rolling basis.

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