

An analysis prepared as part of



Overview of Processes and Tools Developed in Support of the Quantitative Analysis for the Vivid Picture Project

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As part of the Vivid Picture project, the Ecotrust team conducted a comprehensive quantitative analysis about current conditions and plausible future scenarios. We developed a framework to support the plethora of analyses required, and constructed a set of tools to facilitate processing and analysis of data. This paper outlines the analytic framework and the individual analyses and supporting tools that function within the framework. Furthermore, the paper describes how the tools interact and identifies additional sources of information about individual analyses.

The framework itself can be thought of as an expert system, where a series of different data, assumptions and applications interact to help the Ecotrust team quantify differences resulting from different scenarios. Figure 1 represents a logical model diagram showing the interactions of the different components of the framework. In this diagram, gray boxes represent empirical data, spatial and non-spatial, about current conditions or future projections (e.g. county specific population projections). The green boxes represent assumptions or recommendations that help define a sustainable food system (i.e. what might be done differently such as increased eater awareness and increased consumption of healthy foods) and the pink boxes represent analytical processes or quantitative models such as an outlet placement model.

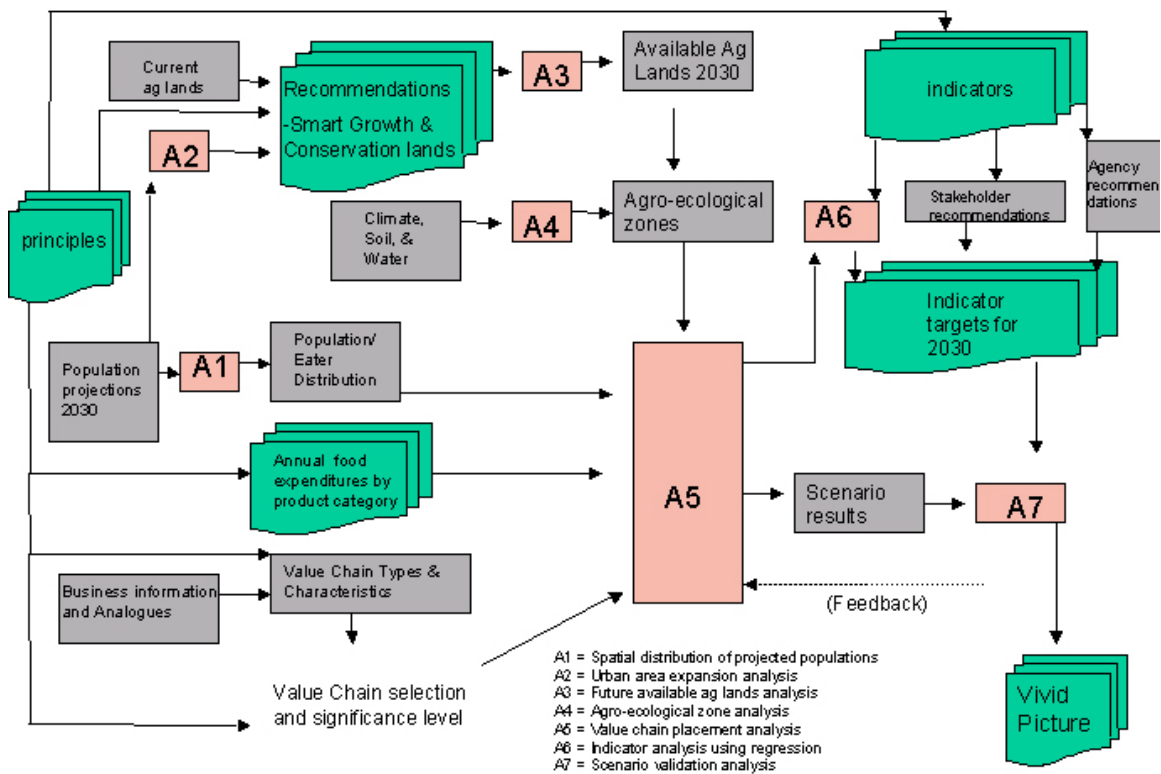


Figure 1. Analytic framework logical model

This paper focuses primarily on tools we developed to support the quantitative model elements in this flow chart (the pink boxes). Additionally, a data dictionary is included (appendix A) identifying key GIS data sets used in all the analyses. This data dictionary includes only key data layers used. A comprehensive data dictionary is available listing

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all data layers compiled for the Vivid Picture Project. All data sets are available to the ROC council. Additionally, comprehensive documentation of analytic methods and resulting data can be found in the materials provided to the ROC council as part of the Vivid Picture project deliverables.

At the core of our analytical approach is the placement of value chains on the landscape (A5). This analysis derived from a set of baseline conditions that constrain the value chains analysis. Wherever possible, we used existing data and research pertaining to landscape and population “givens”. Where data did not exist, however, analytic steps were used in defining the inputs to the value chains analysis. These analyses include a predicted population analysis (A1 from figure 1), urban area expansion analysis (A2), available agricultural lands analysis (A3) and agro-ecological zone analysis (A4 in figure 1). Once these givens/constraints are applied we follow with the value chain analysis. Finally, measurement of results are expressed as indicators and adjustments are made as feedback for model refinement (A6 and A7).

“The tool set” developed to support the analyses are software applications that draw on empirical data, results of spatial analysis and specific assumptions defined by users (generally guided by the qualitative process of the project). These applications have been developed using arc macro language (AML), a proprietary scripting language intended for the use of customizing ArcINFO, a major GIS developed by Environmental Systems Research Institute (ESRI). Appendix B lists all AMLs used in the analyses described in this paper, and all source code has been made available to the ROC council. It is important to note that these software programs are not stand-alone applications that could be run on desktops or online, but rather comprise an expert system housed on the Ecotrust GIS server.

In each analysis, parameters specific to that analysis are defined by data sets (e.g. differences between two urban expansion analysis scenarios) and by input files containing empirical data and assumptions (e.g. food outlet – distribution associations). Input files are read into computational processes by applications and are format dependent. If formatting changes, parameters will be interpreted incorrectly. For example, in the food outlet business rules table that depicts how outlets are placed on the landscape, the 4th and 5th column represent the maximum and minimum sales respectively. The computational process that places outlets assumes the 5th column will always be minimum sales which is critical in constraining the placement of outlets, therefore if another column is added (say at the beginning of the file) the program will interpret maximum sales as minimum sales (because maximum sales used to occupy the fourth column and now occupies the 5th column). Significant differences in placement of outlets would result. Appendix C lists all input files and analytic process associations.

Because some processes are dependent on defined parameters and outputs of other processes, the sequence and nature of the steps in which the overall analysis occurs are crucial. Generally speaking, the parameters for all landscape and population analyses must be defined by the analyst (as described below), while parameters for agro-ecologic zone analysis are derived iteratively: The predicted population analysis effects the urban area expansion analysis, which in turn effects the results of the available agricultural lands, and available agricultural lands effects the results of the agro-ecologic zone analysis. All landscape and population outputs/givens are then used to drive or constrain the value chain analysis. It is therefore crucial that all processes are run in the order listed in figure 1.

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Following is a brief description of each of the major analyses conducted within the analytic framework (A1 – A5), as well as reference to materials documenting their respective methods, programs (tools) and input data.

A1 and A2: Urban-Area Expansion and Projected Population Distribution Analysis

California’s projected population growth will be accommodated by a combination of increasing urban densities and/or expanding urban footprints. We calculated changes in agricultural capacity under a range of growth scenarios and prioritizations. Also, by spatially locating projected population growth within these urbanized areas, we were able to address questions related to future production and consumption, such as food access and levels of local purchasing.

The methods and results for these analyses can be found in “Estimating the Spatially Explicit Population Distribution and Urban Area Expansion in California for the Year 2030” (Mertens, 2005), included as one of the white papers delivered to the ROC council by the Vivid Picture team. In addition, an application was developed to allow for the evaluation of different growth scenarios. Like all other tools developed for the analytic framework, this application is part of an expert system comprised of a set of programs developed for running on top of ArcINFO. The programs are written in Arc Macro Language and are listed in appendix B.

A3: Available Ag Lands Analysis

Starting with California’s 28 million-acre agricultural land-base, we determined the locations, acreages and potential compensation costs associated with a range of ecological prescriptions – riparian buffer zones, wetland protections and wildlife corridors. Methods and results of this analysis are outlined in “Agricultural Lands Available for Production in 2030” (Gunnel, 2005) included as one of the white papers delivered to the ROC council by the Vivid Picture team. The analysis itself draws on specific data sets developed at the state-wide level (appendix A). This particular analysis was conducted as a single process, and is not designed to allow for the alteration of parameters; therefore there are no associated tools or input files.

A4: Agro-Ecological Zone (AEZ) Analysis

Looking at geophysical characteristics such as soils, temperature, precipitation, slope, and elevation, we classified growing conditions across the state and matched crops to agro-ecological zones. These classifications allowed us to describe crop-specific foodsheds for given levels of demand and to map the potential impacts of climate change and groundwater depletion. The intended use of the agro-ecological zone analysis as well as the Available ag lands analysis was to aid in identifying (in a spatially explicit manner) where food production types could be located. This analysis, however, was not fully realized due to data, time and budget constraints. It yielded, however, extremely valuable intermediary results for estimating probable conditions in the future, and can serve as a foundation for building spatially explicit production type placement scenarios. For additional information on the AEZ analysis please see “Agro-ecologic Zone Analysis and

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Evaluation of Correlated Crops in 2030 in California” (Mertens, 2005). Like the available agricultural lands analysis the AEZ analysis was conducted as a single process, with no consideration of alteration of parameters; therefore there are no associated input files. However, due to the complexity of the process, multiple programs were constructed to facilitate the analysis (appendix B).

A5: Value Chain Analysis

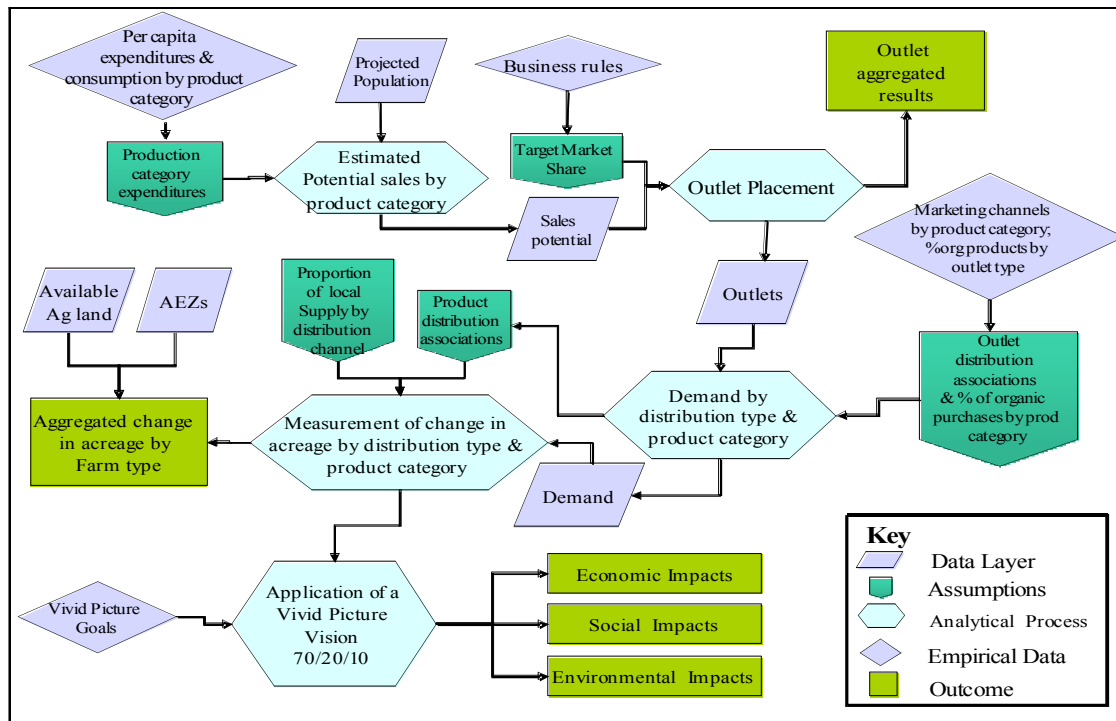
We developed a framework that defined interactions along supply chains for 168 food production types through 17 outlet types and 5 distinct distribution types. These interactions allowed us to describe characteristics such as employment, food access, and pesticide use for a range of food system scenarios. Methods and results of this work are described in the Value Chains white paper (Mertens, 2005). The framework itself was constructed to tell us numerous things about how different players of the food system interact on the landscape when “rules of the game” are shifted. Rules for consumers, production types, distribution types and food outlets were used to recreate relationships currently seen between these players in California’s food scene. New rules have been tested to attempt to show how actors in a sustainable food system might interact and what the environmental, social and economic impacts on the landscape of the envisioned system might be. These “rules” or characteristics are all outlined in detail in the Value Chains white paper referenced above.

These scenarios were tested with a suite of tools, again, developed using AML. The tools include programs for predicting distribution (and sometimes location) of different food system actors under different scenarios. Modification of scenarios is conducted through manipulation of a series of input files that define food system type characteristics and interactions. A list of these input files and their functions can be found in appendix C.

The process itself functions in a linear fashion that requires either data from previous analysis or these input files. Figure 2 illustrates the general process and key requirements underlying the value chain analysis. Data layers result either from previous analysis listed above (e.g. projected population) or are generated as part of the value chain analysis (e.g. outlets resulting from the outlet placement application). Data used are either obtained from empirical sources (e.g. business rules that define outlet types) or from assumptions informed by the qualitative process that allow us to test outcomes of different theories of change.

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Figure 2 Vivid Picture conceptual framework of food chain analysis



Outputs are expressed as GIS data sets often summarized within data tables. In terms of outputs pertaining to production types, we established a framework to store and summarize data. This information is stored within an excel workbook and has a series of macros built in for easy query and interpretation of results. All data, whether used as inputs to the analysis or outputs resulting from the analysis are available to the ROC council.

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References

Gunnell, Analisa Noel, “Agricultural Lands Available for Production in 2030.” White Paper No. 9 prepared for the Roots of Change Council and Fund, October 2005, Ecotrust.

Jaramillo, Carolina, Mike Mertens “Interactions of Food System Types in Localized Value Chains in California: Implications for a Sustainable Food System in California in 2030”. White Paper No. 11, prepared for the Roots of Change Council and Fund, October 2005, Ecotrust.

Mertens, Mike, “Estimating the Spatially Explicit Population Distribution and Urban Area Expansion in California for the Year 2030”. White Paper No. 8, prepared for the Roots of Change Council and Fund, October 2005, Ecotrust.

Mertens, Mike, “Agro-ecologic Zone Analysis and Evaluation of Correlated Crops in 2030 in California”. White Paper No. 10, prepared for the Roots of Change Council and Fund, October 2005, Ecotrust.

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Appendix A. List of data sets used in analytic processes

DataCategory	DataTitle	Description	Source
Demographic	Census 2000 Block Group Data	Census 2000 Block Group Data provides a seamless statewide GIS layer of census block groups with associated attributes that provide various demographic data.	U.S. Bureau of Census
Demographic	Census 2000 Block Data	Census 2000 Block Data provides a seamless statewide GIS layer of census blocks with associated attributes that provide various demographic data.	U.S. Bureau of Census
Demographic	Census 2000 tract Data	Census 2000 tract Data provides a seamless statewide GIS layer of census tracts with associated attributes that provide various demographic data.	U.S. Bureau of Census
Demographic	Urban and rural areas of California (1990)	The 'URBANRURAL' layer contains arcs and polygons that correspond to the U.S Census Bureau's urban/rural designations in California. These files were derived from the 1992 TIGER files (TIGER V5) for Teale Data Center by Geographic Data Technology, In	U.S. Bureau of Census
Demographic	Secondary and elementary school district boundaries	The 'K12DISTRICTS' layer identifies elementary, secondary and unified school district boundaries. The source for the data layer is the 1992 Census TIGER (Topologically integrated Geographic Encoding and Referencing)/Line files. The Census Bureau rele	Teale GIS Solutions Group
Demographic	Schools	The 'SCHOOLS' layer contains the locations and other data about schools in California. The source of this point coverage is the U.S. Department of Education database of school mailing addresses.	Teale GIS Solutions Group
Demographic	Public Post-Secondary Educational Institutions	The 'CALUNIVA' layer is a point coverage of California public post-secondary educational institutions. It includes University of California campuses, California State University campuses and community college campuses. It does not include private pos	Teale GIS Solutions Group
Demographic	PRISONSA	The 'PRISONS' layer is a point coverage of California adult correctional facilities. Addresses were obtained Corrections web site and geocoded with were then used to create a point coverage with Arc/INFO.	California Department of Correction
Geology and Soils	California STATSGO Databases	Soil maps are available for download. Included are ARC/INFO Coverages, Modified Digital Line Graph Optional (DLG-3) Files, GRASS 4.13 Vector Format Files (available only for Unix), .Descriptive attributes are in dBASE files or INFO tables for AR	Natural Resources Conservation Service
Geology and Soils	Soil	The CASOILS layer is the USDA/SCS STATSGO coverage and databases for the State of California as it existed in November 1999.	USDA, Soil Conservation Service
Hydrology	Department of Water Resources Water Districts	Represents the four administrative districts of the Department of Water Resources.	Teale GIS Solutions Group

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Hydrology	Federal Water Districts for California 1:24,000-scale	Federal Water District boundaries are areas where Federal contracts provide water to the district in California. This database is designed in as a regions polygon database and is updated when sufficient number of changes have occurred to warrant an update	U.S. Bureau of Reclamation coordination with the California Department of Water Resources
Hydrology	Private Water Districts for California 1:24,000-scale	Private Water District boundaries are areas where private contracts provide water to the district in California. This database is designed in as a regions polygon database and is updated when sufficient number of changes have occurred to warrant an update	U.S. Bureau of Reclamation coordination with the California Department of Water Resources
Hydrology	Regional Water Quality Control Boards	The boundaries of the 9 California Regional Water Quality Control Boards are derived from watershed boundaries in the The California Watershed Map (CALWATER version 2.2). Calwater 2.2 is a set of standardized watershed boundaries meeting standardized	Teale GIS Solutions Group
Hydrology	State Water Districts of California	State Water Project District boundaries are areas where state contracts provide water to the district in California. This database is designed as a regions polygon database and is updated when sufficient number of changes have occurred to warrant an update	U.S. Bureau of Reclamation
Hydrology	California Watersheds (CALWATER 2.2)	CALWATER provides a standard nested watershed delineation scheme using the State Water Resources Control Board numbering scheme. The hierarchy of watershed designations consists of six levels of increasing specificity: Hydrologic Region (HR), Hydrolo	California Department of Forestry and Fire Protection
Hydrology	Ground Water Basins	This represents the groundwater basins and sub-basins as defined by the California Department of Water Resources. Groundwater basins are designated on the basis of geological and hydrological conditions, these usually being the occurrence of alluvial	Teale GIS Solutions Group
Hydrology	Hydrographic Point	This represents hydrographic point features such as springs and wells and is derived from USGS (U.S. Geological Survey) DLG-3 (Digital Line Graphs) optional data format. The data was captured from 1- to 100,000-scale maps. Data was captured by manual	Teale GIS Solutions Group
Hydrology	COVERAGE HYDLCA – Major streams in California	This data set is extracted from USGS 1:100,000 DLGs for hydrology and merged into a single data set representing major streams in California. Major water bodies along streams, such as resevoirs, have been centerlined.	U.S. Bureau of Land Management
Hydrology	Hydrography	The hydrography layer consists of flowing waters (rivers and streams), standing waters (lakes and ponds), and wetlands – both natural	Teale GIS Solutions Group

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		and manmade. Two separate feature types are represented: polygons (areas) and lines. Polygon features have attributes	
Hydrology	Canals for California USBR at 1:24,000-scale	Canal system center lines in the Central Valley of California and adjacent areas captured from 1:24,000-scale USGS topographic maps. Updates and modifications made using USGS DOQQs.	U.S. Bureau of Reclamation, Mid-Pacific Region, MPGIS Service Center
Hydrology	Most Current Section 303(d) Listed Waterd - Waterbody Shapefiles	River segments, lakes, and estuaries designated under Section 303(d) of the Clean Water Act. Each State will establish Total Maximum Daily Loads for these waters. Most Current 303(d) Waterbodies coded onto NHD Waterbody reaches (region.rch) to create	U.S. Environmental Protection Agency
Hydrology	Inventory of Dams in BASINS	This dataset provides a locational map of 75,187 dams in the conterminous United States. The National Inventory of Dams was originally developed by the U.S. Army Corps of Engineers and the Federal Emergency Management Agency. It was developed to trac	U.S. EPA
Hydrology	Precipitation Zones: Mean Annual 1900-1960	Isohyetal lines of equal average rainfall were digitized from a 1:1,000,000 source map compiled by S.E. Rantz, U.S. Geological survey, 1969, 1972. The map is based on data covering the period 1900–60. rainfall zones were created by averaging the ra	California Department of Forestry and Fire Protection
Hydrology	Watershed Assessment 1:24,000 Hydrography	Developed by Watershed Assessment Program, in cooperation with the USDA Forest Service Remote Sensing Lab. Includes separate linear and polygon layers. The procedures were based on BLM's Oregon/Washington Hydrography Handbook using the LLID routing a	California Department of Forestry and Fire Protection
Hydrology	Watersheds (CALWATER 2.2)	CALWATER provides a standard nested watershed delineation scheme using the State Water Resources Control Board numbering scheme. The hierarchy of watershed designations consists of six levels of increasing specificity: Hydrologic Region (HR), Hydrol	California Department of Forestry and Fire Protection
Land Use/Ownership	Census 2000 Block Data	Census 2000 Block Data provides a seamless statewide GIS layer of census blocks with associated attributes.	California Department of Forestry and Fire Protection
Land Use/Ownership	Urbanized Areas from 2000 Census Block Data	Provides a seamless statewide GIS layer of urbanized areas, derived from 2000 census block data.	California Department of Forestry and Fire Protection
Land Use/Ownership	Tiger 2000 Transportation Layer - Rail Roads	This dataset is one from a series of transporation layers are derived from the US Census Bureau Tiger 2K (June 7, 2002 Version) information. All the layers are statewide and are arranged by their major Census Feature Class Code (CFCC). All data layer	California Spatial Information Library

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Land Use/Ownership	Tiger 2000 Transportation Layer - State Highways	This dataset is one from a series of transportation layers are derived from the US Census Bureau Tiger 2K (June 7, 2002 Version) information. All the layers are statewide and are arranged by their major Census Feature Class Code (CFCC). All data layer	California Spatial Information Library
Land Use/Ownership	Tiger 2000 Transportation Layer - U.S. Highways	This dataset is one from a series of transportation layers are derived from the US Census Bureau Tiger 2K (June 7, 2002 Version) information. All the layers are statewide and are arranged by their major Census Feature Class Code (CFCC). All data layer	California Spatial Information Library
Land Use/Ownership	COVERAGE NCAPCA – National Conservation Areas, California	Boundaries of the National Conservation Areas in California.	U.S. Bureau of Land Management
Land Use/Ownership	Land Ownership and Management for California	Land ownership and management of California, distinguishing local, state, and federal jurisdictions from private lands and delineating areas managed for the long-term maintenance of natural ecological processes and biodiversity. This layer therefore	University of California, Santa Barbara
Land Use/Ownership	Census 2000 Place Names	Census 2000 Place Names provides a seamless statewide GIS layer of places, including census designated places (CDP), consolidated cities, and incorporated places, with associated attributes.	California Department of Forestry and Fire Protection
Land Use/Ownership	Public and Conservation Lands (2003)	A 1:100,000 polygon features class representing public, conservation and trust land ownership in the state of California. Developed for the California Resources Agency's Legacy Project, this dataset depicts ownership features as submitted by major pu	California Resources Agency Legacy Project, Data developed under contract by VESTRA Resources, Inc
Land Use/Ownership	Roads	The roads layer contains several classes of transportation features including jeep trails, city streets, thoroughfares, unpaved roads, state highways, and interstates. Some of the data is 20 years old; therefore, care should be taken when using data	California Department of Fish and Game
Land Use/Ownership	Major Roads	This represents state, federal, and interstate highways which make up the major roads in CA. 'MAJOR ROADS' contains those arcs from the ROADS coverage for which the item ROUTE1 has a value. ROUTE1 designates the legislative route number for state, fed	Teale GIS Solutions Group
Land Use/Ownership	Railroads and miscellaneous transportation	This represents railroads and miscellaneous transportation features such as transmission lines, airports, pipelines, etc., and is based on the USGS DLG transportation linework derived from the DLG-3 1:100,000 scale digital data series. The coverage h	Teale GIS Solutions Group

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Land Use/Ownership	Tiger 2000 Transportation Layer - Local Roads	This dataset is one from a series of transportation layers are derived from the US Census Bureau Tiger 2K (June 7, 2002 Version) information. All the layers are statewide and are arranged by their major Census Feature Class Code (CFCC). All data layer	California Spatial Information Library
Land Use/Ownership	OWNPCABLM – BLM administered lands in California	This is a derived data set. It is derived from a set of one by one degree tiles of all ownership within California. This data set is not maintained in our standard Master data, but is re-derived automatically every time any one of the ownership data ti	US Bureau of Land Management
Land Use/Ownership	COVERAGE FACMCA – Facilities as point locations, BLM CA	BLM facilities (campgrounds, visitor centers, roads, etc.) in California.	U.S. Bureau of Land Management
Land Use/Ownership	grzpc - BLM grazing allotments in California	BLM grazing allotments in California.	U.S. Bureau of Land Management
Land Use/Ownership	Farmland Mapping and Monitoring Program GIS Data	This ftp site has land conversion coverages.	Division of Land Resource Protection
Land Use/Ownership	Land Use and Land Cover	Land Use and Land Cover (LULC) data consists of historical land use and land cover classification data that was based primarily on the manual interpretation of 1970s and 1980s aerial photography. Secondary sources included land use maps and surveys	U.S. Geological Survey
Land Use/Ownership	Development Footprint	This data layer is an attempt to spatially define the "footprint of development", which includes both residential and commercial development. FRAP has thoroughly analyzed various data layers to determine the preferred method for capturing development	California Department of Forestry and Fire Protection
Land Use/Ownership	Agricultural Preserves and Agricultural Contract Lands	Coverage of Agricultural Preserves/Agricultural Contracts	SANDAG
Other	County Boundaries (1:24000, from FRAP)	In late 1996, the Dept of Conservation (DOC) surveyed state and federal agencies about the county boundary coverage they used. As a result, DOC adopted the 1:24,000 scale Bureau of Reclamation dataset (USGS source) for their Farmland Mapping and Monitoring	CDF (using data from BOR and DOC FMMP)
Other	CalView Landsat Imagery Holdings	This product was created by the U.S. Geological Survey (USGS) and contains Landsat data files in Geographic Tagged Image-File Format (GeoTIFF). The Landsat 1, 2, and 3 satellites carried the multispectral scanner (MSS) sensors; the Landsat 4 and 5 sa	U.S. Geological Survey
Other	Digital Elevation Model (30 meters)	The DEM lattices were imported from 1:24,000 Digital Elevation Models (DEMs) developed by the US Geological Survey (USGS). Each DEM represents 7.5' x 7.5' on the ground, and contains elevation postings	Teale GIS Solutions Group

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		every 30 meters. The DEMs are considered lattice	
Other	Public Forecast Zones from WSOM Chapter C-11	This data set contains Public Forecast Zones for CONUS and Non CONUS.	National Weather Service

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Appendix B. List of programs developed for analytic and data processing

Program Name	Application Group	Description
calc_d_grids.aml	value chain analysis	aml for creating a demand grids associated with specific scenarios
calc_eaterTypes.aml	value chain analysis	aml developed for relating census output files to a census boundary block coverage and calculating eater groups based on defined parameters
combine_els.aml	AEZ analysis	aml developed for transforming input data for aez classification in preparation for an unsupervised classification in Imagine.
place_outlets.aml	value chain analysis	aml for placing outlets according to outlet type and associated business rule table.
pred_pop.aml	predicted population	aml developed for spatially distributing predicted population by demographic
prod_zones.aml	AEZ analysis	reclasses production zones according to probabilities for each production type extracted from param input file and calcs land value by product category
run_assocs.aml	AEZ analysis	runs crop - aez associations and creates a new table that represents our crop-aez matrix
sum_o_chars.aml	value chain analysis	aml developed for summing characteristic results of outlets for different scenarios
sum_o_sales.aml	value chain analysis	aml for determining demand of distribution areas by type and product
test_pop.aml	predicted population	aml developed for testing various population statistics
ua_expansion.aml	predicted population	aml developed for expanding urban areas based on predicted population growth (run with pred_pop).

Appendix C. List of framework input tables and column formats

(detailed descriptions of table data can be found in respective white papers)

Table name: outlet_dist.csv

Table Description: outlet distribution association table

Program association: required input for sum_o_sales.aml

Column headings and format

- Outlet Type Code
- Commodity Category Code
- Distribution Name
- Proportion of product distributed through distribution type by outlet type
- Distribution ID
- Proportion Local purchases

Table name: bus_rules.csv

Table Description: Outlet placement rules table

Program association: required input for place_outlets.aml

Column headings and format

- outlet_type
- proportion of total sales within trade area
- general business rule
- maximum sales
- minimum sales
- maximum trade area
- minimum trade area
- Outlet Type Code

Table name: o_prod_prop.csv

Table Description: outlet product proportions table

Program association: required input for place_outlets.aml

Column headings and format

- Outlet Type Code
- product
- proportion of total sales represented by product
- outlet_type

Table name: o_chars.csv

Table Description: outlet characteristics

Program association: required input for sum_o_chars.aml

Column headings and format

- Outlet Type Code
- Average wage
- number of employees
- ownership type