South Platte Decision Support System

Spatial Systems Integration: Irrigated Lands Assessment

EXECUTIVE Summary

The South Platte Decision Support System (SPDSS) provides data and tools to support informed decision-making regarding South Platte water resources. A key element of SPDSS is the Spatial Systems Integration Component, which has classified and mapped current and historic irrigated areas and irrigation service areas for both ground and surface water in the South Platte River basin. This Irrigated Lands Assessment has utilized satellite images to map over a million acres of irrigated land, information that is used to estimate the consumptive water use for irrigation ditch diversions and wells. This mapping has been implemented in consultation with Colorado water resource managers, water conservancy districts, and hundreds of irrigation ditch companies and water users.

Goals of the SPDSS Irrigated Lands Assessment

There are two major goals of the SPDSS Irrigated Lands Assessment:

(i) Classify and map the irrigated area in Colorado's South Platte River Basin using 2001 satellite imagery data, particularly focusing on:
   - Acreage by Water District
   - Acreage by Crop Type
   - Key Diversions
   - Groundwater versus Surface Water Sources

(ii) Classify and map the historic land use of Colorado's South Platte River Basin irrigated area using aerial photography and/or satellite imagery from 1956, 1976, 1987, 1997 and 2001 particularly focusing on:
   - Historical Acreage by Crop Type
   - Historical Acreage by Water Source

An update of the Irrigated Lands Assessment using 2005 imagery was completed in late 2007. Data summarizing the 2005 irrigated lands are included in this report.

Summary of Results

The main product of the SPDSS Irrigated Lands Assessment is a comprehensive irrigated lands database for the South Platte River basin. This database is composed of two GIS shapefiles: an irrigated parcels shapefile, and an irrigation service area shapefile. The irrigated parcels shapefile contains parcel boundaries of croplands that are irrigated using surface water, ground water, or both. The parcels contain information attributes that describe the water source, 1956, 1976, 1987, 1997 and 2001 crop type, and ancillary data[1]. These data were generated using scientifically defensible methods that yielded very high classification accuracies. The following section provides a summary of the general approach used, central to which was the careful interpretation and digitizing of a base-map of irrigated lands and crop parcel boundaries for the year 2001 using high resolution aerial photography. This base-map allowed all subsequent irrigated lands classification and mapping to be conducted with a high level of detail. The resulting maps are in GIS format, thus the data can be used readily to generate summary statistics for irrigated lands at a number of spatial scales from the basin to the farm, and by a number of different themes including irrigated acreage by water district, by water source, and by crop type. The ability to generate summary statistics and maps of irrigated acreage, for any area of interest and for any of the years mapped, has great utility to South Platte water managers, now and in the future. A summary of results is presented below.

Table 1 presents irrigated acreage by Water District for all years mapped. Although the sum of irrigated acreage for both the South and North Platte increased by nearly 30,000 acres in the twenty years between 1956 (1,099,748 acres) and 1976 (1,129,253 acres), overall it has fallen between 1956 and 2001 (1,016,484 acres) by 83,264 acres. The recent update using 2005 satellite imagery indicates this general trend continues.

Table 1. Summary of irrigated acreage by Water District for all years mapped

[illegible]	1956 Acres	1976 Acres	1987 Acres	1997 Acres	2001 Acres	2005 Acres
1	277,080	328,548	325,786	320,992	324,334	291,761
2	153,555	150,391	152,187	132,959	130,250	116,541
3	177,514	167,165	160,947	147,001	143,415	132,026
4	71,010	66,522	68,384	64,890	62,448	56,825
5	75,960	71,381	71,266	61,681	59,020	53,202
6	37,764	33,795	32,509	26,418	25,389	23,471
7	9,335	2,289	2,252	1,721	2,217	1,452
8	11,732	8,881	8,347	3,419	4,520	3,679
9	1,803	2,804	3,131	1,397	1,695	1,435
23	29,209	27,028	10,113	8,006	7,733	5,225
48	4,431	4,403	4,170	3,708	3,738	3,950
64	131,693	151,804	146,909	147,310	144,961	140,079
80	1,260	1,236	1,140	611	798	874
South Platte Total	**982,345**	**1,016,246**	**987,139**	**920,114**	**910,518**	**830,518**
47	117,403	113,007	110,154	106,299	105,966	106,323
North and South Platte Total	**1,099,748**	**1,129,253**	**1,097,293**	**1,026,413**	**1,016,484**	**936,841**

[1] Unless noted otherwise, results presented in this Executive Summary incorporate classification and mapping of the smaller North Platte River basin (District 47). District 47 was incorporated in this project because it falls within the extent of the satellite imagery used for mapping South Platte irrigated lands.

Table 2 presents summaries of irrigated acreages by water source for all years mapped[2]. ***Figure 1*** illustrates the relative importance of the major water sources used to irrigate mapped acreages at a point in time. ***Figure 2*** graphs the water sources used to irrigate the most recent mapped acreage (2001) for each Water District, highlighting the importance of alluvial groundwater for the irrigated lands flanking the South Platte River as it flows eastwards onto the plains (Water Districts 1 and 64).

Table 2. South Platte River Basin Division 1 Irrigated Acreage by Water Source.

Water Source	1956	% of Total	1976	% of Total	1987	% of Total	1997	% of Total	2001	% of Total	2005	% of Total
Groundwater Only	111,674	11%	176,598	17%	179,383	18%	169,174	18%	165,737	18%	146,843	18%
GW & SW	199,283	20%	235,319	23%	225,050	23%	227,230	25%	234,182	26%	186,399	22%
Surface Water Only	671,388	68%	604,329	59%	581,881	59%	522,494	57%	509,089	56%	495,493	60%
Budweiser (Anheiser-Busch) Multi-Use Water	0	0%	0	0%	827	0%	1,216	0%	1,510	0%	1,783	0%
Total	**982,345**	**100%**	**1,016,246**	**100%**	**987,139**	**100%**	**920,114**	**100%**	**910,518**	**100%**	**830,518**	**100%**

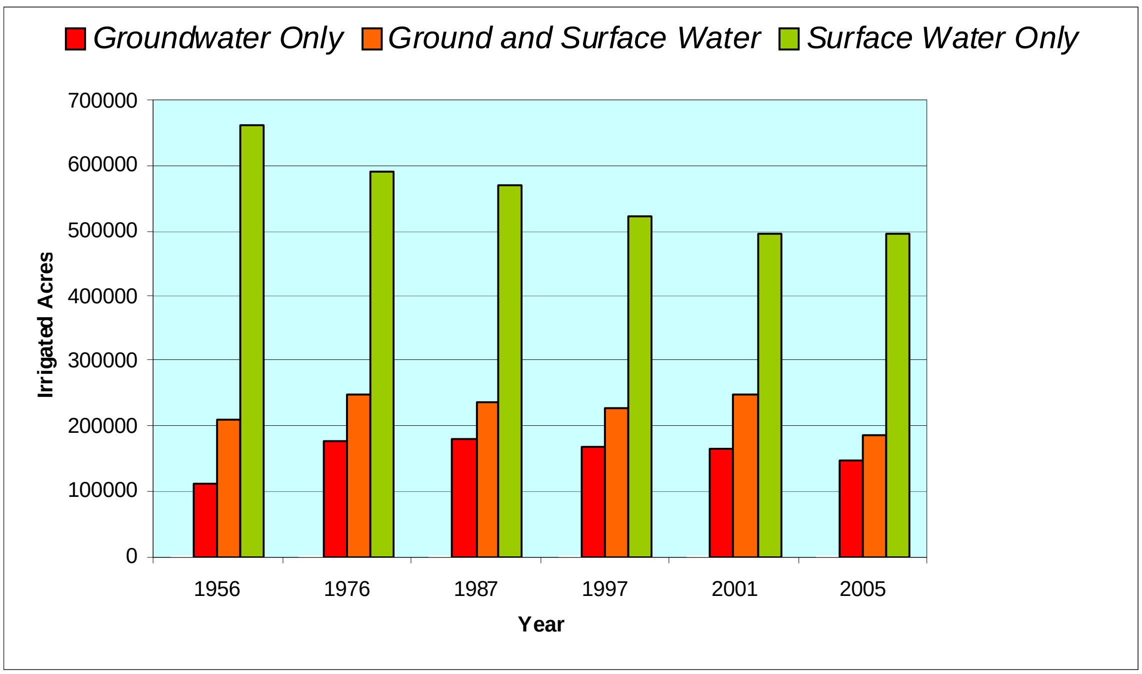
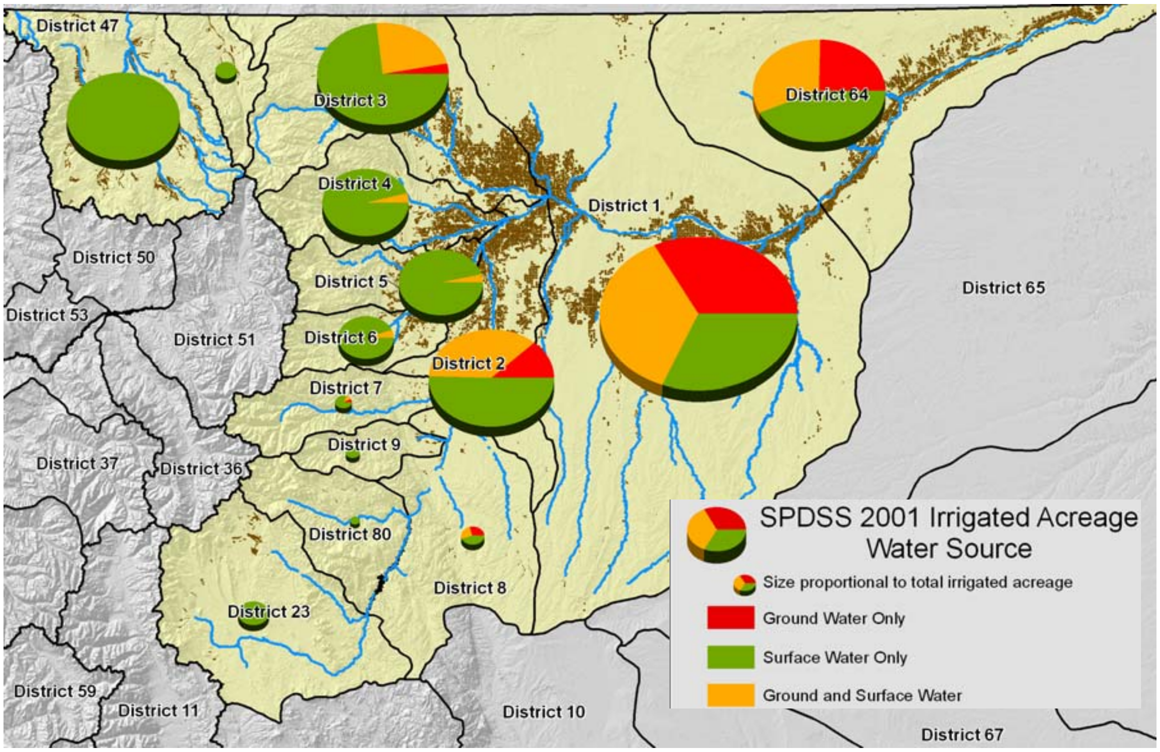


Figure 1. South Platte historic irrigated acreage by water source

[2] District 47 has been consistently irrigated almost entirely with surface water.



Note: The overall size of the pie chart is proportional to the total irrigated acreage of each Water District.

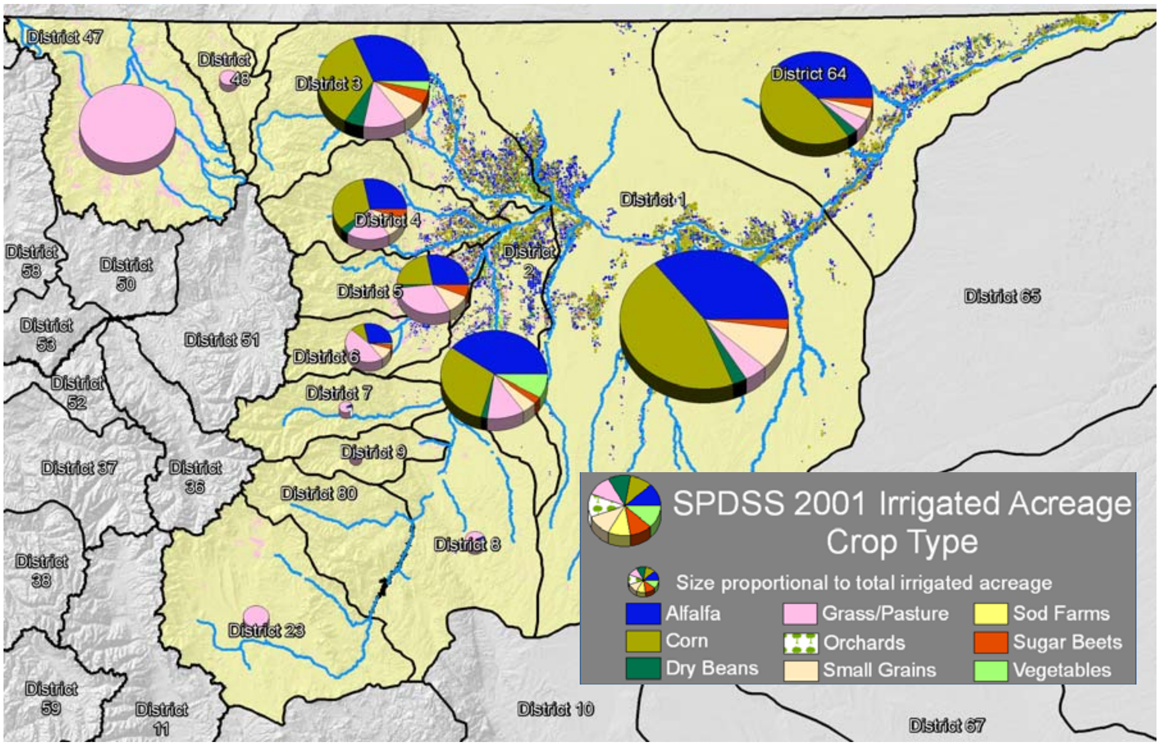
Figure 2. 2001 irrigated acreage by water source

Table 3 summarizes irrigated acreage by crop type for all years mapped. The SPDSS irrigated lands GIS database facilitates analysis of changes in cropping patterns associated with changes in water use, as well as overall irrigated acreage, over time. ***Figure 3*** graphs the crop types making up the most recent mapped irrigated acreage (2001) for each Water District, highlighting the different proportions of crops grown between various Water Districts in the basin.

Table 3. SPDSS Irrigated Acreage by Crop Type for 1956, 1976, 1987, 1997, 2001, and 2005 (South and North Platte basins)

Crop Type	Acreage 1956	Acreage 1976	Acreage 1987	Acreage 1997	Acreage 2001	Acreage 2005
South Platte basin						
Alfalfa	196,734	206,362	217,892	210,705	310,521	237,454
Corn	394,342	423,683	387,976	351,847	333,943	283,936
Dry Beans	52,542	58,523	86,966	9,527	29,401	28,687
Grass pasture	232,633	217,660	131,095	181,799	120,073	160,898
Orchard *w/o* Cover	-	-	-	-	2,239	1,389
Small Grains	37,402	40,192	116,448	67,448	65,849	58,665
Sod Farm	-	-	-	-	5,246	8,192
Sugar Beets	68,691	69,826	46,763	98,060	26,904	25,227
Vegetables	-	-	-	-	16,343	26,071
South Platte basin Total	**982,345**	**1,016,246**	**987,139**	**920,114**	**910,518**	**830,518**

Crop Type	Acreage 1956	Acreage 1976	Acreage 1987	Acreage 1997	Acreage 2001	Acreage 2005
North Platte basin (District 47)						
Grass Pasture	117,403	113,007	110,154	106,299	105,966	106,323
District 47 Total	117,403	113,007	110,154	106,299	105,966	106,323
SPDSS Totals	**1,099,748**	**1,129,253**	**1,097,293**	**1,026,413**	**1,016,484**	**936,841**



Note: The overall size of the pie chart is proportional to the total irrigated acreage of each Water District.

Figure 3. Irrigated acreage by crop type

Classifying and Mapping Irrigated Acreage (2001 and Historic): Summary of General Approach

Using satellite data from 2001, a multi-step process was used to classify and map the Colorado South Platte River Basin irrigated area by water district and crop type:

- Create SPDSS base map.
- Use base map to interpret and digitize irrigated field parcels.
- Classify irrigated field parcels by crop-type using Landsat satellite imagery.
- Map Wells, Irrigation Systems, and Irrigation Service Areas.
- Classification and mapping of historic (1956, 1976, 1987, and 1997) irrigated acreage by crop type and water source.

Figure 4 illustrates the workflow used to classify and map 2001 and historical irrigated acreage by Water District and crop type.

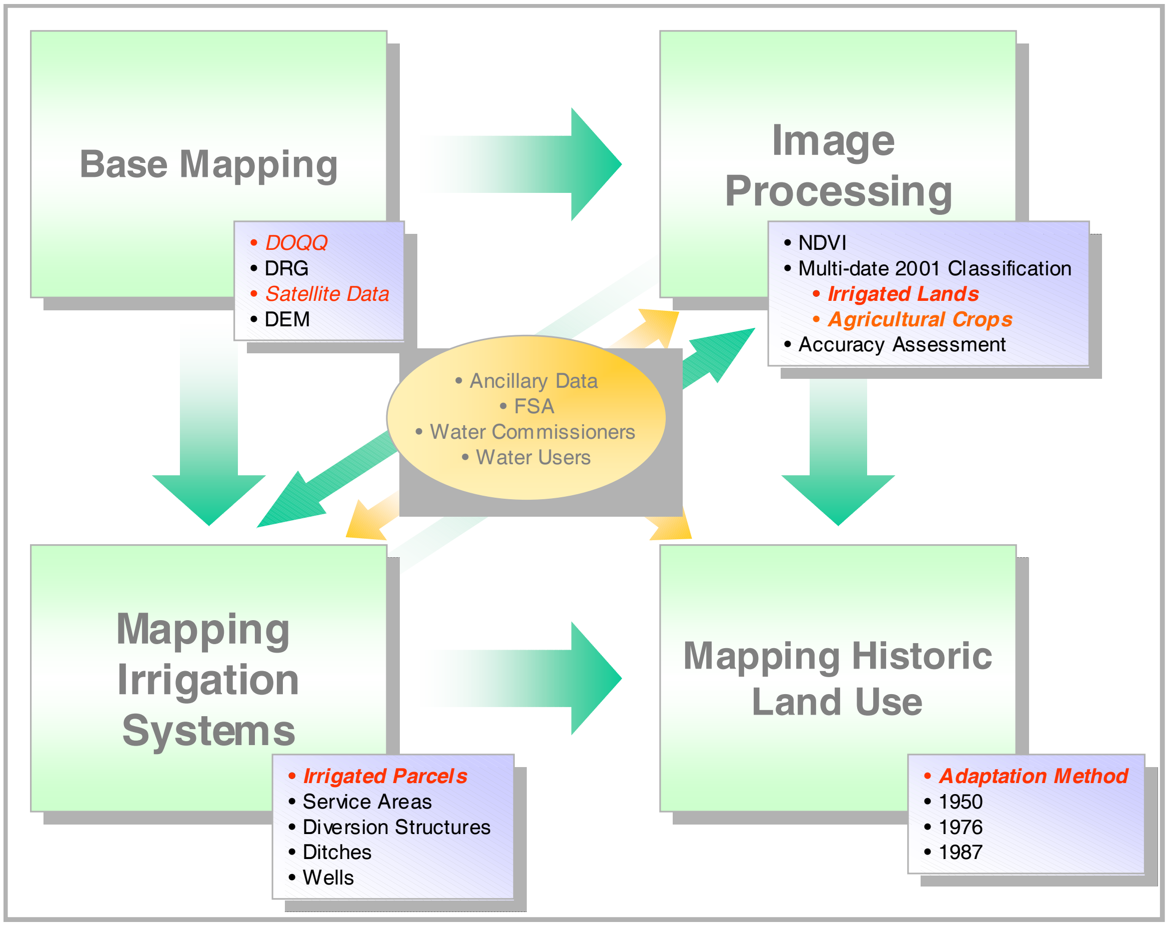


Figure 4. Flow chart of general approach used to classify and map 2001 and historical irrigated acreage by Water District and crop type.

The initial task was to develop a digital, seamless Image Base Map for the entire South and North Platte River Basins to provide a foundation with which to interpret and digitize irrigated field parcel boundaries. In order to provide full coverage, this base map was created using best available imagery. Most of the image base map was made up of 1,418 USGS Digital Ortho Quarter Quads (DOQQs)[3].

The second major task involved identifying and digitizing irrigated field parcels for the 2001 irrigation season. The irrigated field parcels were developed from: (i) the image base map described above, (ii) analysis and classification of Landsat imagery, and (iii) irrigated parcel data from the Northern Colorado Water Conservancy District (NCWCD) and Colorado State University (CSU). The NCWCD data were interpretations of irrigated lands for 1997, and the CSU data were GIS coverages of irrigation center pivots (both data sources used satellite imagery as a basis for interpretation). 2001 Landsat image data were processed according to standard image processing techniques. Imagery was acquired for multiple

[3] DOQQ imagery from the USGS was chosen for its high resolution and for its spatial accuracy, which provide a superior base for mapping irrigated parcels and related characteristics. CWCB shared the cost with USGS for updating another 340 DOQQs. For these areas, the previously available USGS digital orthophotos from the 1980s and early 1990s were replaced with more recent data from the late 1990s. In addition to the USGS DOQQs, aerial imagery obtained by Weld County was also included in the image base map. IRS and LandSat imagery was used to fill in a small portion of the eastern edge of the study area where orthophotos were not available.

Landsat frames, and multiple dates of imagery were acquired for each frame. The imagery was geometrically, atmospherically, and radiometrically corrected.

The general approach to mapping irrigated field boundaries involved three main steps:

(i) Interpreting printed maps and drawing field boundaries;
(ii) Digitizing the field boundaries on screen in a GIS;
(iii) Implementing quality assurance and quality control (QAQC) procedures to ensure consistency and accuracy of digitized field boundaries.

A specific type of image transformation was used in the initial steps of the irrigated parcel delineation. This transformation, called the Normalized Difference Vegetative Index (NDVI), was used to compute the ratio of the measured intensities in the Landsat red and near infrared spectral bands. The resulting index is highly sensitive to vegetation vigor and was used to determine threshold values separating irrigated from non-irrigated vegetation (***Figure 5***).

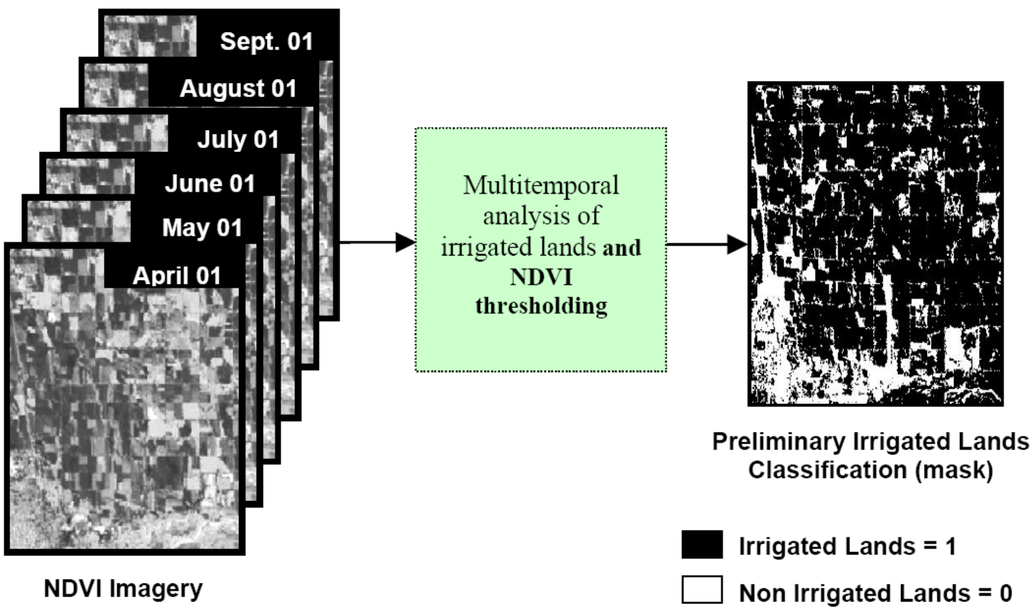


Figure 5. Separation of irrigated from non-irrigated lands using NDVI

The multi-temporal NDVI imagery derived from Landsat data was overlaid on DOQQ and DRG data for analysis using both hardcopy map and on-screen visualization and interpretation. This technique enabled reliable, high-resolution delineations of field boundaries to be made (***Figure 6***).

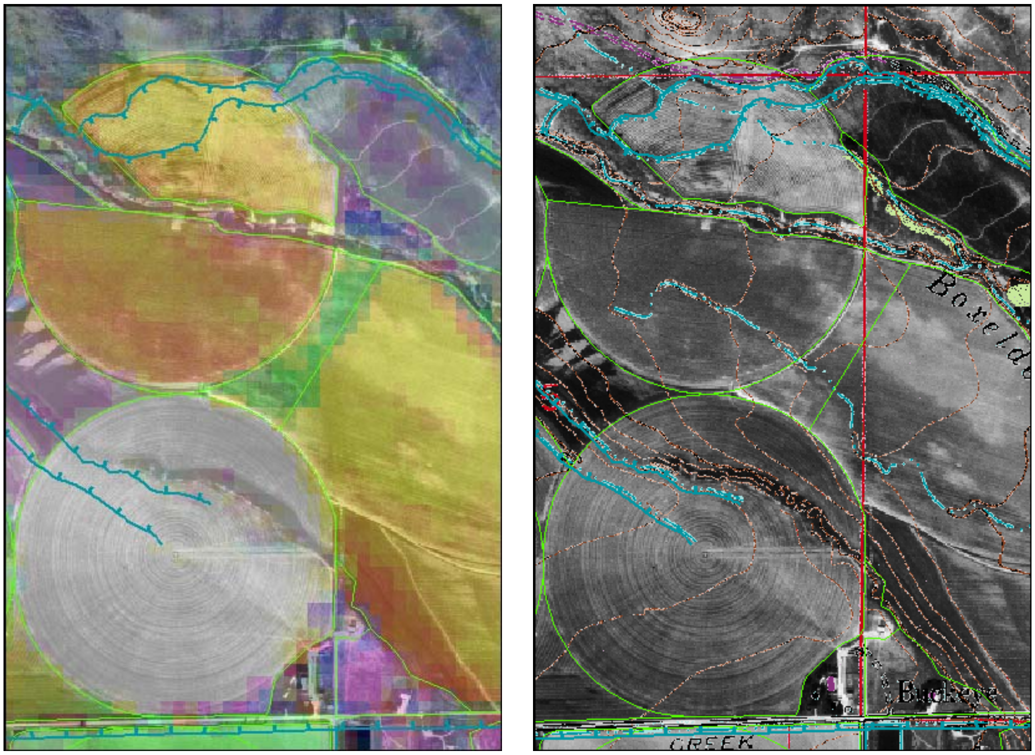


Figure 6. Interpretation and digitizing of irrigated parcels using base-map (DOQQ) and multi-temporal NDVI derived from Landsat images

The classification procedure conducted was hierarchical, starting with the discrimination of irrigated lands from non-irrigated lands through interpretation and analysis of the multi-temporal NDVI data derived from Landsat imagery. This preliminary classification was later refined to delineate irrigated parcel boundaries. After the parcels were delineated, irrigated lands were classified into major crop types using the ERDAS Imagine Maximum Likelihood Classifier (MLC). The maximum likelihood classifier is one of the most popular methods of classification in remote sensing, in which a pixel with the maximum likelihood is classified into the corresponding class.

Reference data collected from FSA were used to train the MLC and evaluate classification performance. The MLC classification was combined with GIS and other ancillary data in a series of rules to assign crop type information to the previously delineated agricultural parcels. In addition, inputs of water commissioners, water users, ditch companies, and field observations were used to refine the classification in an iterative process (***Figure 7***).

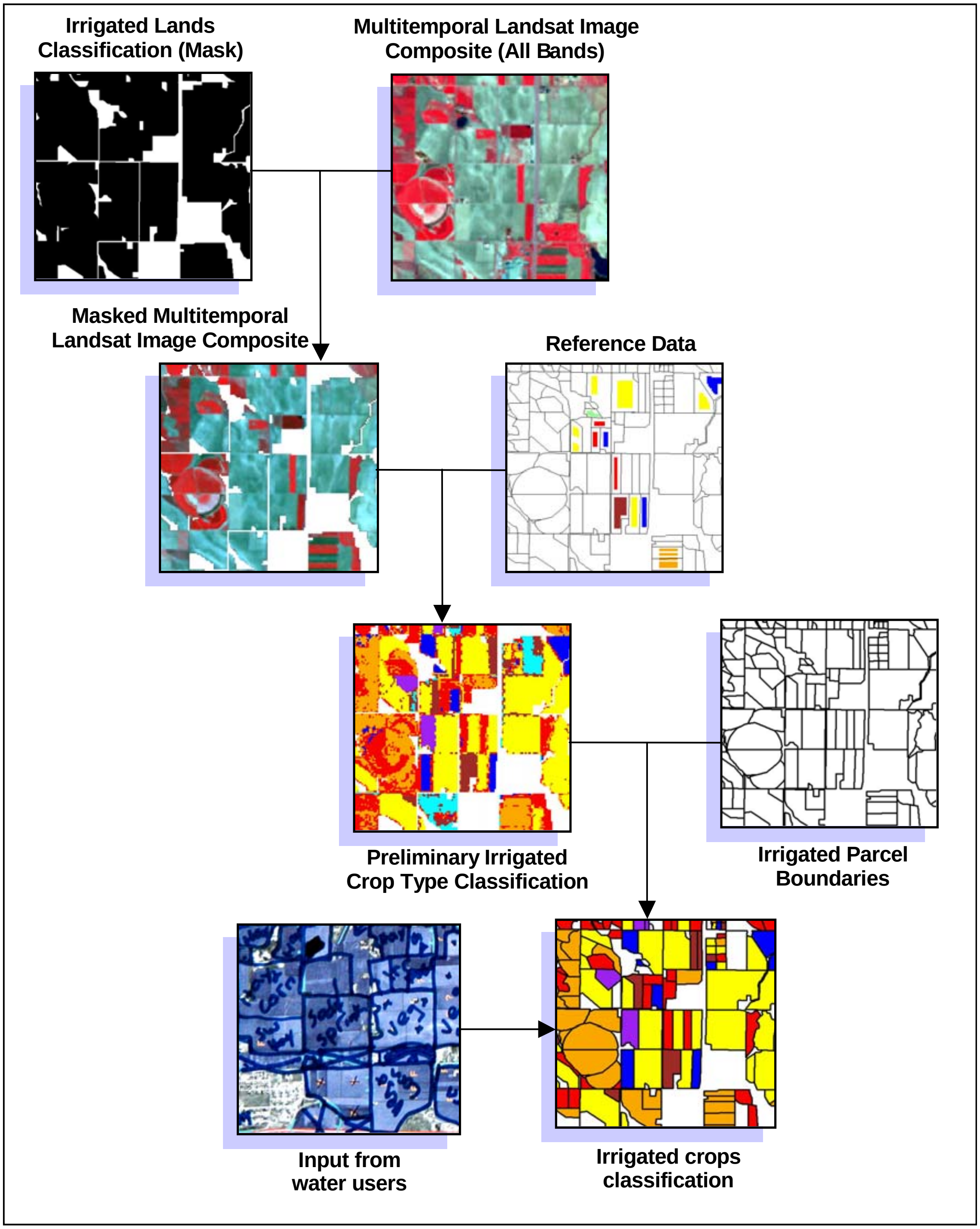


Figure 7. Irrigated Crops Classification Procedure

Crop types to be classified were selected by considering the following criteria: (1) crops and acreage reported by the Colorado Agricultural Statistics, (2) spectral characteristics of the crops obtained from expert knowledge and research literature, and (3) input from Consumptive Use contractor on categories of crops with similar water requirements. Based on this information, the following crops or crop groups were classified: ‘Small Grains’, ‘Dry Beans’, ‘Corn and Sorghum’, ‘Sugar Beets’, ‘Alfalfa’, ‘Grass for Pasture and Hay’, and ‘Vegetables’.

Multi-temporal Landsat data allowed for excellent discrimination of most of the major crop types. The only two classes that presented a challenge for the MLC algorithm due to their similar agricultural practices were ‘Alfalfa’ and ‘Grass for Pasture and Hay’. Confusion between ‘Alfalfa’ and ‘Grass for Pasture and Hay’ was reduced in later classification steps and with information from water users. With the exception of the ‘Vegetable’ class, all crops were classified with the MLC algorithm. The Vegetable class constitutes a group of crops that are important as a whole in the SPDSS area but are localized in specific areas. These vegetable crops have very diverse spectral and temporal characteristics due to both their physiology and the agricultural practices associated with them, making them very difficult to classify on a pixel-by-pixel basis. However, various spectral, temporal, spatial, and geographical indicators make the photointerpretation of vegetable parcels possible. Therefore, vegetable parcels were designated manually from information obtained from vegetable growers, FSA, and water users and verified through photointerpretation and analysis of NDVI imagery.

In addition to the crops described above, the classes ‘Sod Farm’, and ‘Orchard and Tree Nursery’ were added manually in the classification refinement process as a result of interviews with water users and field verification activities. Because of their distinctive cutting patterns, ‘Sod Farms’ were identified mainly by photointerpretation of the combined Landsat and DOQQ imagery.

A major part of the SPDSS irrigated lands mapping involved using Landsat image data to discriminate between different crops in order to assign crop types to irrigated parcels over different time periods during the irrigation season. A combination of visual interpretation, which relies on expert knowledge combined with visual elements of the image (e.g. tone, contrast, shape, context), and digital image classification was used. Digital image classification is based on the spectral information contained in the multiple Landsat bands making up a single image, and classifies each individual pixel based on its spectral characteristics.

To ensure that the satellite imagery was providing accurate information, “ground truth” data were collected through field observations and reference data collected from the Farm Service Agency (FSA), Colorado State University, and private parties such as vegetable farms. Reference data from private parties were collected following standard statistical sampling procedures. Special attention was given to crop types that were difficult to find on a strictly random basis, such as vegetables and dry beans.

The result is that all pixels in an image were assigned to a particular crop type, as well as other classes (e.g. corn, alfalfa, beans, water, forest etc.), resulting in a classified image that is a thematic map of the original image.

Multiple NDVI images (NDVI composites) were critical for analyzing temporal trends for different crop types, the different NDVI values throughout the growing season uniquely identifying the different crop types. ***Figure 8*** shows a graph of average NDVI values over time for different crop types. For more details on image processing and crop classification techniques and procedures, refer to *SPDSS Technical Memorandum 89.2*.

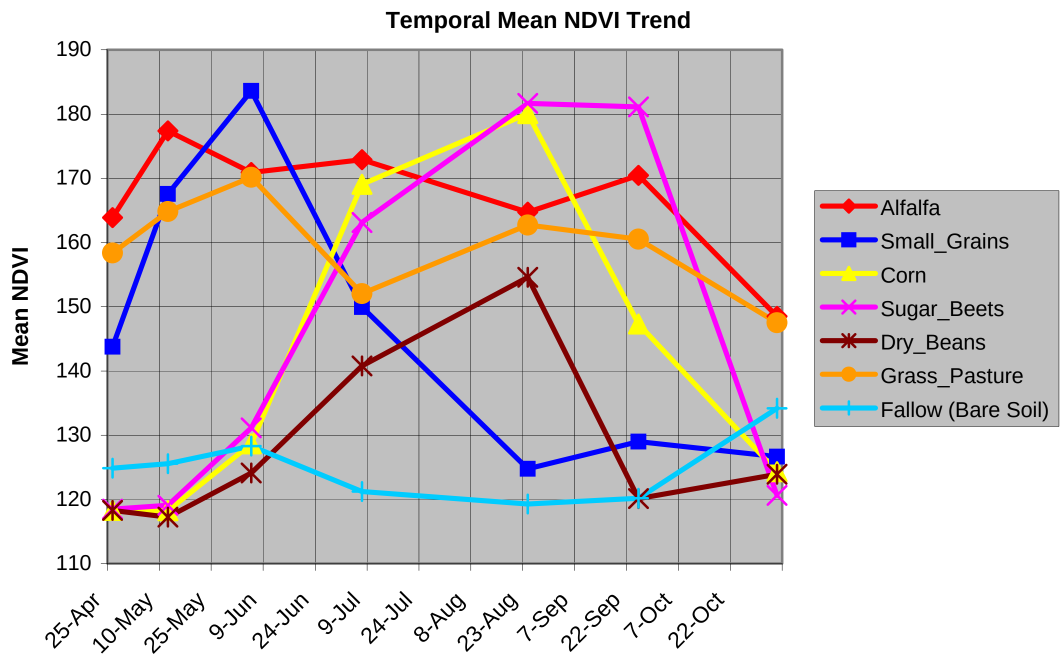


Figure 8. Mean NDVI Trends of Selected Irrigated Crop Types in the SPDSS Area

The statistical accuracy assessment for the irrigated lands classification used data collected from FSA, complemented with information obtained through photo interpretation of DOQQs and NDVI composites. The objective of the photointerpretation was to obtain information on cover types not available through FSA. In conjunction with the photointerpretation and image analysis, an extensive field verification campaign was conducted in 2004. Special attention was given to inconclusive areas, such as marginally irrigated lands for improving discrimination between irrigated and non-irrigated lands. The overall accuracy achieved in the classification was 96 percent.

Mapping and digitizing of irrigation service area boundaries comprised six major steps:

- (i) Analyze topography
- (ii) Digitize service area boundaries
- (iii) Implement QAQC procedures on service area boundaries
- (iv) Attribute service areas with diversion Ids
- (v) Locate Wells and Wells-to-Parcel Matching
- (vi) Verify Irrigation Systems with Water Users

The first step was to identify diversion structures, and analyze the topography above and below each diversion and ditch. Key diversions were extracted from HydroBase, identified, mapped, and matched to a ditch. Diversion structures were matched to a ditch spatially, by matching names, and by matching water source. A Digital Elevation Model (DEM) was used to analyze and identify land that could potentially be irrigated by a diversion structure by highlighting the land above and below that diversion structure and ditch. Topography was analyzed using several different data: preliminary irrigated parcel boundaries, USGS digital raster graphics (DRG) at 1:24,000 scale, hydrography data (including ditches and canals), diversion structures, and a digital elevation model (DEM). These data were used to identify and map ditches.

The second step required digitizing the irrigation service area boundaries by starting at the diversion structure and following the ditch out to its end. The lower end of each service area was bounded by a drainage, river, or by another major ditch. ***Figure 9*** shows diversion structures and ditches with elevation data identifying land above and below the ditch. The yellow boundaries are the digitized irrigation service areas. The preliminary irrigated parcel data was used to highlight areas of irrigation within a ditch service area. Service areas were only digitized around potentially irrigated parcels. The service area boundaries were digitized at a scale between 1:2,000 to 1:8,000, depending on the complexity of the service area.

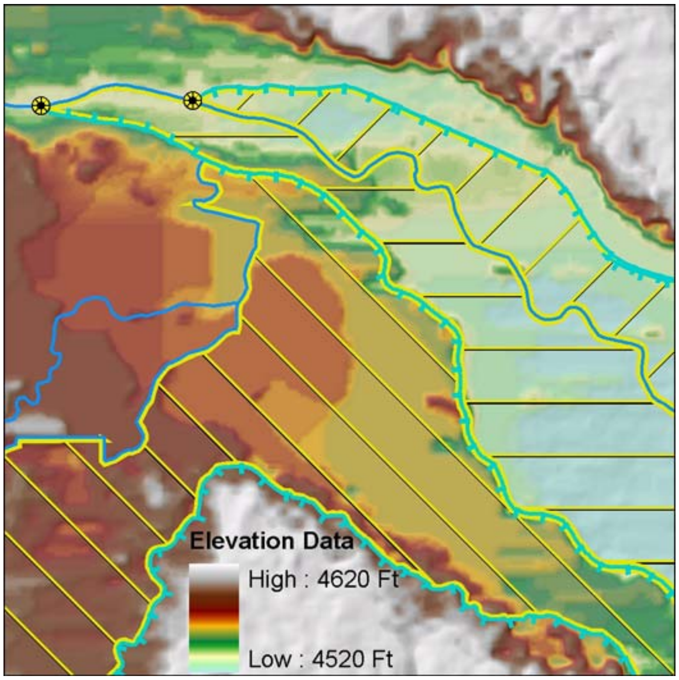


Figure 9. Example of Irrigation Service Areas with Diversions, Ditches, and Elevation

After the service area boundaries were digitized, a check for accuracy and consistency was conducted. The initial check was based on the DEM, digital raster graphics (DRG), and preliminary irrigated parcels. The DEM was used again to ensure that the land within a service area boundary could be irrigated by a gravity system. The DRGs were used to identify any cultural features or obstacles that might block the delivery of irrigation water. The final check on the data was for correct topology. Some legitimate overlaps existed where, for example, two ditches crossed each other, and it appeared that both ditches could irrigate the land.

The next step required attributing service area boundaries with the primary diversion structure identification number (WDID) and the name of the ditch company supplying irrigation water. Diversion structure IDs were then assigned to the irrigated parcels. Each parcel was attributed with the WDID of its corresponding service area. Parcels that overlapped more than one service area boundary were attributed with the WDID of the service area in which the center of the parcel was located. These parcels were then clarified during meetings with water users. Irrigated parcels outside any service area boundary were defined as 'groundwater only' irrigation. If there were no wells near the 'groundwater only' parcels, they were marked as questionable areas and resolved during water user meetings. ***Figure 10*** shows the key diversion structures, decreed irrigation wells, irrigation ditches, 2001 irrigated parcels color coded by the irrigation service area boundaries and labeled with 'ground water' only labels (GW), and the Image Base Map.

Meetings with water users were held to obtain and verify information on irrigated parcel boundaries, ditches and diversion structures, water source, and crop type. This information was used to update and enhance the final mapping product.

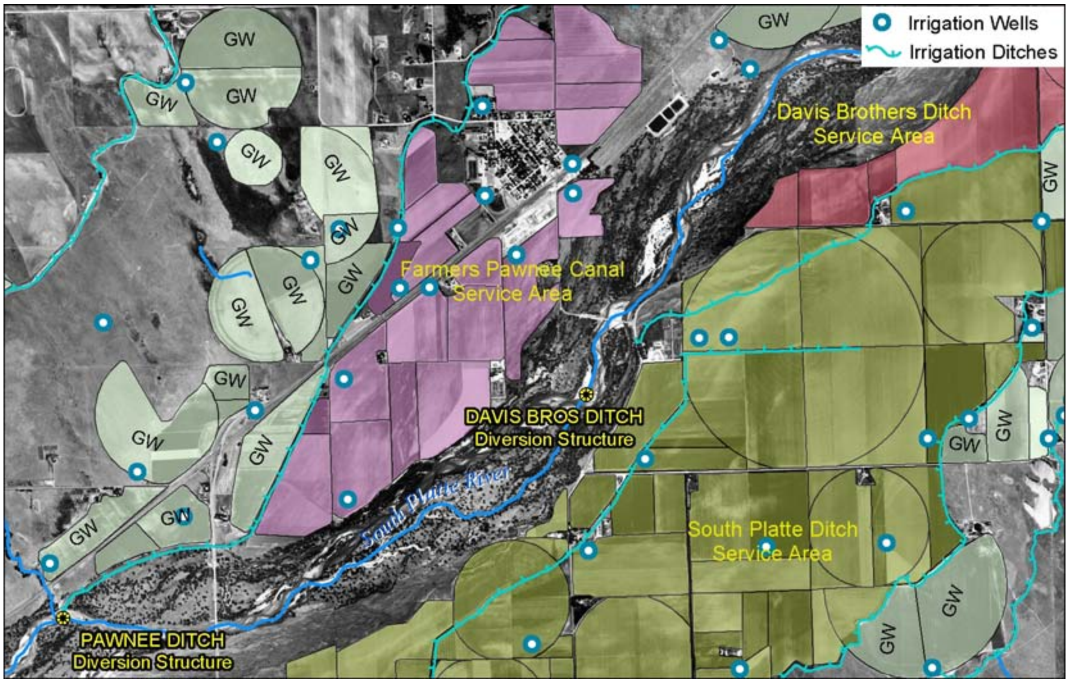


Figure 10. Example of Irrigated Parcels, Service Areas, and Diversions

After the preliminary irrigation service areas were created and diversion structures were assigned to irrigated parcels, irrigated parcels needed to be assigned to wells. The well locations for decrees were obtained from the State's HydroBase[4] database. Well permits were used where there were no well decrees. Maps of wells and parcels were taken to meetings with water users to obtain information on ground water use. Wells that were not specifically assigned to wells by water users were then matched to the parcels with the well-to-parcel matching routine in StateDGI, generally based on well distance to irrigated parcel.

Out of a possible 6,641 active decreed irrigation wells (2001), **5,437** have been matched to one or more irrigated parcels. Out of those 5,437 wells, **5,392** wells are matched to a parcel as a 'unique' match. These wells are matched to only one parcel. Additional parcels that need well irrigation and did not receive a 'unique' well match were matched to a well as a 'shared' match. There are **5,227** 'shared' well-to-parcel matches. A 'shared' well is already matched to either one other parcel as 'unique' or many other parcels as 'shared'. Well-to-parcel matches that are matched as 'estimated' are reserved for parcels that are too far away from a well to realistically be irrigated by that well. There are **194** 'estimated' well-to-parcel matches. These wells may or may not also be matched to other parcels as 'unique' or 'shared'.

Out of a possible 916 active permitted irrigation wells in designated basins with no decreed wells, **727** have been matched to one or more irrigated parcels. Of these, **721** have a 'unique' parcel match, **580** are 'shared', and **29** have 'estimated' parcel matches.

The results of these well-parcel matches are presented in ***Table 4***.

[4] Records on irrigation wells are archived in the State's HydroBase database as decreed wells.

Table 4. 2001 South Platte Irrigated Parcel Well Match Summary

Well Type	Matched	Unmatched	Total
Water Right	5437	1204	6641
Permit	727	189	916
		Total	7557

Classification and Mapping of Historic Land Use (Acreage) by Crop Type and Water Source

The Irrigated Lands Assessment described above was for 2001. In order to monitor changes in irrigated area over time, a combination of aerial photography, satellite imagery, historic maps, applicable GIS data, and agricultural statistics were used to measure the historic irrigation of Colorado's South Platte River Basin. This task focused on: (i) historical acreage by crop type, and (ii) historical acreage by water source.

The 2001 data were used as a point of reference for mapping and attributing historical irrigated acreage. The year 1956 was chosen as the base year for the 1950s mapping because the majority of available aerial photos were from 1956. The years 1976 and 1987 were chosen because the best satellite data existed for these years[5].

An adaptation of 2001 data processing procedures was made to accommodate increasingly limited reference data the further back one moves in time. For the historical study, the analysis, interpretation, and classification of data took place directly after data pre-processing/satellite imagery collection. Wells matching and service area definition was then performed, followed by evaluation and validation.

An extensive imagery search was performed to begin the historic land use mapping. Aerial photography from the 1950s was found to be available for most of the SPDSS study area from the Farm Service Agency (FSA) Aerial Photography Field Office in Salt Lake City, Utah. Aerial photo index maps and select aerial photographs were purchased in hard copy format. These maps were scanned and georeferenced. The USGS EROS data center was searched for available satellite imagery. 1987 LandSat TM data and 1976 LandSat MSS data were purchased for the landuse analysis.

The same procedures and standards used for the 2001 Irrigated Lands Assessment were used for the historical image processing and irrigated lands/crop type classification. Agricultural statistics were used to guide the classification as detailed reference data were not available for the historic periods. Following a sequential interpretative and editing process that essentially modifies the 2001 parcels, the historical parcels for each year were developed. The 200l parcel layer served as the starting point for the 1987 parcel layer. The 1987 parcels were used as a starting point for the 1976 parcels, and 1976 parcels for the 1950s mapping. When required, the Image Base Map created for the 2001 Irrigated Lands Assessment was used as a base for digitizing all historic periods.

A stepwise approach was used to assign a water supply to the historic irrigated parcels. The irrigation service areas developed in the 2001 Irrigated Lands Assessment were used as a starting point. Historic diversion records were used to gain more information on when diversions were current. Irrigation wells were then assigned to the irrigated parcels to supply a groundwater source. Well assignments from 2001 were translated to the historic parcels. Parcels not mapped in 2001 were matched to wells using the State DGI well-to-parcel matching program. A flowchart of these general steps is shown below in ***Figure 11*** and an example of historic change in irrigated lands in ***Figure 12***.

[5] The 1950s decade pre-dates LandSat satellite imaging, thus historic aerial photo index sheets as well as select aerial photos from the index sheets were used for mapping. Historic LandSat satellite imagery existed and was used for mapping 1976 and 1987.

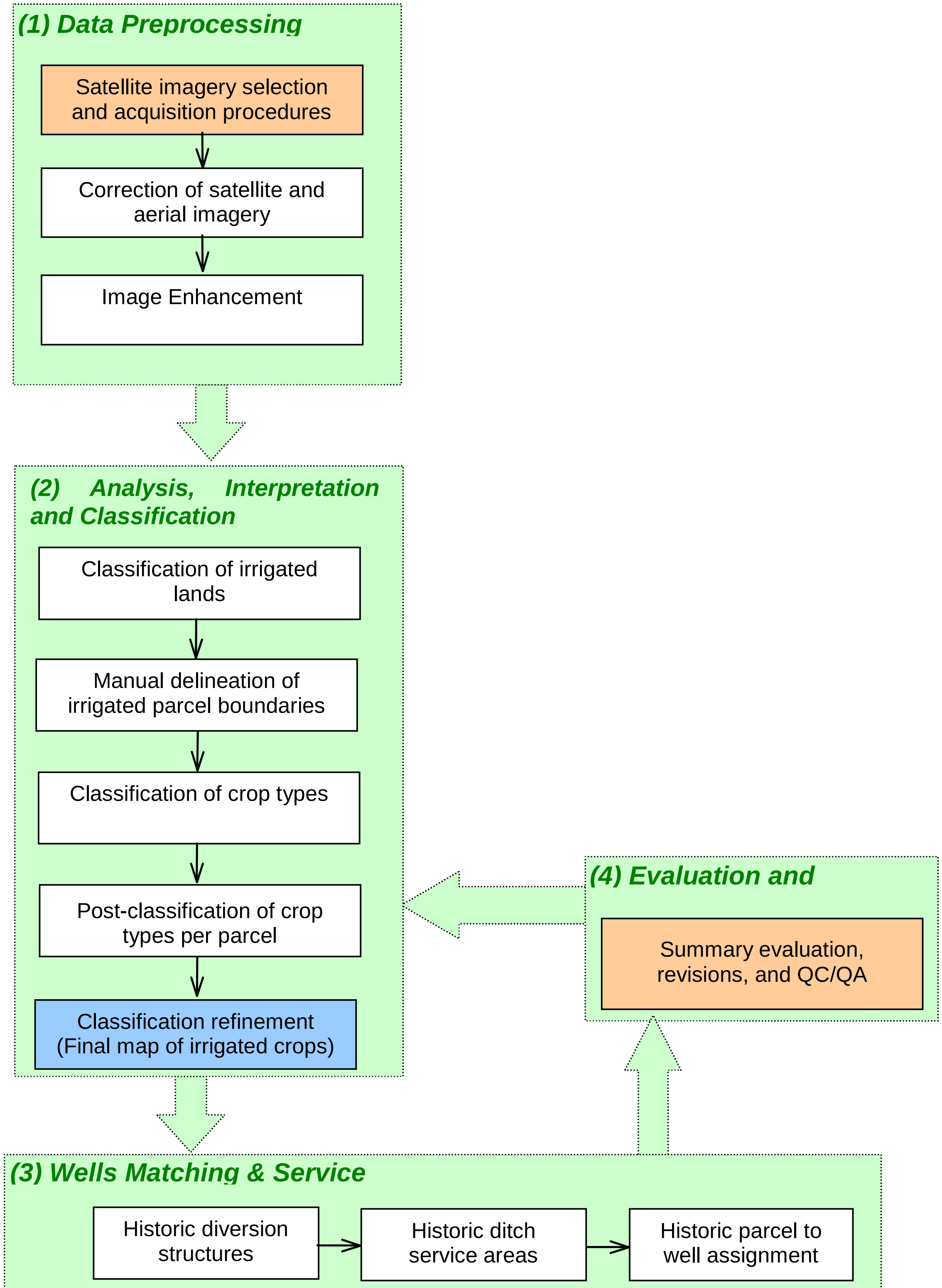


Figure 11. Flowchart of the Historic Land Use Mapping Procedure

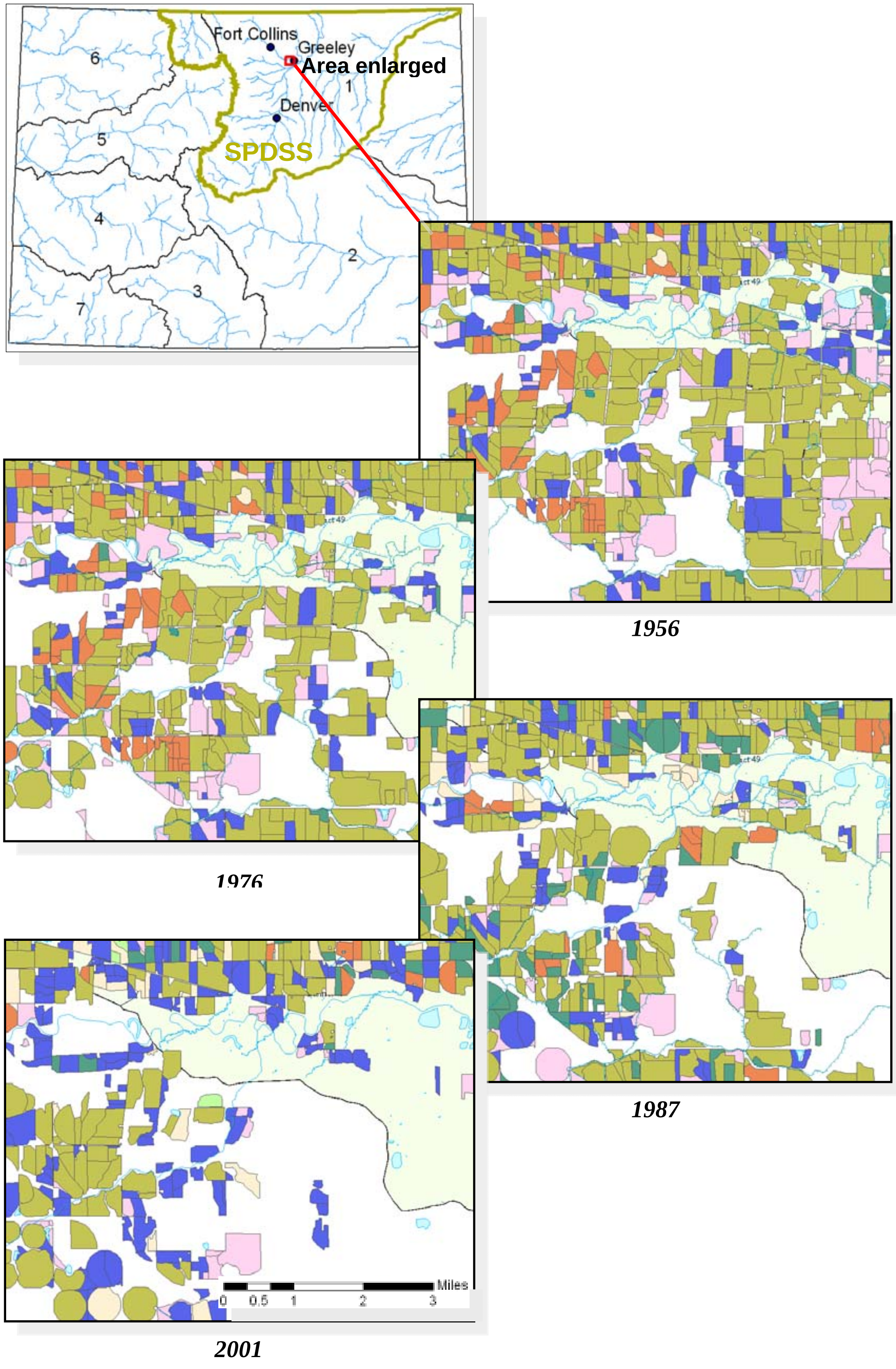


Figure 12. Example of Historic Change in irrigated acreage

Conclusions

This project classified and mapped current and historic irrigated areas and irrigation service areas for both ground and surface water in the South and North Platte River basins. The result is a comprehensive irrigated lands database for both areas. Parcels contain attributes that list the 2001 and historical crop types, water source, and comments or notes learned about the parcels. ***Figure 13*** is an example map of the irrigated parcels color-coded by the irrigated parcel and crop type attributes.

All data created for the South Platte Decision Support System Irrigated lands Assessment are in digital (GIS) format. Irrigated lands information can thus be used readily to generate high quality maps, summary statistics and reports to define irrigated acreages for the entire basin or an area of interest, and to assess this acreage by water district, by water source, and by crop type. Irrigated acreages can also be queried by other GIS information within the SPDSS. The creation of the detailed and very accurate information on irrigated lands presented in this Executive Summary provides water managers the ability to conduct very useful queries, assessments, and sophisticated analysis of the recent (2001) and historic structure of irrigated lands in the South and North Platte basins, and provides the foundation on which subsequent irrigated lands mapping will be based for many years. The first of these updates, which has been completed recently using 2005 imagery, is already being utilized to conduct high spatial and temporal resolution analysis of changes in irrigated lands and associated resource use. As well as supporting critical water resources modeling and management today, this Irrigated Lands Assessment will thus also have great utility to South Platte water managers into the future.

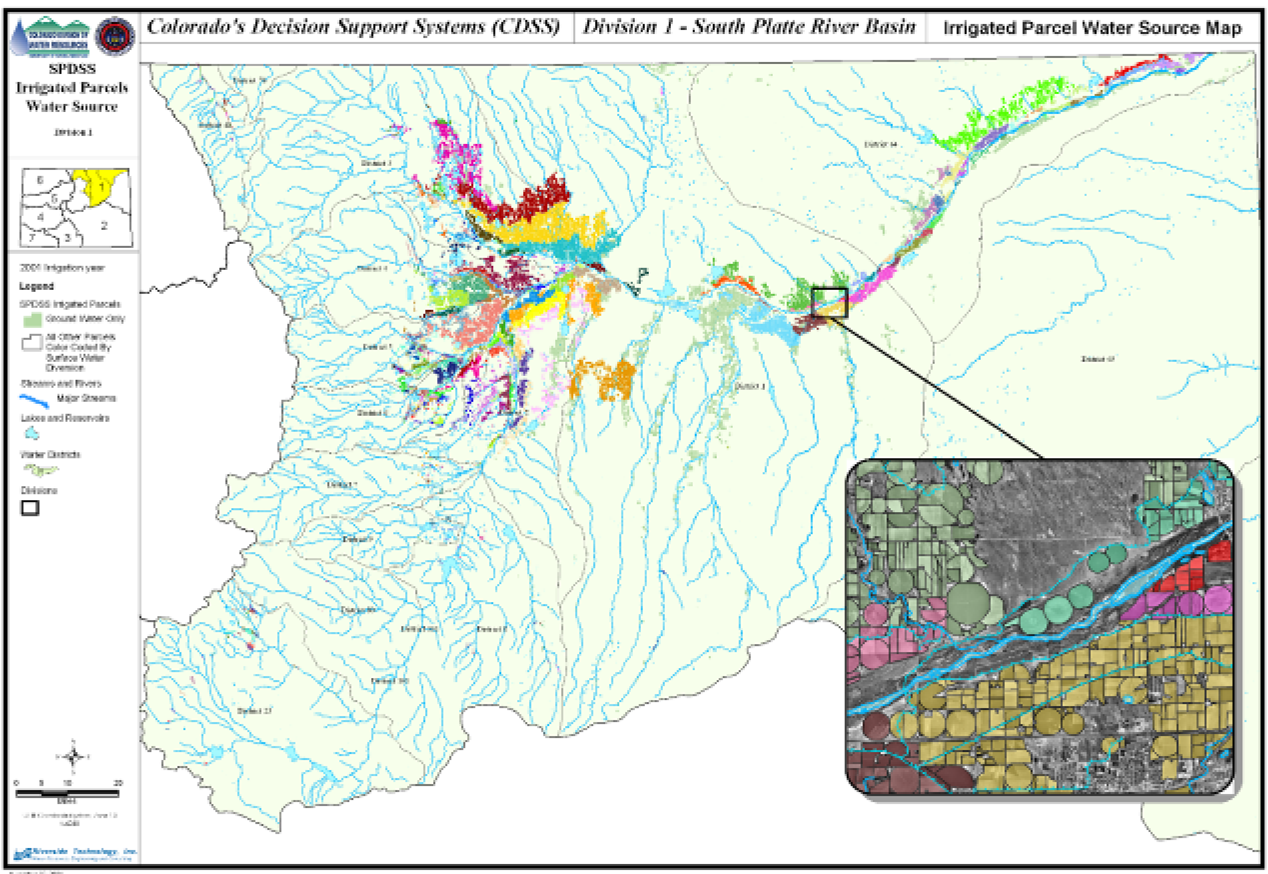


Figure 13. SPDSS Results - Example map illustrating SPDSS Irrigated Lands (Irrigation Service Areas and Crop Types)