Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

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Chapter 7:
Estimates for Consumptive Water Demands in the Delta using DETAW

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7 Estimates for Consumptive Water Demands in the Delta Using DETAW

7.1 Introduction

A new model, Delta Evapotranspiration of Applied Water (DETAW), is being developed to enable consistency between the Department of Water Resources' models CalSim-II and DSM2 and to improve the estimation of consumptive water demands in the Delta for the two models spatially and temporally. DETAW is based on the Simulation of Evapotranspiration of Applied Water (SIMETAW) model (DWR, 2006a,b) with modifications to account for Delta-specific conditions such as seepage from channels. DETAW estimates daily consumptive water demands for 168 subareas within the Delta Service Area at both historical (time varying) and projected (fixed) levels of land use development for the 1922-2003 simulation period. DETAW is driven by a graphical user interface (GUI) that allows for both input data modifications and graphical viewing of a wide array of computed results.

7.2 Background

The CalSim-II model used for planning studies of both the State Water Project (SWP) and Central Valley Project (CVP) systems uses projected land use level based estimates of monthly evapotranspiration of applied water (ETAW) for the lowlands and uplands of the Delta for the simulation period currently 1922-2003. These estimates are computed using the Consumptive Use model (Barnes, 1979). DSM2 uses estimates of monthly ETAW for 142 subareas in the Delta which are computed using the Delta Island Consumptive Use (DICU) model (DWR, 1995). These estimates are then processed to develop the node-specific diversions and return flows for DSM2. Due to differences in the spatial resolutions and computational procedures of the CU and DICU models and differences in the types and sources of input data, results for these two models are not completely consistent. To address these issues a new model called DETAW was developed by UC Davis in cooperation with DWR's Division of Planning and Local Assistance and funded by the Modeling Support Branch of the Bay-Delta Office.

7.3 Description of DETAW

DETAW is a GUI-driven C^{++} computer application for estimating ETAW. DETAW estimates daily soil water balances for subareas within the Sacramento-San Joaquin River Delta region by accounting for evapotranspiration losses and water contributions from rainfall, seepage, and irrigation. This water balance model is similar to that used in the SIMETAW model developed cooperatively by DWR and UC Davis. DETAW calculates daily ETAW for both historical and projected land use development levels. Land and water use categories include eleven crop categories, urban land use, riparian areas, and open water surfaces. For DETAW, historical daily precipitation for 1922-2003 is used for both historical and projected level computations. However, the precipitation (as well as other parameters such land use, etc) can be modified in

DETAW for alternative scenarios, including climate change studies. At the historical level, the crop and urban acreages vary from year to year reflecting actual changes in land use and shifts in crop acreages. At the projected level two land use types are used: one GIS pattern for years that are classified according to the Sacramento Valley Water Year as dry or critical, and another pattern for years that are classified as wet, above normal, or below normal. In either case, total acreages by category (e.g., crop type or urban use) are established through estimation at the Delta Uplands and Delta Lowlands aggregate level; they are then disaggregated to 168 subareas based on two GIS-based land use distributions. For wet, above normal, and below normal years, a GIS composite from the 1992-2002 land use surveys is used (Figure 7.1). For dry and critical years, the 1976 survey GIS layer for the Delta is used (Figure 7.2).

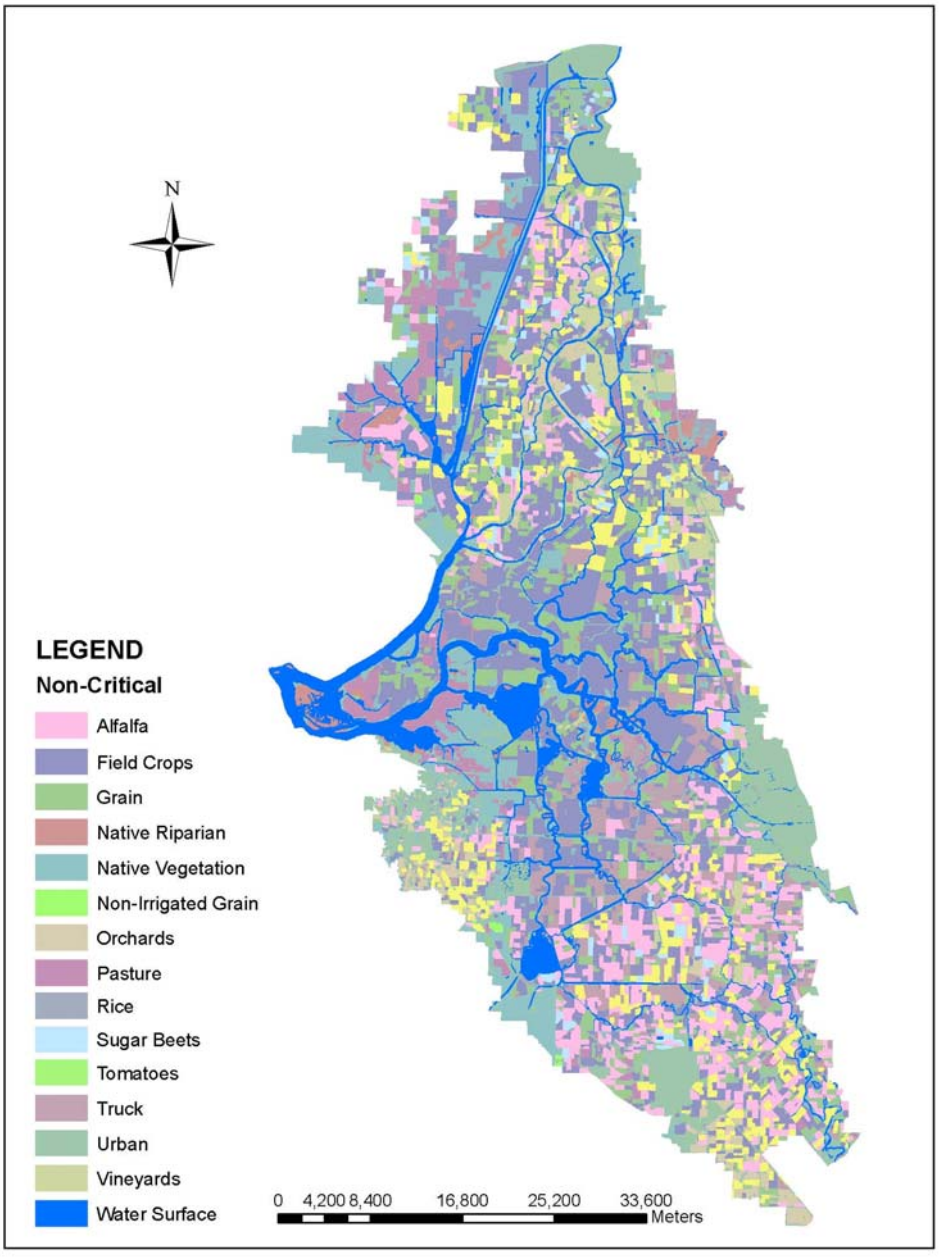

Figure 7.1: Delta land use in non-critical or non-dry water years.

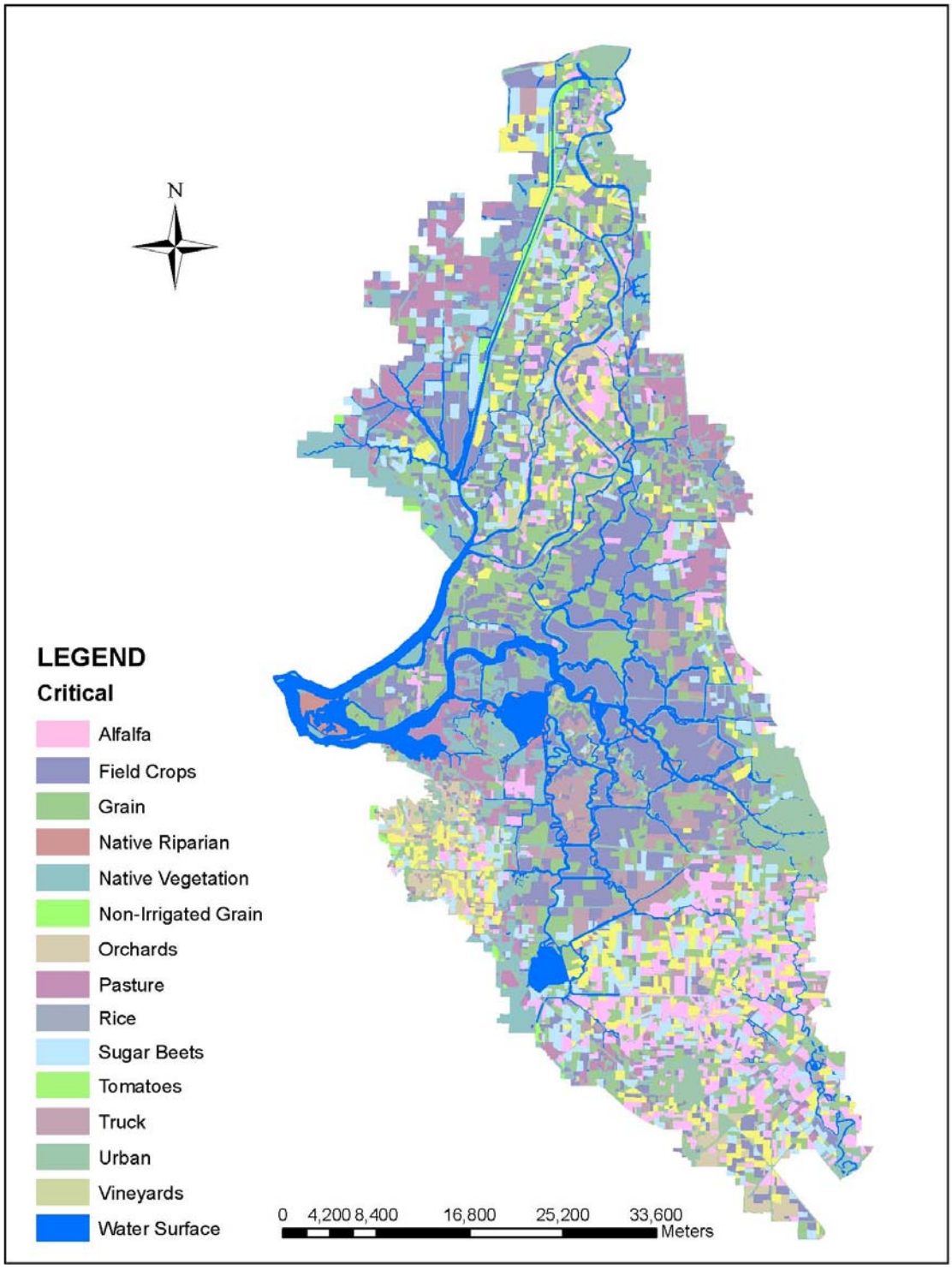

Figure 7.2: Delta land use in critical and dry water years.

Daily estimates of ETAW can be aggregated by DETAW temporally (monthly and annual) and spatially (e.g., by uplands and lowlands) to meet any modeling data needs.

7.4 DETAW's 168 Subareas

The original 142 subareas for the DICU model (Figure 7.3) were digitized from a printed schematic since no CAD schematic or GIS layer could be located. The digitized map was rectified into a GIS layer (Figure 7.4). For spatial analysis computational reasons, the areas were further disaggregated into the168 subareas (Figure 7.5) to eliminate any "satellite" or disjointed areas as represented in the 142 subarea configuration.

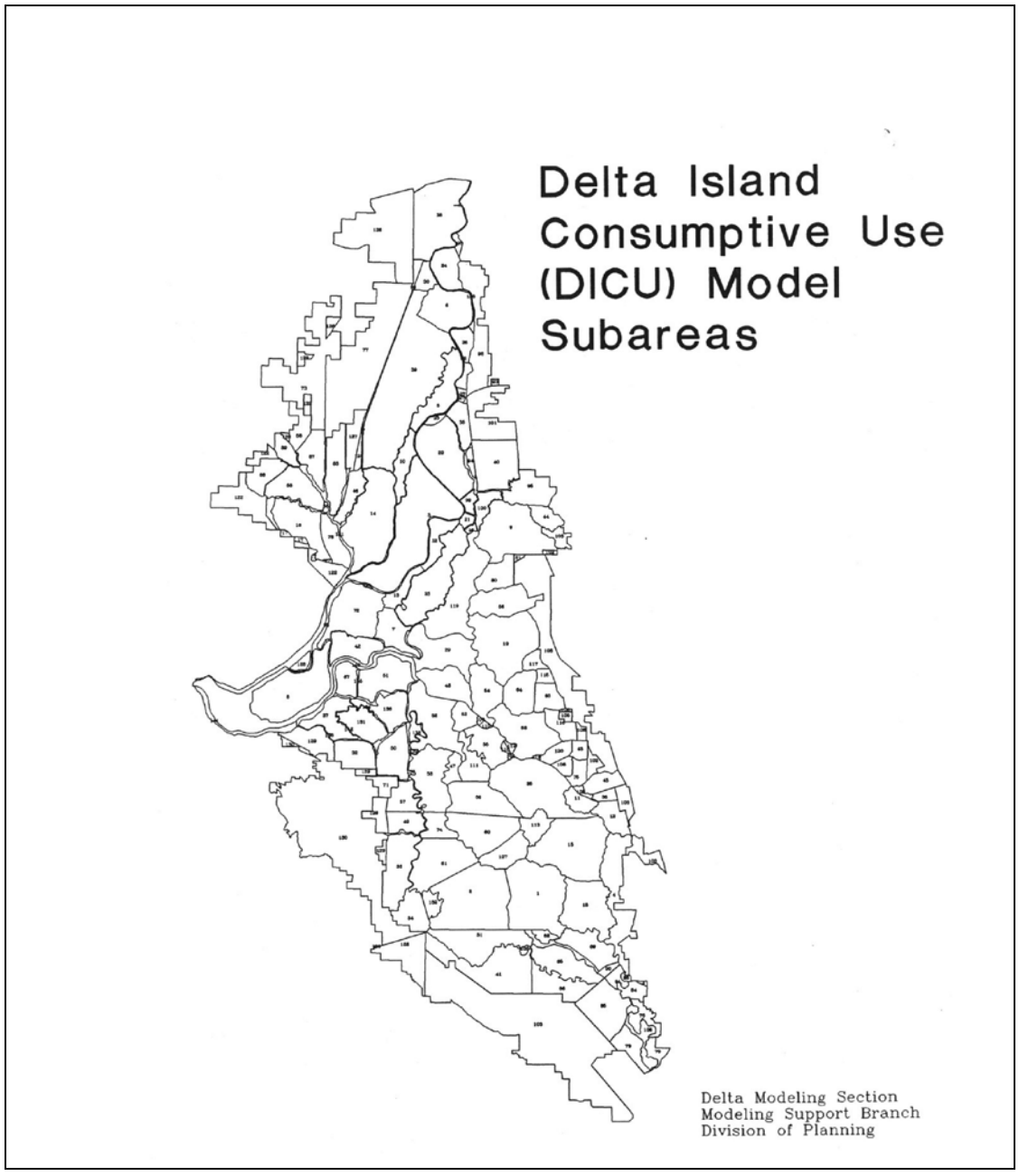

Figure 7.3: Base map for the 142 Delta subareas in DICU.

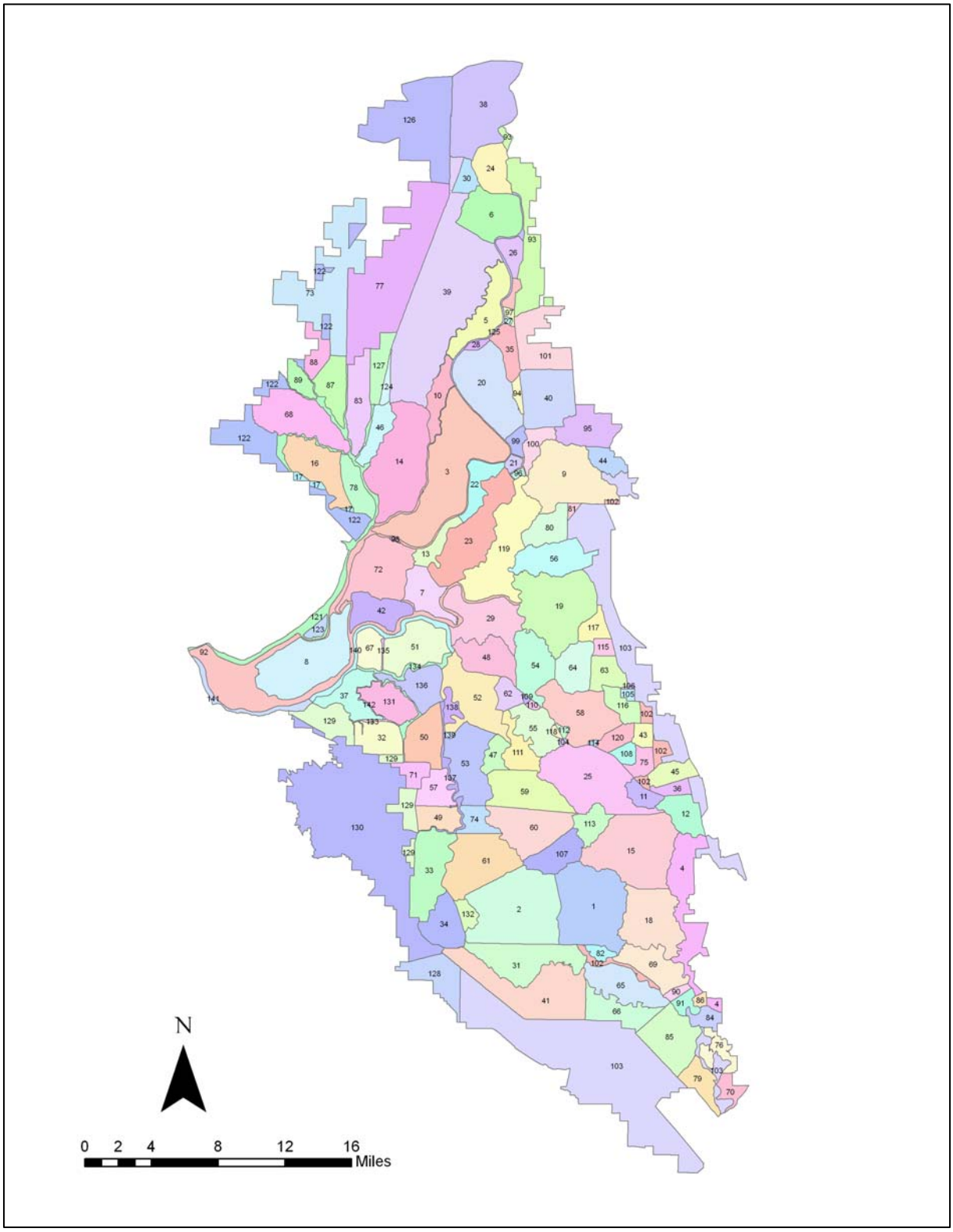

Figure 7.4: Digitized map of the 142 Delta subareas in DICU.

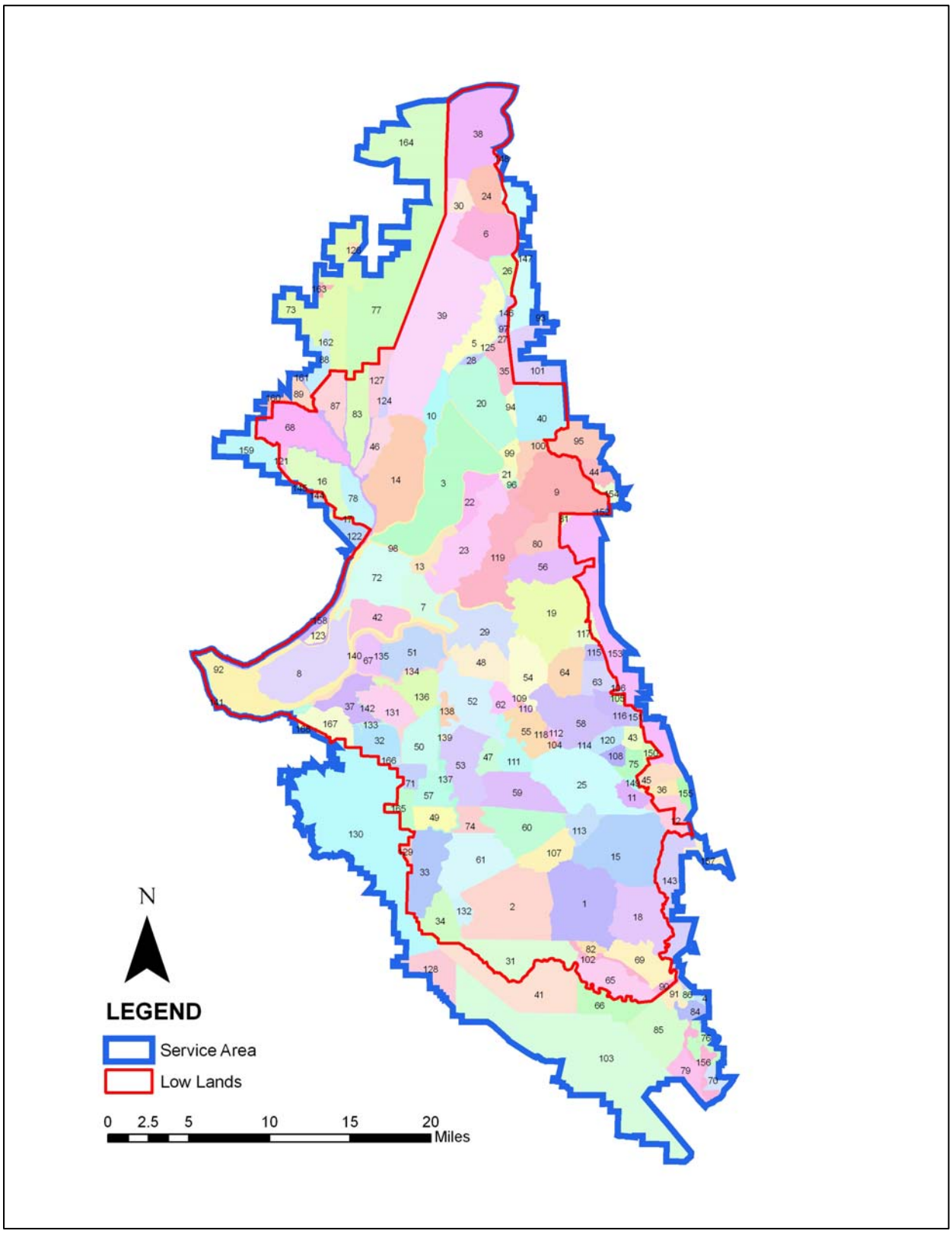

Figure 7.5: DETAW's 168 Subareas.

7.5 Calculating Daily Precipitation by DETAW Subarea

Daily precipitation for each subarea was estimated by Thiessen polygons based on seven precipitation gaging stations located in and around the Delta (Figure 7.6). Some of the daily precipitation data had to be estimated by correlations with other stations. Areal-weighted averages were used for subareas located in more than one Thiessen polygon.

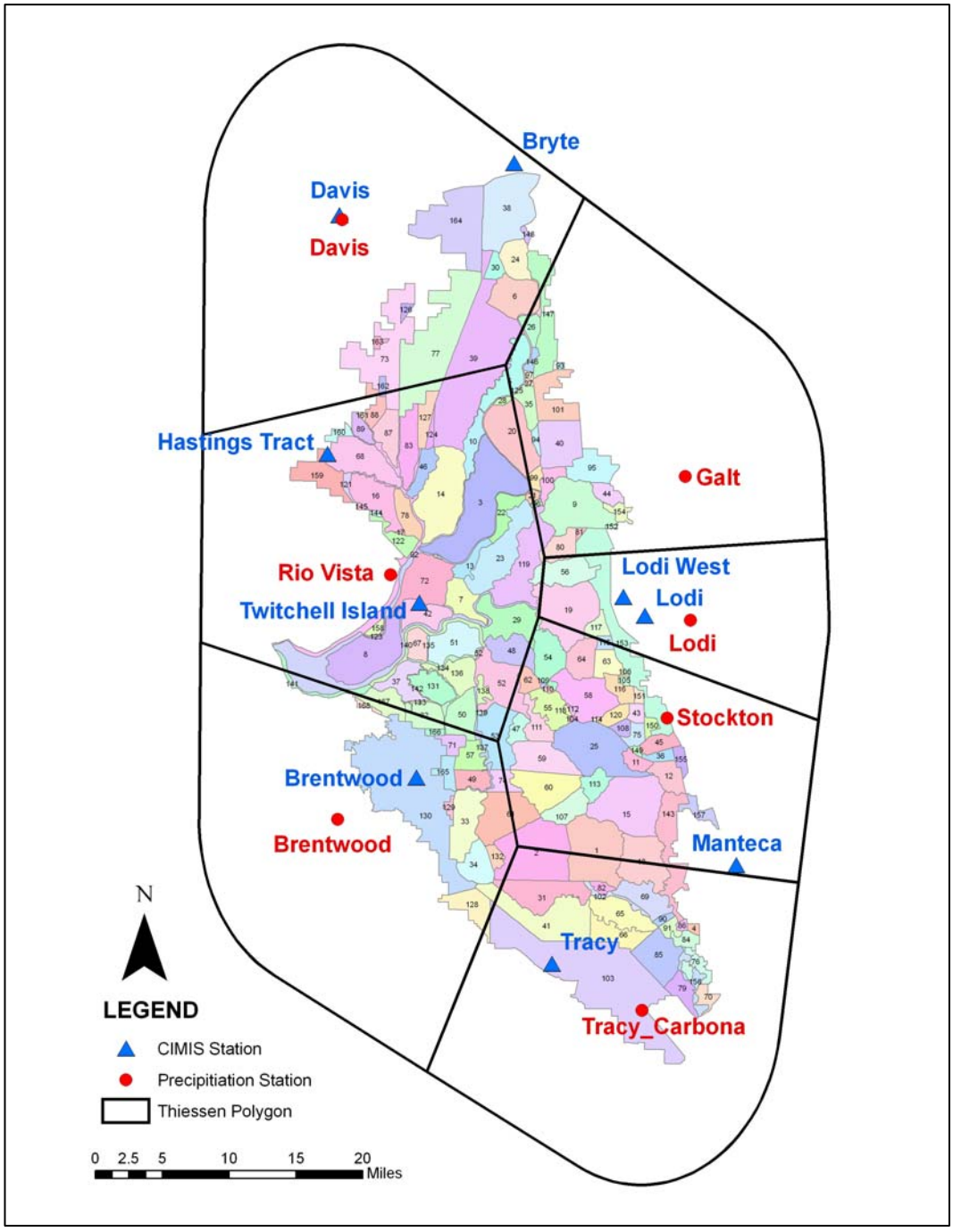

Figure 7.6: Thiessen polygons delineating the association of subareas with precipitation stations.

7.6 Calculating Daily ETo by DETAW Subarea

A key component to calculating ETAW is crop potential evapotranspiration rate, ETo. ETo is calculated by DETAW by using the Hargreaves-Samani equation calibrated to the Pennman-Montieth equation as calculated by the California Irrigation Management Information System (CIMIS) stations located around the Delta (Figure 7.7). The Pennman-Montieth equation could not be used explicitly because long-term climate data input is not available, whereas the Hargreaves-Samani equation is mainly temperature-based and temperature is more readily available than climate data. To account for the spatial variability across the Delta, lines of equal ETo using the CIMIS results were developed and then factors for each subarea were computed. This allows computing daily ETo for each subarea for the entire period of 1922-2003.

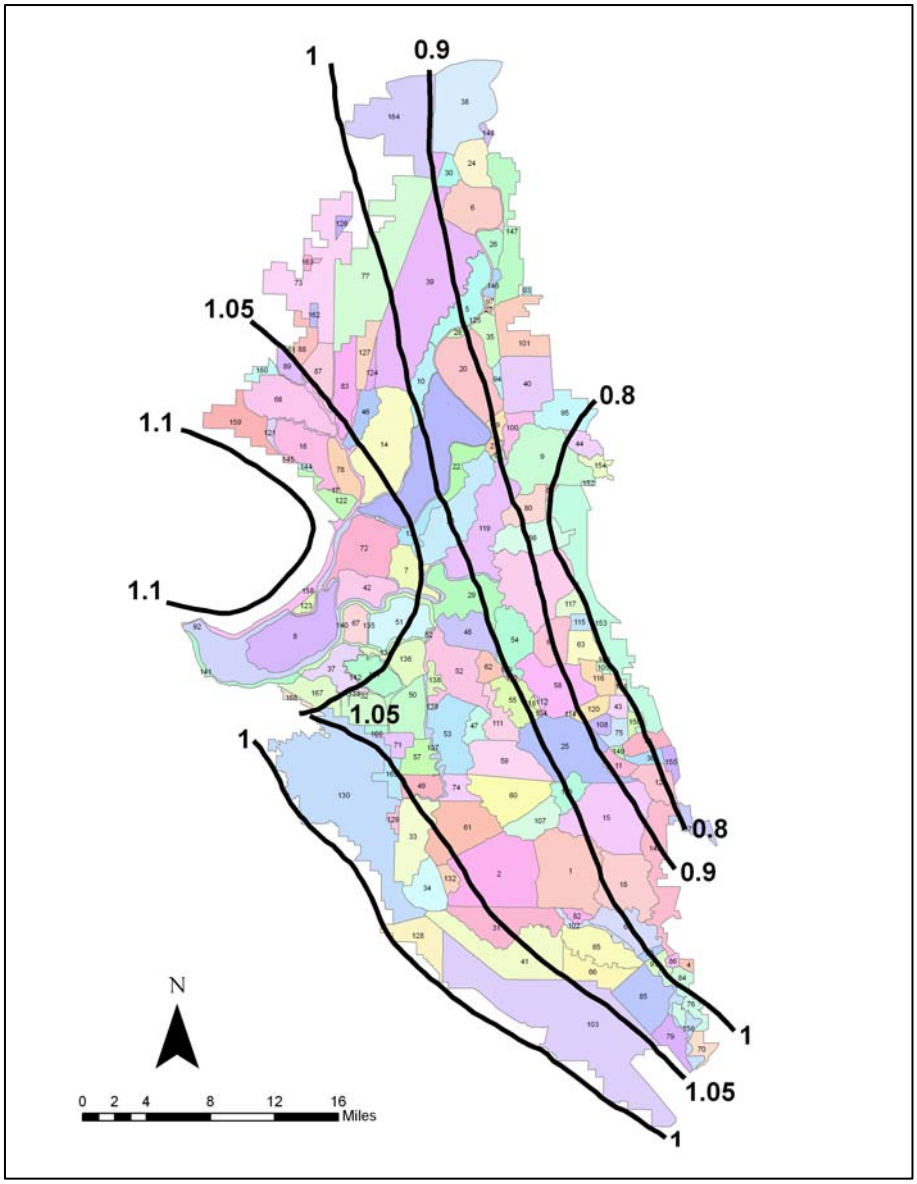

Figure 7.7: Correction factor isolines for the Harvey-Samani and the Pennman-Montieth equations.

7.7 Calculating Daily ETAW

Daily water balances of ETAW are computed for each subarea for each crop category (Figure 7.8). Seasonal crop coefficient curves Kc's are used to estimate the daily crop ETc from the ETo's. Irrigations (diversions from islands) are triggered when the soil water content drops below the yield threshold (allowable depletion multiplied by plant available water) after taking precipitation and seepage into account.

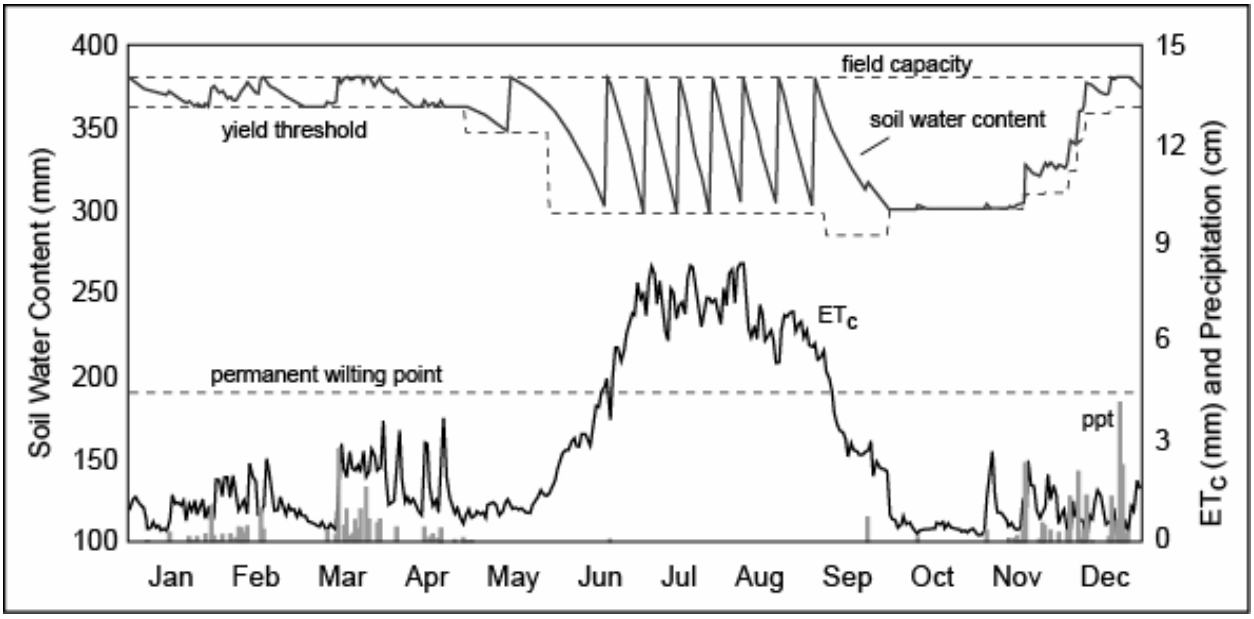

Figure 7.8: Typical daily-varying water balance for a crop.

7.8 Summary

A new model, DETAW, is being developed to calculate consumptive water demands in the Delta. The Delta is divided into 168 subareas. Daily precipitation for each subarea is estimated using Thiessen polygons from seven precipitation gaging stations. Daily potential evapotranspiration rates, ETo, are computed using the Hargreaves-Samani equation and are correlated to the modified Pennman-Montieth equation. Daily crop evapotranspiration unit rates, ETc, are computed using seasonal crop coefficients. Daily water balances taking estimated channel seepage are used to estimate daily ETAW by subarea for the period 1922-2003. These values can then be used to develop daily nodal diversions and return flows for the DSM2 model and estimates of Delta Uplands and Delta Lowlands consumptive demands for the CalSim-II model.

7.9 References

Barnes, George W., Jr. (1979). *Consumptive Use Program Documentation.* Technical Memorandum. Sacramento, CA: California Department of Water Resources, Statewide Planning Branch.

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