

RECLAMATION

Managing Water in the West

Lower Colorado River Accounting System (LCRAS)

Lower Colorado Region

<http://www.usbr.gov/lc/region/g4000/wtracct.html>



U.S. Department of the Interior
Bureau of Reclamation

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Presentation Overview

- 
- Introduction
 - Demonstration of Technology
 - Current Status
 - Future Activities

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Water Accounting and Verification Group

- Paul Matuska – Group Manager
- Nicole Everett – Water Verification Team Lead
- Jeff Milliken – Remote Sensing / GIS Lead
- Katherine Zander – GIS Analyst
- Michael Baker – Remote Sensing Analyst
- David Chubb – Planning Specialist
- Jeremy Dodds - Geographer



LCRAS Development

- 1984, Initiated by the Task Force on Unmeasured Return Flow, consisting of:

- Reclamation,
- U.S. Geological Survey,
- Lower Basin States and,
- Bureau of Indian Affairs.



Yuma East Wetlands

- 1984-1990, USGS finished initial development of LCRAS, Reclamation begins further development.
- 1996, Reclamation applied LCRAS, and issued report, “Lower Colorado River Accounting System Demonstration of Technology Calendar Year 1995”.

Key Components of LCRAS

- Map, monitor, and quantify crop and riparian (phreatophyte) vegetation for water management activities.
- Estimate evapotranspiration (ET) in irrigated areas.
- Estimate ET in riparian areas.
- Estimate Evaporation from the channel and reservoirs of the lower Colorado River and evaporation from canals, lakes, and other open water areas.

Current Program Area

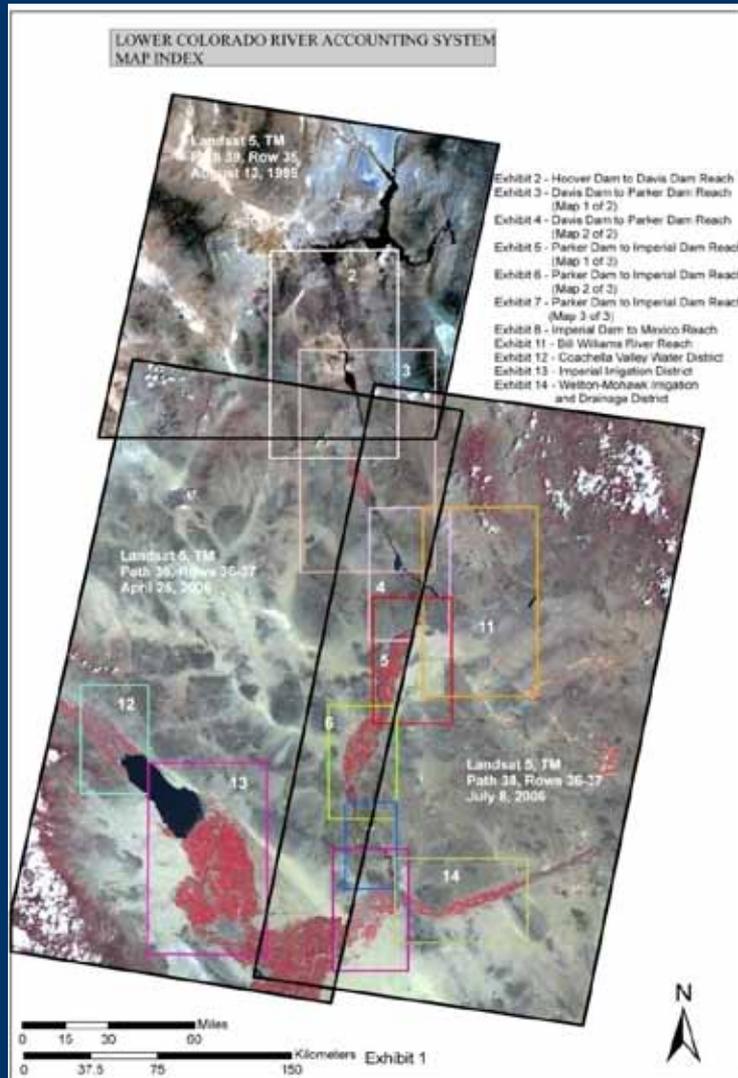
Diverters along the main stem of the Lower Colorado River from Hoover Dam to the Southern International Boundary of Mexico.

Wellton Mohawk Irrigation Dist. , AZ.

Imperial Irrigation Dist. , CA.

Coachella Valley Water Dist. , CA.

Represents approximately 870,000 acres of irrigated lands, and 500,000 acres of riparian area.



Program Areas Shown Over Landsat Imagery

Demonstration of Technology

- Development and Improvement to Initial Methods:
 - Contracted with water resources consultant (Dr. Marvin Jensen) for independent review and recommendations for improvements.
 - Contracted with remote sensing consultant (Pacific Meridian Resources) for improved methods development.
 - Contracted with independent statisticians for calculation and sampling improvements.
 - Reclamation reviews and incorporates recommendations and improved methods.
 - Reclamation begins annual publication of report and conducts stakeholder/public workshops for review and comment.

Program Activities

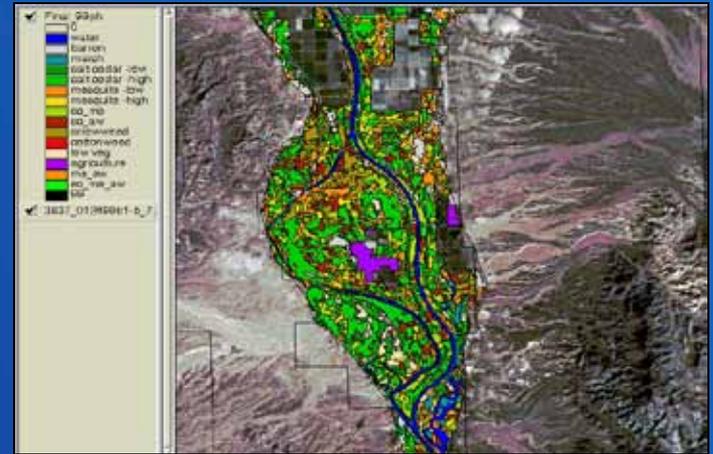
- Mapping and Monitoring
 - Crops, Riparian, Open Water, Fallow Agriculture Land
 - Annual acreage summaries by diverter

- Calculations
 - Open Water Evaporation
 - Evapotranspiration (ET)
 - Crops and Phreatophytes

- Cooperation/funding for weather stations
 - AZMET, CIMIS

- ET Studies
 - USGS Phreatophyte ET Study
 - Alliance University ET Study

- Annual publication of LCRAS report



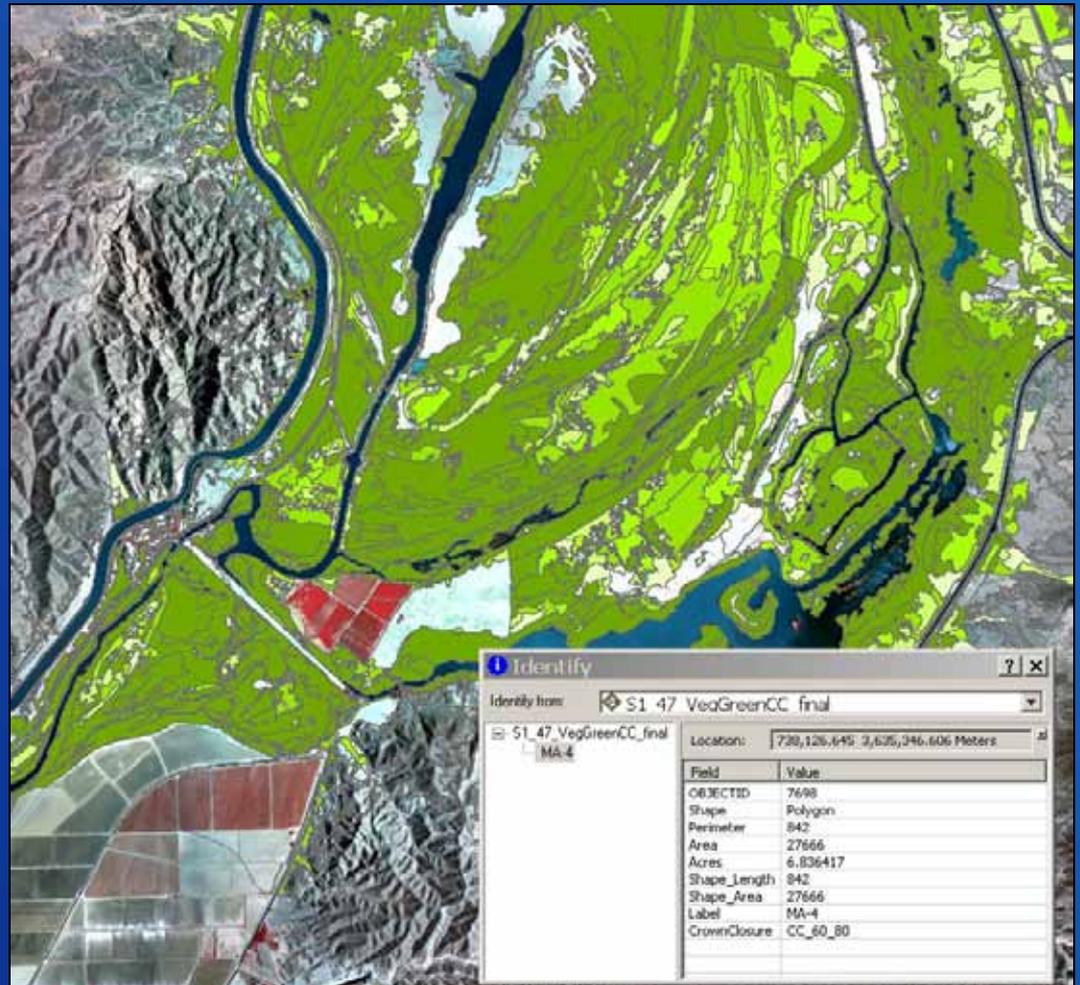
Phreatophytes – Cibola NWR



CIMIS Station – Seeley, IID

Mapping and Monitoring

Remote Sensing and GIS



Riparian crown closure map and relational database

Remote Sensing and GIS

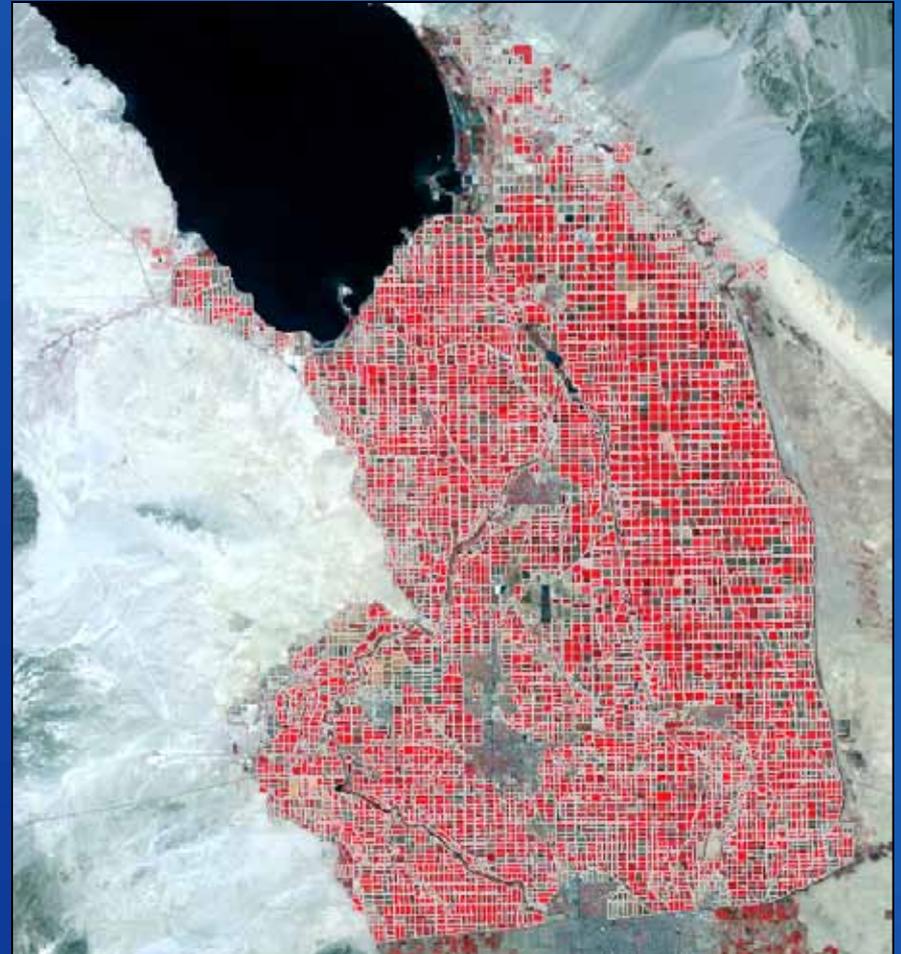
- GIS database that locates, identifies, and quantifies:
 - Crop Types
 - Riparian Types
 - Open Water Surface
- Remote Sensing used to generate data for GIS
- Provides for analysis at:
 - Field level, Irrigation Diverter, River Reach, State Boundaries, or other required geographic area
 - Multi-temporal database allows for historical analysis



Crop database - CVWD

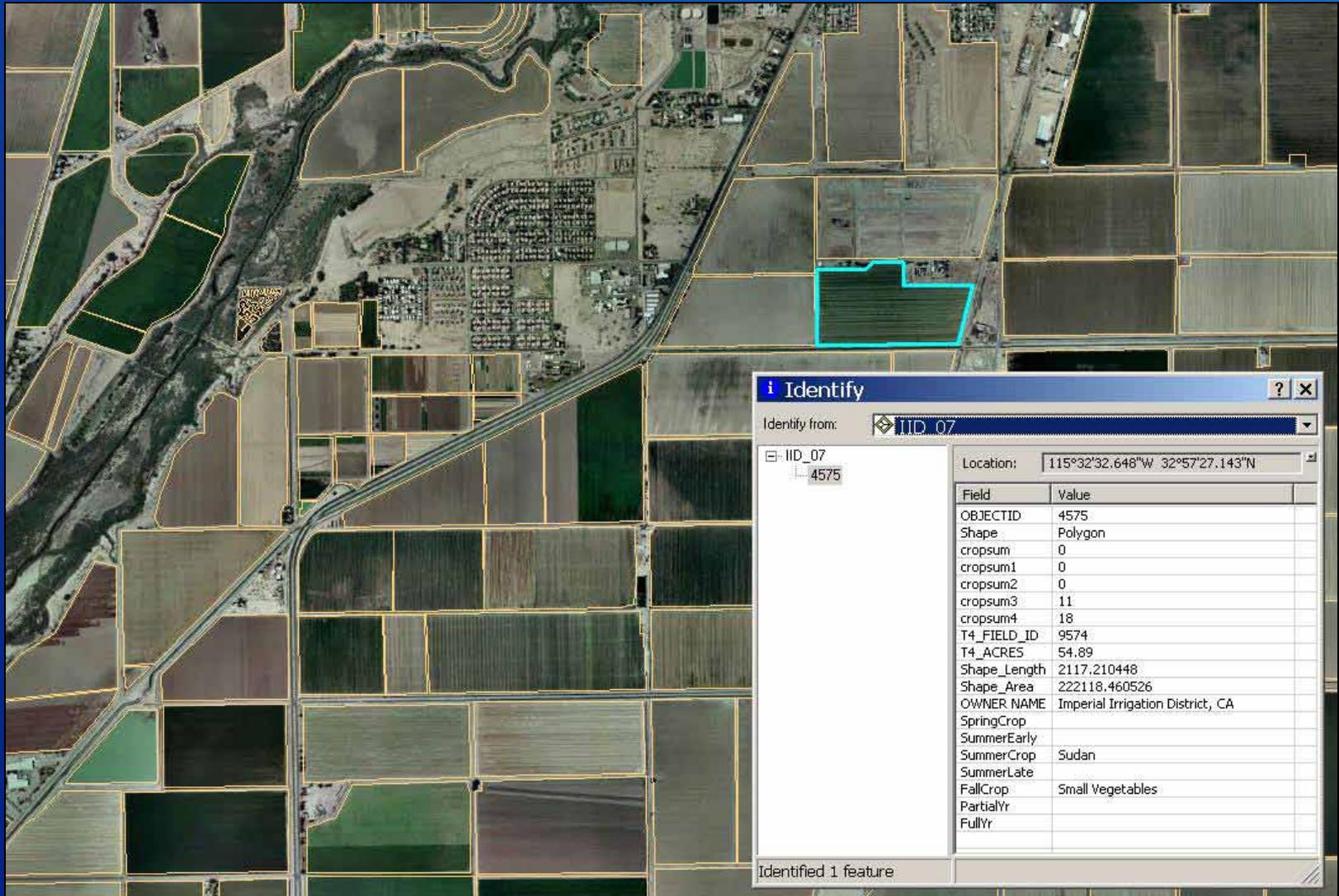
GIS - Field Border Database

- Over 29,000 Fields Digitized
 - Main stem diverters
 - Imperial Irrigation District
 - Wellton Mohawk Irrigation District
 - Coachella Valley Irrigation District
- GIS Database
 - GPS sample verified for accuracy
 - Unique field ID – tracked and archived
 - Updated on routine basis



Imperial Irrigation District – Field Borders over Landsat Image

Field Border Relational Database



NAIP Imagery with Field Borders – IID, CA

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Remote Sensing - Image Classification

Landsat Satellite Imagery and NAIP Imagery

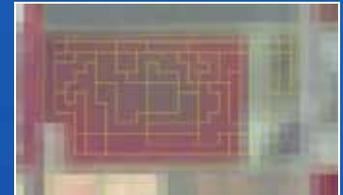
- Classify Crops : 4 times per year (or as needed based on crop calendar).
- Riparian : General updates annually (change detection).
- Open Water Surface : GIS open water surface checked yearly based on comparison to new satellite imagery or NAIP imagery.



Crucifers – Yuma Area

Crop Classification - Procedures

- Ground Reference Data Collection
- Spectral Crop Signature Development
- Automated Crop Classification
- Classification Accuracy Assessment



Crop Classification - Ground Reference Data

- 4 field personnel currently being used (1 from CA DWR).
- Requires approximately 8 days to collect data for each classification period.
- Sample approximately 12% of fields.
- “Capture” crop type, condition & spectral variability.
- Populate field border GIS database for crop classification processing and accuracy assessment.
- Random stratified sample reserved for classification accuracy assessment (~40% of ground sample).



Multi-Year Crop Database

The screenshot shows the ArcMap interface with a map of agricultural fields. The 'Layers' panel on the left lists various irrigation districts (IID) and crop years (LCRAS, CVWD). The 'Attributes of IID_07' table is displayed at the bottom, showing the following data:

14 FIELD ID	14 ACRES	OWNER NAME	SpringCrop	SummerEarly	SummerCrop	SummerLate	FallCrop	PartialYr	FullYr
13742	133.09	Imperial Irrigation District, CA							Bermuda, Rye, or other grass
13743	145.88	Imperial Irrigation District, CA							alfalfa
13744	115.22	Imperial Irrigation District, CA							alfalfa
13746	87.44	Imperial Irrigation District, CA	Small Vegetables				Lettuce		
13747	70.8	Imperial Irrigation District, CA		Melons					
13748	42.6	Imperial Irrigation District, CA			Sudan				
13749	57.83	Imperial Irrigation District, CA			Sudan		Sugar beets		
13750	54.51	Imperial Irrigation District, CA							alfalfa
13761	51.86	Imperial Irrigation District, CA	Small Vegetables				Small Vegetables		
13754	33.65	Imperial Irrigation District, CA	Small Vegetables				Small Vegetables		
13756	76.85	Imperial Irrigation District, CA	Lettuce		Sudan		Small Vegetables		
13757	142.01	Imperial Irrigation District, CA							Bermuda, Rye, or other grass
13758	34.94	Imperial Irrigation District, CA			Sugar Beets				
13761	50.12	Imperial Irrigation District, CA							
13762	66.15	Imperial Irrigation District, CA							Bermuda, Rye, or other grass

IID CY2007 Annual Summary Database Table Shown With Field Border Database – Alfalfa Field Shown in Blue

Demonstration of Technology

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ET and Evaporation Calculation

Estimate of ET by vegetation type, and evaporation from water surface.



AZMET, Mohave area, AZ

The calculation requires:

- Daily reference ET (provided by AZMET and CIMIS).
- Daily precipitation (provided by AZMET, CIMIS, NWS).
- Daily vegetation and water ET coefficients.
- Acreage of vegetation types and water surface (provided by remote sensing and GIS analysis).

ET Calculation

- Calculated for crops and riparian within the flood plain and the Palo Verde and Yuma Mesas.
- Calculated for crops in Wellton Mohawk, Coachella, and Imperial Irrigation District.
- Crop types are grouped into 16 classes including fallow fields.

The sum of the ET_{crop} compiled for calendar year 2007 is approximately 3.34 maf, or about 45% of the lower Colorado River basin use.

- Riparian types are grouped into 14 classes

The sum of the ET_{pht} (main stem Lower Colorado River) compiled for calendar year 2007 is about 0.63 maf, or about 8% of the lower Colorado River basin use.

Evaporation

Calculated for Lake Mohave, Lake Havasu, Senator Wash, Colorado River, Backwaters, Major Canals, Some Minor Canals.

Water surface updated annually in GIS database.

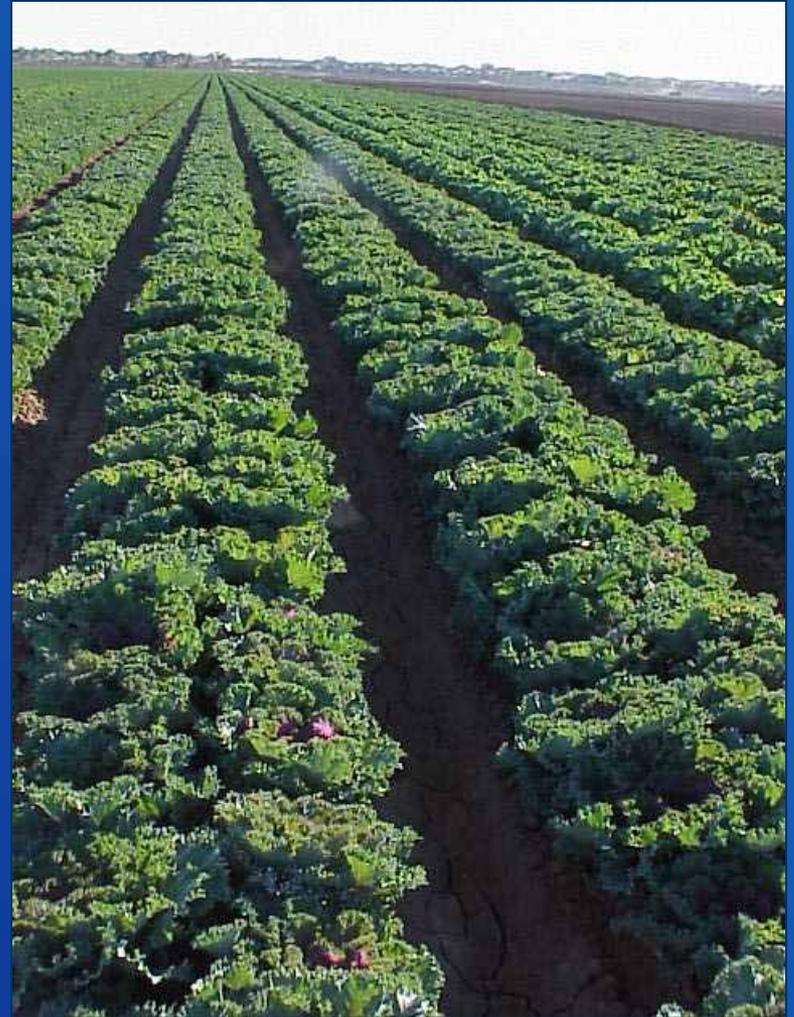
Sum of the evaporation CY2007 : approximately 0.39 maf or about 5% of the lower Colorado River basin water use.



Digitized Canal – Parker Area

Current Status

- LCRAS data does not replace the current decree accounting methodology.
- LCRAS data is being integrated into many water management activities requiring crop, phreatophyte, and associated ET information.
- New technologies are being evaluated and tested to improve or enhance current methods.



Future Activities

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- Integration of emerging remote sensing technologies such as Energy Balance Algorithms for ET determination.
 - Verification and quantification of conserved water for various programs:
 - System Conservation
 - Intentionally Created Surplus
 - Inadvertent Overrun and Payback
 - Fallowing agreements
 - Economic impact analysis for land use conversions, fallowing programs, and other planning activities.
 - Water contract and system conservation program administration, land inclusions, and water entitlement determinations.

Data Web Interface

The screenshot shows a web browser window titled "LC Crops Web - Windows Internet Explorer" with the URL "http://140.214.13.90/LCCrops/LCCropsWeb.html". The browser's address bar and menu bar are visible. The main content area displays a satellite map of a rural area with a grid of green lines representing crop fields. A red rectangle highlights a specific field. Two data windows are overlaid on the map:

Left Window: Lower Colorado Water Conservation Program

Select Crop Year: 2007

Turn Ag Fields Off

Use "Select Fields" button (on toolbar above) to graphically select fields.

Hold "Ctrl" key to multi-select fields.

Right Window: Crop Year 2007

Save to CSV

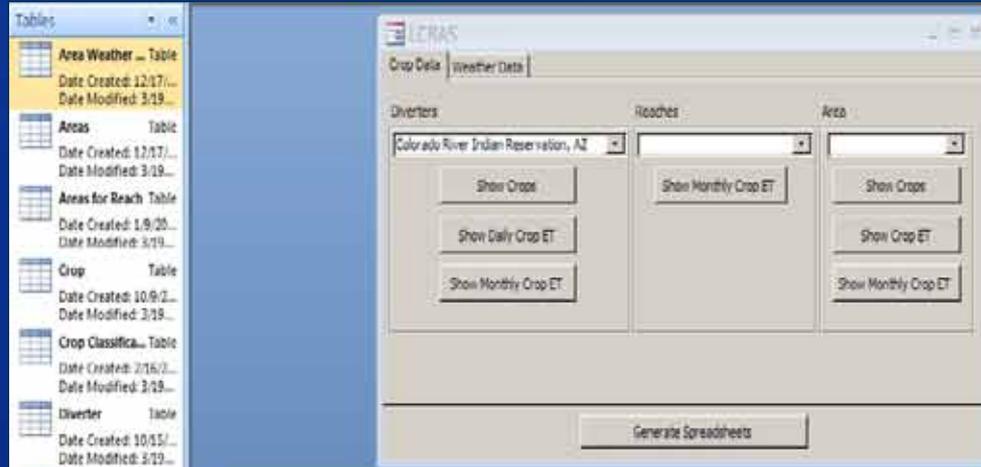
Crop	Acres
Latitude	17.97
Sudan	17.97
Croffers	17.97
Total Acres: 53.91	

Web Interface To Provide Data Query, Summary and Data Download Capabilities

Future Activities

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Improved ET / Evaporation Calculation Software



Relational database application with improved data calculation interface, versatility for customized applications, and automated interface for downloading weather station data.

The screenshot shows a spreadsheet titled 'Crop ET by Diverters Monthly CrossTab'. The spreadsheet has columns for 'Diverters', 'Crop', 'Total Crop ET', and months from 'Jan' to 'Dec'. The data is as follows:

Diverters	Crop	Total Crop ET	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Colorado River Indian Reservation, AZ	Alfalfa-perennial	66.96	2.51	3.8	4.75	6.68	8.53	8.4	8.12	8.32	6.91	3.88	2.31	2.75
Colorado River Indian Reservation, AZ	Bermuda Grass	39.63	0	0	0	3.04	7.63	8.27	7.77	7.38	5.33	0.21	0	0
Colorado River Indian Reservation, AZ	Cotton	34.44	0	0	0	1.02	2.36	5.54	8.34	9.91	6.59	0.68	0	0
Colorado River Indian Reservation, AZ	Deciduous Orchards (pecans & pe	58.06	1.51	1.71	3.3	5.33	7.96	8.42	7.93	7.68	5.73	4.45	2.55	1.49
Colorado River Indian Reservation, AZ	Field Grain (includes field & own	31.36	0	0	1.97	6.52	11.16	10.19	1.52	0	0	0	0	0
Colorado River Indian Reservation, AZ	Grapes	37.67	0	0.26	1.86	4.68	7.88	9.27	7.39	5.6	1.93	0	0	0
Colorado River Indian Reservation, AZ	Lettuce - Fall	5.86	0	0	0	0	0	0	0	0	0	3.1	2.76	0
Colorado River Indian Reservation, AZ	Perennial Vegetables (artichokes &	56.74	1.39	1.62	2.7	5.31	8.64	9.1	8.56	8.24	5.46	3.28	1.37	1.07
Colorado River Indian Reservation, AZ	Small Grains (includes oats, rye, b	25.6	2.66	4.19	6.59	7.89	3.05	0	0	0	0	0	0.29	0.93
Colorado River Indian Reservation, AZ	Small Vegetables (carrots, celantr	19.67	3.22	3.73	4.92	0	0	0	0	0	1.02	2.03	2.27	2.48
Colorado River Indian Reservation, AZ	Sudan Grass	43.53	0	0	2.98	7.36	10.56	11.04	10.12	1.47	0	0	0	0

Concluding Remarks

- Requires trained dedicated staff.
- Requires development of standardized procedures with accuracy assessment
- Requires expertise in Remote Sensing and GIS.
- Requires awareness of emerging technologies for potential methods improvement.
- Benefits from collaboration with partners and stakeholders.
- Requires funding and management support.

Cienega de Santa Clara, Mexico

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Discussion



Topock Marsh – 1 foot CIR

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