Generating relevant climate adaptation science tools in concert with local natural resource agencies

Climate Ready North Bay
prepared by TBC3.org members
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Northern California Climate Adaptation Project
USFS-BLM
March 9, 2016
Outline

Introduction to Pepperwood

Project overview

Sample regional and local results

Applications and lessons learned
Pepperwood Mission: advance science-based conservation science across our region and beyond

The new Dwight Center for Conservation Science

3200-acre reserve in Mayacamas, partnered with CA Academy of Sciences
TBC3  Terrestrial Biodiversity Climate Change Collaborative

Bridging science and climate adaptation for natural resources
North Bay Climate Ready

Serving natural resource agencies in Marin, Sonoma, Napa and Mendocino Counties

Funding: a *Climate Ready* Coastal Conservancy grant to Sonoma’s Regional Climate Protection Authority plus match funds from partners

Pepperwood lead on vulnerability assessment with TBC3 members from USGS, and Point Blue Conservation Science
North Bay Climate Ready
User Groups and Partners

User Group 1: Sonoma County Water Agency with Mendocino County Water Conservation and Flood District
  Domain: Sonoma County plus Russian River Basin of Mendocino County

User Group 2: Sonoma County Agricultural Protection and Open Space District and Sonoma County Regional Parks
  Domain: Sonoma County

User Group 3: Napa County, Departments of Planning and Public Works plus the Watershed Protection District
  Domain: Napa Valley

User Group 4: Marin Municipal Water District (MMWD)
  Domain: Marin County

User Group 5: Regional Climate Protection Authority (RCPA) Municipal Users Group: all nine cities of Sonoma County-public works and planning officers
  Domain: Sonoma County and sub-watersheds
Purpose

To provide agencies with science-based estimates of how climate change may increase the frequency and/or intensity of climate hazards, how they may vary across the county, how that may impact demand for services, and guidance on how natural areas may be leveraged to increase resilience.

Approach

Engage local resource managers and scientists in “mutual learning” focused on exploration of key management questions using a watershed-based model of historical and projected climate-watershed interactions.
Climate Ready North Bay: translating a landscape-level climate-hydrology database into inputs for long-term planning

- Warmer temperatures
- Greater hydrologic variability
- Greater evapotranspiration
- Increased water demand
- Variable runoff and recharge
- Shifts in natural vegetation types
- Increased wildfire risk
- (Not sea level rise!)

Source: Climate Ready North Bay 2015
What kind of long-term plans can use this landscape-level data?

In general:
human health    energy demand    watershed plans
surface water supply    fire and hazard mitigation
sustainable groundwater management
agricultural sustainability    ecological restoration

In Sonoma:
Climate Action 2020
Basin Advisory Panels and SGMA Compliance
Water Agency Adaptation Planning-including reservoirs ops, drought preparedness, demand projections
Hazard Mitigation Planning
SCAPOSD Acquisitions, Regional Parks Management Plans
RCD Watershed Plans
Projected Maximum Summer Air Temperature, 2040-2069

86.4 average +4.2 deg F
Change relative to 1981-2010 average (82.2 deg F)

86.0 average +3.8 deg F

89.2 average +7.0 deg F

Confidence in direction of trend, uncertainty about how fast!
Precipitation (PPT, annual in/y)—large uncertainty!
30-y average, current to projected mid C

Current 1981-2010
43.0 average

Projected 2040-2069
35.0 average
projecting 19-21% less rainfall than 1981-2010!

hot and low rainfall

Projected 2040-2069
54.0 average
projecting 25-35% greater rainfall than 1981-2010!
Mechanisms of groundwater recharge
• Mountain block to regional aquifer
• Mountain front recharge to alluvial aquifer
• Directly through alluvial valley where shallow water table
• Streambed losses
• May return to stream via baseflow
Climatic Water Deficit = drought stress
Potential – Actual Evapotranspiration

Integrates effects of temperature and rainfall on landscape in context of watershed structure

Surrogate for irrigation demand

Correlates with vegetation and fire risk

Potential drought-stress indicator

Increases with all future climate scenarios

CWD mechanistically links energy loading, drainage, and available soil moisture
User-defined data products
How might climate change impact the magnitude and frequency of heat waves impacting the health of vulnerable populations?
How might climate change impact the magnitude and frequency of water supply droughts?

Sonoma County Precipitation, 1920-2099

Scenario 5
Warm & High Rainfall

Scenario 3
Warm & Moderate Rainfall

Scenario 6
Hot & Low Rainfall

Average Historical
45 in/yr

Warm & high rainfall future
Average 59 in/yr
5 yrs exceed historical max
3 yrs approach historical min

Warm & mod rainfall future
Average 47 in/yr
2 yrs exceed historical max
4+ yrs approach historical min

Hot and low rainfall future
Average 36 in/yr
No yrs approach historical max
5+ yrs approach historical min
Given groundwater is more resilient than reservoir supplies, where are the most important groundwater recharge areas to protect?

Projected Groundwater Recharge 2040-2069

- Warm & High Rainfall
  - Average 12.4 in/yr

- Warm & Moderate Rainfall
  - Average 10.3 in/yr

- Hot & Low Rainfall
  - Average 7.9 in/yr

- Consider mapping priority recharge areas that target upper 75% of recharge
- Consider analyzing existing impermeable footprint, where could LID assist in conservation
- Consider analyzing developing areas for conservation of high recharge zones
- Can you use this to prioritize siting studies for injection wells?
- What % of recharge is currently used in each basin? How much area to protect to sustain in future?
Example: Coast Live Oak
does well in all future scenarios regardless of warming magnitude and rainfall

Sonoma Coast Range
Species Level Examples

Example: California Bay is sensitive to rainfall in the Coast Ranges
does well in moderate scenario, but declines in hot and low rainfall

Identify potential “winners and losers” by landscape unit

Example: Tan Oak is sensitive to rainfall and temperature
shows declines in all scenarios

What will be forest winners and losers under climate change?
What are the most fire-prone parts of the county?
How might climate change impact the risk of fire on our regional parks?

Average probability of a burn within 30 years goes up 18% by mid-century

Average fire return interval goes down 18% by mid-century

See Table in “FireRisk.xls” spreadsheet
Sonoma County Vital Signs design for North Bay Climate Adaptation Initiative

Climatic Water Deficit change over time
Source: Pepperwood, TBC3 California BCM, Flint and Flint
climate.calcommons.org hosts BCM 30-y averages for all of CA, and will host “Climate Smart Exchange” to document the Climate Ready North Bay case study plus the climate-smart watershed analyst (coming soon!)
What do the models agree on?  
Take home messages for managers

Rising temperatures across the region will generate unprecedented warm conditions for both summer and winter seasons.

Rainfall is likely to be more variable in the future.

The North Bay region is becoming more arid (subject to drier autumn soil conditions) due to rising temperatures.

Runoff may be increasingly flashy, with rates of groundwater recharge relatively less variable over time.

Protecting available recharge areas will be critical to water supply sustainability.

Water demand for agriculture may increase on the order of 10%.

Fire frequencies are projected to increase on the order of 20%, requiring additional readiness planning and more aggressive fuels management.

Vegetation may be in transition, meriting additional monitoring and consideration of a more drought-tolerant planting palette.
Win-win strategies for climate adaptation

Mitigate greenhouse gas emissions.
Protect key watershed functional areas: floodplains, recharge areas, wetlands.
Recycle and conserve water.
Increase soil moisture holding capacity.
Get serious about fuels management.
Identify native species that are likely to be climate “winners” - protect seed sources.
Keep the landscape connected-riparian and terrestrial habitat corridors.
Prepare for more frequent extreme events.

Invest in preparedness-its cheaper than emergency response!
Lessons learned about “co-production”

Take home messages for vulnerability assessments

*Time and patience are required for a meaningful in-depth iterative exchange—minimum 12 months, 12 meetings.*

*Key players—scientists with appetite for applied work, managers with scientific curiosity, information broker with experience in both realms. NGOs can play critical role of “flexible glue” to facilitate collaboration.*

*Mutual learning is possible! Engaged managers gained the most by “playing” with the data, scientists revealed cool trends when conducting management based queries.*

*Distillation of key take home messages a goal for managers.*

*Managers see products as valuable for outreach and education of their constituencies: additional resources needed to do this well.*

*Integration of long-term climate products into existing planning processes (instead of stand-alone adaptation plans) may be most effective local approach.*

*Regional science linked to local implementation a potent combination—facilitates cross-jurisdictional coordination, but retains local autonomy.*
Thank you!

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TBC3 has built a climate adaptation knowledge base for application to CA Coast Range watersheds.

Climate + Topography → Watershed Hydrology + Topo-climate → Vegetation Cover + Fire Risks → Species Distributions

generating an ensemble of projections for use in scenario planning
Sonoma County Annual Recharge and Runoff, 1920-2099

Scenario 5
Warm & High Rainfall

Scenario 3
Warm & Moderate Rainfall

Scenario 6
Hot & Low Rainfall

1981-2010 Average
Recharge 10 in/yr
Runoff 17 in/yr
End century averages
Recharge 13 in/yr
Runoff 30 in/yr

Recharge is less variable than runoff across all futures
3-day high flows for Upper River and Lower Russian River (modeled)

3-day flows exceedances of 99.9% threshold (per decade)
19,298 cfs threshold for upper river
38,902 cfs threshold for lower river

2001-2015 vs 2016-2099 (exceedances per decade)

<table>
<thead>
<tr>
<th></th>
<th>Upper River: Healdsburg</th>
<th>Lower River: Guerneville</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business-as-usual</td>
<td>1.3</td>
<td>3.9</td>
</tr>
<tr>
<td>PCM A2</td>
<td>1.3</td>
<td>3.9</td>
</tr>
<tr>
<td>GFDL A2</td>
<td>2.0</td>
<td>3.6</td>
</tr>
<tr>
<td>Mitigated</td>
<td>4.0</td>
<td>4.8</td>
</tr>
<tr>
<td>PCM B1</td>
<td>4.0</td>
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</tr>
<tr>
<td>GFDL B1</td>
<td>2.0</td>
<td>3.7</td>
</tr>
</tbody>
</table>

The frequency of 3-day “very high flow” events are up to 4 x more likely to occur than they do currently.

PCM wet model
GFDL dry model
Sentinel Site Soil Moisture Monitoring
(headwaters of Mark West Creek, Russian River)

Normal year plant water use of soil water!

Soils dried out beyond wilting point!
what might the Bay Area vegetation of the future look like?

Current
+7°F drier
+7°F wetter

Conifer
Deciduous Woodland
Evergreen Woodland
Shrubland
Herbaceous
Converted/Non-vegetated
Water

Ackerly 2014
TBC3.org