SEDIMENT MANAGEMENT FOR SOUTHERN CALIFORNIA

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Brent D. Taylor

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Environmental Quality Laboratory
California Institute of Technology
Pasadena, California 91125

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Natural drainage of coastal mountains carries with it erodible sediments which are deposited downstream on coastal plains, and along the shoreline, nourishing local beaches. The beaches, in turn, are subject to the action of ocean waves which cause longshore transport and shape the coastline and beaches. Beach sediments are eventually lost to deeper offshore areas (Inman and Brush, 1973). This complex natural process is dynamic and any equilibrium is usually of a temporary nature even though time scales of change may be long.

The natural sedimentation processes of erosion, transport, and deposition on local watersheds and along the shoreline have been disturbed by man in many coastal communities.

In particular, in the Southern California area, two types of activities have altered natural sediment movements. First, watershed management and flood control works, while achieving great strides in their primary mission, have reduced sediment deliveries from the mountains to the coastal plains and thereby may have significantly interferred with the natural supply of sand to nourish the beaches. Second, the building and maintenace of shoreline and nearshore engineering works, such as harbors and breakwaters, have perturbed the littoral processes. These factors in combination can have significant effects on the coastline. However, due to inherently long time scales involved, deleterious effects may go unnoticed at first, and remedies are often belated and symptomatic.

Proper inland and coastal sediment management must be based on an understanding of both large scale and small scale natural processes. The mechanics of local processes such as hillslope erosion, particle transport by waves, entrapment of sediment by a debris basin, are important. But equally important is a macroscopic appraisal of the primary factors, e.g. annual shoreline sediment delivery by streams and rivers draining to the coast, in the regional sedimentation budget This regional view improves perspective and provides a basis for evaluating the relative importance of human perturbations (control structures, etc.) on the overall process.

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[1]Associate Member, ASCE; Senior Research Engineer, Environmental Quality Laboratory; Project Manager, Sediment Management Project, California Institute of Technology, Pasadena, California.

Inland/coastal sediment management is based not only on an evaluation of physical factors but also on available engineering technology, and on economic, institutional and legal considerations.

In 1975 a Southern California regional sediment management study was initiated as a joint project of the Environmental Quality Laboratory, California Institute of Technology, and the Shore Processes Laboratory, Scripps Institution of Oceanography. As shown in Figure 1, the CIT/SIO study area includes the coastal drainage and shoreline between Point Conception and the USA-Mexico border. The primary objectives in this study are to:

1. Quantify the natural regional sediment budget including local inland erosion rates of sand, gravel, and finer sediments; transport, intermediate deposition and delivery of these sediments to the shoreline by coastal streams and rivers; and littoral transport rates and offshore losses of beach-sized sediment along the coast.

2. Quantitatively identify the specific effects that inland and coastal control structures have on individual budget factors such as the coastal sediment delivery by a large river basin, and on the overall natural balance, particularly with regard to the natural replenishment of beach sand.

3. Identify sediment management alternatives that may be applied on a region-wide basis to alleviate existing problems, e.g. inland debris disposal, and prevent possible future problems such as long-term beach erosion. These management alternatives will be identified through multi-disciplinary analyses of engineering, economic, legal and institutional constraints.

To accomplish these objectives, the CIT/SIO study has been divided into four phases as follows:

Phase I: Planning & Assessment. The purpose of this phase is basically to sort out what is known or can be learned from existing data (Objectives 1 and 2 above) and to define key field data deficiencies.

Phase II: Field Measurements. Inland and coastal field measurements will be made to complement existing field data and help answer questions raised in Phase I (Objectives 1 and 2).

Phase III: Technical Alternatives Evaluation. Technical (engineering) alternatives for improving regional sediment management will be identified and analyzed (Objective 3).

Phase IV: Policy Alternatives Analyses. Feasible technical alternatives will be analyzed with regard to economic, legal, and institutional issues (Objective 3).

Phase I; which is currently under way, will be completed during 1978. Phases II, III, and IV will run concurrently, and will begin following the completion of Phase I.

The underlying strategy in this study is to begin at the largest scale in quantifying sedimentation process factors, and then progressively improve estimates (more precise and geographically detailed) of budget factors as deemed important by the larger-scale appraisal.

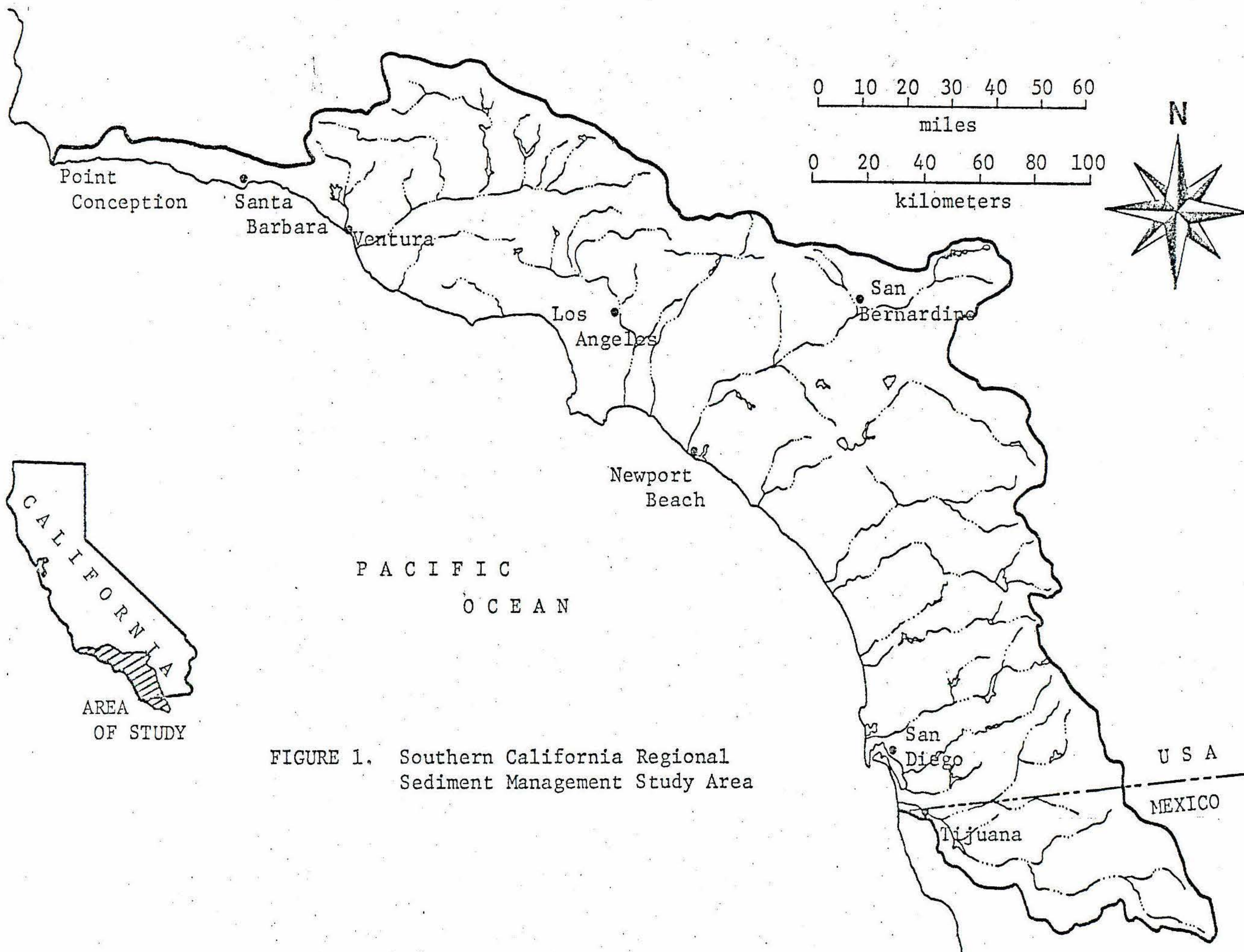

FIGURE 1. Southern California Regional Sediment Management Study Area

Results obtained early in Phase I yielded first-order estimates for the entire study area of the regional sediment budget factors illustrated in Figure 2. These estimates (Taylor, Brown, and Brownlie, 1977) suggest that an average of 12 million m^3 of sediment of all sizes are eroded annually from inland areas. Four million m^3 of this material is sand-sized sediment similar to that which forms natural beaches. However, under present conditions, only about one quarter of this sand reaches the shoreline. The remainder is naturally deposited on alluvial fans and coastal plains or trapped behind flood control structures and in water conservation reservoirs.

Once it reaches the shoreline, beach sand is transported by wave-induced currents. Through this littoral process beaches are created but also large amounts of sand can be lost from the beaches to deeper offshore areas. Chamberlain (1964) measured sand losses of between 150,000 and 200,000 m^3/year down Scripps submarine canyon near San Diego. Scripps canyon is one of six submarine canyons that extend into the littoral zone along the shoreline in Southern California.

Measured sand transport rates along the 400 km reach of shoreline in the study area range from less than 50,000 m^3/year to more than 600,000 m^3/year (DWR, 1967, 1968).

During the past 30 to 40 years sand and gravel mining operations have been responsible for the artificial removal and transport of some 10 million m^3/year of sediment. Also during this same period more than 80 million m^3, or an average of approximately 2 million m^3/year, of sedimentary material has been relocated by coastal dredging and used for artificial beach renourishment.

These results indicate that the scales of the artificial processes of sediment removal, transport, and placement are of the same order of magnitude as the corresponding natural process. Perhaps most importantly, the scale of artificial beach nourishment has been equal to or greater than natural nourishment, and thus for several years artificial nourishment has had a first-order effect on the configuration and stability of local beaches.

Work currently under way is directed toward obtaining improved estimates of the generalized factors in Figure 2 for individual river basins and reaches of shoreline in the study area. These estimates will be used to quantify factors in the five coastal sedimentation cells identified by Inman and Brush (1973), and enable a more detailed definition of the important components in the Southern California regional sediment budget.

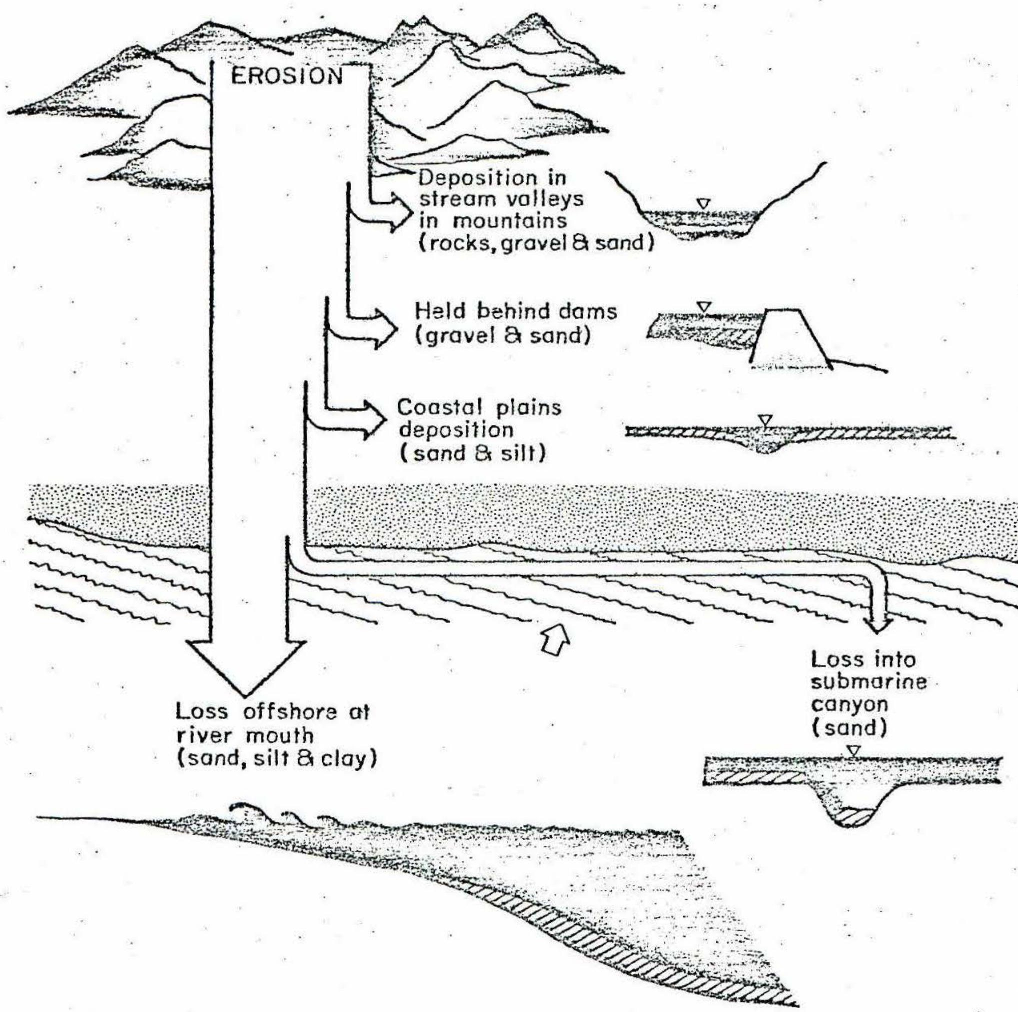

FIGURE 2. Schematic Representation of the Sediment Budget Elements Being Studied for Southern California

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