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VEGETATION AND LAND USE IN NEW MEXICO

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INTRODUCTION
The primary purpose of this study was to map the vegetation and land use patterns of New Mexico insofar as they may be observed or inferred from small-scale satellite imagery. Land use, major landforms and geologic features were also mapped. Landsat (formerly designated as "ERTS," Earth Resources Technology Satellite) imagery constitutes the mapping base. Boundaries between vegetation categories meet U.S. Geological Survey Topographic Division mapping standards for accuracy at 1:1,000,000 scale. Transition zones between vegetation categories are less accurately mapped because of the overlapping nature of dominant species. Nevertheless, these boundary delineations are more exact than would have been possible without photographic control. Satellite imagery makes possible the acquisition of data over vast areas at one time. A comparative interpretation was applied to a uniform statewide base, resulting in a consistent map of patterns of vegetation and land use in New Mexico.

Before compiling this map, all existing maps showing vegetation of New Mexico were studied. The several published maps by various Federal and State agencies were useful for their intended purposes but were not designed for broader use. In some cases, data sources were not indicated, in others, the map categories were poorly defined. In all cases the accuracy of category boundary lines was unknown because a photographic base had not been used in the mapping.

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COMPILATION
This map was prepared directly from 24 separate Landsat color composite transparencies at the scale of 1:1,000,000. The color composites were made by the EROS (Earth Resources Observation Systems) Data Center in Sioux Falls, South Dakota, from bands 4, 5, and 7 (visible green, visible red, and infrared bands, respectively).

The initial interpretation was made by drawing boundary lines on a mylar overlay of New Mexico; topography and color changes were the basis for delineation. Classifying vegetation types or identifying land use patterns was not attempted at that time. After each image had been studied and compiled on the overlay, the map was reexamined to correct the boundaries and to make sure they crossed consistently from one image to another.

The next step was to identify and categorize the patterns according to vegetation type, land use, and landform. Vegetation types follow the style employed by Kuchler (1964) on his map of *Potential Natural Vegetation of the Conterminous United States* with modifications due to local conditions. The New Mexico map, however, shows actual vegetation and not potential natural vegetation. Decisions on vegetation types were based on personal knowledge of the state along with knowledge of the general vegetation relationships in the Southwest. Maps from existing sources were consulted for appropriate areas. Land use and topographic data derived from the Landsat images are superimposed on the vegetation data.

The Landsat map was field checked for accuracy by conducting reconnaissance along more than 4,200 mi of major and secondary highways. The vegetation category boundaries were found to be accurate, particularly in forested regions where changes in cover type proved to be within several hundred meters of their plotted positions. Boundaries plotted between transitional types of vegetation were less accurate.

In general, the boundaries proved to be more accurate than the original identification of the vegetation. Although correctly delineated, several areas were incorrectly classified; in some cases, after field checking, entire categories were added or deleted from the original compilation. In other areas, a single vegetation type did not predominate. In these areas, striped patterns were used to denote two or more dominant types, without attempting to show dominance of one species.

Vegetation types were identified by three factors: vegetation type, land use, and landform. Vegetation types are shown in color. Land use patterns are defined by letters or symbols; landforms, by numbers or a symbol. For example, G4 denotes grazing on gently rolling to flat terrain. A5 denotes agriculture on river bottoms, and R1 denotes recreation in mountains or hills.

VEGETATION TYPES
Vegetation types are organized into the following physiognomic groupings: forests and woodlands, shrublands and shrub savanna, grasslands and steppes, cultivated, and barren.

Forests and woodlands include evergreen, deciduous, and mixed genera. The deciduous types are found almost exclusively along stream and river channels while the evergreen and mixed types occur predominantly in mountain environments.

Shrublands and shrub savanna have a distinct physiognomy and a vastly different economic use. Shrubs are normally less than 2 to 3 meters high and much branched at the base. Furthermore, shrub savanna areas usually contain large areas of grass and are concentrated in the lowlands and foothills in the drier southern half of the state.

Grasslands and steppes cover a large portion of the state. Grasslands include several typical high plains grasses and also include two types of meadows at higher elevation: alpine (exposed mountain tops) and intermontane (valleys protected by surrounding mountains). Steppes include a shrub steppe (grasses and semiarid shrubs) and a semi-arid steppe (kerophytic species dominated by yucca and cholla).

Cultivated includes irrigated agriculture, dry-land agriculture, and orchard crops. Irrigated agriculture and dry-land agriculture, although often highly intermixed, are easily delineated on Landsat imagery on the basis of color. Irrigated fields appear bright red during the growing season while dry-land fields are tan to light brown. The orchard crops also appear bright red but are easily differentiated, being confined mainly to a few narrow mountain valleys.

Barren contains a few widely scattered plants but, for the most part, is devoid of vegetation. Included are playa lakes, sand dunes, and major lakes and reservoirs.

The last (diagonal) lines inserted between names of vegetation types denote "and/or." Multiple names indicate that the area may be occupied by one, or any combination, of the names listed. The common names for the vegetation types are followed in the same sequence in parentheses by their scientific names.

LAND USE
Nine categories of land use are shown on this map: agriculture, forestry, grazing, military, recreation, mining, petroleum production, urban, and no dominant use.

Agriculture, broadly defined as land used for the production of food and fiber is easily identified on satellite imagery by areas having geometric or regular shapes. Further subdivision into irrigated agriculture and dry-land agriculture is made by means of color. Orchard crops appear in narrow valleys and appear in the same color as irrigated crops.

Forestry is a multiple-use category. Besides the normal forestry activities, these lands are also being used to a significant extent for recreation and grazing.

Grazing, by far the dominant land use activity in the state, takes place in nearly all grasslands and lowland areas as well as in many of the mountain areas.

The **Military and recreation** categories were plotted from published maps, because these land uses are seldom visible on the imagery. However, the difference in land use within these areas is often striking, especially in the case of military reservations. Recreation boundaries are drawn around wildlife refuges, wilderness areas, and national parks and monuments. Some of the recreation areas shown are known to support a large amount of recreational activities even though not included in designated wilderness or park areas.

Mining and petroleum development (including mineral, mineral fuel, and petroleum product removal) are shown wherever visible on the imagery (the symbols indicate regions, not specific sites). Other known mining activities that could not be detected on the imagery are not included.

Urban areas are shown mostly for geographic reference; their boundaries extend to city limits.

No dominant use areas are restricted mainly to high mountains, playalakes, and lava flows—areas that are barren or nearly barren vegetation or where rough terrain precludes grazing, farming, or other dominant use.

LANDFORMS
Nine categories of landforms are identified on the imagery: mountains and hills, dissected surfaces, bajada surfaces, gently rolling to flat terrain (including mesa tops), river bottomlands, scarps, lava flows, closed basins, and volcanic cones.

Mountains and hills are easily identified by structure as well as by almost exclusively on these landforms, while piñon/juniper occupy the lower mountain slopes, foothills, and flatlands.

Dissected surfaces have dense drainage networks and much gully erosion. Gully and stream networks are easily identified on the satellite imagery and have a significant effect on land use.

Bajada surfaces consist of coalesced alluvial fans, which are gently sloping depositional surfaces formed where intermittent streams issue from a mountain valley onto a plain. Bajadas are generally bouldery near their tops (adjacent to mountains) and grade downlope into sand and silt.

Gently rolling to flat terrain denotes undulating terrain characteristic of the Great Plains but does not include the foothills of mountains.

River bottomlands include all river and stream channels and floodplains visible on the imagery. These areas characteristically use irrigated agriculture along with groves of cottonwood/willow/tamarisk.

Scarps are shown in two ways. Gently inclined scarp faces wide enough to support vegetation mappable on the satellite imagery are labeled with the numeral 6. Where other prominent scarps are present, but too steep to map on the imagery, the scarp symbol is used (hachures drawn on scarp-face side). Not all the scarps in New Mexico are shown, but the great majority of those visible on the imagery are included.

Lava flows are much more extensive than shown on the map, but due to differing ages, composition, stages of erosion, and vegetation cover, many of the older flows are difficult to identify on map.

Closed basins are extensive, depressed areas without surface outlets and into which the adjacent lands drain. Closed basins in New Mexico are usually occupied by playa lakes.

Volcanic cones are roughly circular or conical hills or mountains standing above the lava flows.

CORRELATION WITH U.S.G.S. CLASSIFICATION SCHEME
A land use classification system was developed by Anderson, Hardy, Roach, and Witmer (1976) for use with remote sensor data (table 1). Their purpose was to provide a comprehensive system, yet general enough for nationwide land use mapping. The system was designed for level I and II mapping and was deliberately left open ended so that level III and level IV may be used by local authorities to fit their particular needs.

We were able to map vegetation by inference, experience, and field examination to level III. Care was taken to structure our justification so that each category has a level I and II equivalent in the U.S. Geological Survey scheme (table 2). This correlation does not show a level-by-level comparison between the two systems but rather gives rough equivalents that allow comparison of our categories with maps that use the U.S.G.S. scheme. The New Mexico categories are not organized by levels, whereas the U.S.G.S. scheme is organized into two distinct levels.

REFERENCES
Anderson, J. R., Hardy, E. E., Roach, J. T., and Witmer, R. E., 1976, A land use and land cover classification system for use with remote sensor data. U.S. Geol. Surv., Prof. Paper 964, 28 p.
Castner, E. F., 1956, The vegetation of New Mexico: The New Mexico Quarterly, vol. 26, p. 256.
Gay, C. W., Jr., Dwyer, D. D., and Steger, R. E., 1970, New Mexico range plants: New Mexico State Univ., Ext. Service Circ. 374, 85 p.
Judd, B. I., 1962, Principle forage plants of southwestern ranges: Rocky Mountain Forest and Range Exp. Sta., Sta. Paper No. 69, 93 p.
Kuchler, A. W., 1964, Potential natural vegetation of the conterminous United States: Am. Geog. Soc., Spec. Pub. No. 16, 116 p.
Leitch, H. L., Yarett, L. L., and Shiflet, T. N., 1971, 100 native forage grasses in 11 southern states: U.S. Soil Conservation Service, Agric. Handbook No. 389.
Little, E. L., Jr., 1968, Southwestern trees, a guide to the native species of New Mexico and Arizona: U.S. Forest Service, Agric. Handbook No. 9, 169 p.
Maker, H. J., Drege, H. E., Link, V. G., and Anderson, J. U., 1974, Soils of New Mexico: New Mexico State Univ., Agricultural Exp. Sta. Rept. 285, 132 p.
State Engineer and Interstate State Commission, 1968, New Mexico State water plan: land use: State of New Mexico, map scale 1:400,000 U.S. Bureau of Reclamation, 1968, New Mexico State water plan, land ownership, and administration: U.S. Dept. Interior, map scale 1:500,000 U.S. Forest Service, 1974, Field guide to native vegetation of the southwestern region: U.S. Dept. Agriculture, 100 p.
U.S. Geological Survey, 1968, State of New Mexico base map: U.S. Dept. Interior, map scale 1:1,000,000 U.S. Soil Conservation Service, 1974, Vegetation map of New Mexico: U.S. Dept. Agriculture, map scale 1:333,333 Wilder, J. W., and Kleckner, R., 1974, Using remote sensor data for land use mapping and inventory: a user guide: U.S. Geol. Surv., Interagency Rept. USGS253, 58 p.

TABLE 1—LAND USE AND LAND COVER CLASSIFICATION SYSTEM FOR USE WITH REMOTE SENSOR DATA

Level I	Level II
1 Urban or built-up land	11 Residential
2 Agricultural land	12 Commercial and services
3 Rangeland	13 Industrial
4 Forest land	14 Transportation, communications, and utilities
5 Water	15 Industrial and commercial complexes
6 Wetland	16 Mixed urban or built-up land
7 Barren land	17 Other urban or built-up land
8 Tundra	21 Cropland and pasture
	22 Orchards, groves, vineyards, nurseries, and ornamental horticultural areas
	23 Confined feeding operations
	24 Other agricultural land
	31 Herbaceous rangeland
	32 Shrub and brush rangeland
	33 Mixed rangeland
	41 Deciduous forest land
	42 Evergreen forest land
	43 Mixed forest land
	51 Streams and canals
	52 Lakes
	53 Reservoirs
	54 Bays and estuaries
	61 Forested wetland
	62 Nonforested wetland
	71 Dry salt flats
	72 Beaches
	73 Sandy areas other than beaches
	74 Bare exposed rock
	75 Strip mines, quarries, and gravel pits
	76 Transitional areas
	77 Mixed barren land
	81 Shrub and brush tundra
	82 Herbaceous tundra
	83 Bare ground tundra
	84 Wet tundra
	85 Mixed tundra
	91 Perennial snowfields
	92 Glaciers

TABLE 2—CORRELATION OF NEW MEXICO CATEGORIES WITH U.S. GEOLOGICAL SURVEY SCHEME

U.S.G.S. Professional Paper 964		New Mexico categories
Level I	Level II	
1 Urban or built-up land	16 Mixed	Urban areas
2 Agricultural land	21 Cropland and pasture	Irrigated agriculture Dryland agriculture
	22 Orchards, groves, vineyards, nurseries, and ornamental horticultural areas	Orchard crops
3 Rangeland	31 Herbaceous	Grama/galleta steppe Grama/buffalo grass "shortgrass prairie" Intermontane meadows
	33 Mixed	Great Basin sagebrush Saltbush/greasewood Creosote bush/tarbrush Scrub oak Grama/tobosa/mesquite shrub steppe Yucca/cholla
4 Forest land	41 Deciduous	Cottonwood/willow/tamarisk
	42 Evergreen	Spruce/fir Pine/fir Piñon/juniper Juniper/oak
5 Water	52 Lakes	Major lakes and reservoirs
	53 Reservoirs	
7 Barren land	71 Dry salt flats	Playa
	73 Sandy areas other than beaches	Sand dunes
8 Tundra	85 Mixed	Alpine meadows

VEGETATION

FORESTS AND WOODLANDS

- Southwestern spruce/fir (*Picea/Abies*)
- Pine/Douglas fir (*Pinus/Pseudotsuga*)
- Piñon/juniper (*Pinus/Juniperus*)
- Juniper/oak (*Juniperus/Quercus*)
- Cottonwood/willow/tamarisk (*Populus/Salix/Tamarix*)

SHRUBLANDS AND SHRUB SAVANNA

- Great Basin sagebrush (*Atriplex*)
- Saltbush/greasewood (*Atriplex/Sarcobatus*)
- Creosote bush/tarbrush (*Larrea/Flourensia*)
- Scrub oak (*Quercus*)

GRASSLANDS AND STEPPES

- Grama/galleta steppe (*Bouteloua/Hilaria*)
- Grama/tobosa/mesquite shrub steppe (*Bouteloua/Hilaria/Larrea/Prosopis*)
- Alpine meadows
- Intermontane meadows
- Grama/buffalo grass "shortgrass prairie" (*Bouteloua/Buchloe*)
- Yucca/cholla (*Yucca/Opuntia*)

CULTIVATED

- Irrigated agriculture
- Dry-land agriculture
- Orchard crops

BARREN

- Playa
- Sand dunes
- Major lakes and reservoirs

Note—Striped map patterns indicate areas with a mixture of dominant vegetation types rather than a single type

LAND USE

- A. Agriculture
- F. Forestry
- G. Grazing
- M. Military
- R. Recreation
- X. Mining
- U. Petroleum production (*Bouteloua/Buchloe*)
- U. No dominant use

LANDFORMS

- 1. Mountains and hills
- 2. Dissected surfaces
- 3. Bajada surfaces
- 4. Gently rolling to flat terrain (including mesa tops)
- 5. River bottomlands
- 6. Scarps
- 7. Lava flows
- 8. Closed basins
- 9. Volcanic cones

Boundaries for areas of differing vegetation, land use, or landform

Boundaries for military reservations, wildlife refuges, wilderness areas, and national parks and monuments

Scarps (barbs on downhill side)