Advancing decision support for climate adaptation in agriculture and natural resources

California Adaptation Forum
July 31, 2023

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

cdfa

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

CALIFORNIA PISTACHIOS

Agenda

3:00p Welcome!

3:10p Presentations

- Janet Hartin (UC ANR)
- Michael Wolff (CDFA)
- Bob Klein (CPRB)
- Romain Maendly (DWR)
- Tapan Pathak (UC ANR)

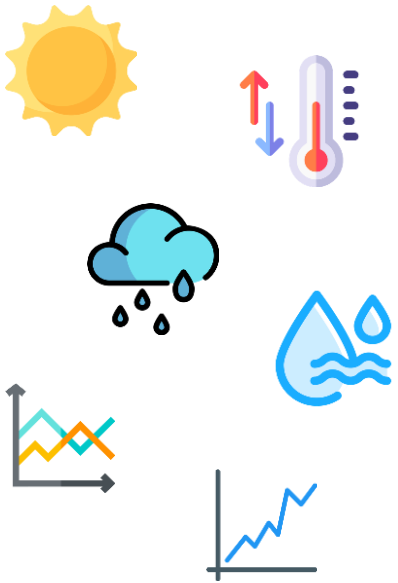
4:00p Break

4:10p Breakout discussions

4:40p Discussion
Continuing the conversation
Concluding remarks

Why talk about decision support?

We Know How Climate is Changing



Decision Support

applied

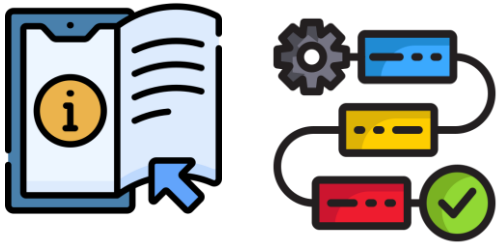
practical

user-friendly

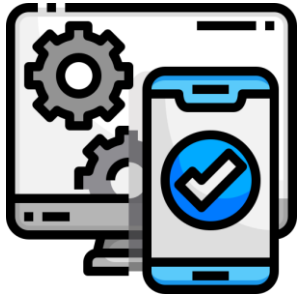
Impacts & Adaptation

What do we mean by ‘decision support’?

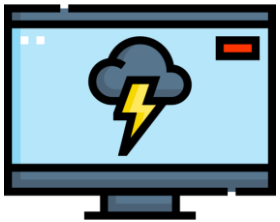
networks



decision guides



apps



forecasts

custom data

Presenters

Janet Hartin
UC ANR

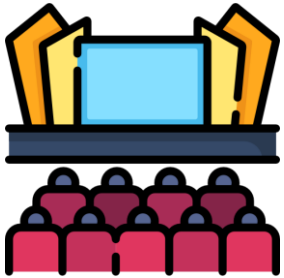
Michael Wolff
CA Dept of Food & Agriculture (CDFA)

Bob Klein
CA Pistachio Research Board

Romain Maendly
CA Dept of Water Resources

Tapan Pathak
UC Merced

Presentations



~10 minutes each

Questions

- **In-person**: after the presentation, or use the Whova app
- **Zoom**: chat

Breakout Groups

1. What kinds of decisions or issues do you face in your work related to climate change?

Breakout Groups

2. What information sources do you currently turn to to help you make these decisions? Where are the gaps or shortfalls?

Breakout Groups

3. How could information tools be more relevant and accessible to you and the groups you serve?

Breakout Groups

4. What can researchers do to help?

Continue the conversation…

Sign-up to receive email announcements

From Research to Implementation: Cooling Urban Heat Islands with Climate-Resilient Trees

Janet Hartin, UC ANR Area Environmental Horticulturist
San Bernardino, Los Angeles, and Riverside Counties

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Challenge #1: 95% of Californians are directly impacted by urban heat islands (UHIs)

Surface temperatures of (left to right): black asphalt, artificial turf, concrete sidewalk, and living groundcover

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Challenges #2 and #3: California has a tree drought and (often) a moisture drought

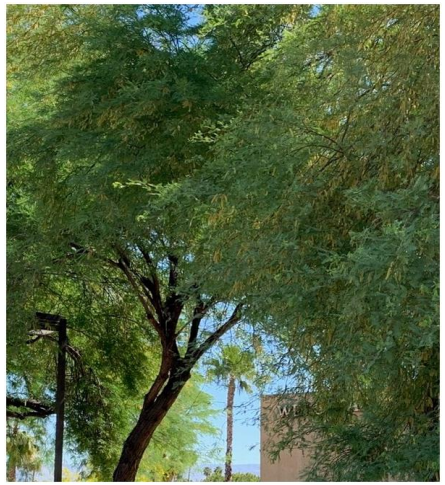
- While there are ~ 9 M street trees in California, their density has decreased 30% since 1988. CA cities have the lowest tree canopy per capita (108 yd^2) in the U.S.

How are trees part of the solution?

The shade of one tree can reduce surface temperatures of asphalt by more than 50°F in coastal cities, 60°F in inland cities, and 70°F in desert cities. Surrounding air temperatures are reduced by 6-12°F.

Goal #1: Identify drought, heat, and pest resistant trees through collaborative research (UC ANR/USFS)

Measuring performance of underplanted landscape tree species based on heat and drought resistance, CO_2 sequestration, pest resistance, rareness, longevity, etc.



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Climate and weather data help identify resilient tree species we further investigate in research trials

Free Tools:

- Cal-adapt (climate models): https://cal-adapt.org/
- i-Tree (ecosystem benefits in $, species lists, tree canopy, etc.) https://www.itreetools.org/
- Cal EPA (urban heat islands):
  - https://calepa.ca.gov/climate/urban-heat-island-index-for-california/
  - https://calepa.ca.gov/2022/01/31/individual-maps-and-data-files
- USDA/USFS (tree canopy cover, disease incidence, pollution): https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd645759.html
- California Irrigation Management Information System (CIMIS) (irrigation scheduling): https://cimis.water.ca.gov/

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Goal #2: Prioritize enhancing tree canopy cover in low-shade neighborhoods

Partner with other organizations and groups to:
- ensure that people most in need receive trees and are part of the decision making process
- ensure that trees reach their maximum lifespan through providing free tree care helplines

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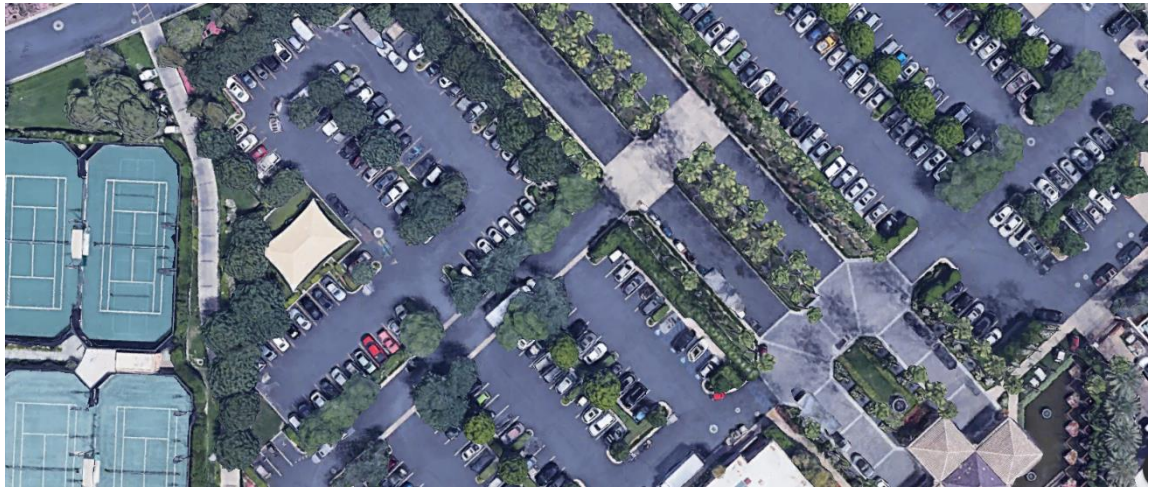
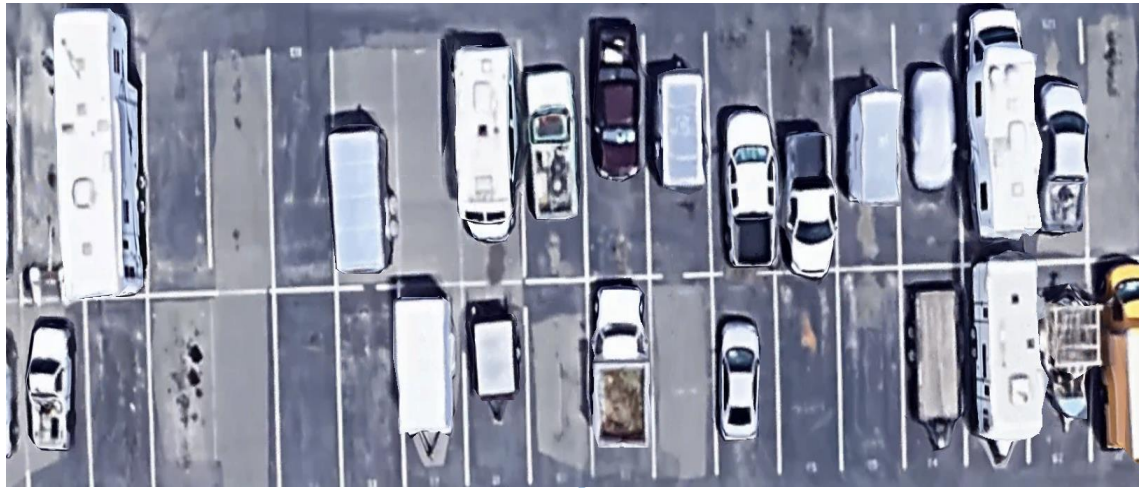
These neighborhoods are 3 miles apart





Example of a project that has provided over 1,200 free trees to residents of San Bernardino County since 2020

Master Gardener – University of California Cooperative Extension

INLAND EMPIRE RESOURCE CONSERVATION DISTRICT

CALIFORNIA CLIMATE ACTION CORPS

COMMON VISION COALITION

And over 20 other groups including cities, water districts, schools, community gardens, etc.

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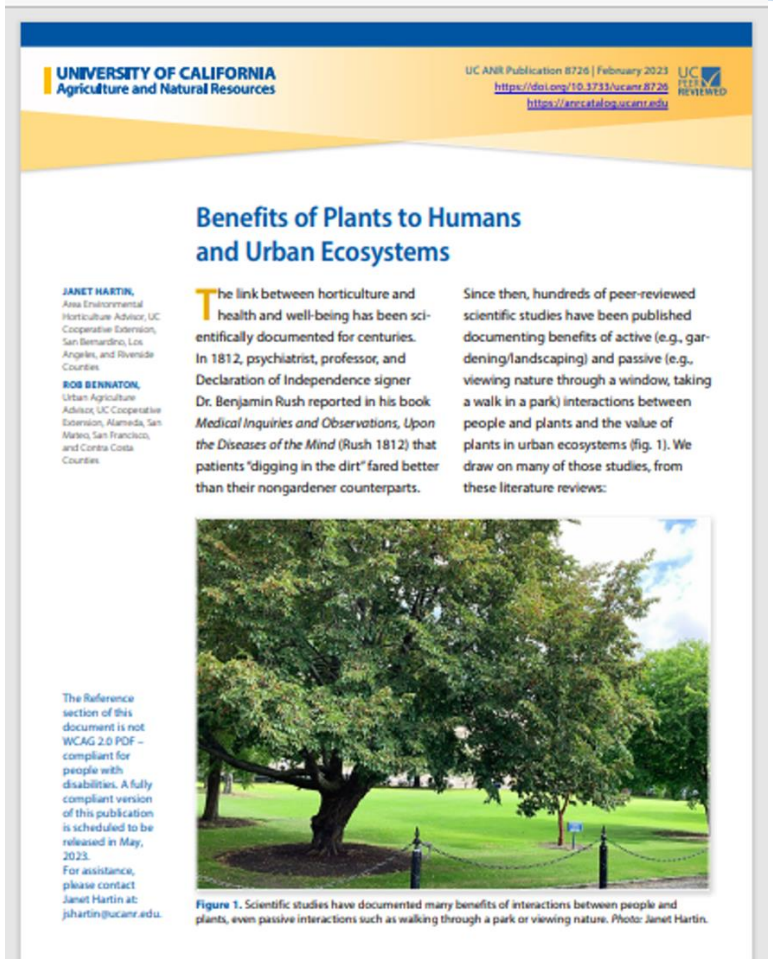
Resources

- Benefits of Plants to Humans and Urban Ecosystems https://anrcatalog.ucanr.edu/pdf/8726.pdf)

- UC ANR Research and Education Influences Landscape Water Conservation and Public Policy https://doi.org/10.3733/ca.2018a0041

- Water Requirements of Landscape Plants Studies Conducted by University of California Researchers https://doi.org/10.3733/ca.2018a0041



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UC ANR Publication 8726 | February 2023
https://doi.org/10.3733/ucanr.8726
https://anrcatalog.ucanr.edu

UC PEER REVIEWED

Benefits of Plants to Humans and Urban Ecosystems

JANET HARTIN, Area Environmental Horticulture Advisor, UC Cooperative Extension, San Bernardino, Los Angeles, and Riverside Counties

ROB BENNATON, Urban Agriculture Advisor, UC Cooperative Extension, Alameda, San Mateo, San Francisco, and Contra Costa Counties

The link between horticulture and health and well-being has been scientifically documented for centuries. In 1812, psychiatrist, professor, and Declaration of Independence signer Dr. Benjamin Rush reported in his book *Medical Inquiries and Observations, Upon the Diseases of the Mind* (Rush 1812) that patients "digging in the dirt" fared better than their nongardener counterparts.

Since then, hundreds of peer-reviewed scientific studies have been published documenting benefits of active (e.g., gardening/landscaping) and passive (e.g., viewing nature through a window, taking a walk in a park) interactions between people and plants and the value of plants in urban ecosystems (fig. 1). We draw on many of those studies, from these literature reviews:

The Reference section of this document is not WCAG 2.0 PDF – compliant for people with disabilities. A fully compliant version of this publication is scheduled to be released in May, 2023.
For assistance, please contact Janet Hartin at: jshartin@ucanr.edu.

Figure 1. Scientific studies have documented many benefits of interactions between people and plants, even passive interactions such as walking through a park or viewing nature. *Photo:* Janet Hartin.

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Thank You!
Janet Hartin
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Climate Decision Systems: Developments Seen in California and the Roads Ahead for Agriculture

Michael Wolff, Sr. Enviro. Scientist,

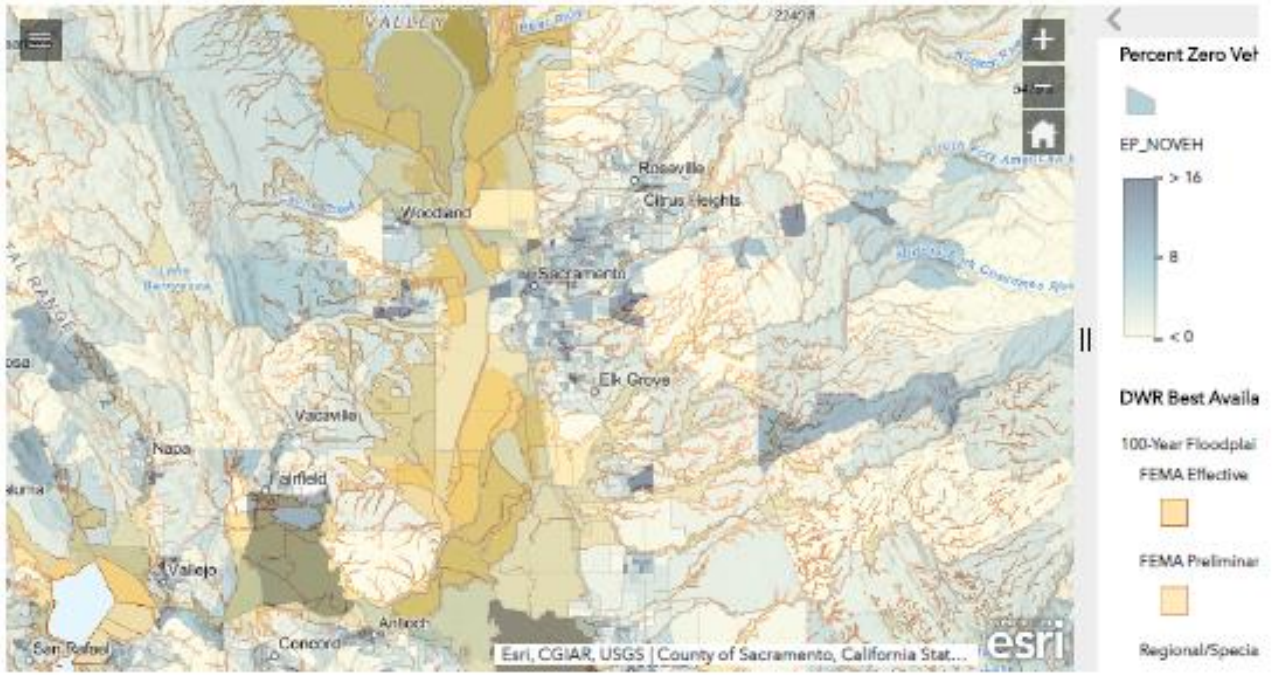
CA Dept. of Food and Agriculture

Vulnerable Communities Platform: Data

- *In beta version; more later*
- Collects and combines spatial data, see right:

Listed under "All Hazards":

- Climate
- Hydrology
- Demographics
- Economics
- Pollution
- Wildfire



VCP Demo | Extreme Heat | Coastal and Inland Flooding | Wildfire | All Hazards | Resource Springboard | Case Study | More

Vulnerable Communities Platform: Indices

- Also collects Spatial Indices, see right

Listed as "More -> Other Tools":

Healthy Places Index

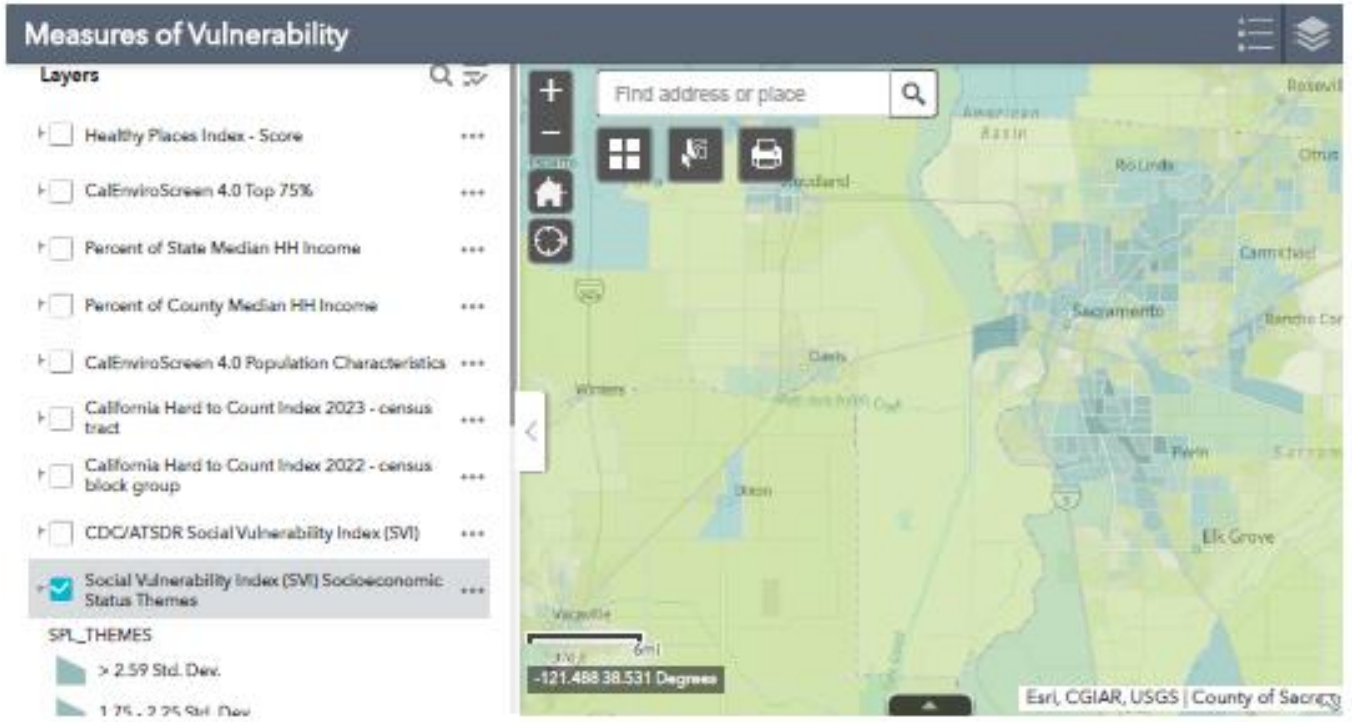
CalEnviroScreen

Median HH Income

Social Vulnerability Indices

Priority Populations

- *Does not run its own indices (requested)*



Vulnerable Communities Platform: Feedback and Involvement

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- *Other functions as seen below, including*

Orientation *as "Resource Springboard"*

And ***Use Cases*** *under "Case Study."*

- Being developed as part of the State's 5th Climate Change Assessment by ICARP
- Has been shown at regional workshops.
- OPEN TO PUBLIC COMMENT or INVOLVEMENT through the feedback form on the "beta" website: at right *or*

https://vcp-beta-1-1-gov-opr.hub.arcgis.com

Potential Agricultural Vulnerability Indices

- First version designed by CDFA contract in 2012 by UC faculty
- Cropping, Social, and Economic Indices could be calculated
- Seeking a platform like “Vulnerable Communities”
  - if index creation is enabled
- Main variables, from existing data sources:

1. Rural Population
2. Ag jobs as % of total jobs
3. Farm Disaster Payments
4. % Land area in 100-yr floodplain
5. Spatially-inferred crop climate sensitivity
6. Crop Dominance
7. Pesticide application rates
8. Commodity concentration: by acreage or economic product
9. Climatological, using Cal-Adapt: Variation of precipitation, extreme heat, probability of drought, and potential evapotranspiration

10. *Broadband access can also be considered… but awkward fit into indices.*

Cal-Adapt Future Climate Modeling *for Agriculture*

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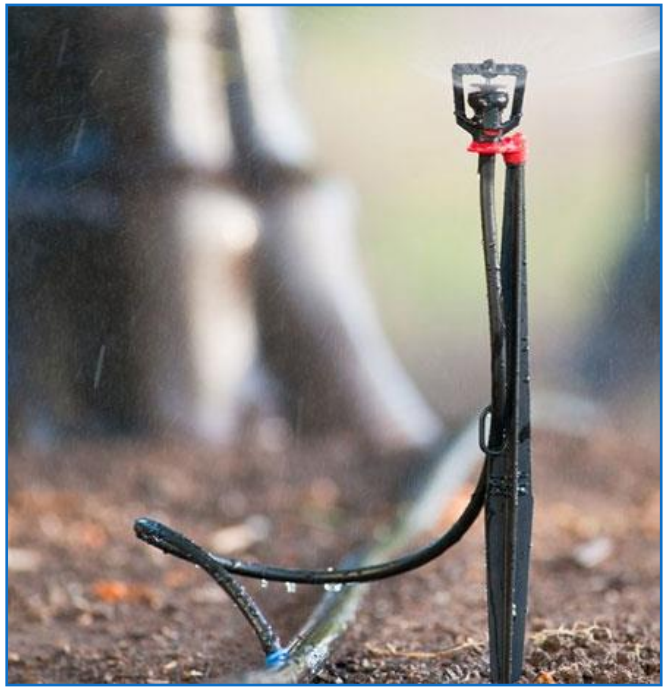
- Cal-Adapt created by California Energy Commission
- Limited current capacities for Agriculture:
  - Average Maximum and Minimum temperatures help to determine whether future conditions are likely to be conducive to particular crops.
  - Maps of Projected Change of the same
  - Extreme Heat Days predictor with adjustable threshold (could be made crop-specific)
  - Extreme Weather: Wind speed with adjustable threshold
  - Extended Drought Scenarios: but irrigation means that local conditions are of varying relevance
  - Long-term “standardized” Potential Evapotranspiration

Cal-Adapt and Agriculture: Requested Future Capacities

- *Growing Degree Days* for a given crop could be calculated with the current tool, by creating a wizard where the user would define the planting period.
- *Chill Hours* for tree crops could be integrated with downscaled, time-of-day modeling framework
- *Frost risk*: should be feasible with current modeling data, although some weakness would come from the lack of topography and high-resolution microclimates.
- *Improved wind speed* predictions, also with time-of-day modeling
- *Improved potential evapotranspiration* predictions accounting for wind speed, radiation, relative humidity, vapor pressure. These can be transferred to evapotranspiration estimates for particular crops using set factors. Underlying calculations would be similar to “human heat experience” metrics which others have requested multiple times.



- *Agriculturally-accessible descriptions of “probability” and “risk” could be tailored to particular wizards or tools, like those suggested above.*

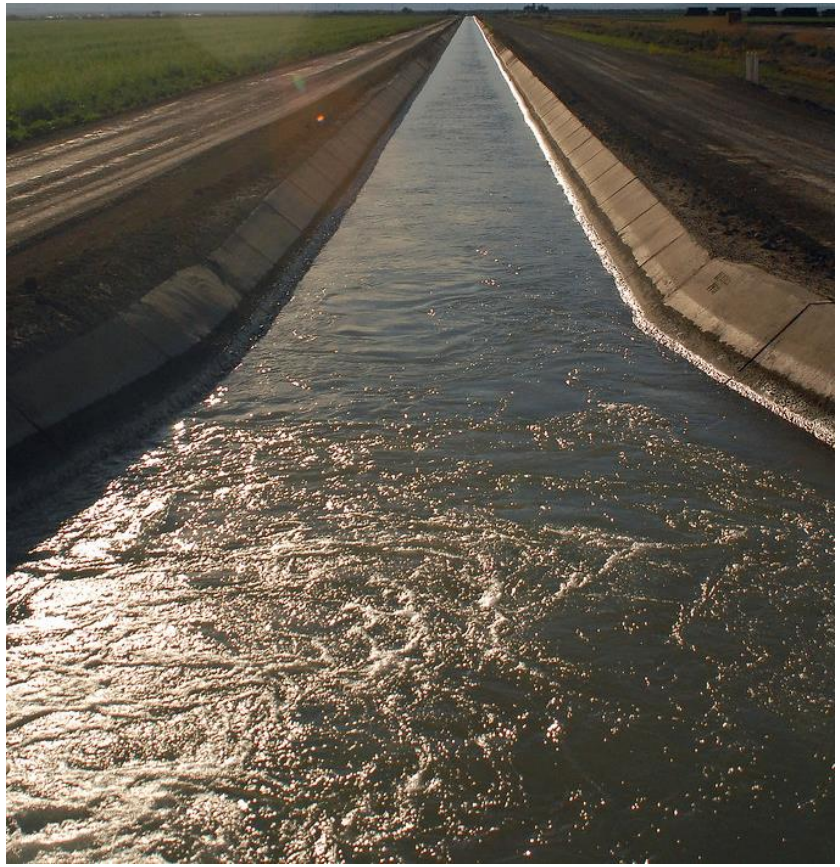
CalCIS: California Climate Information System

Created by Budget of 2022-23 with around $16 million

Beta being designed now by NASA JPL, still identifying use cases within state agencies

Contract Goals:

- “developing data products to help decision makers
- utilize state of the art spaceborne and airborne remote sensing data
- integrating predicted climate
- [possibly also gathering land-based observations like CIMIS]
- currently climate and remote sensing data is managed in department silos with little integration and tremendous variability in departments’ access
- exponentially increasing amount of environmental and climate data is readily available from NASA and other sources.”
- A number of existing State analytical processes could be automated…
- Develop automatically updated, public-facing tools and datasets useful to stakeholders (such as pest management for agriculture).



“Cropping Climate Atlas”

- Stakeholders have requested “atlases” of current and future crop ranges to help visualize their future options.
- CDFA contracted a guide describing “climate change impacts” on crops in San Diego area (see right):
- That can be seen by googling “CDFA Climate Change Consortium.”
- Useful work can be done on an “Atlas” basis, but predicting crop ranges is complicated by crop breeding over time, like efforts to make almond varieties with lower chill hour requirements.
- *Further feedback to CDFA is welcome.*

Climate Adaptation in California Ag – Lessons from Pistachios

BOB KLEIN, MANAGER

CALIFORNIA PISTACHIO RESEARCH BOARD

AGRICULTURE IN CALIFORNIA

- California is the #1 agricultural state
  - >$50 billion in farm receipts
  - Over 300 different crops but top 10 make up 65% of total
- Commodities are allowed to organize into marketing orders, commissions, etc
  - Under state or federal supervision
  - Generally initiated by growers and periodically re-authorized by referendum
  - Operate on mandatory assessments
  - Over 50 California MOs, Commissions plus federal MOs, Agreements, R&Ps

MARKETING ORDER ACTIVITIES

- Each MO is different, can only do what their program allows
  - Marketing – promotion, inventory management, public relations
  - Governmental relations – Fed MOs can't lobby
  - Statistics – acreage, production, inventory/shipments
  - Research
    - Pistachio program is limited to production research and grower education
    - Production research is not intended for promotional activities

CALIFORNIA PISTACHIOS

- Industry started in 1976, 1.5 million pounds from 4500 acres
- Continuous growth, 1.2 billion pounds from 450,000 acres
- 95% of production in South San Joaquin Valley, remainder in Sac Valley
- 1500 grower entities – family farms to retirement funds
- Pistachios require relatively cold winters, hot and dry summers, adequate water
  - 600-700 hours of chill < 45F
  - No rain during summer
  - About 40” water, “salt tolerant”, drought resistant
  - Trees are very long-lived

CALIFORNIA PISTACHIO RESEARCH BOARD

- Begun in 2007, reauthorized in 2012, 2017, 2022 with >95% support
- Nine Members, Four Alternates, One Public Member
- CPRB is limited to production research and grower education
  - Board Members set research priorities
  - RFP sent out annually, primarily UC and USDA researchers
  - > $2.5 million for research budget
  - Typically fund about 40 projects annually, some are ongoing

CPRB and Climate Adaptation

- Declining chill hours over the last few decades, models are not encouraging
  - Better understanding of chill conditions
  - Mitigation of lack of chill
  - Breed varieties with lower chill requirements
- Increasing pest/pathogen pressure
  - Warmer summer temperatures shorten pest generation times, increase pest populations
  - Better models for predicting pest populations
  - Predict optimal pesticide application times

CPRB and Climate Adaptation (continued)

- Weather Monitoring
  - Macroclimate monitoring used California Irrigation Management Information System (CIMIS) under DWR. Inadequately maintained and value is compromised
  - CPRB is putting out 30+ stations in pistachio orchards
    - Data used for chill, crop maturation, pest, irrigation models
- Water Supply
  - Pistachios are almost always under drip systems
  - Research on irrigation uniformity, saline irrigation, cover crops
- Outreach – Fruit and Nut Research and Information Center at UC-Davis

ADAPTATION

- Growers (and the CPRB) must look at economics both short and long term
- Most climate adaptability is dealt with on short term
- Climate adaptability is hampered by unknown endpoints, lack of researchers
- Budgets are limited and must be split between:
  - Immediate issues (pesticide residues, flooding, mycotoxins, quality)
  - Looming issues (Invasive pests)
  - Regulatory adaptability (Over a third of the budget)

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Water Resources and Climate Change: Research Needs

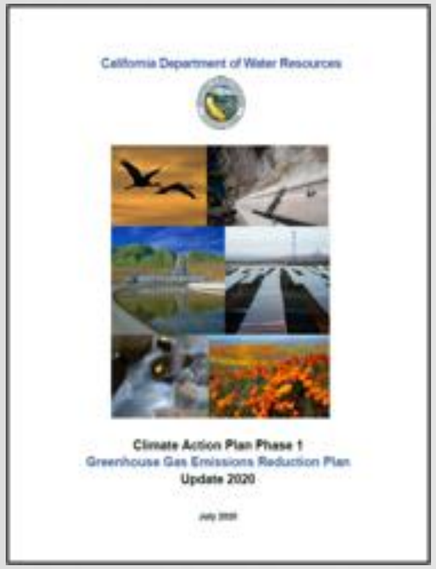
July 31st, 2023

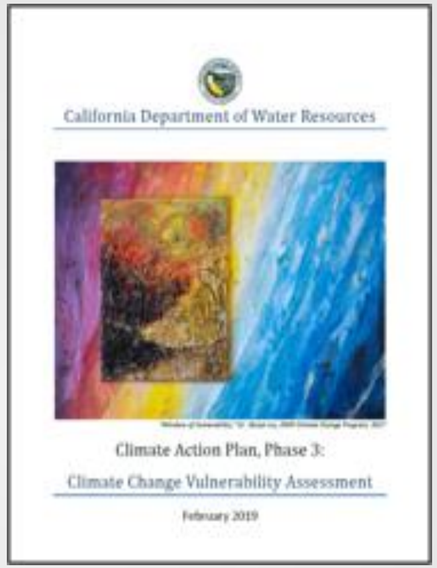
California Adaptation Forum

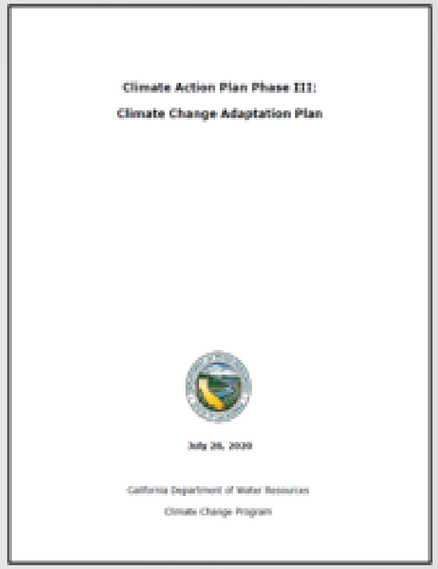
Romain Maendly, PE
Climate Action Coordinator for IWM

Climate Action Plan (CAP)

DWR's Comprehensive Response to Climate Change







Phase I: Greenhouse Gas (GHG) Emissions Reduction Plan

Phase II: Consistent, high-quality climate change analysis across all DWR programs

Phase III: Vulnerability Assessment and Adaptation Plan

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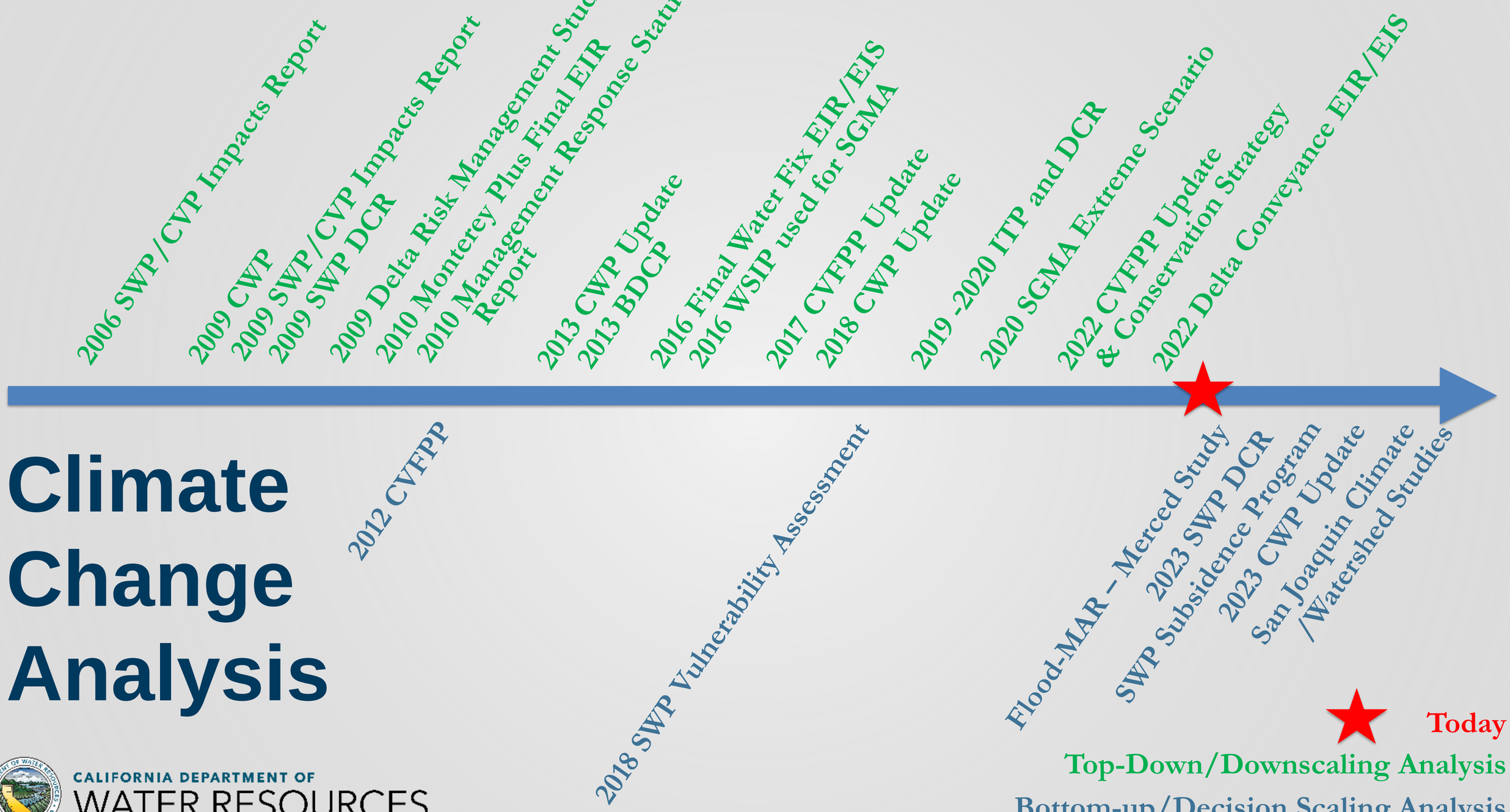
Climate Change Analysis



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Using Climate Projections at DWR

“Top Down” or **Downscaling** Approach

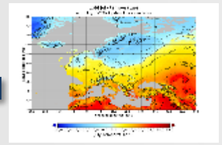
Select a Couple of General Circulation Model (GCM) Projections

Downscaling, Hydrologic Modeling

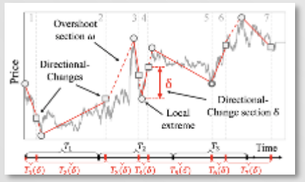
Operations and Planning Models

Conditional System Performance Projections

Source: NOAA GFDL



Source: SEI WEAP



Original method of developing climate change plans

There are 100’s of Global Climate projections

→ Pick a scenario or set of scenarios to localize and use as the “future”

→ Predict future performance of your water system

→ Determine vulnerabilities and adapt as indicated

- Did we cover the full range of uncertainty to be prepared?
- Would the results be different if a different set of projections or method were used?
- How likely is this future, what is the risk?

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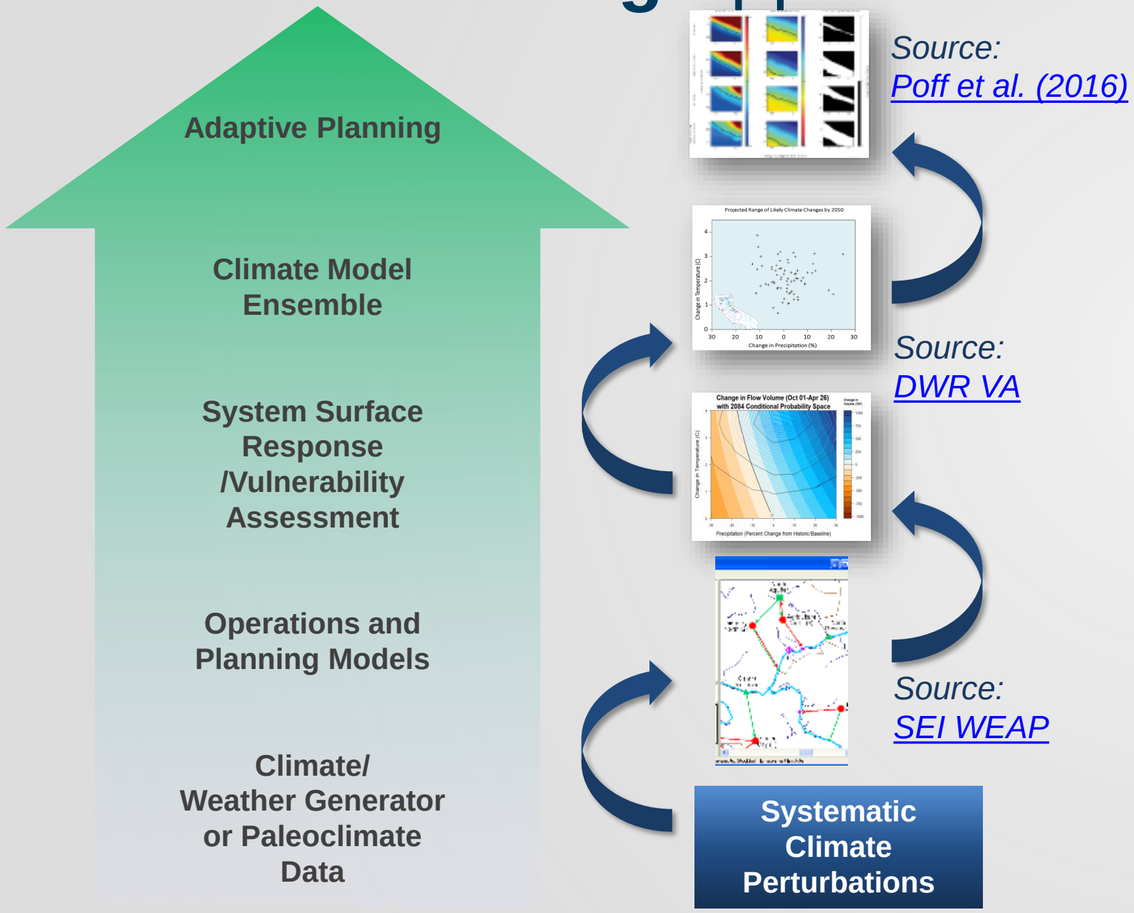
Using Climate Projections at DWR

“Bottom Up” or **Decision Scaling** Approach



A way to prepare when you aren’t sure what’s coming (Stress Test)

- → Determine the sensitivity of a water system to a range of stress (weather or climate possibilities). **Where is our system vulnerable?**
- → Determine what threshold of performance is unacceptable or ‘breaks’ the system. **Find tipping points.**
- → Determine how likely that is to happen. **Incorporate those original climate projections to assess the risk of these “unacceptable outcomes.”**
- → **ADAPT!** Take decision(s) toward what is “most” likely and/or “most” acceptable based on this risk assessment.

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Climate Action Plan – Phase III

Vulnerability Assessment (2019)

- Wildfire
- Extreme Heat
- Sea Level Rise
- Long-term Persistent Hydrologic Changes
- Short-Term Extreme Hydrologic Changes
- Habitat and Ecosystem Services Impacts

Adaptation Plan (2020)

Four priorities:

- Staff Safety- Extreme Heat
- State Water Project- Loss in Performance
- Upper Feather River Watershed- Wildfire
- Landscapes (Ecosystems and Habitats) - Stress on Species and Habitats

DWR's Recommended Research Priorities for California's 5th Climate Change Assessment:

1. Identify gaps in monitoring infrastructure to track a changing climate
2. Identify and promote adaptation actions
3. Improve forecasting capabilities supporting climate resiliency
4. Encourage and support collaborative scenario planning
5. Utilize social sciences to understand and improve adaptive capacity
6. Ecosystems/Ecological impacts and adaptation/mitigation opportunities
7. Wildfire impacts on water resources

These Priority Research Areas with State and collaborative science initiatives including California Climate Action Plan, Delta Science Action Agenda, and the Water Resilience Portfolio.

Questions

Romain.Maendly@water.ca.gov

https://www.123rf.com/

CalAgroClimate.Org – Decision Support Tools for Managing Risks in Agriculture

Tapan B. Pathak, Ph.D.
Cooperative Extension Specialist – Climate Adaptation in Agriculture
Department of Civil and Environmental Engineering
University of California, Merced

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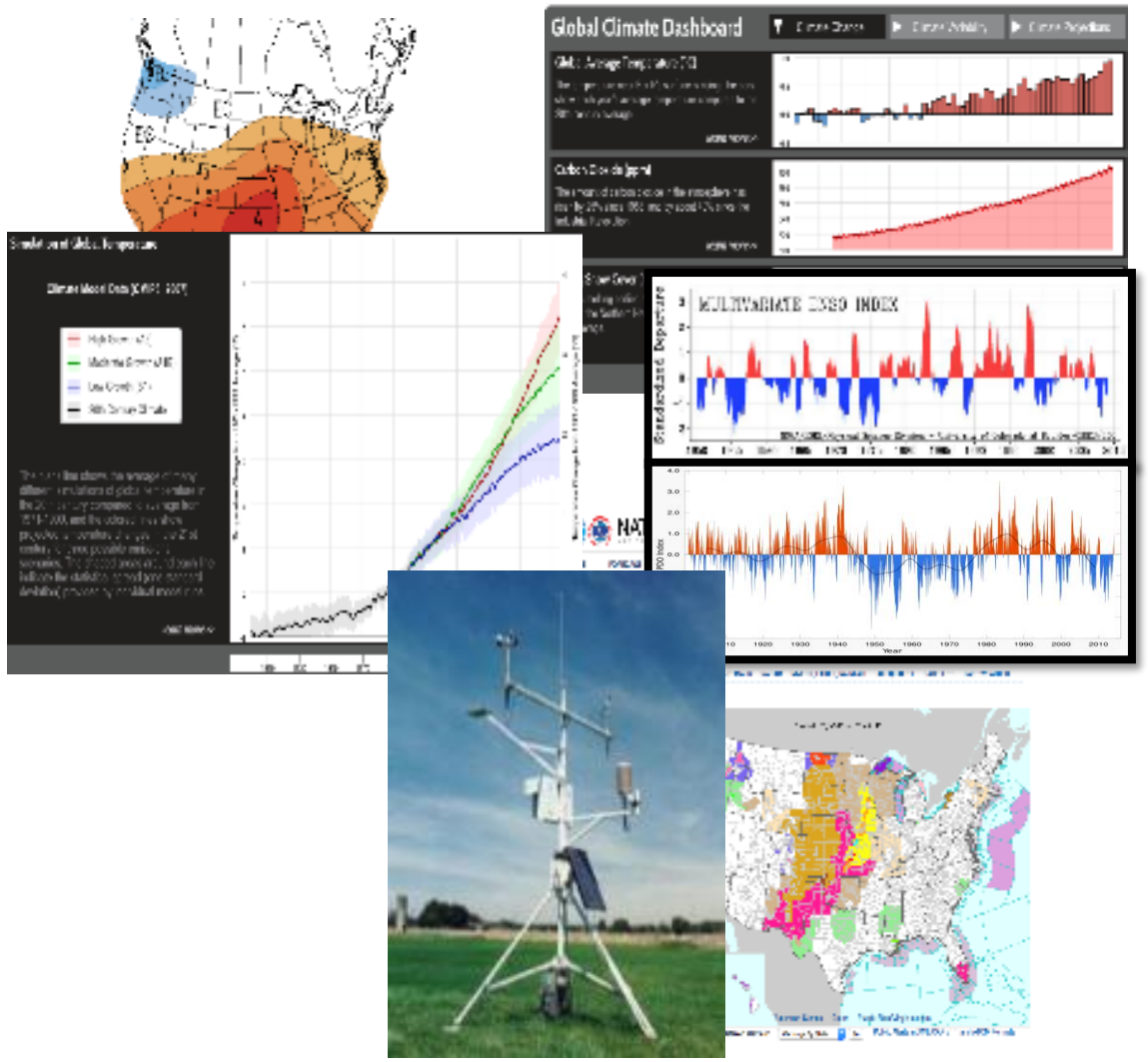
Agriculture and Natural Resources

Need to Translate Data into Decision Support

- Turning the large amount of technical climate research into readily understandable information is a challenge (USDA 2014)
- CA Dept of Food and Ag has high priority to compiling a list of grower needs for weather information for decision making
- Farmers need crop specific information to enable decision making (Jagannathan, Pathak et al., 2023)



CalAgroClimate

Decision Support Tools for Managing Risks

Tapan Pathak

Applied climate in agriculture

Steve Ostoja

USDA California Climate Hub

Lauren Parker

USDA California Climate Hub

Shane Feirer

GIS analyses with emphasis on natural resource related topics

Robert Johnson

GIS/Web Development

Prakash Jha
Project Scientist

https://calagroclimate.org/

USDA California Climate Hub
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CalAgroClimate

Decision Support Tools for Managing Risks

TOOLS

Heat Advisory

Maximum temperature forecast.

Frost Advisory

Minimum temperature forecast.

Crop Phenology

Calculate growing degree days.

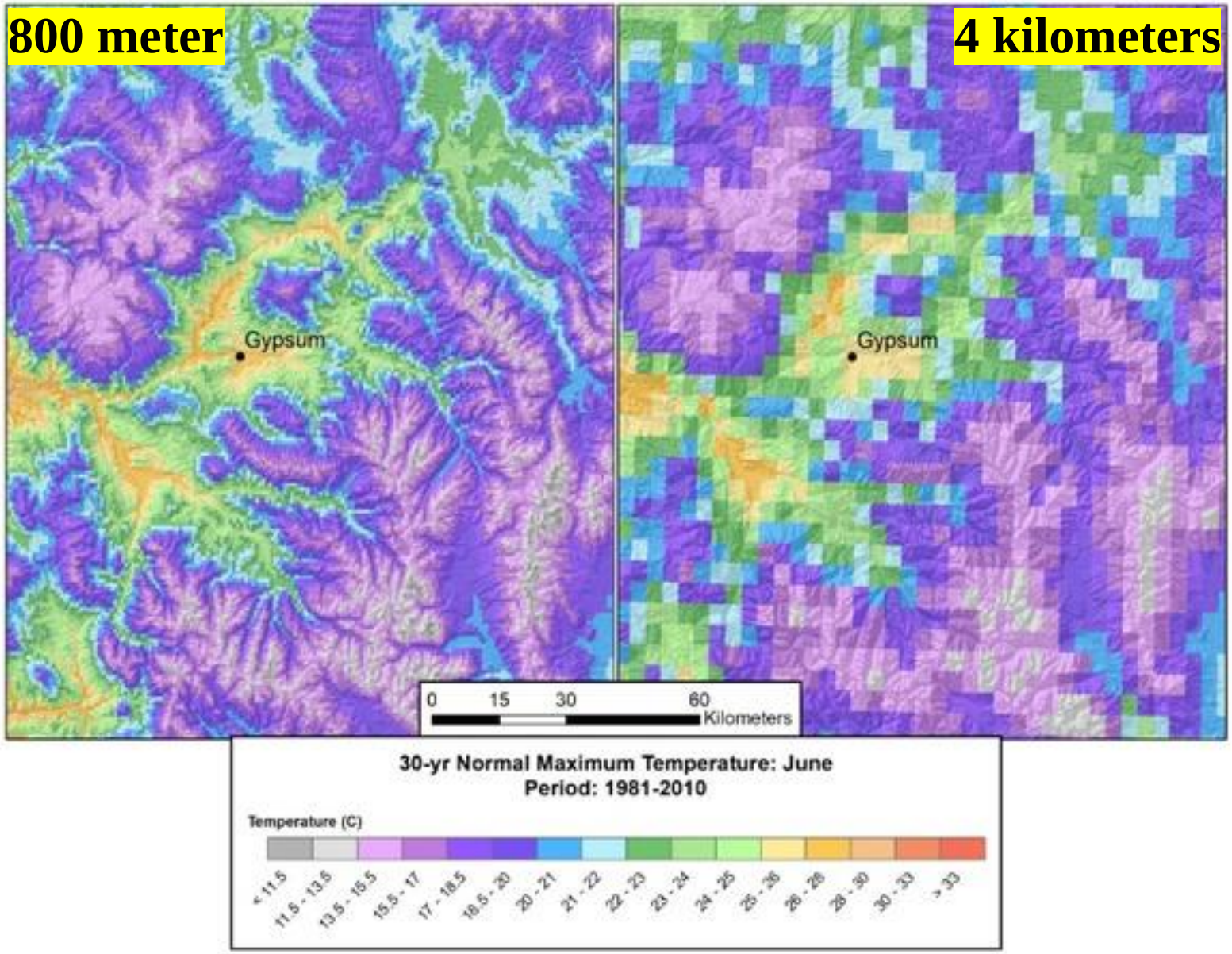
Pest Advisory

Tool to predict crop pest life stage.

Agroclimate Indicators

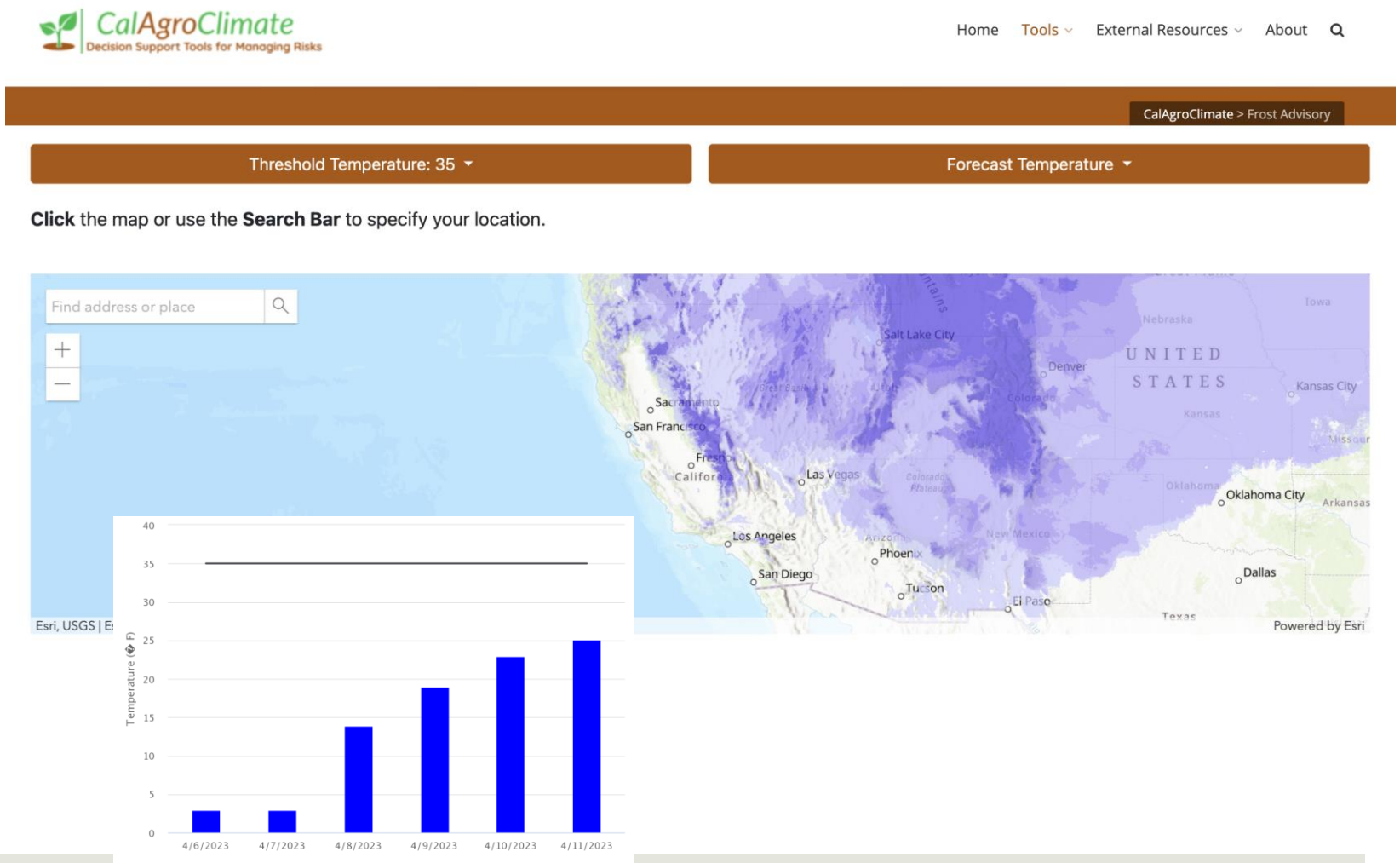
Historical data aggregated by county.

High-Resolution PRISM Data



Frost Advisory Tool

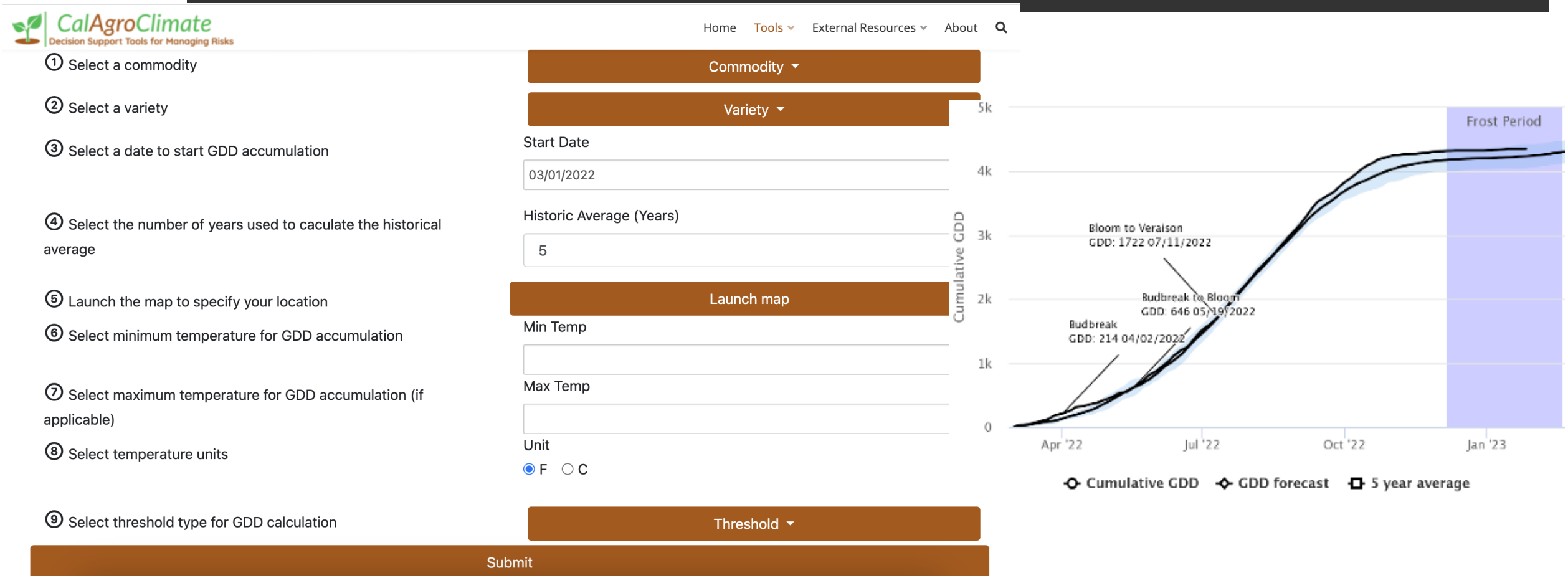
- Frost damages can be damaging to some specialty crops
- Growers need to plan in-advance to manage risks
- Frost risk tool with number of consecutive frost days
- Easy and effective visual tool to assess frost risks across California and US.



Heat Advisory Tool

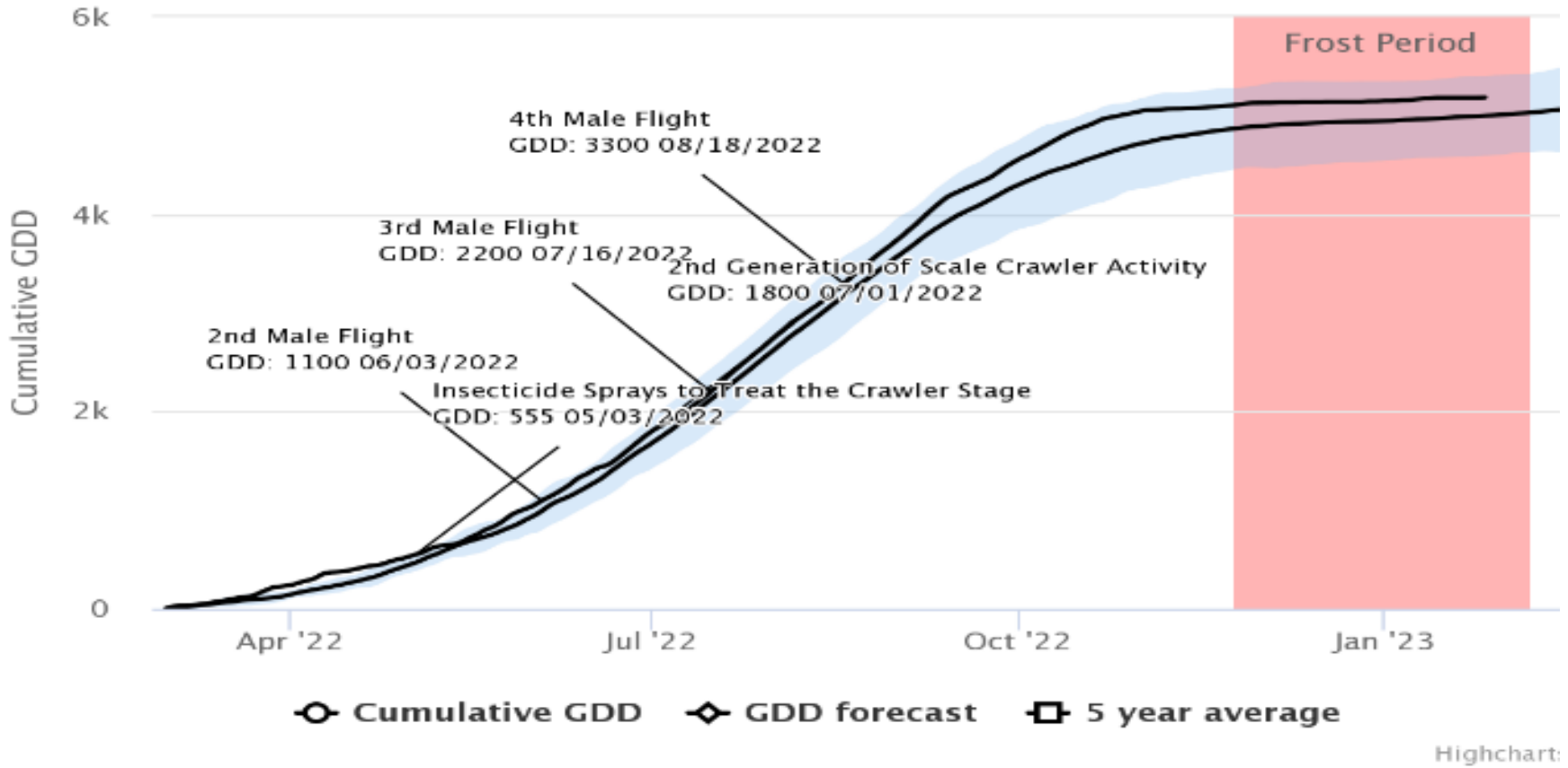
- Climate change is increasing extreme heat events
- Heat Advisory tool provides easy access to heat risk advisory for next 7 days using
- Predictions can help farmers plan for strategies such as irrigation, shading etc.

Crop Phenology Tool



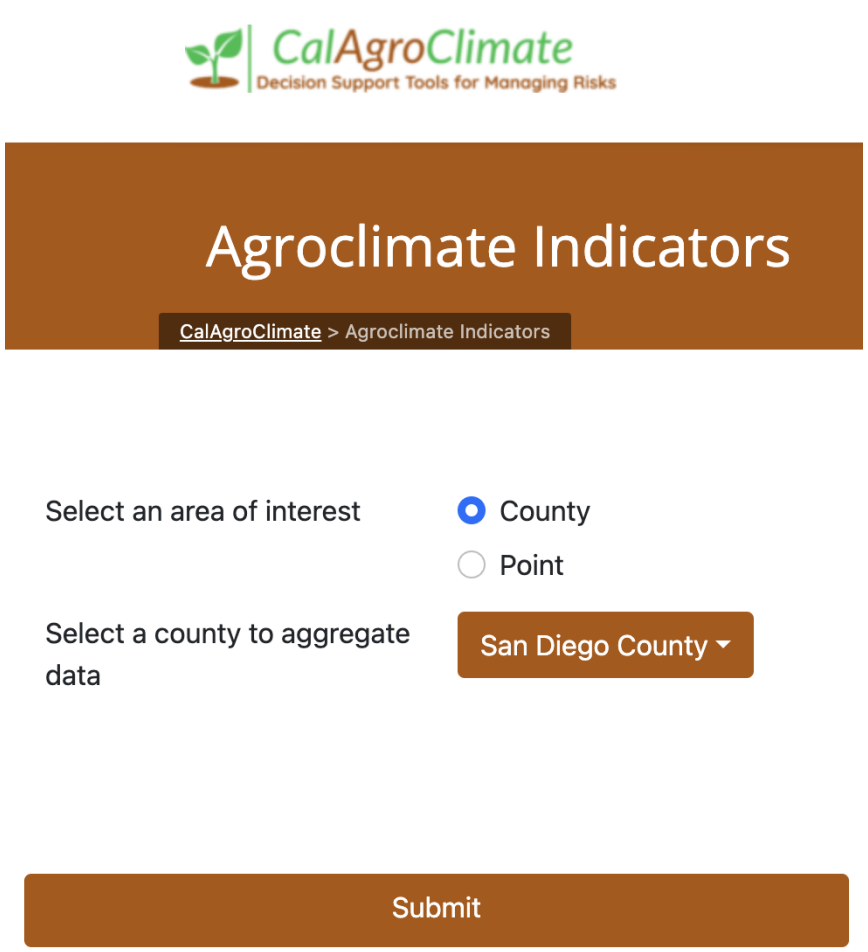
- Tool integrates high resolution PRISM 800m data to track crop development (bud break, flowering, fruiting, etc.) based on GDD accumulation
- It can assist with in-season management decisions such as planting, harvest, field scouting, fertilizer applications etc.

Pest Advisory Tool



- Managing pests is one of the biggest challenges for growers. Climate change is expected to increase pest pressure
- This tool allows users to keep track of crop specific pests based on the GDD accumulations (information derived from UCIPM)
- Helps growers in taking necessary actions to implement integrated pest management practices

Agroclimatic Indicators



- Frost Days
- Last Spring Freeze
- First Fall Freeze
- Freeze-Free Season
- Tropical Nights
- Hot Days
- Extreme Heat Days
- Heatwaves
- Diurnal Temperature Range °F
- Diurnal Temperature Range °C

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https://calagroclimate.org/

CalAgroClimate
Decision Support Tools for Managing Risks

Agroclimatic Indicators

CalAgroClimate
Decision Support Tools for Managing Risks

Home Tools External Resources About

Select an area of interest
- (●) County
- ( ) Point

Select a county to aggregate data: Fresno County

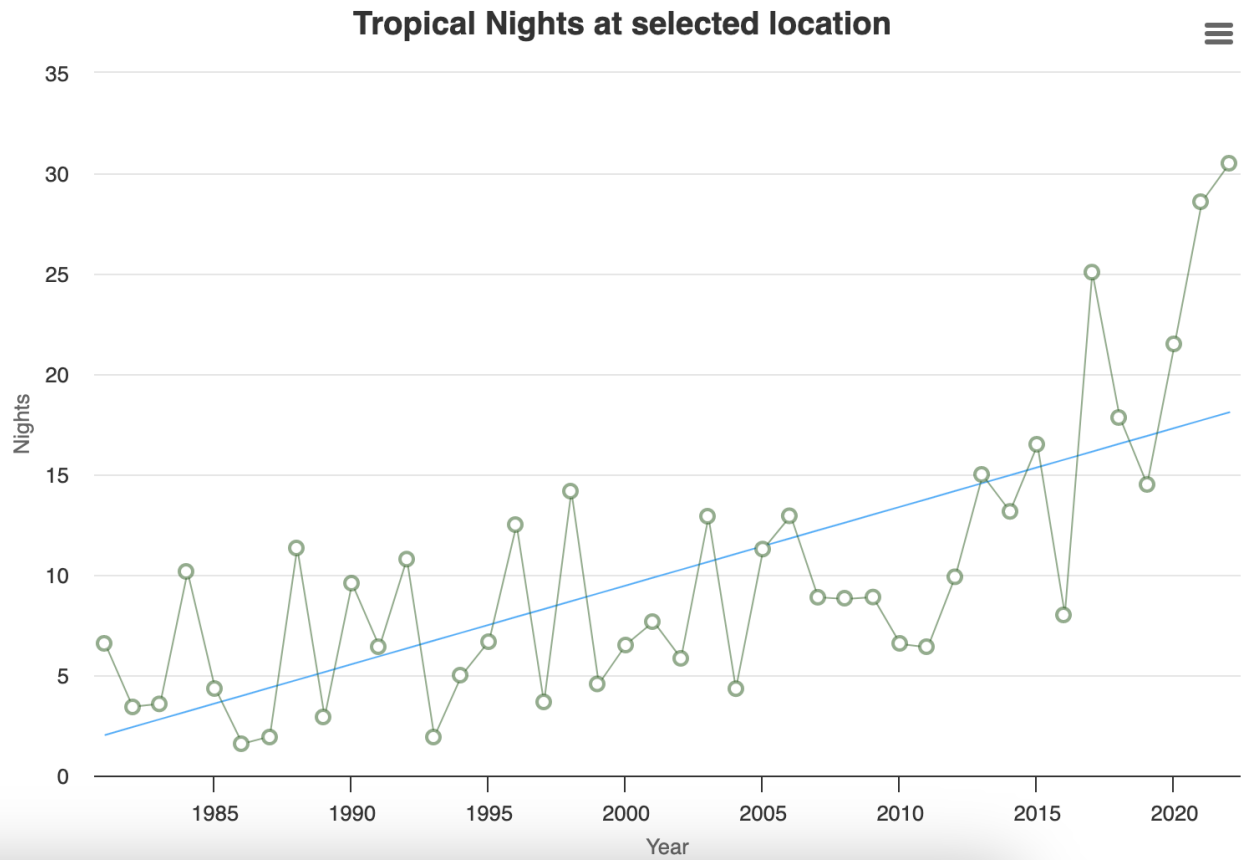
Submit

Tropical Nights

The number of nights per year with a minimum temperature > 20 °C

Relevance to Specialty Crop Production

- Can reduce fruit set in tomatoes
- Impacts winegrape berry chemistry, pathogen susceptibility, and yield
- May decrease yield of table grapes



Next Steps

- Tools only have value if used for informed decision-making
  - Tools demonstration and dissemination
  - Improve user experience
  - Improve existing tools based on the feedback
  - Add more relevant tools and adaptation resources
- Strengthen collaborations
- Funding

Thank You!

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