lowing the river water to enter the drainage ditches and raise the water table into the root zone of the crop. On the lower islands, and as alluviation and subsidence affected the elevation of the upper islands, the tide gate system worked poorly. Pumps were then installed to rid the tracts and islands of water in order to maintain a 3- to 4-foot dry root zone and the crops were watered by subirrigation. (See page 5.)

Problems in peatlands

Delta peatlands have faced flooding as their major problem since the first levees were constructed in the early 1860s. Approximately 100 levee failures have occurred since 1900—about 35 of them since 1930. Before 1950, most failures were because of overtopping of the levee. Since then, upstream dams have reduced that particular threat. However, levee instability is becoming more prevalent, mainly because of subsidence of the islands' interior land surface and, to a lesser degree, building up of the channels by alluviation. These two factors result in an increasingly unbalanced load on the levees.

Subsidence is primarily the result of peat oxidation, although wind erosion, shrinkage, and compaction may also contribute. Oxidation takes place continually in peat above the water table. It is accelerated by tillage and greatly speeded up by burning of peat fields—a common practice for a period of 60 to 70 years. Typically, soils were burned at 3- to 5-year intervals for the purpose of controlling weeds and other pests. Each burn commonly oxidized 3 to 5 inches of peat soil. Today this practice is avoided, but peat fires are still a threat when accidentally started by careless stubble burning, faulty exhausts, or careless travelers.

The first methodical investigation of subsidence began in 1922. It was found that the most recently reclaimed peatland suffered the greatest rate of subsidence. The average annual subsidence was nearly one-fourth of a foot per year.

Wind erosion also plays a part in lowering the surface of peat soils. Light, dry peat soils are easily carried by winds considerable distances. Measurements have revealed, however, that less than one-eighth inch of peat soil is typically eroded each year by winds.

Sediment brought in by water and deposited on the channel bottom results in increased channel elevation in relation to adjacent island as described before. This process of alluviation increases the chance of levee failure.

Seasonal water flow diminishes in late summer, although in normal rainfall years Delta outflow is sufficient to retard salt water intrusion from Suisun Bay. The exception is during "dry" and "critical" years when low river flow enables the salt water to penetrate the western Delta islands, causing damage to crops when used for irrigation. Salt accumulation in the root zone is another hazard where subsurface irrigation is practiced in peat soils. (See article on page 10.) As a result of the constant threat of salinity, only proper management and good water quality can sustain yields.

Although the Delta lands were considered a worthless swamp by miners and entrepreneurs of the Gold Rush era, men of determination have transformed them into a vast agricultural and recreational paradise. Farmers have long faced recurring problems of flood, fire, and the continual pressure of subsidence. Today, they are facing new challenges concerning the quantity and quality of water allowed to pass through the Delta waterways. These new pressures on the Delta may require new changes and will, no doubt, add another colorful chapter to its history.

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Subirrigation in the Delta

The peatlands of the Sacramento-San Joaquin Delta are irrigated almost entirely by subsurface methods. Gravity surface irrigation is not suited to these organic soils because of high infiltration rates and variable subsidence which makes surface distribution difficult. Sprinkler irrigation is an alternative, but is not widely used because of the high capital outlay and high energy costs.

In a typical Delta subirrigation system, water from the river channel is siphoned over the levee and into a system of unlined head ditches and small lateral ditches ("spud ditches") cut into the peat soil. Spud ditches are 6 inches wide, from 10 to 24 inches deep and are commonly spaced from 40 to 80 feet apart. (See illustration.)

Several times during each irrigation season, the spud ditches are filled. This quickly raises the water table in the porous peat soil from a depth of 3 or 4 feet to within 6 to 10 inches of the surface. Water stored in the root zone, which in peat may be as much as 6 inches per foot of soil, is then depleted by the crop and by evaporation from the soil surface. As a result, the water table gradually drops until irrigation is necessary again.

Drainage is provided by larger and deeper ditches cut from 300 to 1,000 feet apart. These are connected to a main drain, 7 to 10 feet deep, through which water flows to a pump and is returned to the river.

Ray Coppock