Front Range Infrastructure Resources Project Land Characterization Activities

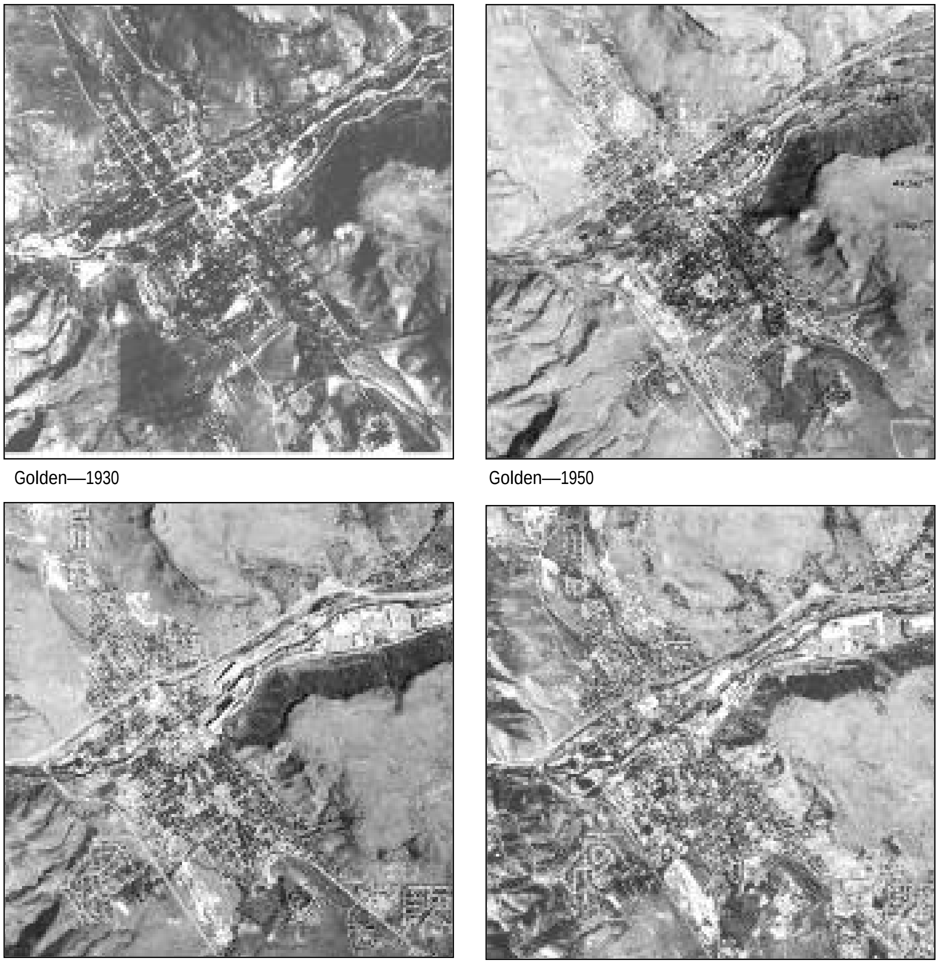
Infrastructure construction and maintenance are critical to a community's sustainability and vitality. Rapid population growth has resulted in inadequate infrastructures in communities in many areas of the country. Building and maintaining the infrastructure, such as roads and buildings, require large volumes of three natural resources: aggregate (primarily crushed stone, sand, and gravel), water, and energy. As urban areas expand, local sources for these resources become depleted, inaccessible, and more costly to recover. Because of exploding population growth, the Denver metropolitan area must now deal with conflicting claims between urbanization and preserving the natural resources needed to sustain urbanization (fig. 1).

Figure 1. Suburban expansion results in competing use of the land (agriculture and gravel extraction).

Background

Between 1991 and 1997, Colorado became the Nation's fifth fastest growing state. Most of the new growth occurred along the Front Range, from the eastern foothills of the Rocky Mountains to the short-grass prairies of the high plains, called the Colorado Piedmont. The U.S. Geological Survey's (USGS) Front Range Infrastructure Resources project (FRIRP) is generating information on the natural resources critical for the infrastructure needed by growing urban areas and developing methodology to help in the planning process. Land characterization models will help both the technical and nontechnical person understand the nature of the land and make informed decisions and assessments. The project, which began October 1, 1996, is focused on a demonstration area in the northern Colorado Front Range urban corridor. The demonstration area includes most of the Denver metropolitan area and the rapidly growing areas to the north in western Adams County, eastern Boulder County, southeastern Larimer County, and southwestern Weld County. Subsequent studies will expand the area to the entire Rocky Mountain Front Range urban corridor (from Cheyenne, Wyoming, to Pueblo, Colorado).

A dichotomy does not exist between the physical and human environment; they must be studied together. Humans have no control over the occurrence of resources; often the occurrence of a single resource rather than a diversity of resources affects the development of urban areas. The Denver metropolitan area developed because of one important resource — gold. Agriculture developed as a response to the increasing populations of gold seekers. The development of the agriculture patterns (large cooperatives to build irrigation canals) developed as a response to the physical environment (good soils needing irrigation). Understanding the interrelationship of the landscape with human activity, how it has changed (fig. 2), and how it might continue to change is important in the urban environment, for it is in the urban environment that humans' impacts on the physical environment are most evident.



Golden—1930 Golden—1950 Golden—1970 Golden—1990

Figure 2. Aerial photos of Golden from 1930 to 1990. Understanding urban trends with a temporal database facilitates decision-making processes.

Critical Landscape Characteristic Components

The USGS, along with local entities, is identifying those critical components that define the landscape along the Front Range. The physical characteristics of the earth, air, water, and ecology intermingle with human settlement patterns of yesterday and today. The causes, timing, types, impacts, and extent of change vary from place to place. Local changes in land use can have effects that ripple throughout a larger region. The combination of local and Federal data resources will enable the project to yield credible and comprehensive insights into the character and impacts of land use change, insights that can contribute to plans for creating a balance between urban growth and environmental protection. Understanding how and why an urban area has developed can aid in understanding how the region may continue to grow. A temporally consistent database is essential for the project. Existing geographic features over the study area range in age from the 1950's to the 1990's. A revision of these features is necessary to model the current conditions in the area. The temporal database resulting from this project will document the urban land transformation (fig 3). The database can be used by urban and regional planners, policy and decision makers, and earth scientists to measure trends in urban sprawl, analyze patterns of water pollution and sedimentation, understand how development affects ecosystems, and develop predictive modeling techniques to better forecast future areas of urban growth.

A geographic information system (GIS) will integrate the data generated by the project. A temporally consistent reference for all the project data is provided by the base cartographic data layers. By combining the physical characteristics of the land with the human settlement patterns, we can achieve a more accurate and comprehensive depiction of the landscape, which can help communities make decisions regarding growth and its impacts.

The database framework will include the following:

Base Cartographic Data Layers

- transportation networks
- surface hydrography
- administrative boundaries
- elevation
- manmade structures
- township, range, and section lines (Public Land Survey System)

Physical Characteristics of the Land:

- soils
- engineering properties of the geologic structure
- ground-water availability
- depth to water table
- water table thickness
- aggregate (sand and gravel) availability and quality
- oil and gas quantity and quality
- environmental impacts of oil and gas production
- locations of abandoned coal mines and depth of coal mines
- vegetation communities
- species communities
- rankings of slope

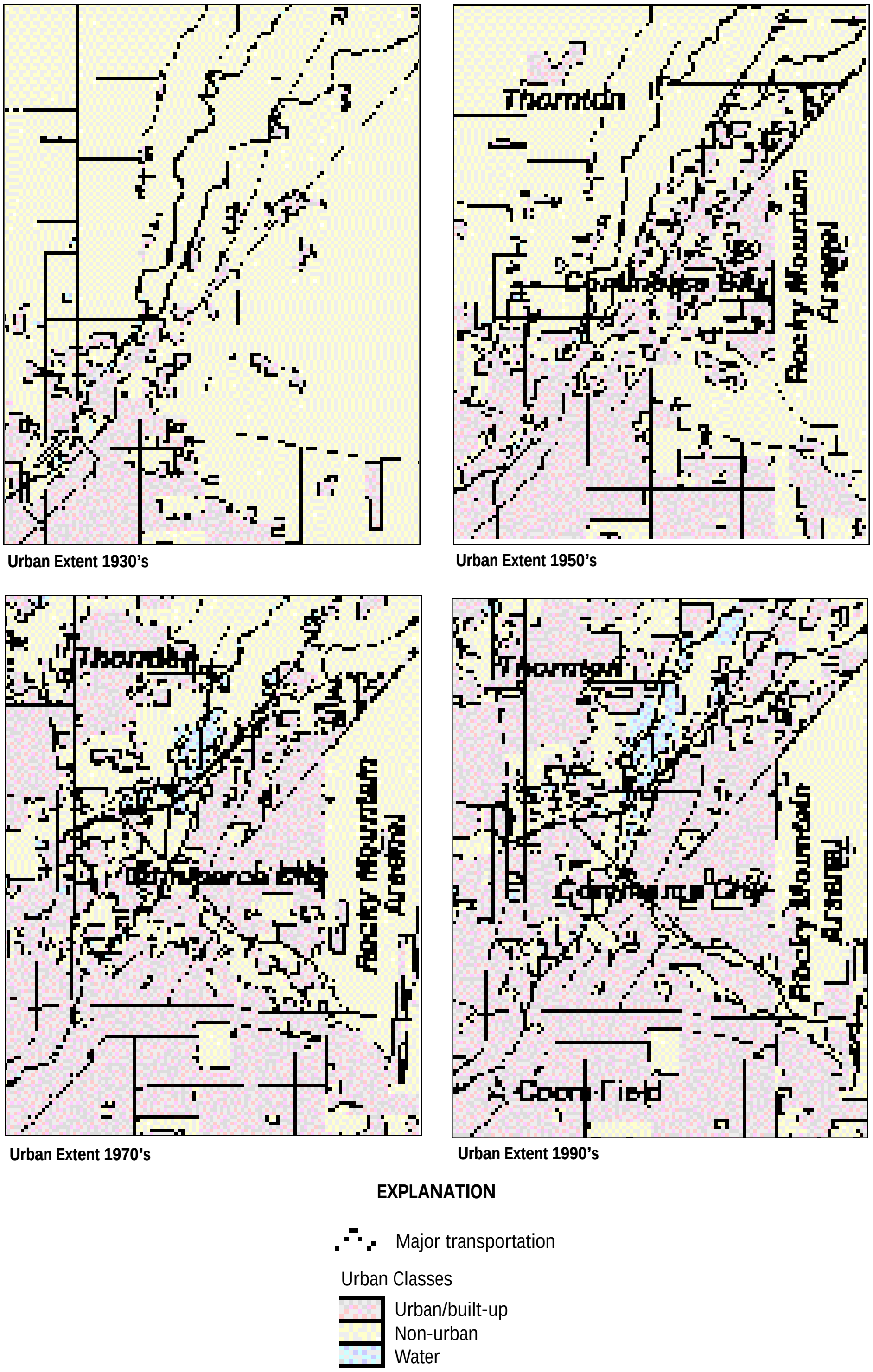


Figure 3. Visualizing urban growth through time. Commerce City, Colo.

Human Induced Characteristics of the Land:

- 1930's land use and land cover data
- 1950's land use and land cover data
- 1970's land use and land cover data
- 1990's land use and land cover data
- urban growth scenarios
- population demographics, including:
  number of potential new jobs
  number of school-aged children
  effects on current transportation networks

Land cover data contain information about what is on the surface of the land (for example, deciduous forest). In the urban environment, what is on the surface of the land is captured in terms of how the land is being used (for example, single family residential).

Group Spatial Decision Support System

Decisions regarding land and natural resources are often complex and emotionally charged. Different parties often have varied interpretations of a proposed change. As part of the FRIRP project, the USGS is developing a Group Spatial Decision Support System (GSDSS) (fig. 4). A GSDSS is a software package that combines the natural resource information obtained from the FRIRP with socioeconomic information obtained from a local entity, such as the Denver Regional Council of Governments, to aid planning agencies in making land use decisions. For example, if a proposal to put in a new subdivision were under review, planners might view species habitats, geology, soils, water, and energy information plus socioeconomic information, such as number of potential new jobs, impacts on current transportation networks, and increase in the number of school-aged children. Using the GSDSS, planners will be able to create different scenarios and easily see how each one may create varying levels of impact on an area; they will then make decisions that are based on the impacts of implementing a proposed change.

Information

For more information on the project visit our web site at: http://webserver.cr.usgs.gov/frirp/FRIRP.html.

For more information on the individual aspects of the project contact any of the following:

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For information on other USGS products and services, call 1-800-USA-MAPS, use the EARTHFAX fax-on-demand system, which is available 24 hours a day at 703-648-4888, or visit the general interest publications Web site at http://mapping.usgs.gov/www/products/mappubs.html.

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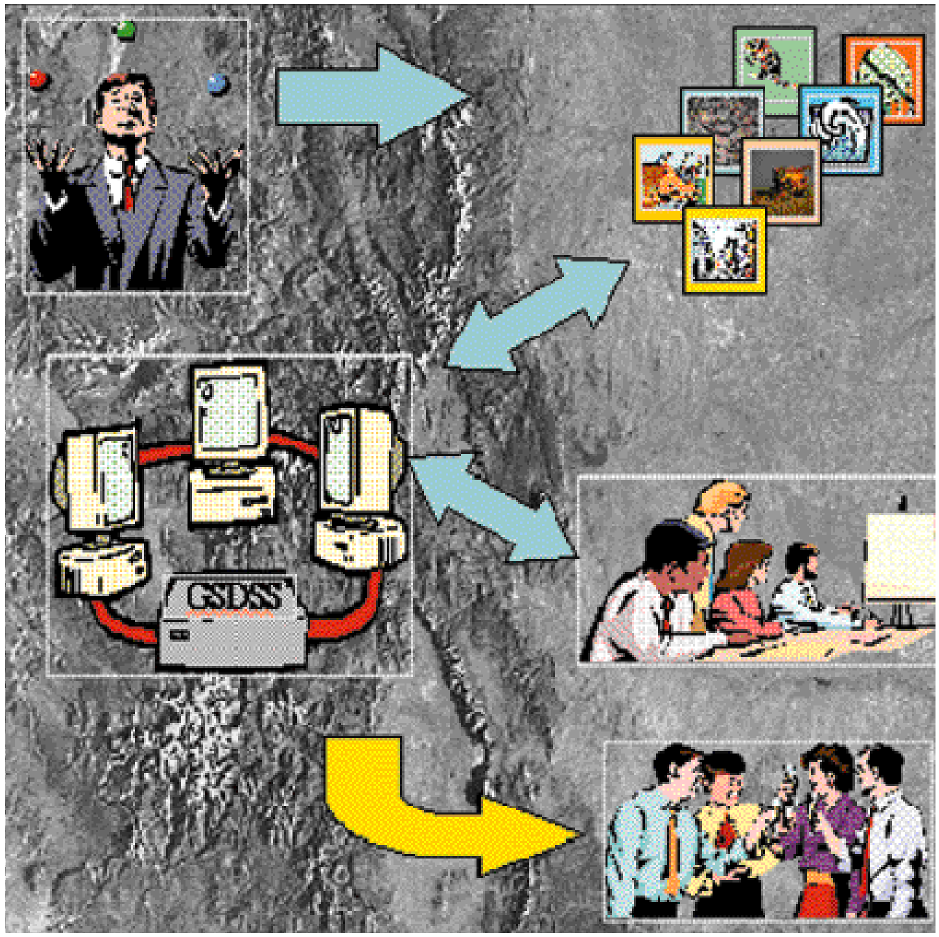

Figure 4. GSDSS brings together natural resource and socioeconomic information to aid planning agencies in making land use decisions.