LAND IQ WORKSHOPS

KAWEAH SUBBASIN

VIRTUAL, MARCH 17, 2022
1:00 - 3:00 PM
AGENDA

1. Logistics
2. Welcome & Introductions
3. SGMA and the Kaweah Subbasin
4. LandIQ: Monthly Field by Field ET, Precipitation, and Land Use for SGMA Compliance
5. Kaweah Water Dashboard Introduction
6. Q&A
1. Microphone and video is turned OFF for all participants

2. Q&A – Questions can be submitted using the Q&A feature on your Zoom menu. We will pause and address questions periodically during the workshop.

3. Technical difficulties – If you have technical difficulties, use the Chat feature to ask questions and receive assistance
Aaron Fukuda – Mid-Kaweah GSA, *Interim General Manager*

Eric Osterling – Greater Kaweah GSA, *General Manager*

Michael Hagman – Lindmore ID & East Kaweah GSA, *Executive Director*

Joel Kimmelshue – Land IQ, *Founding Partner and Principal Soil and Agricultural Scientist*

Savannah Tjaden – Provost & Pritchard Consulting Group, *Product Manager*

Trilby Barton – Provost & Pritchard Consulting Group, *External Affairs Specialist*

Rebecca Quist - Provost & Pritchard Consulting Group, *External Affairs Specialist*
LIVE POLL
SGMA 101

Eric Osterling – Greater Kaweah GSA,
General Manager
SGMA 101
SUSTAINABLE GROUNDWATER MANAGEMENT ACT

CALIFORNIA LAW
SIGNED IN SEPTEMBER
2014

SGMA MANDATES
GROUNDWATER
SUSTAINABILITY BY 2040

GRANTS LOCAL CONTROL
TO GROUNDWATER
SUSTAINABILITY AGENCIES
SGMA TIMELINE

COMPLETE

FORM AGENCIES - JUNE 2017

COMPLETE

DEVELOP PLANS - JAN 2020

IN PROGRESS

IMPLEMENT PLANS - 20 YEARS

IN PROGRESS

ACHIEVE SUSTAINABILITY - 2040
KAWEAH SUBBASIN (PRIORITY BASIN)

3 GSAs

• East Kaweah GSA
• Greater Kaweah GSA
• Mid-Kaweah GSA
GROUNDWATER CONDITIONS

Under SGMA, the Kaweah Subbasin is tasked with ensuring this groundwater supply is available for years to come. This means balancing the estimated 80,000+ acre-feet of groundwater overdraft occurring on average every year.
GROUNDWATER SUSTAINABILITY PLAN (GSP)

- Physical description of groundwater management area
- Water budget
- Monitoring program and projects
- Sustainability in 20 years
- Measurable objectives / thresholds
- Annual reporting
- State evaluations for compliance
IMMEDIATE GSP IMPLEMENTATION NEEDS

• Accurately and efficiently understand groundwater demand on an ongoing basis

• Refine water accounting mechanisms to implement GSA policies
Q&A
LAND IQ

Joel Kimmelshue – Land IQ, Founding Partner and Principal Soil and Agricultural Scientist
Monthly Field by Field Evapotranspiration, Precipitation, and Land Use for SGMA Compliance

KAWEAH SUBBASIN

MARCH 15, 17, 25, 2022
Land IQ Technical Disciplines

Land-Based Sciences: Land and Water Resources
- Agronomic assessments/soil science
- Water quality and supply evaluations
- Salinity and nutrient management
- Agricultural reuse
- Land stabilization and erosion control
- Soil reclamation and irrigation/drainage

Spatial Sciences: Remote Sensing and GIS
- Consumptive use estimation and crop identification
- Large landscape evaluations
- Irrigation and drainage
- Production agriculture

Development
- Data management tools
Land IQ currently provides monthly, field by field consumptive use, land use, and precipitation results for:

- 22 GSAs or Districts
- 35-40 different crops
- Multiple water sources
- Supports various allocation methods and water management strategies
- Monthly reports with accuracies
- Delivery within 25-30 days
- Integration to on-line platform results
STATEWIDE LAND USE

- Minimum field size of 2.0 acres – many times less

- Overall accuracy of 97.6% based on independent ground-truth validation dataset

- Approximately 50 crop legend categories, which represent 98% of all irrigated lands

- Over 15,000 miles of ground truthing each year

- Urban is approximately 50% of ag footprint (4.7 million acres versus 9.6)
• Overall accuracy of 97.1% based on independent ground-truth validation dataset for specific crop type.

• Overall accuracy of 98.1% based on independent ground-truth validation dataset for grouped crop type.

• Mapping completed for 2014, 2016, 2018, 2019, 2020, 2021

• Publicly available for 2014, 2016, 2018

### LAND USE ACCURACY

<table>
<thead>
<tr>
<th>Crop Class</th>
<th>User’s Accuracy (number of correctly classified acres/total acres)</th>
<th>Number of Groundtruth Sample Acres</th>
<th>95% Two-tailed Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almonds</td>
<td>100%</td>
<td>74,441</td>
<td>0%</td>
</tr>
<tr>
<td>Cherries</td>
<td>100%</td>
<td>10,940</td>
<td>0%</td>
</tr>
<tr>
<td>Dates</td>
<td>100%</td>
<td>12,570</td>
<td>0%</td>
</tr>
<tr>
<td>Kiwis</td>
<td>100%</td>
<td>185</td>
<td>0%</td>
</tr>
<tr>
<td>Olives</td>
<td>100%</td>
<td>2,886</td>
<td>0%</td>
</tr>
<tr>
<td>Pecan nuts</td>
<td>100%</td>
<td>16,243</td>
<td>0%</td>
</tr>
<tr>
<td>Rice</td>
<td>100%</td>
<td>862</td>
<td>0%</td>
</tr>
<tr>
<td>Young Perennials</td>
<td>100%</td>
<td>26,210</td>
<td>0%</td>
</tr>
<tr>
<td>Plums, Prunes and Apricots</td>
<td>100%</td>
<td>22,548</td>
<td>0%</td>
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<tr>
<td>Sunflowers</td>
<td>100%</td>
<td>29,491</td>
<td>0%</td>
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<tr>
<td>Walnuts</td>
<td>100%</td>
<td>40,315</td>
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</tr>
<tr>
<td>Pomegranates</td>
<td>100%</td>
<td>2,572</td>
<td>0%</td>
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<tr>
<td>Grapes</td>
<td>99%</td>
<td>3,613</td>
<td>0%</td>
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<tr>
<td>Citrus</td>
<td>99%</td>
<td>3,010</td>
<td>0%</td>
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<tr>
<td>Tomatoes</td>
<td>99%</td>
<td>35,209</td>
<td>0%</td>
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<tr>
<td>Cotton</td>
<td>99%</td>
<td>3,739</td>
<td>0%</td>
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<tr>
<td>Peaches/Nectarines</td>
<td>98%</td>
<td>12,478</td>
<td>0%</td>
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<tr>
<td>Mixed Pasture</td>
<td>97%</td>
<td>27,851</td>
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<tr>
<td>Corn, Sorghum and Sudan</td>
<td>97%</td>
<td>37,383</td>
<td>0%</td>
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<tr>
<td>Potatoes or Sweet Potatoes</td>
<td>97%</td>
<td>1,416</td>
<td>0%</td>
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<tr>
<td>Alfalfa and Alfalfa Mixture</td>
<td>96%</td>
<td>393</td>
<td>0%</td>
</tr>
<tr>
<td>Miscellaneous Field Crops</td>
<td>96%</td>
<td>1,769</td>
<td>0%</td>
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<tr>
<td>Avocados</td>
<td>95%</td>
<td>2,565</td>
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<tr>
<td>Unclassified Fallow</td>
<td>94%</td>
<td>4,052</td>
<td>0%</td>
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<tr>
<td>Carrots</td>
<td>96%</td>
<td>606</td>
<td>0%</td>
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<tr>
<td>Beans (Dry)</td>
<td>95%</td>
<td>2,580</td>
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<tr>
<td>Bush Berries</td>
<td>95%</td>
<td>5,847</td>
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<tr>
<td>Onions and Garlic</td>
<td>95%</td>
<td>2,716</td>
<td>0%</td>
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<tr>
<td>Peppers</td>
<td>94%</td>
<td>4,128</td>
<td>0%</td>
</tr>
<tr>
<td>Melons, Squash and Cucumbers</td>
<td>92%</td>
<td>1,988</td>
<td>0%</td>
</tr>
<tr>
<td>Miscellaneous Grain and Hay</td>
<td>92%</td>
<td>2,617</td>
<td>0%</td>
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<tr>
<td>Safflower</td>
<td>91%</td>
<td>12,429</td>
<td>0%</td>
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<tr>
<td>Strawberries</td>
<td>91%</td>
<td>7,179</td>
<td>0%</td>
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<tr>
<td>Apples</td>
<td>90%</td>
<td>13,015</td>
<td>0%</td>
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<tr>
<td>Lettuce/Leafy Greens</td>
<td>83%</td>
<td>4,297</td>
<td>0%</td>
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<tr>
<td>Peppers</td>
<td>82%</td>
<td>6,713</td>
<td>0%</td>
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<tr>
<td>Flowers, Nursery and Christmas Tree Farms</td>
<td>80%</td>
<td>265</td>
<td>0%</td>
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<tr>
<td>Cole Crops</td>
<td>79%</td>
<td>765</td>
<td>0%</td>
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<tr>
<td>Miscellaneous Truck Crops</td>
<td>71%</td>
<td>623</td>
<td>0%</td>
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<tr>
<td>Miscellaneous Grapes</td>
<td>67%</td>
<td>1,449</td>
<td>0%</td>
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<tr>
<td>Miscellaneous Deciduous</td>
<td>58%</td>
<td>333</td>
<td>0%</td>
</tr>
<tr>
<td>Miscellaneous Subtropical Fruits</td>
<td>48%</td>
<td>32</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Reference**

**Predicted**

<table>
<thead>
<tr>
<th>Crop Class</th>
<th>Total Acres</th>
<th>Correct Acres</th>
<th>Incorrect Acres</th>
<th>% Correct</th>
<th>Commission Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citrus and Subtropical</td>
<td>16,012</td>
<td>16,000</td>
<td>12</td>
<td>99.9%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Deciduous Fruits and Nuts</td>
<td>12,914</td>
<td>12,914</td>
<td>13</td>
<td>99.9%</td>
<td>0.0%</td>
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<tr>
<td>Field Crops</td>
<td>5,185</td>
<td>5,185</td>
<td>5</td>
<td>100.0%</td>
<td>0.0%</td>
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<tr>
<td>Grain and Hay Crops</td>
<td>37,201</td>
<td>37,201</td>
<td>0</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Pasture</td>
<td>38,115</td>
<td>38,115</td>
<td>0</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Rice</td>
<td>26,210</td>
<td>26,210</td>
<td>0</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Truck, Nursery and Berry Crops</td>
<td>4,128</td>
<td>4,128</td>
<td>0</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Total Acres: 16,012, Correct Acres: 16,000, Incorrect Acres: 12, % Correct: 99.9%, Commission Error: 0.0%
APPLIED/RECEIVED VERSUS CONSUMED

- **Applied/Received Water**
  - Irrigated Fields/Orchards/Groves
    - Surface Water
    - Groundwater
    - Precipitation
  - Non-Irrigated Fields/Orchards/Groves
    - Precipitation

- **Consumed Water**
  - Occurs in both irrigated and non-irrigated environments
EVAPORTRANSPIRATION

• **Evapotranspiration** = Evaporation + Transpiration

  • **Evaporation**: Water evolved into the atmosphere from soil and plant surfaces after precipitation or irrigation (never goes through the plant)

  • **Transpiration**: Water evolved into the atmosphere from translocation through the plant (goes from roots to leaves)
EXAMPLE ON NON-IRRIGATED FIELD

- Only water the field “sees/receives” is precipitation
- So, what happens to that precipitation? – ET happens!
  - Recently disked field – Evaporation – occurs from the soil surface
  - Rangeland – Evaporation AND Transpiration
- So, how much is left after ET?
  - Usually not much because of how and when it rains
  - Land IQ measures the ET (consumed water)
  - Received Water > Consumed Water
EXAMPLE ON NON-IRRIGATED FIELD

• Givens:
  • 20-acre field
  • Rainfall only = 1.20 inches – From Land IQ rain gauges
  • 1.75 acre-ft consumed – From Land IQ monthly analyses

• Results:
  • 1.75 acre feet/20 acres = .0875 feet (or 1.05 inches)
  • 1.05/1.20 = 88% of the water was consumed = gone
  • 12% of the water was not consumed: (0.15 inches, 0.0125 feet, 0.21 acre feet)
    • Stored in the root zone for future use, OR
    • Passed the root zone to groundwater
EXAMPLE ON NON-IRRIGATED FIELD

• Conclusion:
  • Just because you have 1.20 inches of rainfall on a non-irrigated field, does not mean you can pump 1.20 inches for irrigation somewhere else.
GROUND TRUTHING FOR CALIBRATION – WHY?

• Defensible
• Independent validation
• Calibration to actual conditions
• Avoiding interpolation during cloud and smoke cover
• Understanding specific field conditions and management
• Allows for continual improvement of models
• Allows for crop-specific modeling
• Stations used are a combination of eddy covariance and surface renewal approaches developed through collaboration with DWR (Delta) and UC Davis researchers
• A “ground up” approach
• Within the next 6 months will have nearly 100 stations installed in the South Valley

• Collaboration with UC Davis, UC Cooperative Extension and USDA Agricultural Research Service

• Native/non-irrigated areas included

• Establishment of spatial precipitation with multiple rain gauges

• For the purpose of understanding crop specific and repeated measurements

• Necessary for more accurate estimation of consumed water in any water allocation/market approach
DELIVERABLE – FIELD BY FIELD ET

- Monthly results delivered within 25 days of the previous month
- Calibrated and validated by ground truthing climatic stations
- Reviewed by independent advisors
- Used for tracking water use, water management, reporting, allocations, water markets, etc.
DELIVERABLE – FIELD BY FIELD CROP TYPE

• Same methodology used to provide crop type to CA Dept of Water Resources as a requirement of SGMA
• Consistent with results for DWR
• Essentially real-time crop type for inclusion in modeling
• Can be used by GSAs/Districts for tracking irrigated acreage, customer base, in-season water planning and management
DELIVERABLE – FIELD BY FIELD PRECIPITATION

• Results collected by rain gauges at ground truthing stations
• Incorporation of other public rain gauge results (e.g. CIMIS, airports, cities, etc.)
• Conversion of point data into a spatial precipitation map by month and by year
• Assignment of a field-by-field precipitation for rainfall contribution to ET, water budget tracking, allocations, modeling, etc.
DELIVERABLE – FIELD BY FIELD PERMANENT CROP AGE

• Same methodology used to provide crop type to CA Dept of Water Resources as a requirement of SGMA
• Consistent with results for DWR
• Highly correlated to consumed water
• Yet another line of evidence that people can use to refine their water management allocations and forecasting
ONLINE FIELD-BY-FIELD RESULTS AND DELIVERY

Land Use

Monthly ET

Online Viewer and Data Download Tool
MULTIPLE APPROACHES TO CALIBRATION AND VALIDATION

- Ground Truthing
- Eddy Covariance
- Surface Renewal
- Measured versus Predicted
- Literature
- Applied Versus Consumed
- Agronomic Knowledge and Experience
- Groundwater Pumping Allocations
- Grower Acceptance
DEVELOPMENT OF INDEPENDENT ADVISORY GROUP

- Retired UC Cooperative Extension Agents and Farm Advisors:
  - Blake Sanden, MS – 26 years in Kern County
  - Allan Fulton, MS – 35 years in Kings, and Northern CA counties
  - Review results every month beginning in 2021 and offer suggestions for improvements

- 2-3x per year Advisory Group:
  - Blake Sanden, MS - Retired
  - Allan Fulton, MS - Retired
  - Daniele Zaccaria, PhD – UC Davis
  - Rick Snyder, PhD – UC Davis, Emeritus
  - Dan Howes, PhD – Cal Poly ITRC
  - Khaled Bali, PhD – UC ANR
  - Pasquale Steduto, PhD – UN-FAO
KAWEAH WATER DASHBOARD

Savannah Tjaden – Provost & Pritchard Consulting Group, Product Manager
Currently, no tool exists for landowners and the Kaweah Subbasin GSAs to easily share up-to-date water use information within the context of SGMA. This makes quantifying and efficiently responding to groundwater use difficult.
Purpose & Introduction

**Why**

- Achieve groundwater sustainability targets under SGMA while providing groundwater and surface water flexibility to preserve existing economies

**What**

- Water Dashboard

**How**

- Manage long-term water demand & availability
- Provide landowners with information to strategically respond to new constraints on groundwater
- Allow for easy information sharing (reporting & billing) between landowners and their GSA
VALUE FOR GROWERS
AN ONLINE WATER BANK ACCOUNT THAT...

EMPOWERS KAWEAH SUBBASIN LANDOWNERS TO STRATEGICALLY RESPOND TO SGMA

DELIVERS KEY WATER USE INSIGHTS AT THE FARM LEVEL

TRACKS OWNER-SPECIFIC WATER ACCOUNTING & INVOICING ASSOCIATED WITH SGMA COMPLIANCE
DEVELOPMENT PRINCIPLES

- Phased development, ongoing process.
- Landowner engagement is primary focus of development, ensuring features best suit the needs of local landowners.
- Diverse farm company structures are in mind to ensure account set-up and information sharing is as easy as possible.
### PRODUCT ROADMAP

<table>
<thead>
<tr>
<th>Goal</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landowners</td>
<td>Understand ET data in the context of my farm operations and groundwater pumping</td>
<td>Actively and efficiently manage groundwater and surface water supplies within the context of SGMA</td>
<td>Maximize profitability &amp; optimize long-term asset planning</td>
</tr>
<tr>
<td>GSA members</td>
<td>Register GSA members</td>
<td>Full accounting of water in the subbasin &amp; groundwater billing</td>
<td>Provide maximum flexibility to landowners while achieving sustainable groundwater usage</td>
</tr>
</tbody>
</table>
DEVELOPMENT PROCESS INCLUDES LANDOWNERS

PROBLEM

UNDERSTAND

PROBLEM DEFINITION

DESIGN

SOLUTION

DISCOVER

DEFINE

DEVELOP

LISTEN

INTERVIEWS

FOCUS GROUPS, Q&A

TESTING
WATER DASHBOARD PHASE 1 LAUNCH

- **March 2022**: Land IQ Workshops
- **June**: Kaweah Water Dashboard Workshops
- **May**: Kaweah Water Dashboard Phase 1 Release & Landowner Registration Events
- **July**: Landowner feedback & ongoing Dashboard development
• Create a user profile to view your data from all 3 GSAs in a single location

• View historical Land IQ data
  • Average ET by crop type
  • Total annual and monthly usage for all land under your control
  • Annual and monthly usage for individual parcels under your control

• View your groundwater allocation for each GSA (based on proposed or approved rules and regulations for each GSA)
THANK YOU!

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