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THE NATIONAL PRESS / PALO ALTO, CALIFORNIA
Figure 1

Figure 2
THE CHANGING FORM AND STRUCTURE OF THE SOUTHERN CALIFORNIA METROPOLIS

RICHARD E. PRESTON
San Fernando Valley State College

PART I*

The framework of a giant, sprawling, super-city has emerged in Southern California. Housing approximately 12 million persons, its urban landscape is scattered over 13,000 square miles and stretches along the Pacific Ocean for 300 miles between northern Santa Barbara County and the Mexican Border. This new regional city is focused on a narrow coastal strip and in adjacent mountain valleys, and has taken on the form of a loosely knit complex of people, commerce, and industry—all fused in a single system by highly developed freeway and communication networks, a common technology, and numerous shared values.¹

The prime city is Los Angeles, but the overall pattern is polynuclear. There are five distinct metropolitan sub-systems in addition to Los Angeles-Long Beach; namely, Santa Barbara, Oxnard-Ventura, Anaheim-Santa Ana-Garden Grove, San Bernardino-Riverside-Ontario, and San Diego (Figure 1). All are related within the structure of the regional economy and all lie within the sphere of influence of Los Angeles but, at the same time, each is separate and dominates its own cluster of lesser cities.

This report considers: (1) how, and some of the reasons why, the urban landscape presently existing in Southern California has evolved; (2) recent spatial trends contributing to the form and structure of Greater Los Angeles; and (3) some broader implications of this example of urban development.

URBAN DEVELOPMENT IN SOUTHERN CALIFORNIA SINCE 1940

In this section, the study area is viewed from two perspectives. One perspective is based on the expanding built-up portions of Santa Barbara, Ventura, Los Angeles, Orange, San Bernardino, Riverside, and San Diego Counties, while a second angle is gained by examining data for the seven counties as a whole. Both areas are referred to here as the “Southern California Metropolis.”²

Population Change

Total population has grown rapidly in the Southern California Metropolis and, when number of people rather than percentage growth is used as a yardstick, 1940 is the takeoff point. The build-up for World War II was under way and Southern California aircraft plants and shipyards were hiring large numbers of workers. Rapid population growth continued until after the war, when job scarcity caused a reduction in immigration, but the flow of new people increased in 1948 and did not slacken appreciably until the middle of the last decade. During the 1950’s and 1960’s the keys to population growth were jobs in defense and other government-related programs, first tied to the Korean War and then to the missile-space program and Southeast Asia.

The population of the seven-county area was three and one-half million in 1940, five and one-half million in 1950, about nine million in 1960, and in January, 1970, the California State Department of Finance offered an estimate for July 1, 1970, of 11,700,000, a figure accounting for 55 percent of the estimated population for the state of California.³ Growth rates over the past thirty years were striking. From 1940 to 1950, population increased at a rate of about 700 persons per day; between 1950 and 1960, the rate was approximately 1,000 persons per day; and between 1960 and 1970, about 750 persons per day. Population forecasts for the immediate future indicate that growth will continue. Population in the seven counties is expected to increase from the 1970 level of approximately twelve million to about seventeen million in 1985.⁴

*Part II of this article will appear in the next issue of the California Geographer.
Immigration has been especially important in the region's growth; however, its contribution relative to natural increase has declined over the last half of the 1960's. Between 1940 and 1950, immigration contributed 73 percent of total population increase. The peak year for net immigration was 1942, when over 300,000 persons arrived in the Metropolis and accounted for nearly 90 percent of total population gain in that year. Between 1950 and 1960, migration as a percentage of total population growth was 67 percent, but between 1960 and 1969 the percentage dropped to 55. The role of immigration is expected to continue to decline in the immediate future.

Los Angeles and Orange Counties have played a special part in the immigration picture, a role elucidated by a view of the situation between 1955 and 1960. During that period, about 1,000 migrants arrived in the Metropolis each day. Of this group, around 700 located first in Los Angeles and Orange Counties, a fact emphasizing the importance of these counties—and especially of the city of Los Angeles—as the port of entry for migrants. The remaining 300 settled elsewhere in Southern California. As time passed, about 300 of the original 1,000 left the state, and about 300 of the 700 who first settled in Los Angeles and Orange Counties moved to other parts of California, leaving approximately 400 of the original 1,000 migrants as residents of Los Angeles and Orange Counties. Although not providing anything like a detailed discussion of migration, the above figures do emphasize its significance in the region's growth, and the related roles of Los Angeles and Orange Counties.

Changes in Areal Arrangements

Changes in the areal arrangement of population within the Metropolis have been remarkable, and are revealed by a series of population density maps (Figs. 2, 3, and 4). The overall pattern of change since 1940 has been one of concentric expansion resulting primarily from increases in population and an associated demand for new housing. Peripherally located and exhibiting both the ills and benefits of "scatteration," this growth has featured massive tract construction of free-standing single-family dwellings outward from the major cores, as well as around numerous lesser cities. Urban expansion around each center is typified by a succession of activities, each stage of which results in more intensive use of the land. Agricultural areas have given way to single-family homes, and homes and open spaces located near points of relatively high accessibility or on land zoned for industry have yielded to industrial and commercial land use. Finally, some of the seemingly secure tracts of single-family homes have been overrun by low-density apartments and varied activities dependent on increased population densities. The expanding circles of low density urban development have gradually coalesced, rendering physical but not political distinctions between communities fiction in many cases. Because peripheral expansion has taken place not only at the outer edge of the major centers but also outward from sub-nuclei, numerous "named" communities have developed, and many exhibit considerable economic and social sophistication. The proliferation of such communities contributes directly to the area's highly developed polynuclear form.

By 1965, the pattern of growth outlined above had transformed the Southern California Metropolis into a continuous geographical phenomenon with population densities of over 50 persons per square mile in every county planning area throughout its 300-mile length. The gaps existing in 1960 between the San Bernardino-Riverside-Ontario complex and Palm Springs, and between Palm Springs and the urbanized portions of the Coachella Valley were closed as well, thus extending the Metropolis approximately 160 miles across the desert to the northern boundary of Imperial County. It is not intended to imply that the Metropolis is devoid of open spaces; many such areas exist both within and at the fringes of the megalopolitan pattern. However, although such areas are ostensibly rural, they often are (or shortly will be) functionally urban. Concrete evidence that an urban landscape was developing along megalopolitan lines was provided in the 1960's when the Census Bureau created Standard Metropolitan Statistical Areas (SMSAs) in Orange and Ventura Counties, and designated Oxnard-Ventura and Anaheim-Santa Ana-Garden Grove as their respective central cities. Creation of a SMSA in
Figure 5
Freeways and place names in the 60-mile circle

Figure 6
TOTAL RETAIL SALES BY CENTER-1963
SALES IN MILLIONS OF DOLLARS

Major Retail Centers
Central Business Districts
(Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade, Major Retail Centers)
Orange County caused the division of the Los Angeles-Long Beach SMSA, which in 1950 and 1960 included both Los Angeles and Orange Counties. The entire reach from San Luis Obispo County to the Mexican Border was thus composed of six contiguous SMSAs. Moreover, by the middle 1960's nine metropolitan nuclei were recognized by the Census within the Los Angeles agglomeration alone, and when the relatively free-standing central cities of San Diego, Santa Barbara, and Oxnard-Ventura are added, it is clear that a megalopolitan, rather than metropolitan, pattern has emerged.\textsuperscript{13}

Several areas deviate from the pattern of areal expansion outlined above. For example, the City of Los Angeles has recently experienced increases both in population density and functional complexity at its center as well as greater spread. This trend toward centralization stems from a continued growth of commercial, financial, office, and industrial facilities in the downtown and along several corridors leading outward from the CBD. Contributing also is an expansion of high-rise facilities in general around downtown Los Angeles, and the fact that the whole built-up area is undergoing an expansion of low-density apartments. Other centers experiencing strong centripetal forces are Santa Monica, Pasadena, and Long Beach within Greater Los Angeles, and downtown San Diego.

\textbf{FORCES STIMULATING REGIONAL URBAN GROWTH}

Urban development in Southern California has been stimulated by the immigration of numerous persons. Thus, it is in order to seek the forces underlying the areas' growth. It is not presumed to answer the question of why such phenomenal growth took place in this region rather than elsewhere. Attention is set on the questions, “Why do people continue to flow into the Metropolis?” and “Why has the Metropolis developed so rapidly since 1940?”

It appears that people come to the region initially because of its climate and reputation for prosperity, features that have benefited from publicity in communication media of all types. Most of those who stay, however, find work and have at once a high standard of living and an opportunity to enjoy climate and other amenities. The main reason for permanent immigration to the Metropolis, therefore, is that the job market is generally expanding and attractive, especially for the skilled.\textsuperscript{14}

To some non-measurable extent, it can also be argued that the Metropolis has operated since the latter part of the 19th century almost continuously in a state of boom psychology. In short, “nothing succeeds like success.” A crowd attracts a bigger crowd. There need not be a reason that is apparent at all; the fact that others are doing it is sufficient motivation for many. This is not to imply that all find success and stay, but simply that opportunities elsewhere look better than at home, so people come to the Metropolis because they have heard that chances for success are good there. Little doubt exists regarding the significance of this condition in the growth of Southern California.

\textbf{The Regional Economy}\textsuperscript{15}

The Southern California economy is now the second largest regional economy in the nation, trailing only that of the New York area. At the end of 1969 there were 4,652,500 persons gainfully employed in the regional labor force, an increase of 1,275,300 over 1960. The largest employment categories in 1969 were manufacturing, services, and retail trade, in that order. Unemployment in 1969 was 4.1 percent, well below the decade high of 6.8 percent of 1961.

Manufacturing has been the most important employment category throughout the decade; in fact, much of the phenomenal economic growth since 1940 can be traced directly to expansion of manufacturing employment. Its importance as prime mover of the regional economy is supported by the fact that one out of every four jobs in the Metropolis was in manufacturing during the 1960's. The primacy of greater Los Angeles in manufacturing is pronounced. Los Angeles County firms paid three out of every four manufacturing payroll dollars in the Metropolis in 1968.

The significance of aerospace and defense-related spending to the regional economy should not be understated.\textsuperscript{16} These activities presently account for one out of every ten civilian jobs and four out of every ten manufacturing jobs (Table 1). Aerospace and defense-related industries also account for well over 40 percent of total regional manufacturing payrolls. Announced federal budget reductions in NASA and Department of
### TABLE 1 - MANUFACTURING, DEFENSE ORIENTED, \(^1\) AND TOTAL EMPLOYMENT IN THE SEVEN-COUNTY STUDY AREA\(^2\)

<table>
<thead>
<tr>
<th>Year</th>
<th>Employment, 1969</th>
<th>Wage and salary workers in manufacturing</th>
<th>Manufacturing as a % of total employment</th>
<th>Wage and salary workers in defense-oriented industries</th>
<th>Defense-oriented employment as a % of total employment</th>
<th>Defense-oriented employment as a % of manufacturing employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total civilian employment</td>
<td>3,377,200</td>
<td>903,000</td>
<td>26.7</td>
<td>384,900</td>
<td>11.4</td>
<td>42.6</td>
</tr>
<tr>
<td>Employment, 1960</td>
<td>3,433,700</td>
<td>902,900</td>
<td>26.3</td>
<td>386,100</td>
<td>11.2</td>
<td>42.8</td>
</tr>
<tr>
<td>1961</td>
<td>3,586,100</td>
<td>951,100</td>
<td>26.5</td>
<td>412,700</td>
<td>11.5</td>
<td>43.4</td>
</tr>
<tr>
<td>1962</td>
<td>3,707,700</td>
<td>959,400</td>
<td>25.9</td>
<td>411,300</td>
<td>11.1</td>
<td>42.9</td>
</tr>
<tr>
<td>1963</td>
<td>3,822,000</td>
<td>951,100</td>
<td>24.9</td>
<td>389,900</td>
<td>10.2</td>
<td>41.0</td>
</tr>
<tr>
<td>1964</td>
<td>3,934,200</td>
<td>971,300</td>
<td>24.7</td>
<td>394,800</td>
<td>10.0</td>
<td>40.6</td>
</tr>
<tr>
<td>1965</td>
<td>4,154,400</td>
<td>1,064,100</td>
<td>25.6</td>
<td>449,300</td>
<td>10.8</td>
<td>42.3</td>
</tr>
<tr>
<td>1966</td>
<td>4,321,500</td>
<td>1,116,100</td>
<td>25.8</td>
<td>485,500</td>
<td>11.2</td>
<td>43.5</td>
</tr>
<tr>
<td>1967</td>
<td>4,476,800</td>
<td>1,146,700</td>
<td>25.6</td>
<td>484,900</td>
<td>10.8</td>
<td>42.3</td>
</tr>
<tr>
<td>1968</td>
<td>4,652,500</td>
<td>1,154,400</td>
<td>24.8</td>
<td>457,900</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>1969</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

1. Defense-oriented industries are defined here as: (1) aircraft and parts; (2) electrical machinery, equipment and supplies (largely electronics); (3) ordnance and accessories (largely missiles and related equipment); and (4) instruments and related product.

2. Los Angeles, Ventura, Santa Barbara, San Bernardino, Riverside, Orange, and San Diego Counties.


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<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Export</td>
</tr>
<tr>
<td>Durable manufacturers</td>
<td>579.7</td>
<td>65.6</td>
</tr>
<tr>
<td>Primary and fabricated metals</td>
<td>91.4</td>
<td>40.9</td>
</tr>
<tr>
<td>Non-electrical machinery</td>
<td>61.0</td>
<td>75.0</td>
</tr>
<tr>
<td>Electrical machinery</td>
<td>113.0</td>
<td>72.9</td>
</tr>
<tr>
<td>Transportation, equipment, instruments, and ordnance</td>
<td>242.1</td>
<td>73.6</td>
</tr>
<tr>
<td>Stone, clay, and glass</td>
<td>22.0</td>
<td>70.0</td>
</tr>
<tr>
<td>Lumber, furniture products</td>
<td>34.4</td>
<td>42.0</td>
</tr>
<tr>
<td>Other durable manufacturers</td>
<td>15.8</td>
<td>50.1</td>
</tr>
<tr>
<td>Non-durable manufacturers</td>
<td>233.4</td>
<td>44.8</td>
</tr>
<tr>
<td>Apparel, textile, and leather products</td>
<td>57.7</td>
<td>68.0</td>
</tr>
<tr>
<td>Paper products and printing</td>
<td>52.1</td>
<td>35.0</td>
</tr>
<tr>
<td>Chemicals and petroleum</td>
<td>42.1</td>
<td>46.5</td>
</tr>
<tr>
<td>Rubber</td>
<td>23.7</td>
<td>57.4</td>
</tr>
<tr>
<td>Food and beverages</td>
<td>57.8</td>
<td>22.9</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>813.1</td>
<td>59.7</td>
</tr>
<tr>
<td>Agriculture, forestry, fisheries, and mining</td>
<td>47.3</td>
<td>11.2</td>
</tr>
<tr>
<td>Contract construction</td>
<td>163.9</td>
<td>.3</td>
</tr>
<tr>
<td>Transportation, communication, and public utilities</td>
<td>147.6</td>
<td>35.5</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>161.7</td>
<td>15.0</td>
</tr>
<tr>
<td>Retail trade</td>
<td>429.9</td>
<td>9.4</td>
</tr>
<tr>
<td>Finance, insurance, and real estate</td>
<td>131.5</td>
<td>16.8</td>
</tr>
<tr>
<td>Services</td>
<td>476.2</td>
<td>13.3</td>
</tr>
<tr>
<td>Government</td>
<td>277.8</td>
<td>7.6</td>
</tr>
<tr>
<td>Total: All Industries</td>
<td>2,649.0</td>
<td>27.0</td>
</tr>
</tbody>
</table>

Defense contracts were felt in the employment picture by 1969, and further decline in employment in these areas is expected in the immediate future. The challenge to diversify presently faces numerous firms that have depended on federal funds for aerospace and defense work. Should they fail to meet this challenge, the effect on the regional economy could be considerable.\footnote{1}{The importance of manufacturing and its defense-oriented component is shown in an “Economic Base Theory” context in Table 2, and the role of these activities as sources of exports generating regional economic growth since 1950 is quite clear.\footnote{18}} Only one more of the region’s numerous sources of basic income will be treated here. The tourist industry capitalizes on both the area’s natural and man-made amenities, and has long-standing importance in the economy.\footnote{19}{The Southern California Visitors Council estimates that in 1950 over 2,500,000 tourists visited the Metropolis and spent over $424 million; by 1960, the number of tourists rose to 4,700,000 who spent $715 million. During the 1968-69 fiscal year, over 8,000,000 tourists came to the Metropolis and spent a record $1.25 billion. Such spending is felt in every facet of the regional economy, and it is anticipated that with rising incomes and increased leisure time, this source of basic income will increase.}

Service industries are the second leading employment category in the Metropolis, accounting for 21 percent of all jobs in 1969.\footnote{20}{Growth of the governmental and service sectors, increased production for regional consumption, and the export of a wide variety of services to neighboring cities and regions are all traits of an established metropolitan economy and Southern California—with greater Los Angeles as its focus—is today, in every sense, such an economy.}

Since the region’s growth is closely associated with expanding employment opportunities, it can be asked, “Why are firms attracted?” This also can be related to climate, the reputation for prosperity, personal choice, and to the aura of attractive living. Such reasons may occasionally apply today, but they are largely of historical and secondary importance. Businessmen migrate to the Metropolis because of an optimism generated by the region’s post-depression pattern of economic growth, the size of the domestic and overseas market commanded by the Metropolis, the skill of the labor pool, and the transportation costs of bringing manufactured goods to the region from the eastern United States.\footnote{21}{Businessmen also migrate to the Metropolis because of its large and skilled labor supply, a human resource able to cope with the complexities of space age projects. The skills of the labor force have grown in large part because of the development of the airframe industry and, later, the aerospace, research and development, and electronics industries. Thus, the flexibility of the basic labor force, plus the constant inflow of highly trained scientific and technical people, has become an industrial location factor of substantial importance.}

An Expanding Market\footnote{22}{In addition to the national market, the market for goods and services in Southern California is one of the largest and fastest-growing in the country. According to the 1967 Census of Business, total retail trade in the ten southernmost counties of California was $19.8 billion, a figure when compared to retail trade by states is exceeded by only New York and the State of California as a whole. Wholesale trade accounted for another $25.6 billion in 1967, or over one-half of the state total. Moreover, the domestic market area for Southern California goods and services is readily divisible from other regional markets by mountains and deserts to the east and north, the Mexican Border to the south, and the ocean to the west. As such, the Metropolis commands a continuous market area important enough in its own right to attract new industries and new employment, thus perpetuating its own growth and diversifying its employment structure.}

In addition to expanding local and national markets, the overseas market served by the Metropolis is growing. In 1968, for example, more than $3.7 billion in goods passed through its two customs districts (Los Angeles and San Diego), about $1.7 billion in exports and $2 billion in imports. This represents an enormous increase over the approximately $250 million in goods that passed through the same customs districts in 1940.

A Skilled Labor Pool\footnote{23}
Research and development (R&D) expenditures totaled $24 billion in 1967 and play an important part in the regional economy. In 1965, approximately 15 percent of the nation's R&D firms or divisions of large firms were located in California. Sixty percent of the 752 organizations represented in the state and 76 percent of the 120,936 scientists and technicians were located in Southern California, mostly in Los Angeles and Orange Counties. The technologically and scientifically advanced economic structure of the Metropolis benefits from this concentration of talent, and the concentration itself serves as a magnet for both related firms and immigrants with similar training and interests.

GREATER LOS ANGELES

Dominating the Southern California Metropolis is the heavily developed, urbanized area that focuses on Los Angeles and sprawls outward in all directions from that hub. An agglomeration including portions of five counties—Los Angeles, Ventura, San Bernardino, Riverside, and Orange—it can be accurately described as a territory lying within 60 miles of downtown Los Angeles (Fig. 5). On January 1, 1970, population within this 60-mile circle was estimated at 9,600,000, or 96.5 percent of the total five-county population.

The urban pattern of Greater Los Angeles is typified by low-density spread, dominance of single-family homes, weak centers, dispersed activities, individual mobility, political fragmentation, and by an increasingly complex cultural geography. The product is a prototype of the decentralized, polynuclear city. Until recently, this urban form and structure were unique. Over the past three decades, however, it has become clear that formerly distinctive traits and problems of Greater Los Angeles have become widespread development trends and problems elsewhere.

Regarding such convergence, it is fundamental to consider that Greater Los Angeles has been shaped by the very forces that are presently tearing older compact cities apart. It was built up almost entirely during an era of automobiles, horizontal assembly lines, ubiquitous electricity, freeways and think-factories, and large inputs of people from parts of the nation where apartment living and mass transportation were unimportant. Additionally, its intensive growth coincided with a time of affluence and favorable governmental attitude to home ownership. These same forces are presently breaking down traditional central business districts and spreading the nation's cities across countless acres in a low-density pattern, more like than unlike that of Greater Los Angeles. Thus, it would appear that dynamic forces of greater similarity than at any time in recent history are presently shaping both Los Angeles and other emerging regional cities.

Regardless of its emotional appeal, the urban pattern that has evolved within the 60-mile circle has allowed for mass satisfaction of the drive for "private space," a centrifugal force of profound importance among rank-and-file American families. Thus, if it is inevitable—as most urban experts presently agree—that the spatial pattern of the American city is going to be considerably more dispersed, varied, and space-consuming than in the past, regardless of what metropolitan planners or anyone else may try to do about it, then it is possible that Greater Los Angeles may continue to reveal development trends of considerable generality.

Forces Shaping the Urban Pattern of Greater Los Angeles

The salient feature about Greater Los Angeles in recent years has been new growth. It is the leading urban growth area of the country by almost any measure. According to recent Census estimates, the five-county area has added more people since 1960 than the New York-Northeastern New Jersey Standard Consolidated Area (SCA), and the net increase has been three times that of the Chicago-Northwestern Indiana SCA. Moreover, the Los Angeles five-county area has shown nearly as much population increase as the New York and Chicago SCAs combined. Within the circle, population growth averaged about 250,000 per year since the 1960 Census to total 2,200,000 new residents by January, 1970. This is equivalent to adding to the circle a city larger than Philadelphia or Detroit. The territorial expression of this growth is revealed in Figures 3 and 4 by the expansion outward from Los Angeles of the territory with 500 or more persons per square mile. Such growth is driven by the expanding economy described above, an economy that during the 1960-69 interval generated 118,000 new jobs each year within the 60-mile circle.

The dynamic forces shaping the urban form and structure within the 60-mile circle are
numerous and complicated; however, some of the more important ones will be touched upon below.

The Pattern of Settlement

Of profound significance in the evolution of Greater Los Angeles has been its early pattern of settlement, the spatial organization of which was influenced by dispersed centers over a vast area. By the end of the 19th century, the settlement pattern consisted of a series of interconnected agricultural towns and villages arranged in a loose framework, with productive agricultural areas separating the clusters. The centers were connected by rail and formed a complex of farms and ranches whose city needs were adequately met by towns located at exchange points along a skeletal transportation network. Particular cities or towns did not dominate the entire area; rather, each center was sustained by its own urban field, so the central cities grew only by minor accretions while acting as exchange points for the outer towns which were also expanding and intensifying their local activities. Many outlying centers are virtually as old as the present central cities, and many of these early towns have persisted and are today major cities in their own right. Since the establishment of the basic polynuclear pattern around the turn of the century, land has been a hot commodity. And when automobiles freed subdividers from locations along rail lines, the marketing of this commodity took a simple form—one of filling in open spaces between towns. Nelson has concluded that for many decades after the boom of the 1880's, an expanding population filled in the far-flung framework laid down during the expansive period between 1884 and 1900.

Millions of new residents have entered the 60-mile circle in recent decades, and the City of Los Angeles and its immediate suburbs were able to accommodate only a small fraction of the new arrivals. Dozens of new suburbs were created, continuing the process whereby new cities rose at the periphery and interstitial areas were filled in with low-density development. Moreover, it is only recently that the filling-in process reached a point where the agglomeration as a whole is expanding outward from an entirely built-up interior, but one that is polynuclear as opposed to the compact, single-centered metropolitan model. Reflecting the atypical conditions under which it developed, certain aspects of the 60-mile circle set it apart from other urban complexes.

Areal Extent and Population Density

The areal extent of Greater Los Angeles is immense, a situation illustrated by the fact that the corporate cities of Denver, Chicago, St. Louis, Detroit, Philadelphia, and Pittsburgh would all fit easily into the southern half of Los Angeles County. The 60-mile circle contains both absolutely and proportionally more single family homes than other urbanized regions, and its overall population density is lower. Its population densities are comparatively very low on a corporate-city basis. Prime causes are the vast area covered by the early settlement network, a growth process based on polynuclear expansion, and public contributions to private transportation and housing costs. These factors have rendered land a less-scarce resource than under conditions inherent in the single-centered metropolitan model, and they have enabled a widespread satisfaction of the drive for private space and outdoor living. Influential, as well, are space-consuming regulations related to law and practice in the construction industry; for example, minimum lot size and setback or front-lawn regulations and local building codes and zoning ordinances that prohibited high-rise construction until 1957. Also, Greater Los Angeles' physical plant is new by comparison with most American cities. According to the 1960 Census, only 37 percent of its housing stock was built before 1940 compared to 57 percent nationally, and housing units constructed between 1950 and 1960 accounted for 43 percent of the total housing inventory compared to 28 percent nationally. The coincidence of a rapidly growing single-family housing inventory with a time of affluence and widespread automobile ownership is clear.
LAND ZONED FOR INDUSTRY

INDUSTRIALLY ZONED LAND and MAJOR INDUSTRIAL EMPLOYMENT CENTERS

Figure 7

GROWTH CENTERS
1. Simi-San Fernando
2. San Gabriel
3. Inglewood-Torrance
   Palos Verdes
4. Norwalk-Fullerton
   Santa Ana

POPULATION CHANGE:
April 1960 to January 1970

Statistical Areas:
- Adding 50,000 or more inhabitants
- Adding 20,000 to 49,999 inhabitants
- Adding 10,000 to 19,999 inhabitants
- Adding 1 to 9,999 inhabitants
- Losing Population
- With more than 50,000 inhabitants in 1960.

Source: U.S. Census of Population and Los Angeles, Ventura, San Bernardino, Riverside, and Orange County Planning Departments.

Figure 8
Dispersed Retail and Service Activities

Retail and service centers are scattered, a pattern in keeping with both the historical geography of the area and the tendency of tertiary activities to pursue middle-class buying power into the suburbs. Numerous commercial districts developed early in the dispersed towns, and many were able to compete effectively for trade areas. This pattern of spatial competition, plus the distance between many of the centers, hindered the development of a single dominant downtown along traditional lines. Subsequently engulfed by urban sprawl, the established business districts persisted, but after World War II the older centers were unable to supply the retail goods and shopping convenience demanded by mobile, affluent suburbanites, so numerous planned shopping centers geared to serve suburbanites were built. The dispersion of retail and service trade is shown by the pattern of “Major Retail Centers in 1963” (Fig. 6). Major retail centers embrace two kinds of trading concentrations: established central business districts and larger shopping centers, the latter normally focusing on a department store. Added to these in Figure 6 are the main business districts of Ventura, Oxnard, San Bernardino, Ontario, and Riverside. One index of retail spread is afforded by the change in number of major retail centers in Los Angeles and Orange Counties between 1958 and 1967. During that time, the number of centers rose from 43 to 121, and most were near the urban periphery in areas of rapid development.

Industrial Dispersal

Industrial dispersal in metropolitan regions is a nationwide trend, but within the 60-mile circle it is not just a by-product of recent events. Like the polynuclear commercial pattern, it is a product of the area’s historical geography. Manufacturing has found no overriding locational features in any part of the agglomeration, and although older industrial districts in proximity to railway lines and freight terminals form the largest nodes, industry is located in every direction from the urban cores (Fig. 7), especially along major rail lines and adjacent to airports or harbor areas. Significant also is the fact that practically all of the area’s industry came relatively late, and most of the desirable close-in sites were already occupied. In addition, three of the region’s leading industries have unusually large land requirements. Aircraft and motion picture production occupy large buildings adjoined by large plots of land for airfields and outdoor scenes and sets, and perhaps no industry has greater land-employee ratio than oil refining. The widespread nature of industrial development in the 60-mile circle contributes to urban sprawl and the need for individualized transportation for both people and goods.

Today, numerous industries are tied to neither railways nor the waterfront but need large tracts of land, and land is available at the best price on the urban periphery. Land zoned for industry and land costs are presently the main factors in industrial site selection, and this condition, plus the suburban location of large areas zoned for industry, the proliferation of planned industrial parks and freeways at the periphery, and the suburban location of most of the educated technical people so necessary to many modern growth industries, have stimulated industrial dispersion. An analysis of industrially zoned land in Los Angeles, Orange, San Bernardino, and Riverside Counties demonstrates this point. The median price per acre in 1963-64 varied from a low of $6,000 in San Bernardino-Ontario to a high of $157,500 in Santa Monica. Moderately low-priced areas were Riverside, $7,500; Industry, $17,500; and Santa Ana, $21,000. Relatively high-cost locations were Culver City, $145,000; Central Los Angeles, $80,000; and Glendale, $75,000. Such data indicate that, with few exceptions, land costs decrease with the distance of an industrial zone from the Santa Monica area.

Another factor contributing to industrial scat teration is the increasing number of industrial parks. In combination with the already widespread pattern of industrially zoned land in the area, and in addition to numerous industrial parks that are fully occupied, ninety-two parks were seeking occupants in 1969. Moreover, in many cases these parks combine with planned shopping centers to provide nuclei stimulating residential scatter in fringe areas.
Freeways

Because of the low density urban pattern and distances separating homes, jobs, and other destinations, mobility is a way of life in Greater Los Angeles. The attempt to handle such mobility has thus far rested on freeways (Fig. 5). Within the 60-mile circle are over 500 miles of freeway. Besides accommodating individualized travel needs—both for people and goods—by handling the nearly five million cars and 60,000 trucks registered in the five-county area, the location of freeways appears to determine to a great extent the geographical pattern of urban expansion. Such development tends to anticipate and follow freeways into less-crowded peripheral areas. For example, Orange County growth mushroomed as the Santa Ana Freeway moved southeastward from Los Angeles, and the same thing is happening along the Ventura Freeway to the north. Freeway construction is accompanied by a surge of single-family construction and the entry of suburban shopping centers and low-rise apartments. Financial and trade facilities are not far behind, and soon industry moves into the area. The value of property increases and new cities are incorporated to supply local government services and educational facilities. This is the prototype of most of Greater Los Angeles' peripheral growth in recent years. It rests to a large degree on the first phase of freeway construction.3

The collection and distribution system within the 60-mile circle is increasingly dependent upon trucks and for those activities relying on trucks, freeways are more than just a convenience, they are a necessity. In 1964 there were over 8,100 "for hire" truckers in the fourteen southernmost counties of California, an area that used a total of over 61,000 trucks. Los Angeles alone has more trucks than New York, Cleveland, and Detroit combined.3 7

Automobile Culture

It is too simple to dismiss the pattern of urban growth as only a product of the automobile era. For instance, population growth has been largely from immigration, and it can be inferred from the states from which the immigrants came that only a small percentage had previous experience with apartment living or mass transportation. Rather, they were from areas where single-family homes were part of the accepted mode of living, and movement was highly individualized and thus dependent on the automobile. The cultural background of the inhabitants, therefore, shows through as a strong force shaping the pattern of Greater Los Angeles. Their predilections were not seriously blocked but were encouraged by the overall set of circumstances operative in the region at the time of their arrival.3 8

Nevertheless, inhabitants of the 60-mile circle are dependent on the automobile to a degree greater than in any large urban area in the nation.3 9 Several reasons have been offered for this, in addition to the cultural one considered above. Mass transit throughout Greater Los Angeles has been—and is—inefficient, especially in relation to the journey to work. The car has been used in the area for a long time; in fact, it was effective early, even before the advent of enclosed glass-and-steel bodies and reliable heaters. Cars can still be used all year around with less inconvenience than in eastern and midwestern cities. The agglomeration lacks a dominating commercial-industrial core, a condition further accentuated by a dispersed pattern of non-residential development which contributes to a tangle of origins and destinations, individualized travel habits, and the failure of mass transit on economic grounds.3 0 It should also be noted that the space devoted to streets and freeways, plus the vast areas needed to store cars, contribute significantly to low density spread.

Affluence and the Availability of Housing Loans

Inhabitants of the 60-mile circle are not only numerous, most are prosperous and enjoy a comparatively high level of personal income. Total personal income for the five counties in 1968 was higher than for the states of Ohio, Texas, or Michigan, and was exceeded only by the states of Pennsylvania, Illinois, New York, and California as a whole. Per-capita income
exceeds the average for most parts of the country as well. Residents of the 60-mile circle averaged $4,000 in 1968, well above the national average of $3,421, and Los Angeles County inhabitants averaged still higher at $4,295. Significant points here are that the bulk of the area’s inhabitants can afford to purchase “private space” in the form of single-family homes in outlying areas, and can afford to purchase and drive automobiles to work.4

A substantial portion of the homes in Greater Los Angeles have been constructed in a period when the federal government’s philosophy was to encourage and aid home ownership. The Federal Housing Administration and Federal and California Veterans Administrations insured and guaranteed loans with little or no down payment, low interest rates, and monthly payments spreading over periods up to thirty years. These conditions encouraged hundreds of thousands of families to buy homes in suburban areas. Some Recent Areal Manifestations

Some of the development trends suggested above are exemplified by the areal pattern of population growth over the past decade (Fig. 8). The four population growth centers occupy level terrain near the periphery where abundant developable land is accessible by freeway, land prices are low, and basic urban needs are available.42 Such growth areas are stimulated in their early stages by a common urge—the search for cheap land. This search scatters urban development and feeds upon itself. The developer’s primary objective is land that is close enough to sources of employment for the prospective owners, but at the same time far enough away from more intensively developed centers where land costs are high. In finding and establishing his development on cheaper land, he creates another center of high-priced land which, in turn, encourages more forays into other cheap areas.43 Living needs necessary to set off peripheral growth areas—like basic gas, electricity, shopping, health, and city services—are usually numerous at the fringe because of accessibilities
resulting from scatteration, while access to metropolitan jobs and higher level goods (Fig. 6) are obtained by freeway connections with a variety of nodes rather than from any single center. The widespread nature of employment in the 60-mile circle, as well as the pattern of manufacturing employment, is shown in Figure 9.

Summary

From the points made thus far, it would appear that recent development trends in Greater Los Angeles call for a still more dispersed urban pattern. Such is the case because private movement costs associated with gaining access to major urban nuclei have increased, public investment in transportation facilities have sharply reduced private transportation costs at the periphery, and the drive for private space remains a paramount motivation for families able to afford it. Moreover, the growing accumulation of capital in transportation facilities, coupled with the increasing substitutions of information flows, have gradually dissipated many of the advantages of economic proximity that traditional business centers had to offer. When the space requirements of modern industry and the location of the bulk of middle-class buying power are considered, it is not surprising that the lion's share of employment opportunities are found away from older centers as well. Accordingly, it appears that the number of middle-class families actually minimizing their spatial contingencies by locating in the suburbs is increasing every day. On a broad scale, therefore, it would seem that the current strategy of constructing high-volume, high-speed, radial freeways articulated by circumferentials should amplify the growth trends considered above in all expanding regional cities.

REFERENCES

1 As used here, the terms urban form and urban structure follow the interpretation of Catherine Bauer Wurster, who defines them as follows: "'Form' means the physical pattern of land use, population distribution, and service networks, while 'structure' signifies the spatial organization of human activities and interrelationships." C. Bauer Wurster, "Form and Structure of the Future Urban Complex" in L. Wingo Jr. (ed.) Cities and Space (Baltimore: Johns Hopkins Press, 1963), p. 75. Both terms are subsumed in the term "pattern" as it is used in this report.

2 The term "Southern California Metropolis" is not original to this report. It was used at least as early as 1959 in Southern California Research Council (publisher), The Southern California Metropolis—1980, Report No. 7 (Los Angeles: 1959).


7 The outstanding precedent set thus far for describing a megalopolitan development is that by Gottmann. So, to facilitate easy comparison between areal aspects of urban growth in the Southern California Metropolis and that observed along the northeastern seaboard of the United States, the same indices of population density were used here as were used by Gottmann. See, J. Gottmann, Megalopolis: The Urbanized Northeastern Seaboard of the United States (New York: Twentieth Century Fund, 1961), especially the maps on pp. 6, 386 and 387. In the present study, population figures and area measurements for judicial townships were used for 1940; density figures for the county census areas used in 1960 were extracted from U.S. Bureau of Census, Area Measurement Reports, "Areas of California: 1960," Report GE-20, No. 6 (Washington, U.S. Government Printing Office, 1965), sources of data for local county planning areas were: Santa Barbara County Planning Department, Ventura County Planning Department, Los Angeles County Regional Planning Commission, Orange County Population Research Committee, Riverside County Planning Department, San Bernardino County Planning Commission, and the San Diego County Planning Department. For a full utilization of this approach, see, R. E. Preston, "Urban Development in Southern California Between 1940 and 1965," Tijdschrift Voor Economische en Sociale Geografie, Vol. 58 (1967), pp. 237-254.

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Ibid.


SOME GEOGRAPHICAL CONSIDERATIONS
OF SITING NUCLEAR POWER REACTORS ALONG THE CALIFORNIA COAST

PETER F. MASON
University of California, Santa Barbara

Rapid change has traditionally been one of the dominant characteristics of the geography of California. Population increase and technological innovation have prompted constant reassessment of man’s relationship to his environment in an almost fluid geographical context. Unprecedented population growth has engendered major societal shifts and migrations, and caused profound environmental change. One of the acknowledged necessities of the urban-industrial society that has become the landscape dominant in California is electricity, and the insatiable demand for it doubles every nine years. By 1990, power demands will be four times the present level.

The demand for electricity is high not only because of rapid population increase, but because of the wider use of electricity on a per-capita basis. In short, electricity is one of several technological innovations affected by man as a culture builder, and with it may be assigned many benefits. However, most, if not all, technology carries with it some costs which are absorbed by the environment. Given conventional means of electrical generation, the environmental costs take two forms: (1) the consumption of non-renewable fossil fuels (coal, fuel oil, or natural gas), and (2) the release of oxides of sulfur and nitrogen and partially burned fuel as waste products into the atmosphere. In a real sense, exhibited here is a self-defeating, resource-consuming, environmental-polluting system that with the probability of certainty will increase environmental costs as population continues to increase.

To meet the present and future demand for electricity in California, the major private and public power companies, in conjunction with the State of California, are now committed to a program of increased use of nuclear energy as a basis for electrical power generation. Nuclearization of the power industry will provide a source of electricity independent of fossil fuel consumption, and one that can reduce visible amounts of atmospheric pollution. As uranium supplies diminish, emphasis will likely be placed on sodium-cooled, fast-breeder reactors that, under normal operation, have the capacity to generate as much uranium fuel as is consumed, and thus assure abundant future supplies of electricity.

Benefits and Costs of Nuclear Power Reactors

Benefits

The benefits of nuclearization are believed to be numerous, although pronounced differences of opinion and facts are revealed by proponents and opponents of the technology. The cost of electricity derived from use of nuclear energy is believed to be quite low. Some disagree, however, and indicate that nuclearization does not and is not expected to compete with conventional means of power generation. In fact, several utility companies have been forced to raise power rates because of their nuclearization programs. Moreover, the costs of nuclearization would be greater if the disposal of spent reactor waste fuel was not assumed by the federal government.

A second benefit of nuclearization, affecting society indirectly, is its non-consumption of mineral fuels. Coal, petroleum, and especially natural gas are in decidedly short supply when viewed in the context of rapid population increase and proportionate increase in electricity consumption.

Nuclear power plants are believed to be producers of relatively “clean” electricity when viewed in contrast with coal- or petroleum-fueled power plants which emit various combinations of oxides of nitrogen and sulfur and hydrocarbons into the atmosphere. This advantage over non-nuclear power plants may be one of the more persuasive points in defense of nuclearization.
NUCLEAR POWER REACTOR COMPLEXES AND POPULATION* ALONG COASTAL CALIFORNIA
(Estimated Installed Capacity by 1990)

<table>
<thead>
<tr>
<th></th>
<th>Nuclear Reactor Complexes</th>
<th>Power Capacity (kilowatts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Point Conception</td>
<td>6,600,000</td>
</tr>
<tr>
<td>2.</td>
<td>Diablo Canyon</td>
<td>5,740,000</td>
</tr>
<tr>
<td>3.</td>
<td>Montezuma</td>
<td>5,280,000</td>
</tr>
<tr>
<td>4.</td>
<td>San Onofre</td>
<td>4,686,000</td>
</tr>
<tr>
<td>5.</td>
<td>Mendocino</td>
<td>4,060,000</td>
</tr>
<tr>
<td>6.</td>
<td>Long Beach</td>
<td>3,000,000</td>
</tr>
<tr>
<td>7.</td>
<td>South Moss Landing</td>
<td>3,000,000</td>
</tr>
<tr>
<td>8.</td>
<td>Sorrento Valley</td>
<td>3,000,000</td>
</tr>
<tr>
<td>9.</td>
<td>Ormond Beach</td>
<td>2,000,000</td>
</tr>
<tr>
<td>10.</td>
<td>Malibu</td>
<td>1,473,000</td>
</tr>
<tr>
<td>11.</td>
<td>Harbor</td>
<td>1,000,000</td>
</tr>
<tr>
<td>12.</td>
<td>Humboldt</td>
<td>240,000</td>
</tr>
</tbody>
</table>

*1960

Sources:
Costs

Cost factors are both obvious and obscure. Production costs are common to both nuclear and non-nuclear plant alike. The nuclear reactor program is developmental and not operational, meaning that the practical economical value of nuclearization cannot be demonstrated. In such a context, the assessment of cost factors in comparison with conventional power plants is difficult. Personnel costs may be a second important factor. The relatively high level of technological sophistication associated with the reactor program may require a higher-salaried technical work force than would be required of non-nuclear plants. In any case, obvious personnel cost factors, plus waste fuel disposal and aggregate liability costs assumed by the federal government, are directly or indirectly passed on to the consumer and taxpayer.

Less obvious costs are passed on to the environment. Unfortunately, these are not only poorly documented but, where documented, are poorly understood as they affect the ecosystem. In the single-minded attempt to meet societal demands for electricity, the benefits of nuclearization qualitatively and quantitatively tend to overshadow the costs of the technology. Moreover, population pressures force the system to compress time in accord with present and prospective electricity demand, which does not allow sufficient means to objectively assess or carefully test the effects of this developmental technology on the environment.

Some of the specific costs passed on to the environment include: (1) release of heated water, causing thermal pollution of marine and riverine environments; (2) release of radionuclides into the atmosphere, raising the level of atmospheric radioactivity; (3) release of radionuclides into marine and riverine environments to be incorporated into the ecosystem for circulation and biological concentration at various levels of the food chain; (4) net release of radionuclides into the total environment to bring about both short-term (somatic) and long-term (genetic) effects within densely settled populations; and (5) production of waste reactor fuel which, when removed from the reactor, exhibits high radioactivity and temperature levels and must be carefully transported, processed, and disposed of in storage areas for several decades. Explicit in the transfer of highly radioactive spent reactor fuel from reactor source to waste disposal location is the potential for accidental release of this lethal material which presents an additional cost. Environmental recovery from failures in the technology of handling highly radioactive wastes is seldom complete, which may in fact be much too high a price to pay for electricity.

Nuclear power reactors in general are relatively simple in design and operation and, given the apparent demand for increased electricity, such plants offer many benefits. The obvious economic and less-obvious environmental costs will vary in importance according to the geographical site and situation of the reactor. For this reason, attention is directed to the present and future development and siting of nuclear reactors in the California coastal environment.

DISTRIBUTION OF NUCLEAR POWER REACTORS AND POPULATION IN CALIFORNIA

Most Californians live in cities clustered along the coastal and/or southern part of the state. Moreover, the state’s center of population—now near the UCLA campus in the Santa Monica Mountains—is shifting steadily southward. Adding to the increasing concentration and congestion of population along the coast is the continued preference of newcomers to choose either the San Francisco Bay area or southern California as living sites. Future population growth is expected to bring the coalescence of these two centers into a West Coast megalopolis, including the urbanization of the Central Valley.

The distribution of nuclear power plants—operative, under construction, or planned for the next two decades—indicates (1) a large concentration of uniformly sized plants in Southern California in close proximity to major urban centers, and (2) a series of variable-sized and irregularly spaced large plants from Point Conception northward to Point Arena (Figure 1). Most plants are in close proximity to either dense populations or areas likely to experience considerable population increase and urban development over the next
FAULT SYSTEMS\(^1\)  
AND  
LANDSLIDE SEVERITY\(^2\) IN  
CALIFORNIA

<table>
<thead>
<tr>
<th>Severity</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>Dark Gray</td>
</tr>
<tr>
<td>Medium</td>
<td>Gray</td>
</tr>
<tr>
<td>Minor</td>
<td>Light Gray</td>
</tr>
<tr>
<td>Blank Areas</td>
<td>Non-existent</td>
</tr>
</tbody>
</table>

Note - Severity measured by size and frequency of occurrence relative to engineering works.

Sources:
\(^1\)N.E.A. Hinds, California Division of Mines Bulletin 158.  
Mason: Siting Nuclear Power Reactors along the California Coast

The size of the reactor determines both the amounts of nuclear fuel necessary to generate power to reactor capacity and, accordingly, the amounts of spent nuclear fuel produced and radionuclides released to the environment under normal operation. Moreover, the potential energy for nuclear excursion (or failure) is related to reactor size, which is an important factor to consider in siting nuclear reactors near centers of existing or future population.\(^1\)

NUCLEAR POWER REACTORS IN THE CALIFORNIA COASTAL ENVIRONMENT

Inspection of the distribution of present and future nuclear reactors reveals a pattern of siting that interrelates reactors with several important environmental factors, including existing patterns of faults and fault zones, landslide severity, and atmospheric pollution, all of which are directly related to problems of reactor safety and environmental pollution.

Faults and Fault Zones

The almost daily tremors felt by residents of many coastal California cities is sufficient reminder that this is an area of tectonic-seismic instability. The crust of coastal California is shaped by an intricate network of faults that lace the Coast, Transverse, and Peninsular Ranges. Most of these faults have been active during the Quaternary Era. Mapped traces of faults indicate relatively broad fracture zones along which faulting and earthquake activity has occurred, and it seems realistic to assume that areas between mapped fault zones are also tectonically unstable. In any case, man in settling these areas assumes the risk of possible earthquake damage and destruction.

Structures that house nuclear reactors are engineered and constructed according to specifications established by the U.S. Atomic Energy Commission (AEC) which has ultimate responsibility and authority in nuclear reactor licensing. Crowe indicates that often the criteria used for regulation of an industry are determined by the industry that is being regulated.\(^1\) The case of the AEC, in part, supports this view because experts on atomic energy most often heard at AEC reactor licensing hearings are selected from the ranks of both the AEC and the power industry seeking the permit to operate reactors. Assumed in the licensing criteria is the factor of safety of the reactor core in the event of intense seismic activity and subsequent earthquake damage.

A comparison of the distribution of nuclear power plants with existing patterns of faults and fault zones indicates that (1) one-half are situated on active fault zones; (2) 16 percent are within ten miles of an active fault; (3) 16 percent within twenty miles of an active fault; and (4) 16 percent beyond the twenty-mile limit (Figure 2). Given the likelihood that some of the faults mapped are believed to be inactive, it is prudent to note that well over two-thirds of the reactors planned are situated in or near seismically unstable regions through which pass active fault systems.

Landslide Severity

The factors that tend to promote slope failure, mass-wasting, and related landslide forms in coastal California can possibly endanger structures housing nuclear reactors. The relationship between climate and landscape development has become almost assumed in most geomorphological research, as factors and elements of climate ultimately govern the rate and magnitude of geomorphic process development. Specific forms of landslide activity are commonly related to the factors of over-steepening, over-loading, and over-saturation of slope to promote slope failure. Seasonally high precipitation concentrated in one or two winter months tends to both overload and lubricate slope material. The combined processes of active stream erosion and valley development and active wave erosion and cliff development oversteepen slopes to promote slope failure. A map of regional landslide severity (Figure 2)\(^1\) indicates that all present or planned nuclear power plants are situated in areas with major landslide severity. Given the past slope development history of the region, reactor structures sited in this region are subject to damage, potential reactor failure, and nuclear excursion.
EXTENT OF AIR POLLUTION IN CALIFORNIA 1961 -- 1963

Source:
J.T. Middleton: California against Air Pollution (California Department of Public Health, Sacramento, 1961)

Map 3
Atmospheric Pollution

The California climate is diverse, due in large part to the strong definition of climatic controls upon the landscape. Several of these promote atmospheric stagnation and seasonally raise the air pollution potential for much of the coastal segments of the state. Among these are included (1) a subtropical high pressure (Pacific High) that imparts stable, subsiding air to produce an upper-air subsidence inversion over much of the state during the summer; (2) a cold off-shore ocean current that chills and cools the lower atmosphere and promotes low-level inversion conditions; and (3) pronounced topographic barriers of the Coast, Transverse, and Peninsular Ranges that rise above the coastal inversion layer, allowing the air trapped below to stagnate and become polluted along the relatively narrow confines of the limited coastal fringe.

Nuclear power plants add to atmospheric pollution (atmospheric radioactivity) under normal operation through regular releases of radionuclides in amounts considered to be below measurable harm to man. Under abnormal operation, wherein technical failures result in a malfunction of the reactor or environmental factors damage the reactor core, potentially massive amounts of radioactive material are released to all realms of the environment, including the atmosphere. The effect of the net release of radionuclides into the relatively stable atmosphere of the air basins along the California coast is difficult to assess. The probability is real that, in time, such substances enter the food chain and pass indirectly at concentrated levels to man and, ultimately, his progeny. Reactor sites may be well-ventilated according to AEC reactor licensing specifications, but the air basin within which the automobile, conventional power plant, and nuclear power plant alike are situated may ultimately suffer under excessive burdens of waste.

Comparing the distribution of existing patterns of air pollution as a fairly accurate measure of regional air pollution potential with the distribution of nuclear reactors, it is found that (1) one-quarter are situated in areas now suffering from acute air pollution (eye irritation); (2) one-third in areas of noticeable air pollution (plant damage); and (3) 16 percent in areas with moderate air pollution (reduced visibility) (Figure 3). Since air pollution is related to population increase it is presumed that, since 1963 when data were assembled for the air pollution map, the quality of the atmosphere has degraded.

The combination of seismic, geomorphologic, and atmospheric environmental factors all relate very directly to the security and safety of nuclear reactors. The first two—earthquakes and landslides—endanger the reactor structures and increase the chance of risking the release of massive amounts of radioactive material (fuel and spent fuel) into the environment. The last—the atmosphere—is one environmental realm that receives considerable amounts of fissionable material. Over the short run, the environmental consequences of reactor failure are evident, but perhaps most important are the long-term consequences of normal radioactive waste release into the relatively limited air basis of the agricultural-urban regions of the California coast, and the eventual incorporation and biological concentration of radionuclides into the food chain.

CONCLUSION

The California environment is being rapidly changed through complexly interrelated processes that accompany urbanization. As our technological civilization continues to advance through successive stages, it becomes apparent that the benefits of science and technology on the quality of life must be weighed against costs inflicted upon the environment. Nuclear reactors represent an important technological solution to the man-environmental problems of fossil fuel consumption and atmospheric pollution caused by conventional means of power generation. Through geographical analysis, this paper has sought to present the broad environmental context of siting nuclear power reactors in California, and to raise the question of long-term environmental costs weighted against the short term benefits of nuclearization.
Within California over the past century the many problems that have arisen have been equalled by the determination and resolve of many to develop effective solutions. The impact of technology and urbanization on the California environment may be ultimately the most important problem. At stake now may not be the quality of life, but survival of life as we know it.

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2 Ibid.
4 Thermal pollution is an additional agent of environmental degradation that is associated with large scale power generation. By 1980 20 percent of all the fresh water runoff in the United States will be used for power plant cooling purposes. During periods of drought and/or during low rainfall seasons 30-50 percent of total runoff will likely be used in this way. See Environmental Science and Technology (1968), Vol. 2, p. 399.
5 See footnote number 1 for reference to a report recently published in conjunction with the power industry which details the plans for future development of nuclear power in California. Particular attention is given to ways and means by which public intervention and opposition to nuclearization may be eliminated or minimized so as to not unnecessarily delay the program.
6 Artificial production and release of radioactivity to the atmosphere is one consequence of large-scale nuclearization. Artificial radioactivity penetrates and biologically concentrates in all realms of the environment. See M. Eisenbud, Environmental Radioactivity (New York: McGraw-Hill Book Company, Inc. 1963).
7 This is an advanced reactor being developed to eventually replace conventional reactors. Because both are developmental many technological problems must be solved, particularly for the breeder reactor. According to Government estimates, the state of the art for breeder reactors will not be perfected until at least 1974. Some shortcomings of the breeder program are outlined by G. F. Tape, "The Increasing Importance of the Breeder Program (A Symposium)," Chicago, Illinois, April 23, 1968. USAEC release No. S-17-68, April 23, 1968.
8 Subsidies paid by the U.S. Government to support nuclearization of the private power industry include (1) contribution to reactor construction costs, (2) research and development support, (3) five-year waiver of lease charges on fuel, (4) low guaranteed charge for reprocessing irradiated fuel, (5) high guaranteed buy-back prices on by-product plutonium for weapons use, (6) undefined costs in radioactive waste disposal, and (7) Government indemnity to cover third-party liability claims in the event of major reactor accidents. Unfortunately for power consumers, rising power rates: often attend nuclearization despite generous Government subsidy. See A. J. Ackerman, "Atomic Power Plants--What's Wrong With Them?" Hydroelectric Power Session, American Power Conference, April 28, 1965, Chicago, Illinois.
10 According to the Atomic Energy Act, atomically produced electricity is in the research and development stage. All nuclear power reactors are experimental, not commercial, because their practical (economic) value has not been demonstrated.
11 Section 170c. of Public Law 88-703 (Price-Anderson Act of 1957) states "...the aggregate liability for a single nuclear accident (reactor accident)...shall not exceed the sum of $500,000,000,000 together with the amount of financial protection required..." Thus the total liability assumed by Government is not more than $500,000,000 plus private insurance obtained by the reactor operator which to date has not exceeded $50,000,000. Thus 1/14th of the total $7 billion cost of a "maximum credible accident" is assumed by Government and the power industry. For a discussion of possible reactor accidents see USAEC, Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Reactor Plants, WASH-740, U.S. Government Printing Office, March, 1957, Washington, D.C., and L. Mattison and R. Daly, "Bodega: The Reactor, The Site, The Hazard," Nuclear Information, April, 1964, pp. 1-2.
14 M. Eisenbud, op. cit., p. 262.
15 The fire at the Dow Chemical-AEC Rocky Flats plutonium fuel facility near Denver, Colorado, did an estimated $20,000,000 worth of damage, but decontamination costs exceeded $40,000,000.

Reactor accidents from various known and unknown causes can result in varied levels of damage. An "excursion," an uncontrolled nuclear reaction, may result in (1) the containment of reaction products within the reactor structure, (2) the release of volatile fission products, or (3) the 50 percent release of all fission products from the containment building. These spatial and temporal hazard levels associated with reactor failure are detailed in references cited in footnote 11.


OCCUPANCE PHASES OF THE LOWER RIO GRANDE
OF TEXAS AND TAMAULIPAS

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The sequence of settlement in the Lower Rio Grande can be viewed in the context of two dissimilar cultures—Hispanic and Anglo-American—at different levels of technology that have occupied the region contemporaneously. Two occupancy phases—pastoral and agricultural—are salient, the latter composed of periods based on (1) population growth of the region’s two largest cities, the twin cities of Matamoros, Tamaulipas, and Brownsville, Texas (Fig. 1), and (2) man’s changing impress upon the landscape.

THE PASTORAL PHASE

The Pastoral Phase began in the mid-18th century with arrival of colonizing parties at the Rio Grande from the Mexican interior. The Spanish government of Mexico initiated colonization of the northeastern territory in 1746 to subdue nomadic Indians and to prevent encroachments from New France. Count Jose de Escandon was named conquistador of the new province of Nuevo Santander, which extended north and south of the Rio Grande from the Rio San Antonio to the Rio Panuco (Fig. 2). In the 18th century, Spanish missionaries and colonists under the auspices of Escandon set up a line of towns and ranchos along the Rio Grande. The first settlements were made, in order, at Camargo, Reynosa, and Rancho de Dolores (Fig. 2) and with exception of Reynosa, were upstream from the delta region.

Cattle rearing became the dominant activity in the area, and agriculture was restricted to small subsistence plots near the river. Long isolated from larger population concentrations to the north and to the south, the sparsely inhabited frontier became the habitat of feudal cattle ranchos; primitive lines of communication into and within the region limited commerce to the spasmodic movement of a few commodities of value.

The original site of Matamoros near the south bank of the Rio Grande between two esteros or lakes, attracted a settlement nucleus in Indian times. In 1765, the place was known to the Spaniards as San Juan de los Esteros, a name later replaced by Refugio. At century’s end, Matamoros was an insignificant Indian congregacion; not until 1821 was it organized as a village.1

Military operations by the United States in the Mexican War were responsible for inception of twin settlements at the Matamoros-Brownsville sites. Brownsville began as a scattering of jacales, or huts, near the fort established by General Zachary Taylor across the Rio Grande from a similar bastion in Matamoros.2 The original place, called Shamondale, was erased subsequently by the shifting channel of the river. Thereafter, buildings were brought into a grid of streets from which a larger pattern evolved (Fig. 3). Brownsville and Matamoros were the largest towns on the river prior to the Civil War.3

During the Mexican War and for some years afterward, the Rio Grande was navigable from its mouth to Rio Grande City far upstream. Extensive shipping was carried on directly from Brownsville wharves, but nothing was done to keep the river open, leading to its gradual abandonment. The region sank into obscurity until the U.S. Civil War.

The Civil War brought enormous, though temporary, population increase (Fig. 1) and boom times to Mexican and Texas settlements along the lower Rio Grande which, as an international waterway, was free of the union blockage. The Rio Grande became the only outlet in the Confederacy for cotton exports. Brownsville became a thriving river port once again and had a population of 25,000 (Fig. 1), while Matamoros numbered approximately 40,000 inhabitants. The two centers temporarily were the world’s greatest cotton markets. Following the economic boom of the Civil War, the Lower Rio Grande entered an era of somnolence and isolation. The populations of Matamoros and Brownsville plummeted; almost eighty years were to elapse before the Civil War population figures were surpassed. Dissimilar population trends for the remainder of the century meant that by 1900 the two places were more nearly equal in size than at any time during their existence.
The mainstay of land use in Texas—as in Tamaulipas—was livestock rearing. Agriculture existed on a modest scale, and the variety of crops foreshadowed the future diversity of land use that would arise with improved transportation to the outside world. Cotton, sugar cane, vegetables, fruits, corn, and beans were raised. Commercial production of vegetables was delayed until after 1904, but nonperishables—cotton and corn—were grown in fairly sizeable quantities. Some cotton was exported with difficulty and corn, a dietary staple for the Latin American population, was a subsistence crop.

Isolation was broken for Tamaulipas late in the 19th century, some ten years before railroads arrived on the Texas side from the north in 1904. Yet Mexico was to remain economically backward and hamstrung by revolution for at least another generation. The Rio Grande delta had always been distinct from areas upstream because with primitive methods, some water could be diverted onto alluvial flatlands. In the Pastoral Phase, this essentially meant the brush stood higher and the grass grew thicker, but cattle rearing persisted as the focus of man’s activities. This phase of sequent occupance continued on the Mexican side until the 1930’s. Meanwhile, Brownsville eclipsed Matamoros in population growth pending subsequent economic development of Tamaulipas in the 1940’s.

THE AGRICULTURAL PHASE—TEXAS

The Early Period (1904-1918)

In the latter part of the 19th century, Europeans and American southerners came to the Texas Lower Rio Grande to conduct mercantile operations and to settle on cheap land. Some of this group experimented with new crops—sugar cane, tobacco, and citrus. Speculators from the United States North began to arrive in the region and acquired large tracts of land. When rail transportation northward was established by the St. Louis, Brownsville, and Mexico Company (later replaced by the Missouri Pacific) in 1904, a new phase was ushered into Texas—but not into Tamaulipas. The present imprint of urbanism north of the river is related directly to technology operative in this formative stage of the settlement pattern. Only Elsa, Port Isabel, and Brownsville had origins dissociated with the coming of rails (Fig. 4).

In the early years of pioneer settlement (1904-1918), rail connection to the north made the area less remote, and the opportunity to irrigate fertile deltaic soils was recognized. By 1910, land investment companies had been formed and massive projects were initiated to clear, irrigate, and transform the landscape into an agricultural oasis. Prospective settlers, or “home-seekers,” were recruited by promotional schemes, particularly from the Midwest. Not all home-seekers remained, but the number of farms climbed steadily.

Between Brownsville and San Benito, a large acreage was planted in sugar cane. However, the distance to markets forced operations to succumb to competition from Louisiana sugar districts. Once citrus and truck crops became commercially important, cane production ceased. The unreliability of the railroad, bandit incursions from across the Rio Grande, and difficulty in finding a marketable crop added to uncertainties of permanent settlement until after World War I.

The Post-World War I Period (1918-1929)

Settlers in greater numbers came to the area following the war, bringing with them new ideas for crops and markets and assuring the demise of sugar cane. Since World War I, winter truck crops, cotton, and citrus have occupied the best agricultural lands; cattle ranches were pushed inland by the spread of irrigated agriculture and were removed to areas beyond the irrigation ditches and to the wet coastal prairies.

Railroad and highway connections were improved and by the end of the period, concentration of the crop triumvirate—truck, cotton, citrus—in specific districts was recognizable. The west (around Mission–McAllen) was dominated by citrus; the southeast (around San Benito–Brownsville) was planted mainly in winter truck and summer cotton. A transitional area focused on Weslaco with land devoted about equally to truck, cotton, and citrus. To the north (around Raymondville–Lyford) truck crops and cotton were concentrated.
THE DISPERSED CITY OF THE LOWER RIO GRANDE

Figure 4
The Stagnation Period (1930-1940)

The depression years of the 1930’s were a time of stagnation in Brownsville’s population growth. However, the number and value of fruit and vegetable shipments from the Lower Rio Grande grew throughout the decade as produce moved northward by rail. Tracks of the Southern Pacific were laid southward through Hidalgo County to McAllen. Another line was extended from Edinburg east to Santa Rosa, thence southeast to Brownsville, the terminal point for the two rail lines serving the area. Of greater economic importance was the opening of Port Brownsville in 1936, which provided cheap water transportation via a deep-sea outlet (Fig. 4). Growth of Port Brownsville was allied closely with expansion of cotton cultivation on both sides of the river. Port facilities served a hinterland, not only in Texas and Tamaulipas but in a large part of northern Mexico.10 The long-time dependence upon Brownsville as a funnel for commodities destined for or leaving the Mexican Lower Rio Grande and much of northern Mexico was strengthened.

The Modern Boom Period (1940-1960)

Brownsville more than doubled its population to 48,000 during these two decades of prosperity, due partly to the extremely close economic interdependence with the Matamoros Cotton Region and to the growing size and importance of Matamoros. Yet, the Mexican center was unable to furnish its residents with adequate retail and other services or with their main source of wage income, both of which they were forced to seek across the border.

Irrigated acreage continued to expand, chiefly as a result of the building of Falcon Dam upstream. In the 1950’s, a noticeable shift from citrus cultivation to increased planting of cotton and vegetables took place, relegating citrus to tertiary importance. The cumulative effect of economic and environmental handicaps promoted a downward trend for citrus, whose diminution would be more evident after 1960.

Vessel traffic and tonnage mounted at Port Brownsville as cotton, ores, and petroleum products passed through the facility. For a time, the port again ranked as the leading cotton-shipping point in the United States. Although large amounts of Texas cotton left the docks, more than half of the fiber was from the Matamoros Cotton Region.11 Contributing greatly to port growth was the extension to it in 1949 of the Intracoastal Waterway, giving direct access to the Mississippi Basin and to the Great Lakes.

THE AGRICULTURAL PHASE – TAMAULIPAS

The Pre-Commercial Period (1930-1940)

Development of a commercial agricultural economy in the Tamaulipas Lower Rio Grande was hindered by distance from the Mexican core region and by tariff restrictions excluding nearby United States markets.12 But the reappearance of national stability after the Revolution and improved public health methods paved the way for an upsurge in population growth for Matamoros.

A monocultural emphasis on cotton existed at the commercial level, but the expense of pumping water onto the natural levee usually made dry farming necessary.13 Ubiquitous fields of maize and beans maintained their historic position as principal subsistence crops, with grazing continuing to occupy the largest land area.

The Early Commercial Period (1940-1953)

Cotton proved a profitable product for the region as economic development became rapid between the early 1940’s and the early ’50’s. Heavy demand and highly remunerative prices for the fiber in world markets after World War II encouraged expansion of the cultivated acreage and prompted the Mexican government to undertake new irrigation projects. Thousands of workers poured into the area seeking employment, not only in the enlarging cotton industry but also in great interrelated public works of dam, canal, and highway construction.14

During this period, Matamoros assumed its place as the industrial, commercial, and financial hub of the Tamaulipas Lower Rio Grande. The number of inhabitants increased
CALIFORNIA GOLD MINING LANDSCAPES

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California is known as the “Golden State.” Gold was the principal attraction for the early pioneers and its exploitation stimulated the growth of the state for many years. This precious yellow metal led California’s mineral production for over half a century, until surpassed by petroleum in 1907, but gold continued to be the state’s most valuable metallic mineral until World War II. Since 1848, California has yielded more than 100,000,000 troy ounces of gold, valued at nearly $2,500,000,000.¹

Today, California gold mining is almost non-existent. The last major gold mining operation in the state—a dredge working on the Yuba River—ceased operations in October, 1968 (Fig. 1). With the shutdown of this dredge, gold mining as an industry virtually ended in California.² A few mines are still in partial operation and some gold is found by amateur prospectors and skin divers. However, most gold produced today is a by-product of other mining operations. In 1968, only about 15,000 ounces of gold, valued at slightly more than $600,000, was produced.³ Nearly two-thirds of this figure came from Yuba River operations. Record yield occurred in 1852—the height of the Gold Rush—when an estimated 4,000,000 ounces were recovered.

GOLD MINING LANDSCAPES

The past exploitation of this precious yellow metal has left a striking imprint on the land. Some conceptions of a gold mining landscape may include roads, settlements, and other features associated with the exploitation of the metal. This paper, however, focuses on the several types of landscapes created by the mining operations themselves.

Four distinct types of landscapes are associated with gold mining. Most are located in the foothills of the Sierra Nevada, with secondary locations in the Klamath Mountains. A few gold mining landscapes are scattered throughout the Trans-Sierra and the Mojave Desert (Fig. 2).

Figure 1.
A floating gold dredge. This dredge is of the same design as the last operating dredge in California.
**CALIFORNIA GOLD MINING LANDSCAPES**

- Panning Landscapes
- Hydraulic Landscapes
- Dredge Landscapes
- Lode Mine Landscapes

Figure 2
The Malakoff Diggings. This area has recently been made into a state park to preserve this gold mining landscape.

The Pine Tree and Josephine mine. This mine, north of Mariposa, is one of the few in the Mother Lode to still have surface buildings.

Dredge landscape along the Yuba River. This landscape occupies some twenty square miles.

The Kennedy mine. Two of the three remaining tailing wheels are in the foreground; in the background, the headframe rises over the remains of the bunkers. All other surface equipment has been removed.
PANNING LANDSCAPES

The least perceivable gold landscapes are areas of panning debris. A small scale of operation and scattered locations have made this landscape type much more difficult to recognize than other gold landscapes which represent larger operations and more centralized locations. Panning landscapes are often marked by round, symmetrical piles of rock and gravel from one to three feet in height, generally evenly spaced over an area. These piles are often obscured by grass, brush, and trees, and their distinctive shape has sometimes been greatly modified by over a century of erosion. Along the smaller intermittent streams, sharp angular rocks—which contrast markedly with stream-rounded ones—also distinguish a panning landscape.

Placer gravels containing gold weathered from quartz veins and transported by water were first exploited on a large scale during the Gold Rush of 1848-1849. The first implements used were the pick and the pan. Soon, machines were developed which enabled the miners to process larger amounts of dirt and gravel. The rocker, the long tom, and the sluice were basically wooden boxes or troughs into which auriferous gravel and water were poured. The lighter materials were washed out of the box and the gold, being heavier, dropped to the bottom, where it was caught by cleats.4

The primary locations of this early placer mining—and hence today’s panning landscapes—are the stream valleys along the western slope of the Sierra Nevada. Following the historic discovery by James Marshall at Coloma on January 24, 1848, the American River became the initial goal of most gold seekers. Quickly the Argonauts began to search northward to the Feather River and southward to the Kern. North of Amador County the diggings were called the “Northern Mines” and south of this county they were termed the “Southern Mines.” Gold was also discovered on the Klamath River in 1848, and many miners moved into the Trinity Mines.

Although most of the Sierra foothills and much of the Klamath Mountains have been well-worked for gold, panning landscapes are today limited in extent and occupy very small areas. In addition to the reasons cited above, reservoirs on the major rivers have inundated many placer mining areas. Since this was usually the initial type of mining in most areas, subsequent settlements have expanded over and eradicated many placer remnants.

Rich surface placers were quickly exhausted. By the middle 1850’s, miners were turning to other methods to reach deeply buried auriferous gravels. In the Sierra, gold had been trapped in stream channels of tertiary age and these channels had been buried by volcanic deposits.

HYDRAULIC LANDSCAPES

The chief method of exploiting these buried gravels—hydraulicking—has created the second type of gold mining landscape. This type of mining began near Nevada City in 1852 and spread rapidly throughout the Sierra foothills and the Klamath Mountains.5 It involved the direction of a jet of water against a hillside. The stream of water undermined the hillside and the earth and gravels were then washing through a sluice to trap the gold. Because of the depth of these buried channels, hydraulicking became the cheapest method of exploiting the auriferous gravels.

Hydraulicking ended for all practical purposes in 1884. A judicial decision prohibited the dumping of debris in the Sacramento and San Joaquin Rivers and their tributaries.6 The mines had been dumping their waste into streams which carried it into the Central Valley, covering once prime farm land with silt and debris. The decree did not outlaw hydraulic mining itself, but the costs involved in impounding the debris made most hydraulic operations unprofitable, and hydraulicking has been of little importance since this date. A few hydraulic operations—principally in the Klamath Mountains—have been worked since 1884, but their output has been minimal compared with other types of gold mining.

Hydraulic landscapes are widely scattered in the foothills of the Sierra Nevada. Near Columbia, hydraulic mining has washed away soil and left the limestone bedrock visible. In some places, pillars of dark grey limestone rise some ten feet from the surrounding ground
level; these may be as large as five or six feet in width. Broken smaller pieces litter the ground adjacent to the huge boulders. Much of this area is overgrown with the “Tree of Heaven,” a plant brought to California by Chinese miners.

The area around Volcano also presents a hydraulic landscape. Mining activities were not as intense as at Columbia, so more soil remains. The exposed bedrock here is limestone and the appearance of the Volcano area is similar to that of Columbia. Fewer pillars of limestone mark this landscape and much of the hydraulic debris is overgrown by berry vines.

Perhaps the most striking example of a hydraulic gold mining landscape is the Malakoff Diggings (Fig. 3). A badlands has been created by the washing away of the hillsides. These badlands are faced with steep cliffs and badly gouged ravines, and soil layers of tan and buff colors have been exposed. Erosion has modified these scars in the earth and they are now clothed with a cover of pines.

Another area of hydraulic landscape is near Weaverville in the Trinity Mines. This area resembles the badlands of the Malakoff Diggins. A great scar has been created on the surface and the hydraulic activities are clearly evident. Mining continued into the 20th century and large-scale operations ceased about 1918.

Many smaller areas in the Sierra Nevada and the Klamath Mountains exhibit areas of hydraulic landscape. Badlands areas and regions of exposed bedrock reveal the extent of past hydraulic mining. Hydraulic landscapes are much more evident than panning landscapes; in fact, many panning areas have been eradicated by later hydraulic operations.

DREDGE LANDSCAPES

The third type of gold mining landscape—dredge tailings—is also associated with placer gravels. Dredging in California began on the Feather River near Oroville in 1898. This landscape is most notable in the Central Valley along the major rivers flowing from the Sierra Nevada. Characteristically, dredge areas are recognized by the orderly rows of rock piles. Often these tailings are composed of rocks with little or no dirt or alluvial material present. Where dirt is present, the rock piles are obscured by vegetation.

The extent of a dredge landscape is related to the type of dredger which operated. On small streams, drag-line dredges have left areas as small as one-tenth of a mile in length by twenty-five feet in width. In spite of their small dimensions, these dredged areas are easily recognizable by their parallel rows of rocks.

Larger floating dredges operating on the Central Valley floor created landscapes that extend over as much as twenty-five square miles. Significant areas of dredge landscapes are located along the Feather River, the Yuba (Fig. 4), on the American, and along the Tuolumne. Smaller dredge areas are located on the Calaveras River and along the Merced River. Streams flowing into the Central Valley from the Klamath Mountains also exhibit dredge landscapes. Clear Creek, south of Redding, has a sizeable area of dredge tailings.

Dredge landscapes are perhaps the most striking and most discernible of the gold mining landscapes of California. The parallel rows of tailings clearly indicate the intensity of past gold mining activity, and any vestiges of the previous landscape have been completely eradicated and covered with the dredge landscape.

LODE MINE LANDSCAPES

The last type of landscape is associated with lode deposits rather than placer gravels. Lode gold was in its place of origin and became the basis of hardrock mining. Lode mine landscapes are scattered and cover very small areas in comparison with the landscapes associated with the exploitation of placer gravels. The largest lode mine landscape covers less than five acres. Because most of the mining was carried on deep within the earth, there is often little surface evidence of these landscapes.

A prominent feature of almost all lode mines is the tailings pile. This waste often forms a distinctive landform at or near the mine site. Many of the mine buildings and most of the surface equipment have been removed, but a few headworks buildings still stand (Fig. 5). Commonly, they are of corrugated iron sheets attached to a wooden framework. Several
Scott: California Gold Mining Landscapes

steel headframes rise over tailings piles and the concrete foundations of stamp mills and other machinery used to crush the quartz. A small number of lode mine landscapes are marked by rusting machinery and other surface equipment.

Although lode mining started in 1849, its technology was not perfected until the late 1880’s and 1890’s. Use of dynamite, use of chlorine and cyanide to treat ores, availability of electricity to replace other sources of power, and improved mining methods in general highlight the long list of achievements of these decades.\(^8\) With the depletion of the surface placers in the early 1860’s, the end of hydraulic mining in the early 1880’s, and the many technological improvements of the 1880’s and 1890’s, lode mining became the dominant form of California gold mining in the 20th century.

The history of lode mining reflects rises and declines caused by several factors. Lode mining declined from about 1915 to 1929 because of high costs following World War I. Increased output from dredge operations partially offset these declines. With the depression of the early 1930’s, production costs were reduced and the mines increased production. In 1934 the price of gold was increased from about $21 to $35 per ounce. In 1940 gold production amounted to 1,455,000 ounces, valued at nearly $51,000,000. This was the highest yield since the Gold Rush.\(^9\)

World War II caused a precipitous drop in gold production. All gold mines were shut down in 1942 by federal government order. After nearly four years of idleness, the order was lifted in 1945. Most lode mines, however, remained closed because of rising production costs. A few of the larger mines reopened, but the last large mine on the Mother Lode ceased operations in 1954.\(^1\) The mines at Grass Valley shut down in 1956\(^1\) and the mines at Alleghany closed in 1966.\(^1\)

Lode mine landscapes are most prominent in the Sierra Nevada along the so-called "Mother Lode," a series of gold-bearing veins running from Georgetown southward to Mariposa, a distance of some 120 miles. North of this belt other important lode mining districts are centered on Grass Valley and Alleghany. Several prominent lode mine landscapes are located along the Mother Lode. An immense tailings site, which is estimated to contain over 3,000,000 tons of waste rock, marks the lode mine landscape of Carson Hill. Another impressive feature of this landscape is the glory hole on the north side of the hill. Carson Hill mines have produced over $26,000,000, including the largest mass of gold ever recovered in California: this lump weighed 195 pounds troy.\(^1\)

A unique form of lode mine landscape is located at the Kennedy mine at Jackson. Four tailings wheels were built to remove tailings from the drainage of Jackson Creek (Fig. 6). The tailings were lifted over a small hill and stored behind an impounding dam. Three of these wheels are presently standing; one has recently fallen in ruins. The Kennedy was the greatest producer of the Mother Lode with a total production of over $34,000,000. The mine has been idle since 1942.\(^1\)

The area around Bodie in the Trans-Sierra also presents lode mine landscapes. Little surface equipment is left, but the area has many tailings piles and mine adits. A significant area of lode mine landscapes is located at Randsburg in the Mojave Desert. Here, tailings piles are found scattered among the few remaining structures, and the surrounding hillsides are dotted with mine shafts and surface buildings.

Although lode mine landscapes are generally not as impressive as hydraulic or dredge landscapes, lode production has been very important. The Mother Lode between Jackson and Plymouth, a distance of some twelve miles, has produced over $160,000,000 in gold, and Grass Valley mines have yielded about $190,000,000 of the precious yellow metal.\(^1\)

**SIGNIFICANCE OF GOLD MINING LANDSCAPES**

These four types of landscapes illustrate the colossal effects on the surface of California caused by gold mining. Gold areas have an “overturned” look. The surface layers have been dug up, turned over, and rearranged by man in his search for gold.

Until recently, gold mining landscapes have been thought to have little or no value. A few small dredged areas have been leveled\(^1\) and some lode mine tailings were reworked in
the depression for gold or used for gravel. However, gravel and boulders precluded agriculture, and the chemicals used for the processing of lode mine ores made general utilization of gold landscapes impractical. In the last few years, however, a practical use has been found for dredge tailings. The Oroville Dam on the Feather River and the new Don Pedro Dam on the Tuolumne are constructed of dredge tailings. Use of these tailings, besides providing materials for the construction of the dams, has resulted in the leveling of areas once covered with debris. Future use of these once valueless areas may include agriculture or recreation.

These man-made gold landscapes stand as a constant reminder of the past importance of gold in the economy of California. Even though erosion has acted on these landscapes for many years, the effects of gold mining will be visible for countless years to come. Such a vast venture as gold exploitation has indeed left its mark.

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16. A few very small areas near Oroville were leveled because municipal land was covered with debris. "Leveling Dredge Ground at Oroville," Engineering and Mining Journal, Vol. 94, No. 17 (1912), p. 782.
17. The dumps of the Utica mine in Angels Camp were worked for small amounts of gold in the 1930's. Clark and Lydon, op. cit., p. 72. In 1927 the California Highway Commission produced 35,000 tons of rock from the dumps of the Mariposa mine in Mariposa. This was used in highway construction and repair. Oliver E. Bowen Jr., and Clifton H. Gray Jr., "Mines and Mineral Deposits of Mariposa County, California," California Journal of Mines and Geology, Vol. 53, Nos. 1 & 2 (January-April, 1957), pp. 128-130.
Although much of the coast line had already been explored, Australia was not formally claimed until Captain Cook landed in Botany Bay in 1770. Officially Australia began on January 26, 1788, when Captain Philip landed at Port Jackson Bay (Sydney) with a charge of 750 convicts. Within a few years, free settlers were attracted and the population began to spread out into the coastal fringe. By 1813, the Blue Mountain barrier behind Sydney had been traversed and at the time of the Gold Rush of the 1850's, much of interior New South Wales had been carved into "squatter's" runs.¹

The Gold Rush brought an influx of migrants from Britain and the already overworked gold fields of California. The surge in population can be seen in the rise from 1840 to 1850 of 138,000 people in New South Wales and over 300,000 in Victoria.² Because New South Wales could no longer act as an effective political unit with people moving farther from Sydney, new colonies were created: Tasmania in 1825, South Australia³ in 1836, Victoria in 1851, and Queensland in 1859.

By 1850, the railroad had proved a useful means of developing the agricultural and industrial potential in Europe and North America. The colonial governments in Australia saw the need for the development of railway networks. Each colony considered itself as a separate political entity and was, in effect, a self-governing unit attempting to maximize the development of its own territory. Growth in each colony was based upon the export of raw material (wool, minerals, and, later, meat) in exchange for finished goods. Thus, the chief port and capital city became the focus of all communication, as well as the center of population, administration, and finance. The boundaries between the colonies were fringe areas between spheres of influence of each capital city. Only at a few points of contact along the River Murray did people of one colony live in proximity to the neighboring colony. Yet within the continent there was mobility as stockmen, shearers, gold seekers, and settlers moved freely from one prospect of opportunity to another. Colonial tariffs on the free flow of goods over the borders was an obstacle to economic interaction. This protective attitude was slowly compromised by the creation of the Commonwealth in 1901.

When railroad development began, the focus was upon the colonial capital. The first railway line was operated in 1854 for two miles between central Melbourne and the port. This was followed by several other small, private railways, that found it uneconomical to operate. By the end of 1855, the colonial governments took over the operation of the railways and large-scale development then began.

THE RAILWAY GAUGE MUDDLE

A railway's gauge is determined by the terrain, the population, the capital available, and the political factors influencing where rolling stock is purchased, if it is not produced at home. By 1860, there were several gauges in use: the narrow 3-foot 6-inch gauge has the advantage of low per-mile construction and operational cost in rugged areas; the standard British or European 4-foot 8½-inch gauge, which provides a longer operating span for more heavy-duty use than narrow gauge; and the Irish 5-foot 3-inch broad gauge, which was developed for heavy-duty use, higher speed, and greater operational life.

Each of the Australian colonies considered the distance and cost factors in the construction of their railway lines. Queensland sacrificed speed for a greater scope and, by using the narrow gauge, was able to extend the railway network up the coast over 1,200 miles and thus develop feeder lines into the vast interior. New South Wales and South Australia agreed to the construction of the broad gauge by 1850, and they were joined by Victoria. At the last minute, partly due to the dismissal of their chief Irish engineer, New
AUSTRALIAN RAILWAY GAUGES

- - - - 4' 8 1/2"
- - - - 5' 3"
- - - - 5' 6"
- - - - New 4' 8 1/2" Trans Australian Lines Open By 1970
South Wales decided to utilize standard gauge. Victoria and South Australia had already ordered their rolling stock, as New South Wales had neglected to inform them of its decision. Western Australia did not begin development of its railways until 1881, and then decided to economize by utilizing narrow gauge. South Australia utilized narrow gauge to smaller country areas.

Thus, on the eve of federation in 1901, Australia had its railway pattern well established. Each colonial capital was a hub with the rail network radiating from it. Connection between the colonies was based upon trans-shipment of goods and passengers, resulting in innumerable delays and inconveniences; connection between South Australia and Victoria was effected easily, as both states utilized the same gauge.

Trespassing across colonial borders occurred only in a few instances to meet special needs. New South Wales had turned a deaf ear to the demands for a rail link to the mines at Broken Hill, a distance of over 700 miles from Sydney. Thus, local private interests formed the Silverton Tramway and constructed a narrow gauge line to Cockburn, 35 miles away on the South Australia border, where it linked up with that colony’s narrow gauge line specially constructed from Port Pirie. This was done to facilitate the movement of Broken Hill ore. Along the River Murray border, several New South Wales agricultural centers were denied railway lines, so Victoria was granted service rights and had three lines crossing into New South Wales.

Although the states in 1921 agreed in principle to the concept of standardization, only a few key lines have seen the effect of this. In 1932, the Queensland railways standardized their portion from Brisbane to the New South Wales border, a distance of some 75 miles. In 1962, Victoria completed a standard gauge line running over 190 miles from Melbourne to Albury on the River Murray. Thus, standard gauge now exists from Melbourne over 1,200 miles to Brisbane.

THE TRANSCONTINENTAL RAILWAY

In the Governor General's speech at the federation ceremonies for the Commonwealth's establishment, reference was made to a proposed Commonwealth project to construct a rail link between Port Augusta in South Australia and Kalgoorlie in Western Australia, thus providing for an 1,108-mile link between the two closest points (Map 1). This had been one of the promises to induce Western Australia into the Commonwealth.

The chief engineers of the state railways met in conference in 1903 and recommended the use of a standard gauge line in the event of national standardization. Parliament authorized study of a route in 1907 and, in 1911, passed the Kalgoorlie to Port Augusta Railway Act, which enabled construction to begin. The route had to pass through the Nullarbor—a flat, limestone plain with less than ten inches of precipitation (Photo 1). The Nullarbor is treeless, devoid of water courses, subject to searing heat and clouds of dust. The flat topography with virtually no surface drainage made it easy to construct the line, but the lack of potable ground water, the heat and the flies of summer posed problems for the construction and maintenance crews (Photo 2). The route is the straightest in the world, with one 297-mile portion that is in perfectly straight alignment.

On October 17, 1917, the rail crews working from both ends met, and on October 22 the first passenger train rolled westward. The trip across the Nullarbor was long and dusty. Locomotive water had to be shipped to watering stops en route until 1927, when a successful treatment of ground water with barium carbonate made local water available for this purpose. Air conditioning was introduced in lounge and dining cars in 1936, but a fully air-conditioned train was not in operation until 1952.

The complete journey to or from Sydney took six days, and passengers were kept busy changing trains. For example, if one were traveling from Perth to Sydney, the first change was at Kalgoorlie from the narrow gauge to the Commonwealth standard gauge. One then changed at Port Augusta to the broad gauge, then at Adelaide to the overnight sleeper train, then again at Melbourne. A gauge change was made at Albury to the standard gauge and, at last, one would arrive in Sydney.
Figure 1. Flat limestone plain of the Nullarbor near Cook, South Australia. Note the low scrub and the lack of trees.

Figure 2. Typical railway towns housing construction and maintenance crews. This is Rawlina in western Australia.

Figure 3. Flinders Street station in Melbourne is the busiest railroad station in the nation. It is only used for suburban traffic.

Figure 4. Modern stainless steel and aluminum sleeping cars now in use on transcontinental line.
In 1911, the Commonwealth took over completion and operation of two South Australian lines which were planned to provide a north-to-south transcontinental line. Pressure from Queensland and a lack of funds have hindered the completion of such a line. By 1929, the narrow gauge line from Port Augusta reached 800 miles to Alice Springs. The line south from Darwin was pushed 316 miles inland, leaving a gap of 622 miles. When Japan bombed Darwin in 1942, allocations were made to pave a road from the Alice Springs railhead north. Today combined rail and road transport make the expenditure of capital to complete the line impractical.

Increased traffic on the transcontinental line has resulted from growth in agricultural and mineral output and a corresponding population increase in Western Australia. In 1937, the line was extended to Port Pirie as the narrow gauge line from Broken Hill and the broad gauge line from Adelaide meet here. Improvements in service were made with the use of diesel-electric locomotives in 1951, and with new passenger cars coming into service in 1952, making this the most luxurious line in Australia. The completion of the standard gauge line between Melbourne and Albury in 1962 brought into service new overnight passenger trains between Sydney and Melbourne, thus eliminating one gauge change. The Westland Express operating between Kalgoorlie and Perth was the most uncomfortable part of the journey, as carriages did not provide private single cabins nor were toilet facilities available in each cabin. The change in gauge at Kalgoorlie was eliminated in June, 1969, by completion of the standard gauge over this route to Perth (sample timetable, Table 1).

Freight service was also improved. Victoria and South Australia allowed interchange of freight cars after 1962, and facilities for the lifting of freight cars from one gauge to another made it possible for goods to be shipped across the continent without being removed from a car.

### Table 1

**Sample One-Way Timetable on the Trans-Australian Line as of July, 1969**

<table>
<thead>
<tr>
<th>Station</th>
<th>Miles from Brisbane</th>
<th>Time</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lv. Brisbane</td>
<td>0</td>
<td>4.40pm Tu</td>
<td>4' 8½&quot;</td>
</tr>
<tr>
<td>Ar. Sydney</td>
<td>613</td>
<td>8.33am We</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Sydney</td>
<td>613</td>
<td>8.00pm We</td>
<td>&quot;</td>
</tr>
<tr>
<td>Ar. Melbourne</td>
<td>1202</td>
<td>9.00am Th</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Melbourne</td>
<td>1202</td>
<td>8.40pm Th</td>
<td>5' 3&quot;</td>
</tr>
<tr>
<td>Ar. Adelaide</td>
<td>1685</td>
<td>9.00am Fr</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Adelaide</td>
<td>1685</td>
<td>12.30pm Fr</td>
<td>&quot;</td>
</tr>
<tr>
<td>Ar. Port Pirie</td>
<td>1819</td>
<td>3.48pm Fr</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Port Pirie</td>
<td>1819</td>
<td>4.45pm Fr</td>
<td>4' 8½&quot;</td>
</tr>
<tr>
<td>Lv. Port Augusta</td>
<td>1876</td>
<td>6.20pm Fr</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Tarcoola</td>
<td>2133</td>
<td>12.47am Sa</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Cook</td>
<td>2388</td>
<td>6.25am Sa</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Rawlina</td>
<td>2692</td>
<td>2.05pm Sa</td>
<td>&quot;</td>
</tr>
<tr>
<td>Ar. Kalgoorlie</td>
<td>2927</td>
<td>7.45pm Sa</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lv. Kalgoorlie</td>
<td>2927</td>
<td>8.30pm Sa</td>
<td>&quot;</td>
</tr>
<tr>
<td>Ar. Perth</td>
<td>3307</td>
<td>7.00am Su</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
AIR AND ROAD COMPETITION

Although airlines in Australia have expanded in recent years, rail passenger service is still an integral part of Australian life. The standardization of the transcontinental line and the development of newer, more comfortable trains is clear evidence that rail service for passengers and freight is not threatened by air and road competition as in the United States. Several factors explain the position of the railways:

1. In the Australian urban centers, a network of suburban lines developed as the cities grew. Rapid, efficient, and economical service between the central city and suburban areas is an integral part of urban development (Photo 3). In 1966-67, for example, 24,583,000 passenger train miles were logged in the capital cities.8

2. The national highways are either two-lane or single-lane, and road pavement is not complete in the open areas of the interior. Most roads are not suitable for high-speed traffic, and motel accommodations are at present inadequate for the number of people traveling.

3. Air services are readily available between capital cities and to many country centers, but in light of the average Australian wage of approximately $A50 per week, the vast majority of people utilize rail travel, as the saving is substantial (Table 2).

Air travel, road improvement, and the rise of bus and road freight services make full standardization of the nation's railways economically unrealistic. However, the demand on some routes was such that the states of Western Australia, South Australia, and New South Wales joined the Commonwealth in a program to standardize one coast-to-coast line. The Commonwealth Railway of 1,108 miles and the New South Wales line to Broken Hill were already at standard gauge, but needed many new sleepers and improved ballast. New lines had to be constructed 380 miles from Perth to Kalgoorlie, and 300 miles from Port Pirie to Broken Hill. The combined effort involved an expenditure of $A210 million, as new rolling stock and terminal facilities were also needed. This route of 2,442 miles is the most direct from Sydney to Perth, and eliminates the detour through Melbourne and Adelaide of 252 additional miles.

The 1970's thus herald a new era in Australian railway history, a direct and continuous link between the east and west coasts. Rich iron ore from Koolyonobbing, grain from the interior of Western Australia, lead and zinc from Broken Hill, and many other products will be moved with more efficiency to ports on either coast. Passengers will also be able to relax in comfort as they cross the full width of the continent. It is expected that the increased freight and passenger revenue will offset the initial cost by early in the 1980's.

TABLE 2
Sample 1969 Air and Rail Fares—One Way Basis
(Australian dollars)

<table>
<thead>
<tr>
<th>Between</th>
<th>Jet Coach</th>
<th>Rail Second Class3</th>
<th>Jet First Class</th>
<th>Rail First Class4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adelaide and Melbourne</td>
<td>$21.90</td>
<td>$ 9.20</td>
<td>$25.80</td>
<td>$15.85</td>
</tr>
<tr>
<td>Melbourne and Sydney</td>
<td>23.50</td>
<td>11.05</td>
<td>28.40</td>
<td>18.30</td>
</tr>
<tr>
<td>Sydney and Perth</td>
<td>111.601</td>
<td>57.25</td>
<td>133.50</td>
<td>85.15</td>
</tr>
<tr>
<td>Brisbane and Perth</td>
<td>136.202</td>
<td>66.75</td>
<td>163.70</td>
<td>99.40</td>
</tr>
</tbody>
</table>

1 Special $189.20 round trip excursion fares exist.
2 Special $238.40 round trip excursion fares exist.
3 Fare includes sleepers (sharing facilities) on the Trans-Australia portion only between Port Pirie and Perth. Meals are included on this portion.
4 Fare includes sleepers on all trains (private) on all trains except the day coach between Adelaide and Port Pirie. All meals included except on the day coach.
When the new line became fully operational early in 1970, each state and the Commonwealth took on responsibility for the operation of its respective section. Revenue will be shared on the basis of traffic over each section. The new Trans-Australian Express, already in service between Port Pirie and Perth (Photo 4), will provide through service to and from Sydney in 72 hours. Stainless steel and aluminum sleeping cars with such amenities as private showers, new lounge and dining cars make this one of the most comfortable trains this author has experienced. The trip is one of geographic interest as it impresses upon one the immensity of the “Outback.” Traveling across the Nullarbor takes all of one day and the mile-after-mile of unfenced, unsettled, treeless, barren, flat and reddish land rolls by in a virtually unending panorama of monotony. The rail line across the sheer inhospitable country of the Nullarbor is, in many ways, a tribute to the pioneering spirit of the Australian people, since they have labored with much sweat to link together the two core areas of their continent nation.

REFERENCES

1 Inland development extended as far as the fourteen inch isohyet, which averages three hundred air miles inland from the coast.
3 This colony was settled under the Wakefield scheme whereby land was sold and the money used to bring in skilled settlers. No convict settlements were ever established in South Australia.
4 Tasmania also utilized the narrow gauge due to the rugged nature of the island.
6 Queensland feared that an interior north-south line would tap much of the wool and beef trade channeled via its feeder lines to the east.
7 The narrow gauge line to Broken Hill was linked with a standard gauge line from Sydney in 1927. This allows passengers to travel through to South Australia without the detour through Melbourne.
8 Commonwealth Bureau of Census and Statistics, _op. cit._, p. 417. In addition, 22,728,000 train miles of country and interstate travel were recorded. Total earnings for 1966-67 were $A509,920,000 and total operational, maintenance and depreciation costs were $A478,921,000. After all deductions for gauge changes and other financial responsibilities the railways had a loss of $A26,456,000. It is anticipated that increased services will eliminate the loss factor.
TWENTY-FOURTH ANNUAL MEETING
Fresno, California
May 8-9, 1970

The Del Webb Townehouse provided the setting for the twenty-fourth annual meeting of the California Council for Geographic Education, jointly hosted by Fresno City College and Fresno State College. Friday evening was highlighted by a very successful wine-tasting session. On Saturday, thirty-two papers were presented in concurrent morning and afternoon sessions. The luncheon speaker was Harold Tokmakan of Fresno State College, who spoke on "The West Side Valley Project," a study of the impact of the California Water Plan and the new Interstate Highway on the west side of the San Joaquin Valley. The afternoon was enlivened by a panel discussion, "Geography: Revolutionary Survival Science," moderated by Clark Akatiff of San Jose State College. The evening banquet was fittingly capped by Dr. Robert Colwell’s address, "Remote Sensing," and the presentation of a plaque to Arthur Carthew for his many contributions to geography.

ABSTRACTS OF PAPERS PRESENTED

JAMES D. BLICK, San Diego State College—"Mobile Home Parks—A New Feature on the Urban Landscape"

Mobile homes and their parks have recently become conspicuous on the landscape. Traditional trailer parks with their smaller, readily moveable trailers were often situated along major roads, and were in or close to town. The larger, more luxurious and less moveable mobile homes are grouped in modern, well-kept, often very large parks with many of the amenities of life near at hand. Mobile home parks tend to cluster on the outskirts of the built-up urban area where land is still available.

CAROLE S. BROW, University of California, Berkeley—"The Role of Systems Analysis in Geography: Education of a Geographer, 1970"

To answer the question, "How do the various cultures of man relate to their environments?" geography and other social sciences put forth several conceptual schemes which have been found insufficient in many respects. Criticism of the intellectual inconsistencies in the social sciences in general, and efforts to stimulate scientific unity and inter-disciplinary communication, led scientists in several fields to develop "general systems theory" to handle the multi-disciplinary employment of concepts originating independently in various fields. From these efforts evolved systems analysis, a methodological tool to utilize effectively the conceptual tools of general systems theory. Systems analysis, when properly understood and applied, can be a tool to accomplish high yielding and significant geographical research.

ALBERT A. COLOMBO, San Diego State College—"The Persian Gulf"

At a time when the importance of the Suez Canal has decreased in its commercial and strategic importance, the Persian Gulf has increased in both respects. In the wake of the British withdrawal (1971), the danger of any Soviet hegemony—direct or indirect—in the Gulf should be of serious concern to United States geostrategists. Therefore, an examination of the principal dangers in the Gulf is of particular relevance at this time.

G. PHILIP CURTI, California State College, Hayward—"Inn-Signia: A Vignette on the Concept of Locality"

As an expression of locality, a "pub" is a fine example. Its concept, as nodal point for function, is empty and sere without the addition of the human element of people and buildings which, on the length and breadth of an area, make a locality viable with the vertical superimposition of human activity. The character of a locality, its historio-cultural ancestry, may be identified by the name of the inn, by the speech and clothes of its frequenters.

JAMES R. CURTIS, San Jose State College—"A Case Study of Cactus Pear Farming in Santa Clara Valley: Analysis of Locational Factors"

The largest cactus pear farm in the United States is, surprisingly, located in Santa Clara Valley, California, at about 37° north latitude. The factors that account for this particular location represent a combination of cultural and economic influences, rather than the adequate but less than ideal physical factors. This combination of cultural and economic factors includes: (1) the cultural background of the owner; (2) the availability of a large supply of farm labor; and (3) the ability of the owner to lower operational costs of the cactus pear farm by complementing and transferring factors of production from his lettuce farm in Salinas Valley.

L. I. DEITCH, Chico State College—"The Trans-Australian Railway: A New Era in Gauge Standardization" (see page 46 in this volume)

MICHAEL E. ELIOTHURST, San Fernando Valley State College—"Establishment Geography: Or, How to Be Non-relevant in Three Easy Lessons"
This is an examination of the sociology of American Geography at a time when empiricism has become an ideology and empiricist geographers have risen to positions of power and preeminence. The feudal structure of the American education system encourages empiricism, first to get your degree(s) done and then as an ideological position by placing overemphasis on the practical needs of graduation, promotion, and "professionalism." The current empirical stance and "scientific" approach (epitomized by David Harvey’s most recent publication) leads to a refusal to view Geography as a human enterprise, as being basically concerned with the human condition. Within Empirical Geography the positivist approach has evolved, with emphasis on observation, normative laws, and statistical verification, where the "quality" and the formal elegance and mathematical rigor count for more than the purposes for which Geography is employed. These and other factors find Geography in the hands of several thousand "believers" (the empiricists), with outside that feudal empire a few antiestablishmentarians who see empiricism as a philosophically crude system. These few pose the question, to paraphrase Anne Buttimer, should we be satisfied with drafting an opaque objective map of socioeconomic spatial patterns or should we supplement these mechanics with subjective dimensions such as are provided by humanism, existentialism, intuitionism, dialectical materialism, phenomenology, or any combination of these?

DONALD K. FELLOWS, San Fernando Valley State College—"An Aspect of the Geography of Religions: Japanese Buddhism—Its Imprint on the Cultural Landscape of Sawtelle, California"

While it is difficult to identify the imprint of any religion on the cultural landscape of an urbanized, largely secular society, the Japanese Buddhists have made their presence and influence, as well as their religious feelings, highly visible in Sawtelle, by their carefully designed religious gardens. These Buddhist gardens, that front a great number of the homes, are created to portray the universe in miniature and are complete with trees, shrubs and stones, each with full and deep religious symbolism.

LARRY FORD, San Diego State College—"The Geographic Factors in the Origin, Evolution, and Diffusion of Rock 'n' Roll Music"

Many generalizations, laws, and definitions have been developed in the field of cultural Geography dealing with the theme of origins and diffusion. Most studies utilizing this theme, however, have dealt with rather traditionally geographic items. Very little attention in Geography has been given to the recent spectacular rise of "Pop Culture" and its subsequent spread to many parts of the world. The most important and basic element in this new culture is Rock (formerly Rock 'n' Roll) Music. It is my intention to discuss the role of place in the evolution of what was later to become Rock—places such as Memphis, Nashville, Philadelphia, Cleveland, and Liverpool—and to discuss the migrations and social trends that led to the gradual acceptance of Rock by the dominant culture. Some processes involved in the diffusion of this music and life-style to rural western Ireland will also be discussed.

LAY JAMES GIBSON and RICHARD W. REEVES, University of Arizona—"The Economic Complection of Low Order Central Places"

During the summer of 1969, a field study of all small incorporated towns in Arizona was undertaken to examine their role as central places. Included were the 28 incorporated communities which had 1960 populations of less than 2,500. Data was collected on the number of establishments, functions, and functional units found in each town. Correlation-regression analysis was used to determine the relationship between each of these variables and population. A final step involved the comparison of the Arizona study to the findings of a similar study conducted in Iowa by Edwin Thomas. The three coefficients of correlation between population and number of establishments, functions, and functional units indicated only a moderate relationship between variables. This departure from the high relationships suggested by theory and supported in Iowa may be explained by an Arizona landscape of variable productivity and accessibility and by the importance of tourism and other factors external to the system. Comparisons with the Thomas study suggest that Arizona towns generally have more establishments and a greater variety of functions than Iowa towns.

AL GRAVES, University of California, Los Angeles—"Azorean Portuguese: A Study of the Portuguese Dairyman in the San Joaquin Valley of California"

More than a century ago, Portuguese from the Azores Islands began to congregate in the San Joaquin Valley of California. In time, most of these Azoreans turned to dairying as their major livelihood activity. In less than three decades, they had attained ownership of the majority of the San Joaquin Valley dairy farms. Today, they are still in the majority, and represent a very significant ethnogeographic phenomenon.

KEITH D. HARRIES, San Fernando Valley State College—"The Geography of American Crime, 1968"

A series of maps illustrating the pattern of "index" crimes (as defined by the Federal Bureau of Investigation) for the fifty states and Washington, D.C., in 1968 forms the basis of this study. The maps are based on the rates of the crimes per 100,000 people, using a quintile division of the states, rank-ordered by crime rates. Comparisons are made with the earlier criminal geographies of Lottier (1938) and Shannon (1954). While no formal regionalization is attempted, the maps indicate that some states (including California) score fairly consistently in the top quintile, while others are typically found in the lowest quintile.
The science of geopolitics lacks any definition of widespread acceptance. Realistically, it may be considered in light of dynamic approach to political Geography, embodying the action of political science as applied to a geographic base. To recognize a possible difference between geopolitics and political Geography, consider an analysis of political machinations among world powers stressing geographic factors (spelled as Geopolitik) gained an unsavory reputation before and during World War II from its association with a "Deutschland uber alles" policy supported by the Nazi war machine, but the doctrines, most of which could be construed as basically sound, reflected political action against an environmental background. Many of the concepts of geopolitics evolved prior to World War II and its political arena, cannot be isolated from the physical scene. An ever-changing international picture brings to light many lagging concepts which need to be laid to rest. Modern political Geography, along with writings on a new meaning with advances in transportation and communication. Intense interest in the sea as a pioneer area alters old-line land/water relationships. Changing methods of warfare, including those in the Usambara Highlands of Tanzania. The missionaries there built numerous stations, each with a church, school, and other facilities; they cultivated gardens and agricultural lands, introduced a large variety of crops, and promoted irrigation and a good water supply. An extensive road and trail network connected the stations and outstations, and regular mail service was established. The converts were often housed in separate villages, where the houses were built of brick on the rectangular plan, and contained only a nuclear family. These and other missionary activities altered significantly the formerly closely integrated African landscape, and created new patterns which persist up to the present time.

HARVEY E. HEIGES, San Diego State College—"Soybeans: An Example of Spatial Change in Farm Production"

The soybean is a native of the Far East, where it has been a valuable food and oil crop for centuries; the United States has recently awakened to the soybean's potential. During the last four decades uses for soybeans changed dramatically. Originally promoted for livestock forage, soybeans have since developed into a major domestic source of vegetable oil, as ingredients in food and industrial products, and currently as an agricultural substitute. Equally dramatic has been the growth and spatial shift in production from approximately co-terminous with the Corn Belt to three regional concentrations, one outside the original belt. Growing uses, profitability as a cash crop, acreage limitations on other crops, adaptability to different conditions, and its soil-building properties have all contributed to the phenomenal growth and spread of soybeans. Expanding demand for soy protein and oil will bring further growth.

KENNETH JONES, Chico State College—"The Mennonite Colony in Glenn County, California"

Between 1950 and 1965, a number of Mennonite families moved northward into Glenn County from the San Joaquin Valley. They established a religious congregation at Glenn. The majority are employed as farmers; land has been acquired through purchase or rental. The scattered holdings reflect land availability. The casual wayfarer might easily overlook this Mennonite group; however, good tilth and neatness distinguish the properties of its members. Equipment, including household appliances, is up-to-date and of good quality; emphasis is placed upon function. The group, approximately 200, is too small as yet to establish its own school.

PETER F. MASON, University of California, Santa Barbara—"Some Environmental Considerations of Siting Nuclear Power Reactors Along The California Coast: A Geographical Analysis" (see page 21 in this volume)

LOUIS J. MIHALYI, Chico State College—"The Missionary Role in Changing the African Landscape"

The general perception of the missionary role in Africa emphasizes conversion, education, and some medical-health measures. The paper presented illustrates some lesser-known aspects of missionary activities in the Usambara Highlands of Tanzania. The missionaries there built numerous stations, each with a church, school, and other facilities; they cultivated gardens and agricultural lands, introduced a large variety of crops, and promoted irrigation and a good water supply. An extensive road and trail network connected the stations and outstations, and regular mail service was established. The converts were often housed in separate villages, where the houses were built of brick on the rectangular plan, and contained only a nuclear family. These and other missionary activities altered significantly the formerly closely integrated African landscape, and created new patterns which persist up to the present time.

G. ETZEL PEARCY, California State College, Los Angeles—"Geopolitics: A Resurgent Science"

The science of geopolitics lacks any definition of widespread acceptance. Realistically, it may be considered in light of dynamic approach to political Geography, embodying the action of political science as applied to a geographic base. To recognize a possible difference between geopolitics and political Geography, consider an analysis of political machinations among world powers stressing geographic factors in contrast to a description of political entities with regard to their territorial limits and control. Geopolitics gained an unsavory reputation before and during World War II from its association with a "Deutschland uber alles" policy supported by the Nazi war machine, but the doctrines, most of which could be construed as basically sound, reflected political action against an environmental background. Many of the concepts of geopolitics evolved prior to World War II and are now obsolete. In the modern scene, can one seriously believe that the state is an organism which must spatially expand to survive, or that a nation may any longer sell space to save time? Or, can one continue to believe in the great Heartland fable? Yet geopolitical literature available in 1970 looks to the documentation of such authorities as Haushofer, Kjellan, Mackinder, Mahan, and their forerunners as guiding lights. The stirring events of their day appear to have suddenly stopped with VE and VJ Days.

Surprisingly, no new school has come to the fore to carry on the geopolitical sequence as a contemporary science. Yet, the basis of such a discipline looms greater than ever. Factors of location take on a new meaning with advances in transportation and communication. Intense interest in the sea as a pioneer area alters old-line land/water relationships. Changing methods of warfare, including those in the political arena, cannot be isolated from the physical scene. An ever-changing international picture brings to light many lagging concepts which need to be laid to rest. Modern political Geography, along with writings from other sciences, introduces numerous new concepts of significance, but not in concert as a single science which advances with the times. We cannot avoid international tension while warfare and threat of warfare seem to be on the upgrade. To be cognizant of these perils of global proportions, there is a real need for a clearcut field of geopolitics to place the existing situation in proper perspective rather than on a hit or miss basis. Geopolitics is such a science.

ELDOR O. PEDERSON, Sonoma State College—"Land Subdivision and Urban Form: Toward a Theory of Urban Morphology"

Most urban theory concentrates on the social and economic pattern of the city. Such theory is most
useful for many aspects of urban analysis, but it fails to provide adequate basis for the analysis of urban physical form or morphology. While generally assumed to be a co-product of the forces which produce socioeconomic distributions, in fact urban physical form can be a product of a very different set of dynamics. As a first approach to the analysis of urban physical form, land subdivision has been chosen for intensive study. Land subdivision produces one of the most permanent of urban artifacts, an artifact which has profound influences on other aspects of urban spatial organization. The land subdivision process, closely related to land speculation, establishes an urban module (or set of modules), a standardized unit of urban space, which in turn influences the distribution of social and economic phenomena within the city.

ROBERT D. PICKER, California State College, San Bernardino—“Geographic Education—Nineteenth Century Thinking in a Modern Age”

Kenneth Boulding has referred to Geography as having caught the vision of the study of the earth as a total system and thus having strong claims to be the “queen of the human sciences.” Boulding assumes geographers understand and apply the concept of social systems to their research and teaching. Little evidence to this effect exists. By and large, geographic education by-passes this concept and is tied primarily to definition of elements and attributes or causal relationships. Displayed as a static two-dimensional map, these definitions stand as the all-too-familiar areal differentiation. For those geographers who stress spatial interdependence, geographic education seeks an understanding of spatial organization through a search for order and distance-preserving factor; absolute structures and functions are assumed to exist, therefore laws governing organization are set forth. All these ideas are predicated on paradigms of the past. If, however, the so-called new post-Cartesian world and the notions of a purposeful system are considered, additional paradigms become critical.

IMRE QUASTLER, RUSSELL FLYNN, and THOMAS WILSON, San Diego State College—“The Development of the Commuter Airline Network in California”

Since 1966, the commuter airlines have constituted one of the fastest-growing segments of the American airline industry. California has seen a substantial growth of such airlines during this period, especially since 1967. In this paper, the bases of the expansion of commuter airlines are first examined, including both demand and technological considerations. This is followed by a detailed analysis of the expansion of the network of routes in California since 1967. The analysis relies heavily on network measures as derived from graph-theory. Both the dynamic and static aspects of the network are examined. The paper ends with a discussion of the current problems of these airlines and likely changes in California’s network in the future.

RICHARD RASKOFF, Los Angeles Valley College—“Meaningful Term Projects for Undergraduate Geography Classes”

Often, the rigid course structure of lecture-discussion classes does little to stimulate student interest, individual research and investigation. Consequently, the course becomes just another three-unit general education requirement that must be satisfied for graduation. The term project, however, alters this pattern by requiring the student to devote some effort and time to individual research in an area related to the subject. This approach has been tested as a motivation and learning technique for several years in physical and cultural classes by assigning short-term projects that are relevant and meaningful. Projects such as, A Geography of Your Family’s Movement and Reasons for Movement, An Analysis of Your Neighborhood Environment as Shown in Snapshots, have been well received. Enthusiasm has been widespread and related class discussions enlightening. The results have been equally encouraging and range from increased interest in the class, subject matter and environment, and wider usage of the geographic point of view to adoption of geography as a major.

LARRY SCHNEIDER, San Diego State College—“Movements in Location and Crop Type in San Diego County, 1950-67”

This paper provides visual comparison of changes in location and crop types in San Diego county agricultural production between 1950 and 1967. The visual aspects of agriculture changed markedly during this period, especially with the availability of water from the Colorado River. Non-irrigated acreage in San Diego County has fallen drastically, while irrigated acreage has remained stable or risen slightly. Urban competition has removed some of the best agricultural land from use, but increased prices have had the effect of making farming on second-rate land profitable. Changes have taken place within the various irrigated crop categories, always to a crop with a higher dollar-yield per acre.

FRANK K. SCOTT, Chico State College—“California Gold Mining Landscapes” (see page 38 in this volume)

MARGARET E. TRUSSELL, Chico State College—“Pioneer Land Choice in the Upper Sacramento Valley: The Example of Butte County”

The first agricultural settlement in the Sacramento Valley occurred during the Mexican Period. In Butte County, fourteen Mexican grants were claimed, all made from 1843 to 1846. After California became a part of the United States, the Mexican claims were confirmed or denied by the American courts; of the
The map has proven to be an effective medium for disseminating propaganda. Although the more purely propagandistic motives are often seen in the publications of a variety of public and private organizations, these aspects have been developed most highly by those engaged in the advertising profession. Many advertising displays, the obvious product bias notwithstanding, include maps which have been constructed according to sound cartographic principles. Such maps may be separated from the advertising milieu and advantageously adapted to instructional uses in geography. In this paper, the principles of using maps in commercial advertising are briefly reviewed. This is followed by an examination of the potential value of maps in advertisements for communicating geographic concepts and techniques.

OTHER PAPERS

ROBB EIDEMILLER, University of California, Los Angeles—“The Causes for Above Average Precipitation During the Months of December, January, and February 1968-69”

RICHARD ELLEFSEN, San Jose State College—“Physiography of the Sierra Nevada, An Application of the Twin Slide Projector Technique”

JOHN MARZ, University of California, Davis—“Producing Films for Geographic Education”

THOMAS C. MEIERDING, University of California, Berkeley—“Stereographic Images from Contour Maps—Applications in Geography”
This book is a collection of 20 papers and articles which focus on California's environmental problems, their causes, and their possible solutions. It is illustrated with photographs, diagrams, and charts.

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