

Simulating the Spatial and Temporal Variability of Soil Moisture, Recharge, and Runoff in the Mojave Desert using a Deterministic Watershed Model

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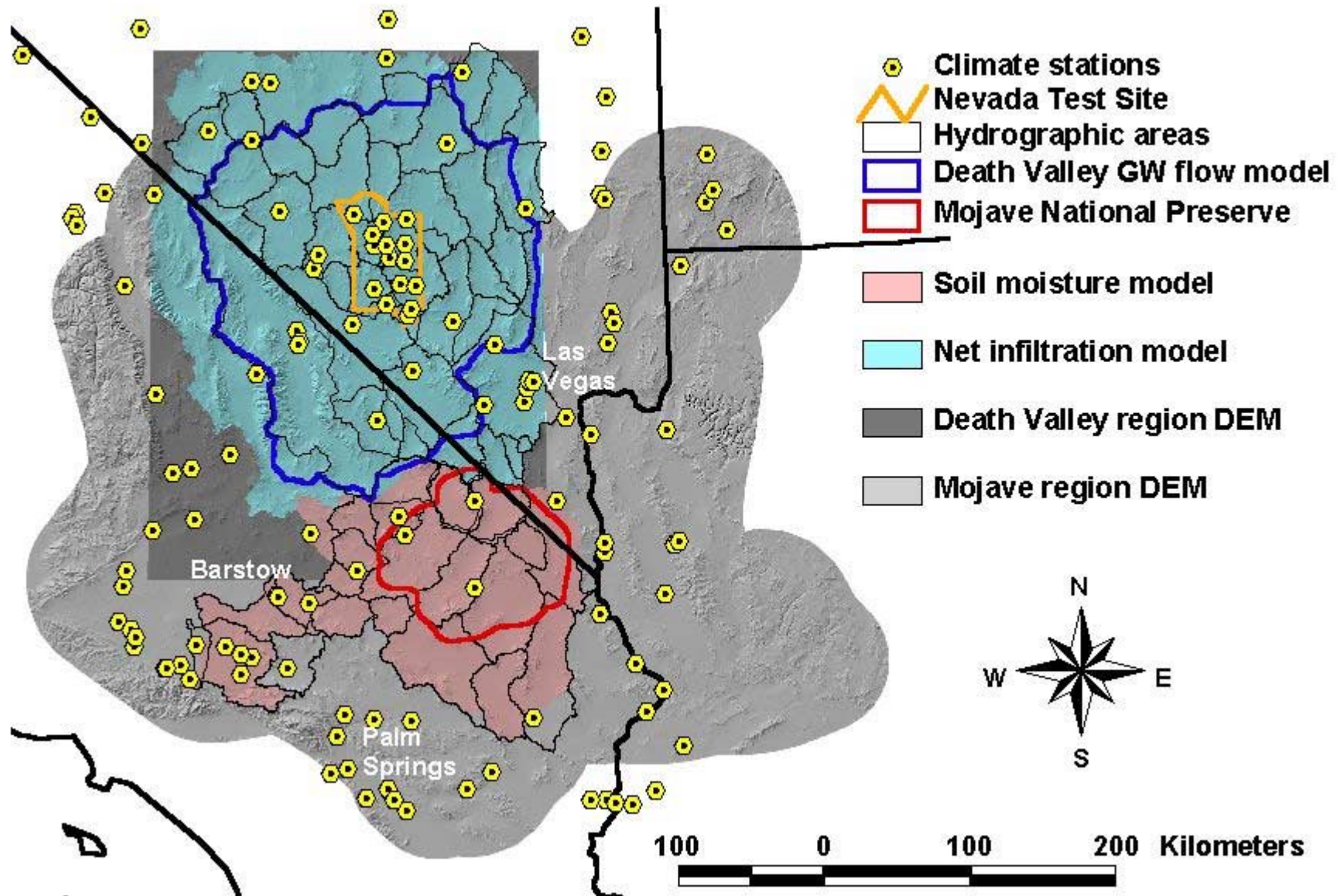
David M. Miller, U.S. Geological Survey, Menlo Park, CA

Study Objective:

Predict ecosystem vulnerability in the Mojave Desert region using spatially and temporally distributed estimates of soil moisture

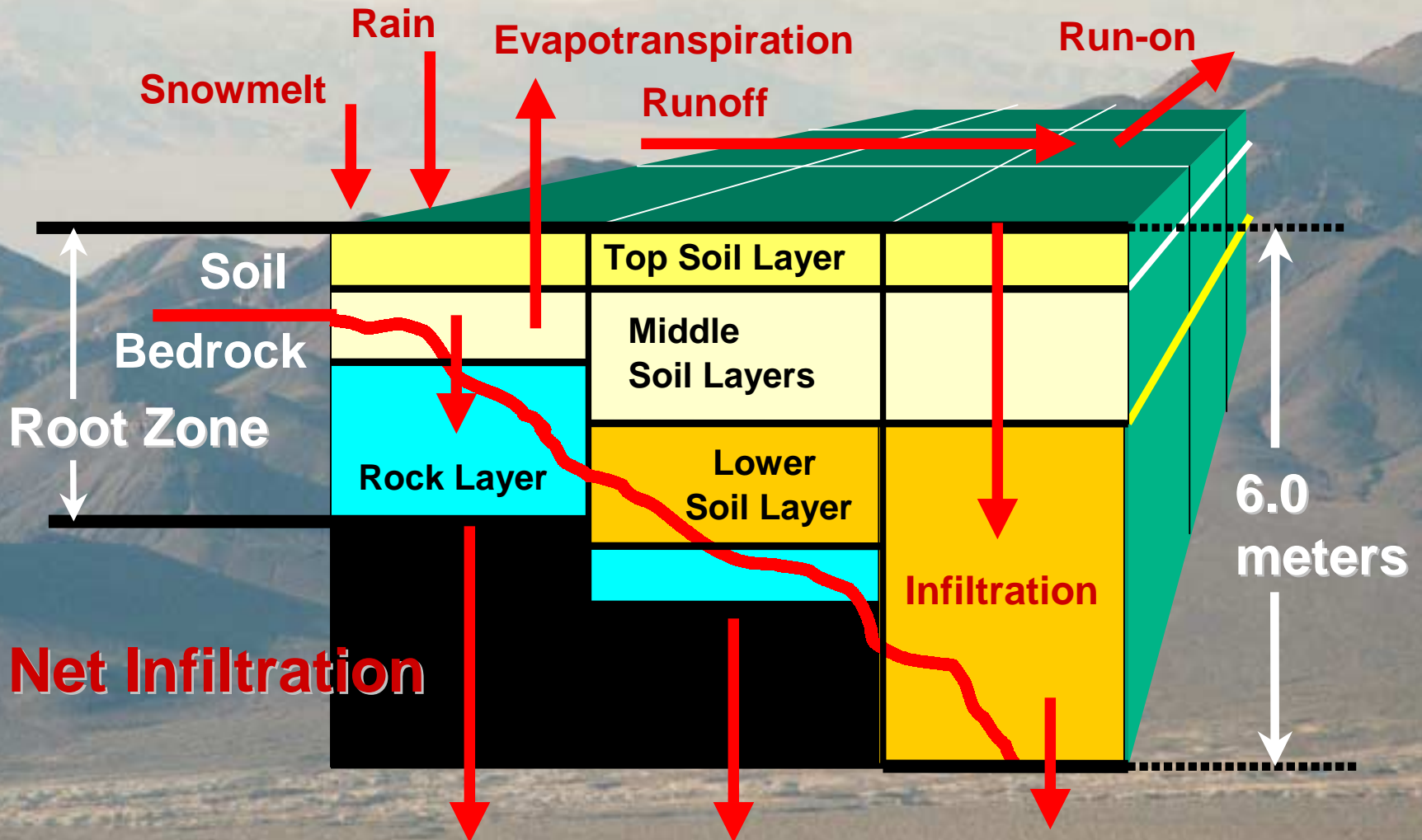


Study Areas: Daily Net Infiltration (Potential Recharge) and Soil Moisture Models



Deterministic Watershed Model:

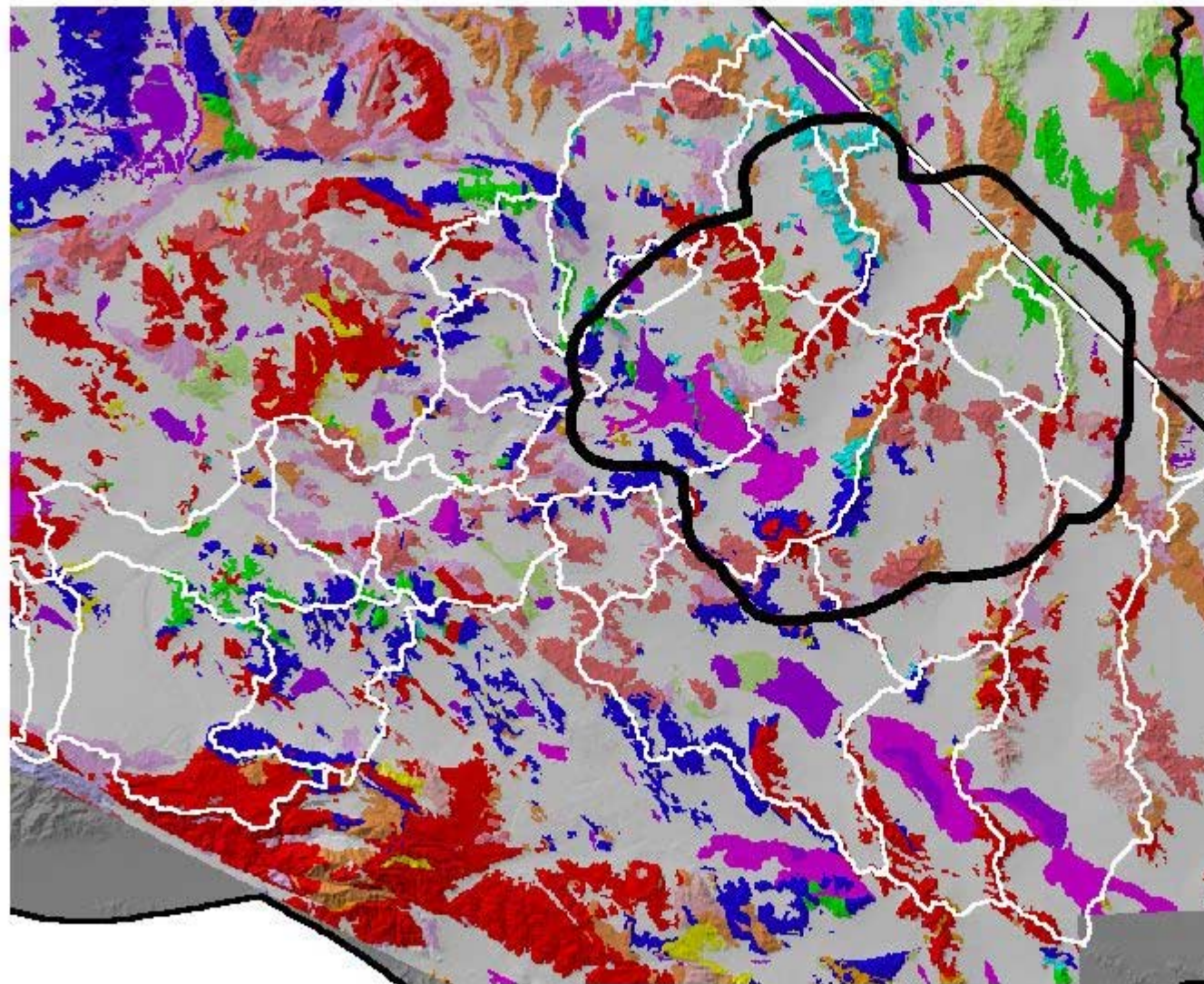
Daily Root Zone Water Balance Model
Hourly Net Radiation Energy Balance Model



Model Inputs:

- **Digital Elevation Model (DEM)**
- **Daily climate records (multiple locations)**
- **Monthly climate models**
- **Monthly atmospheric parameters**
- **Snow melt and sublimation parameters**
- **Evapotranspiration model coefficients**
- **Bedrock geology map and hydrogeologic properties**
- **Soil map and soil properties**
- **Vegetation map and root-zone properties**
- **Initial water content**
- **Stream channel characteristics**
- **Storm duration**

Mojave Desert Regional Geology

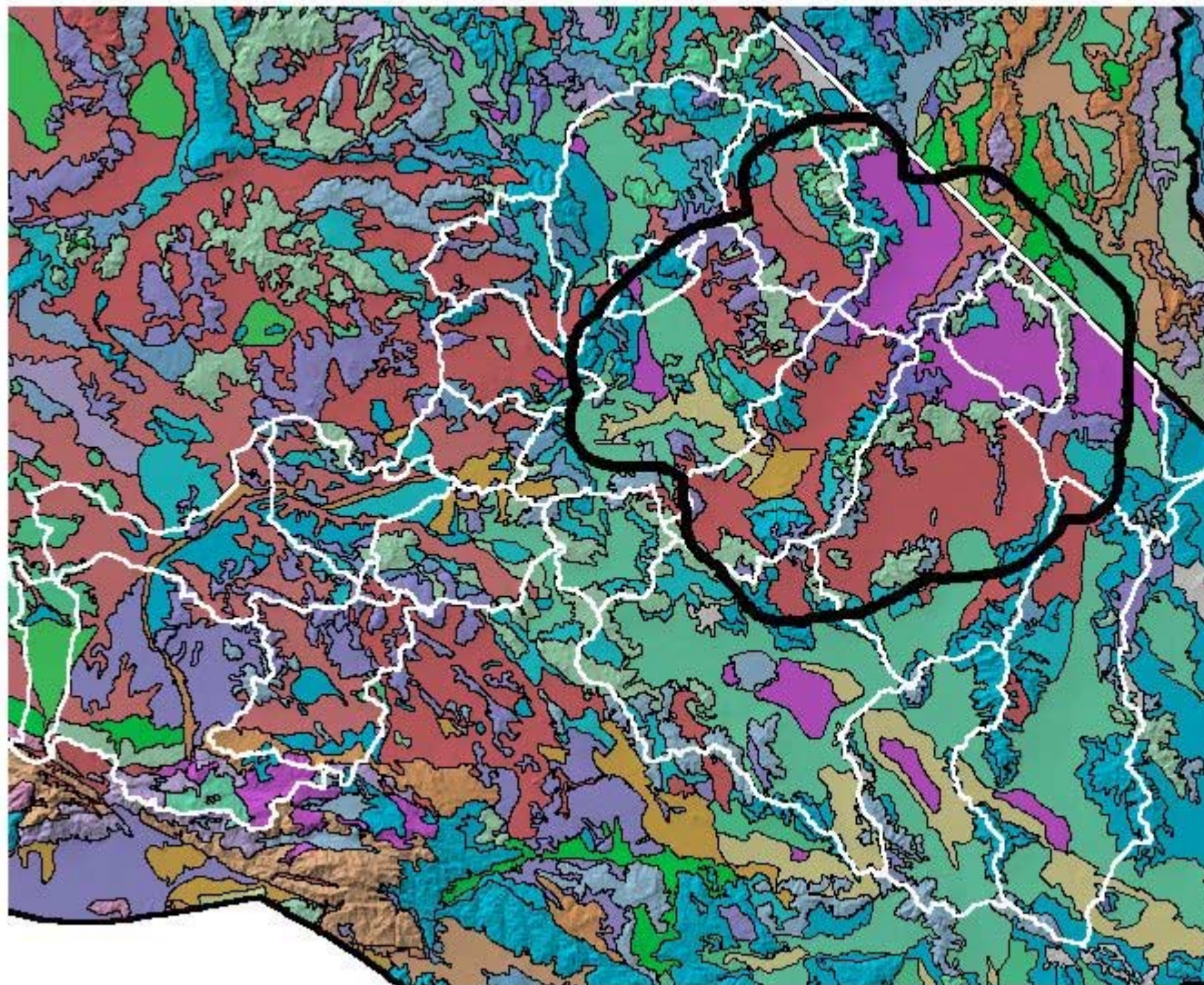


50 0 50 100 150 Kilometers

Generalized Geology



Mojave Desert STATSGO Soil Map Units

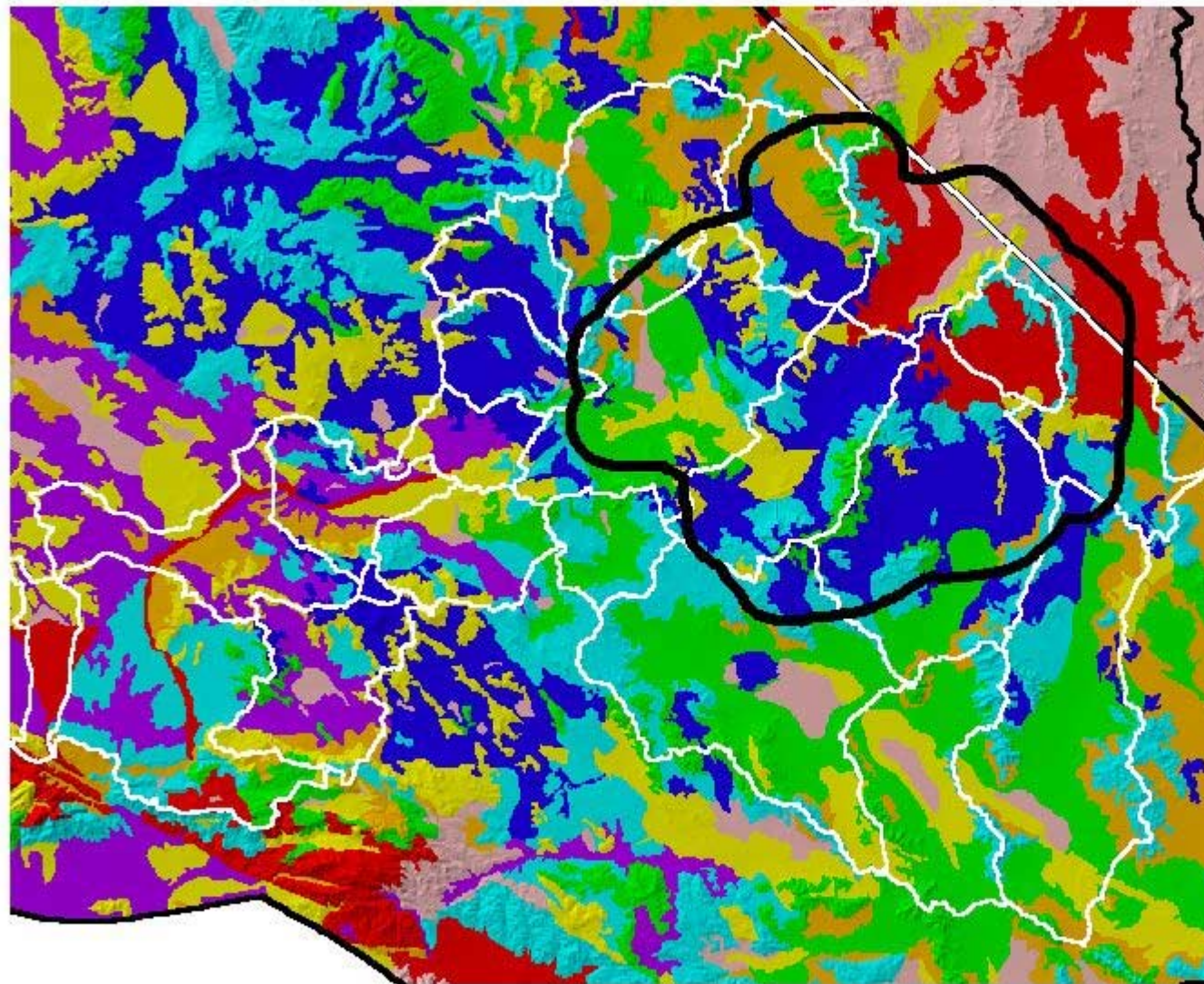


**326 Soil
Map Units
(MUIDs)**

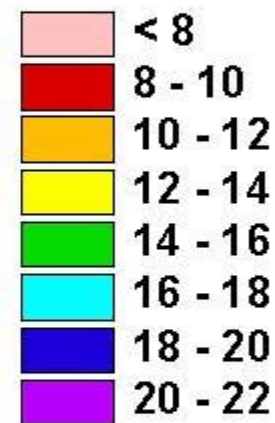
50 0 50 100 150 Kilometers



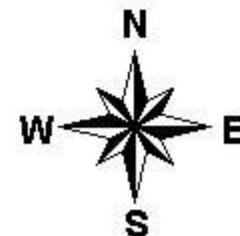
Mojave Desert STATSGO Soil Map Units



Number of
soil
components



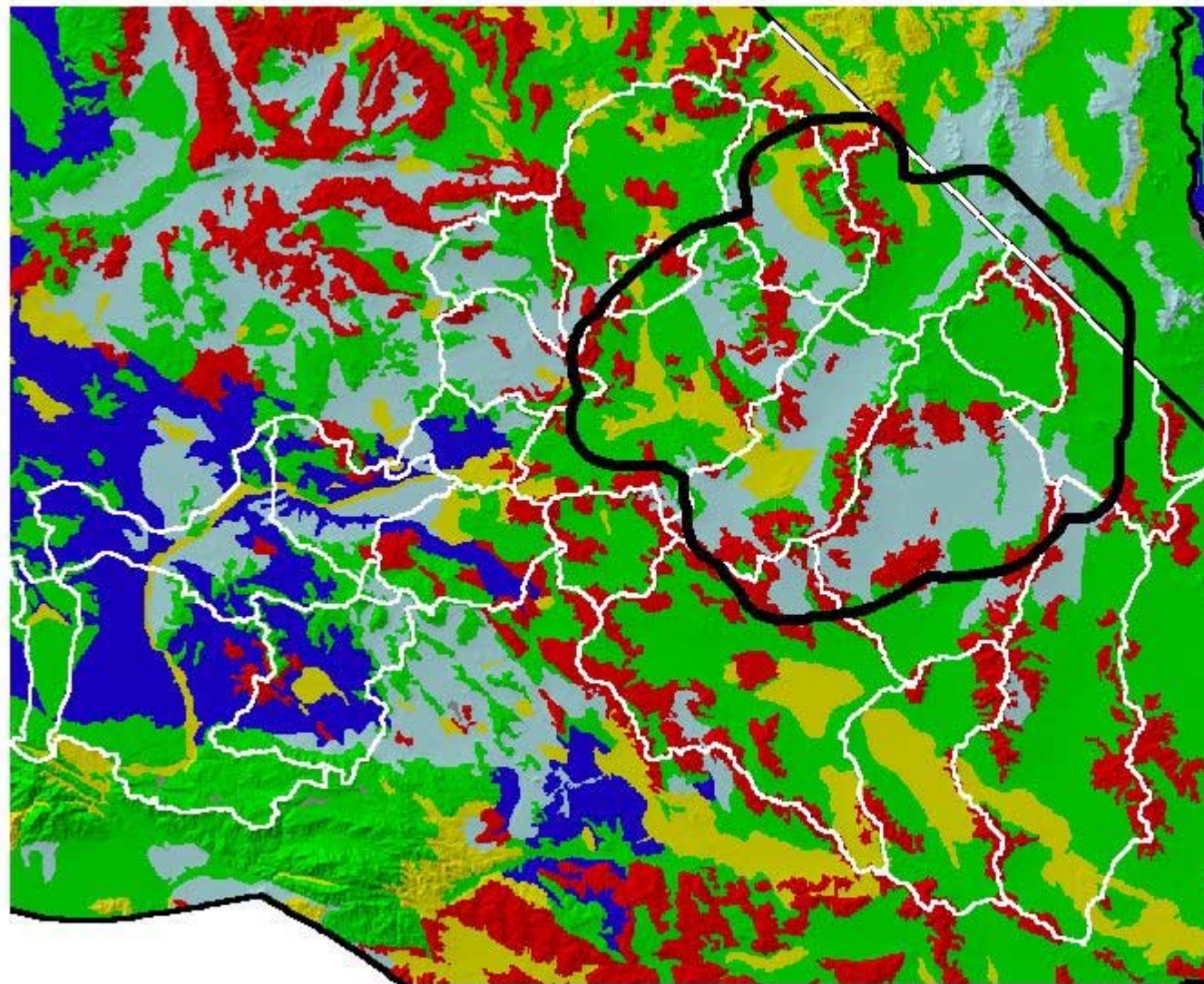
 DEM



50 0 50 100 150 Kilometers



Mojave Desert STATSGO Soil Map Units



Average
number of
soil layers



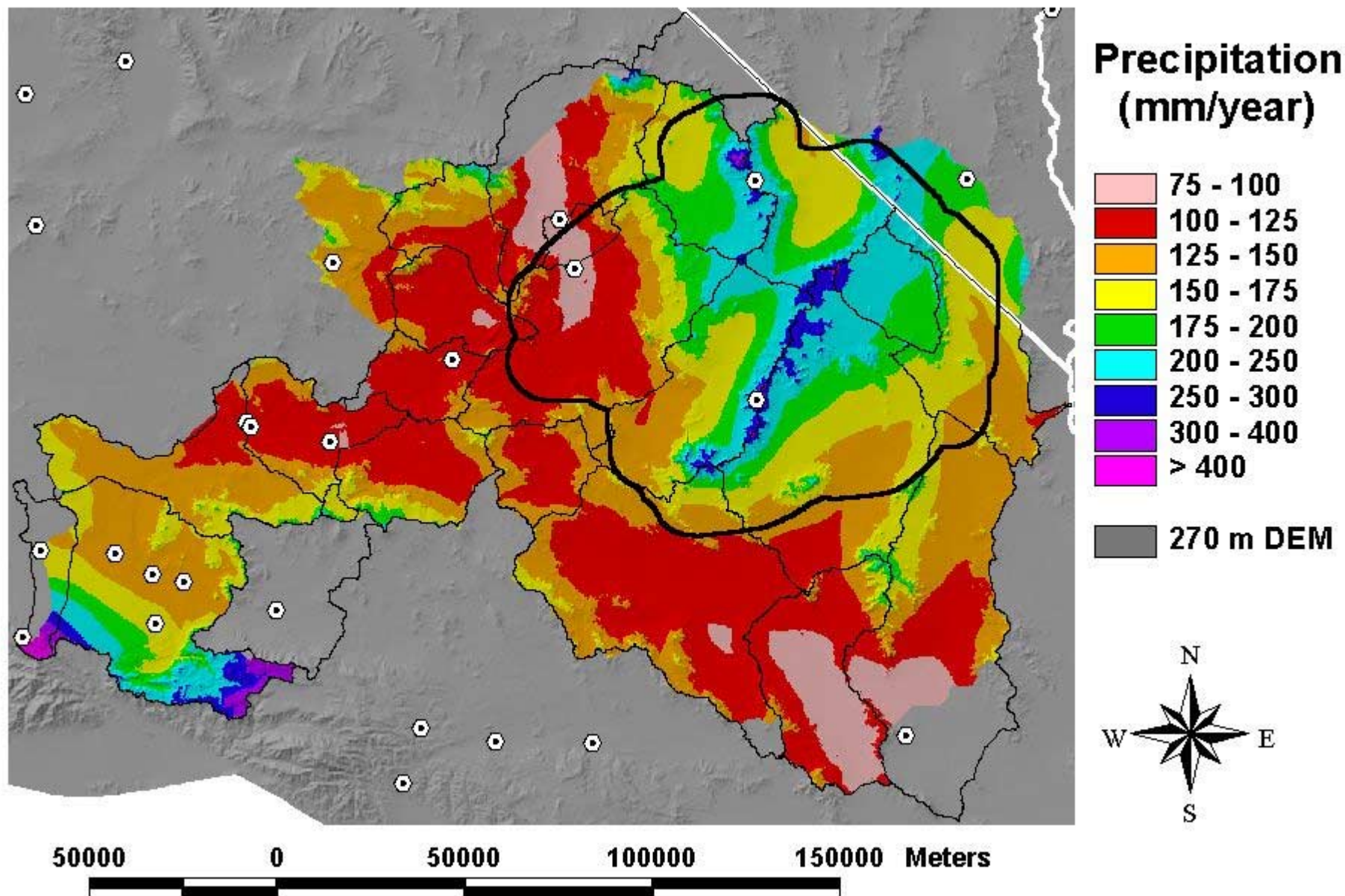
 DEM



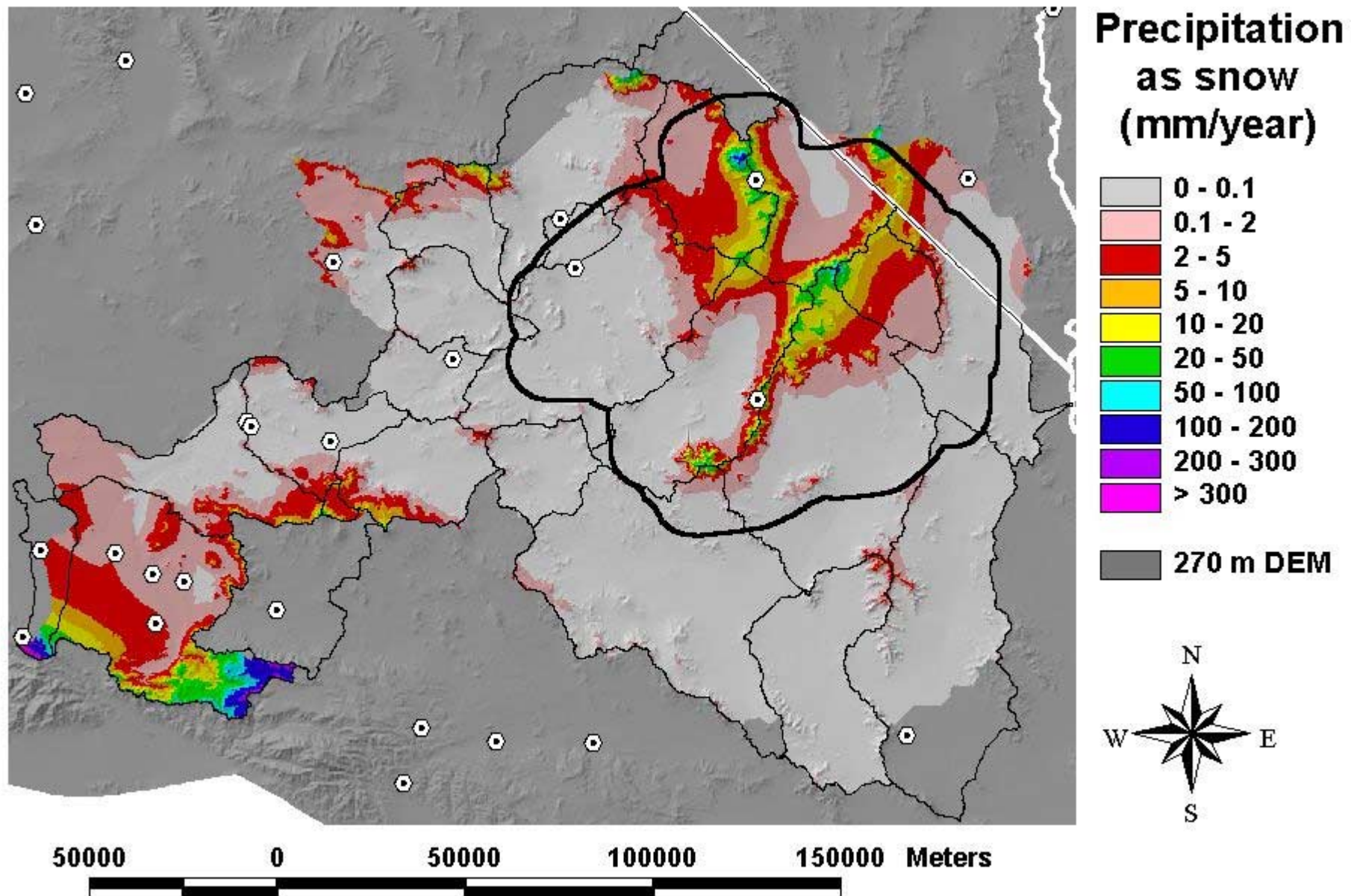
50 0 50 100 150 Kilometers



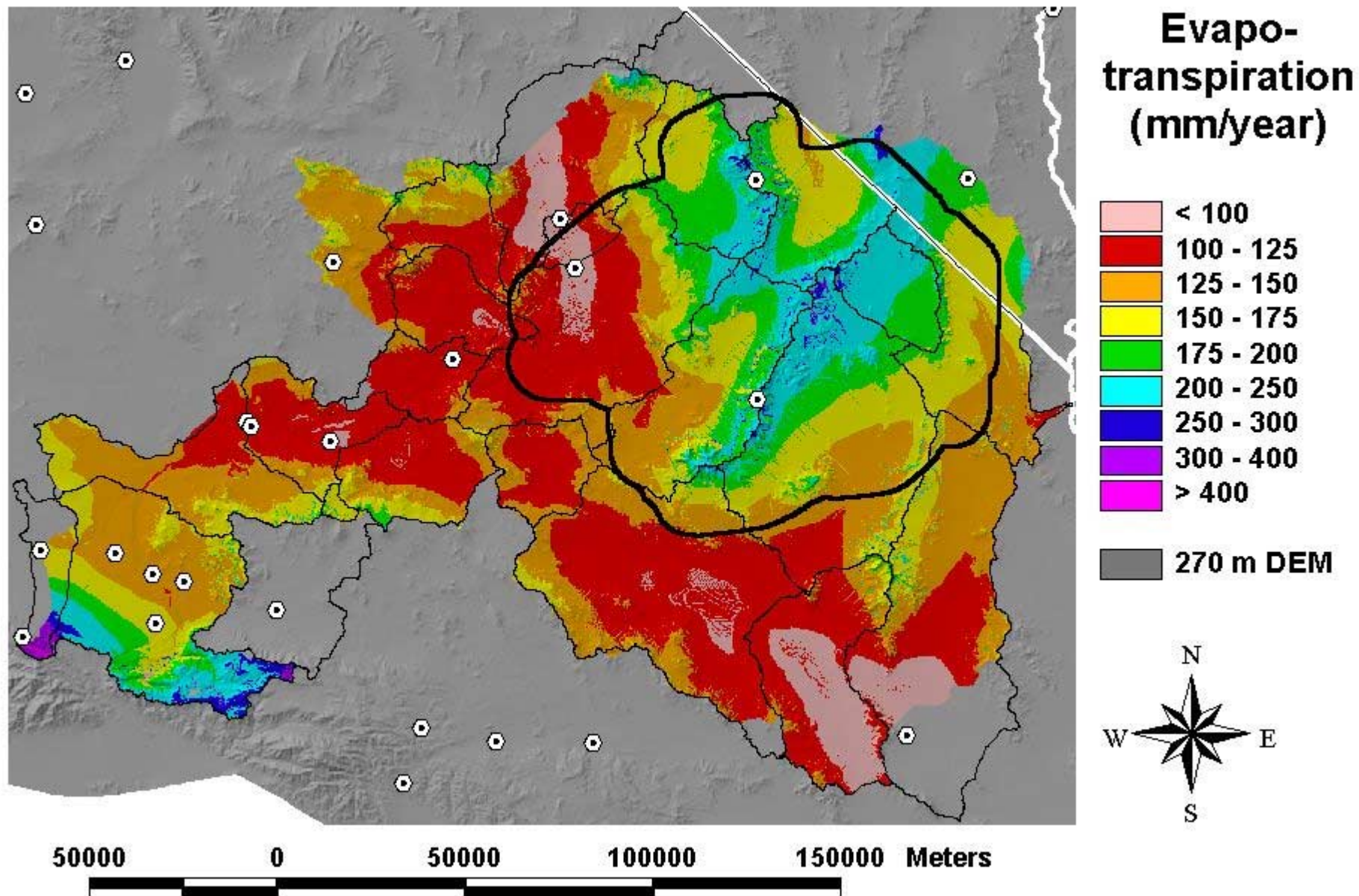
1950 - 1999 Modeled Precipitation



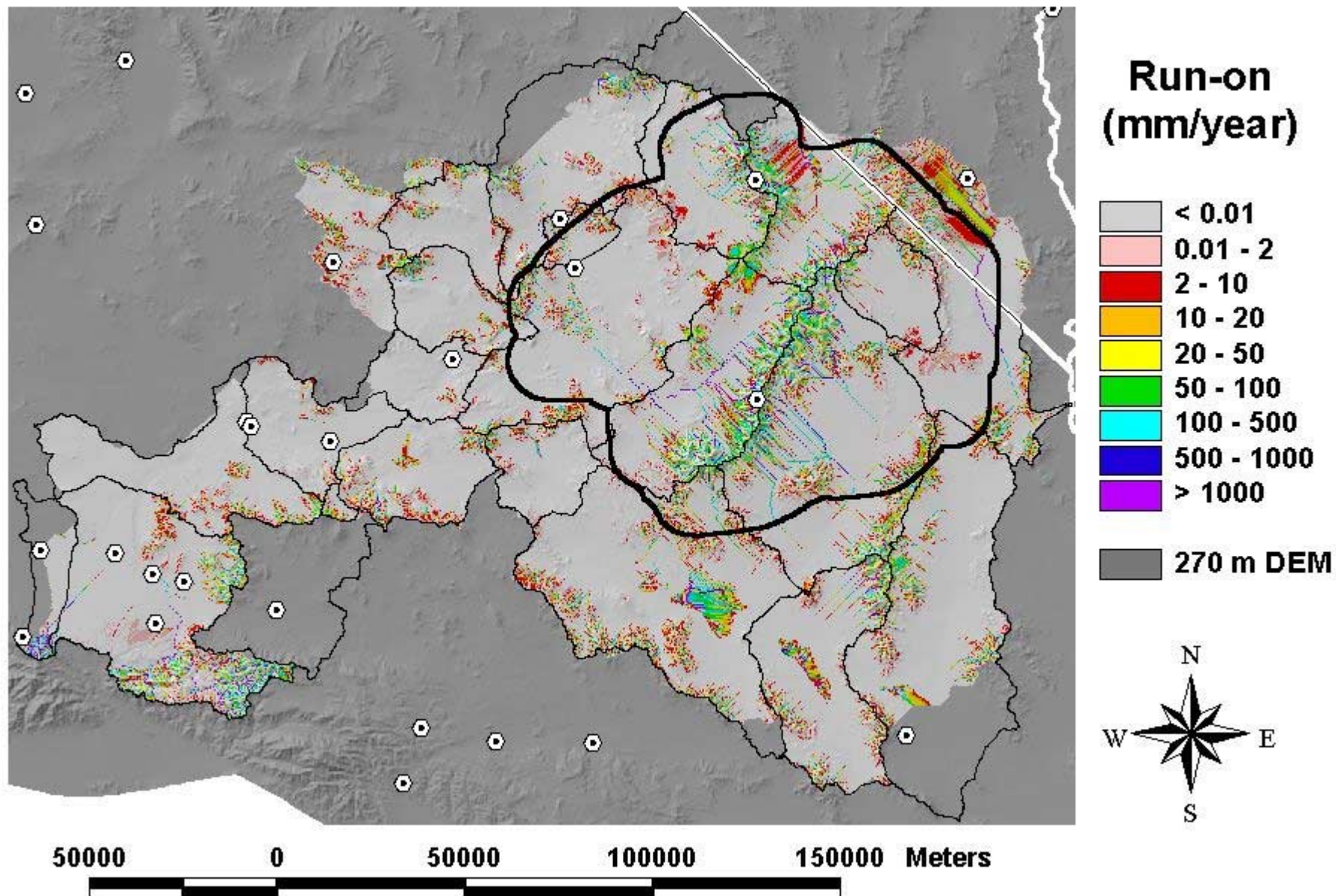
1950 - 1999 Modeled Snowfall



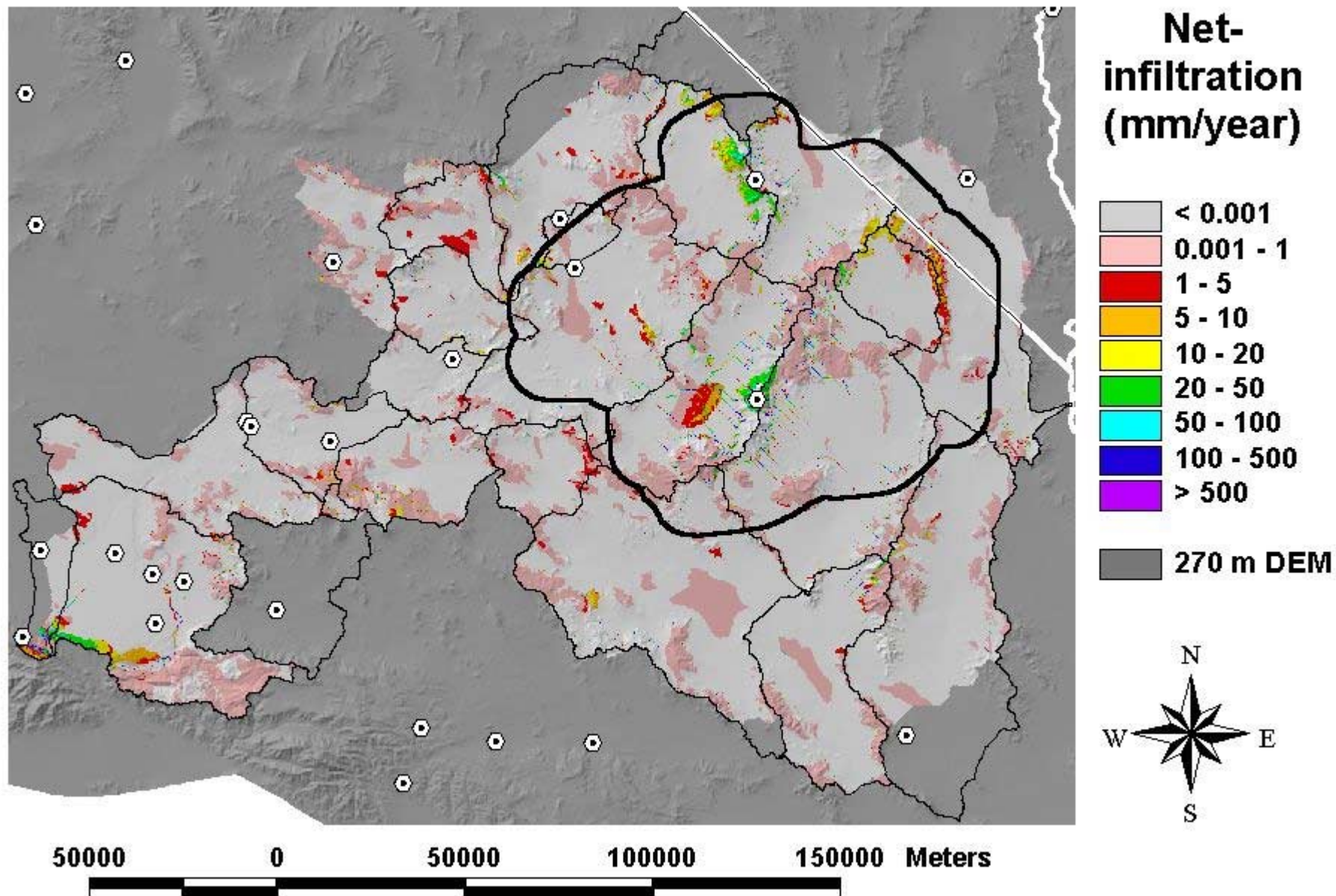
1950 - 1999 Modeled Evapotranspiration



1950 - 1999 Modeled Surface Water Run-on

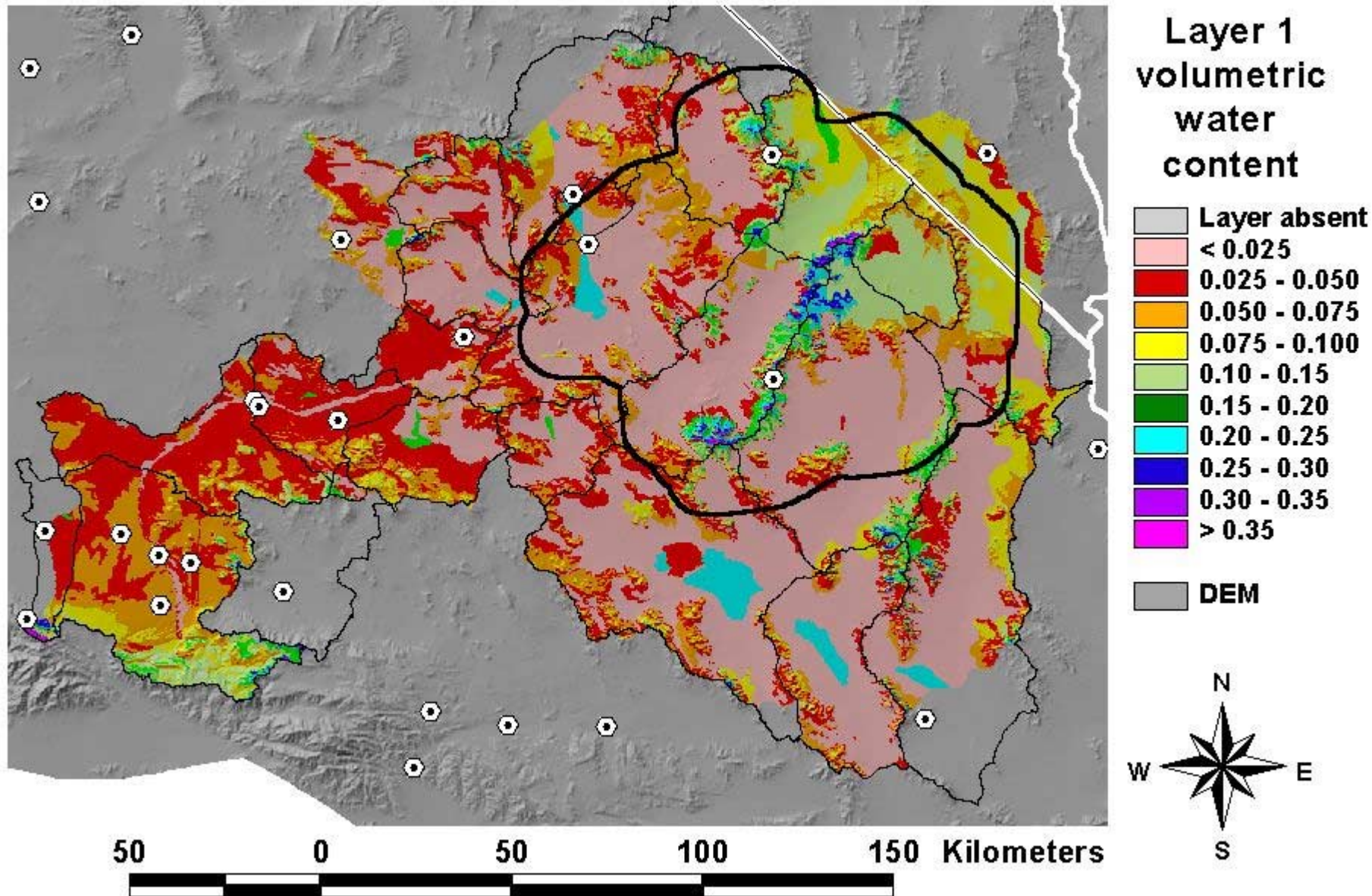


1950 - 1999 Modeled Net Infiltration



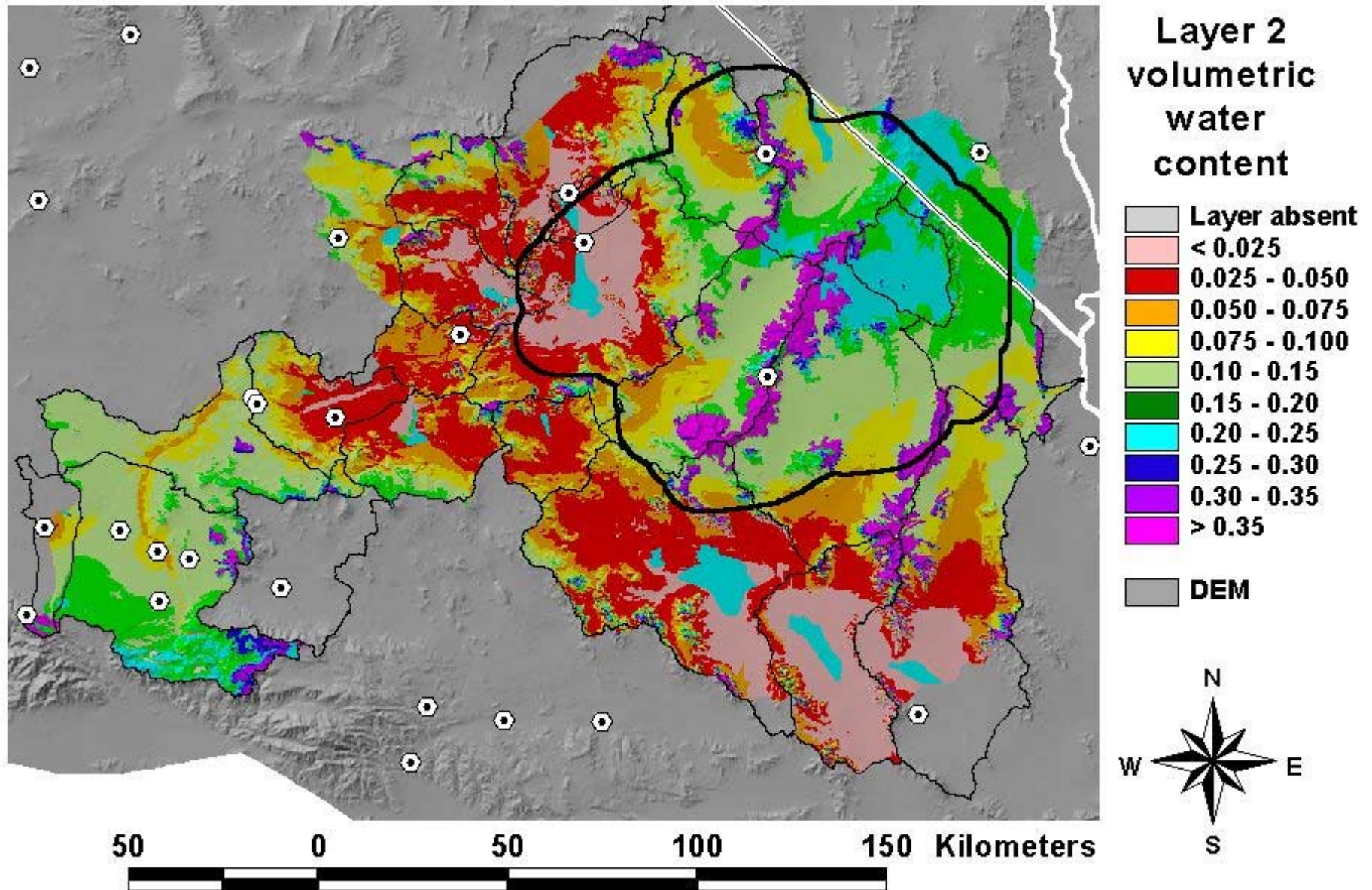
Modeled Water Content: February 12, 1980

Soil Layer 1: 0.0 - 0.1 meters



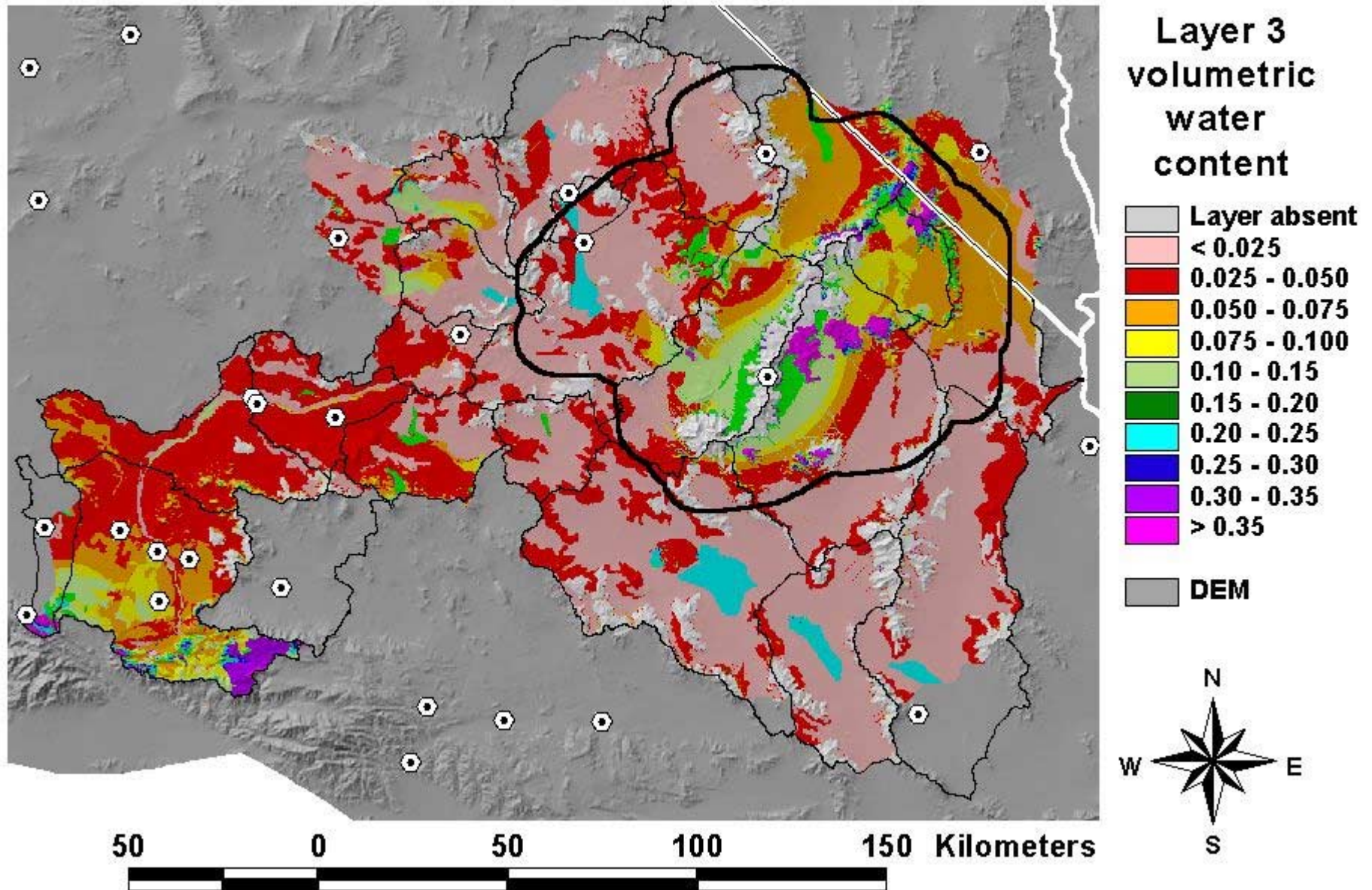
Modeled Water Content: February 12, 1980

Soil Layer 2: 0.1 - 0.3 meters



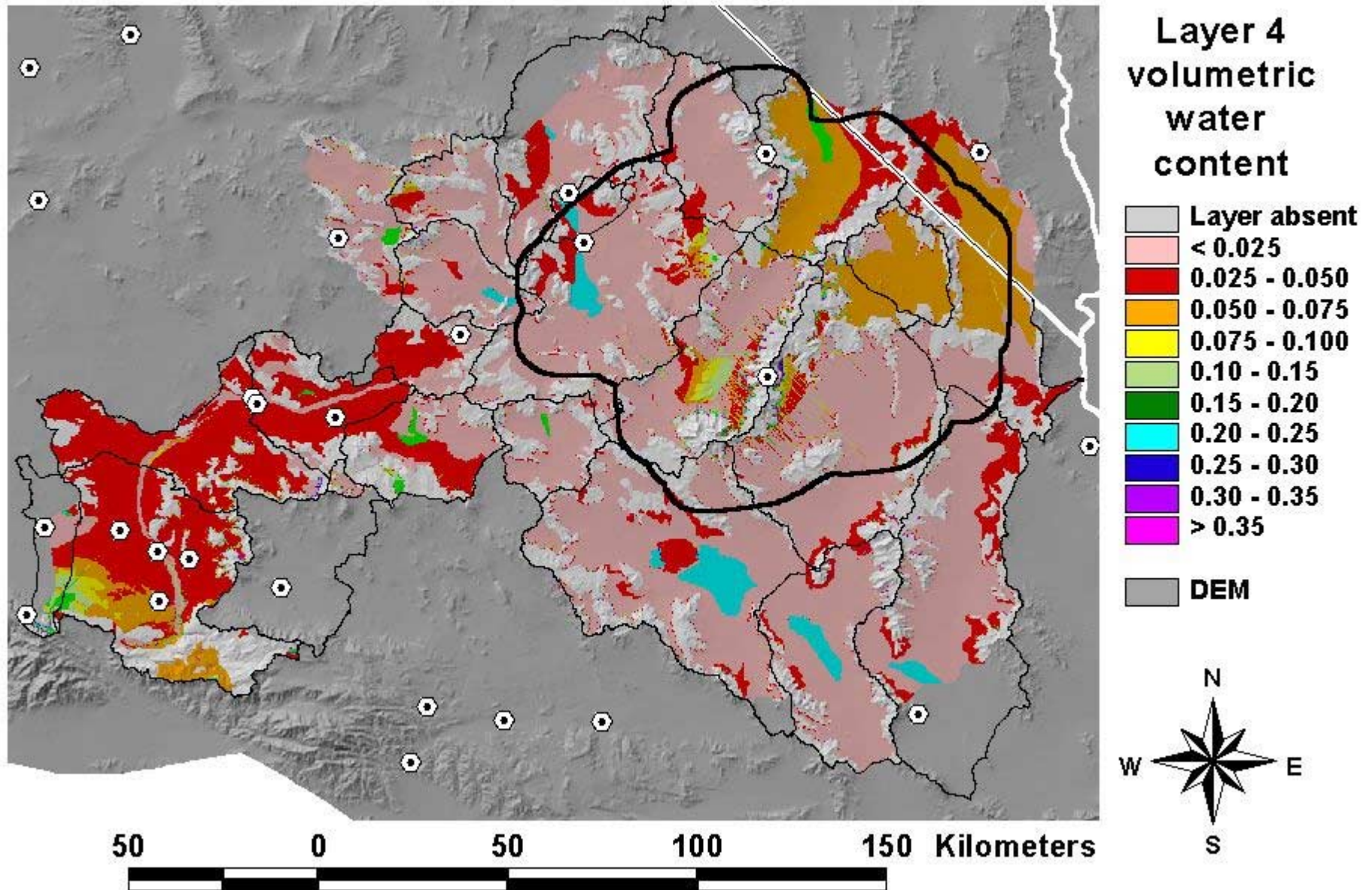
Modeled Water Content: February 12, 1980

Soil Layer 3: 0.3 - 1.0 meters



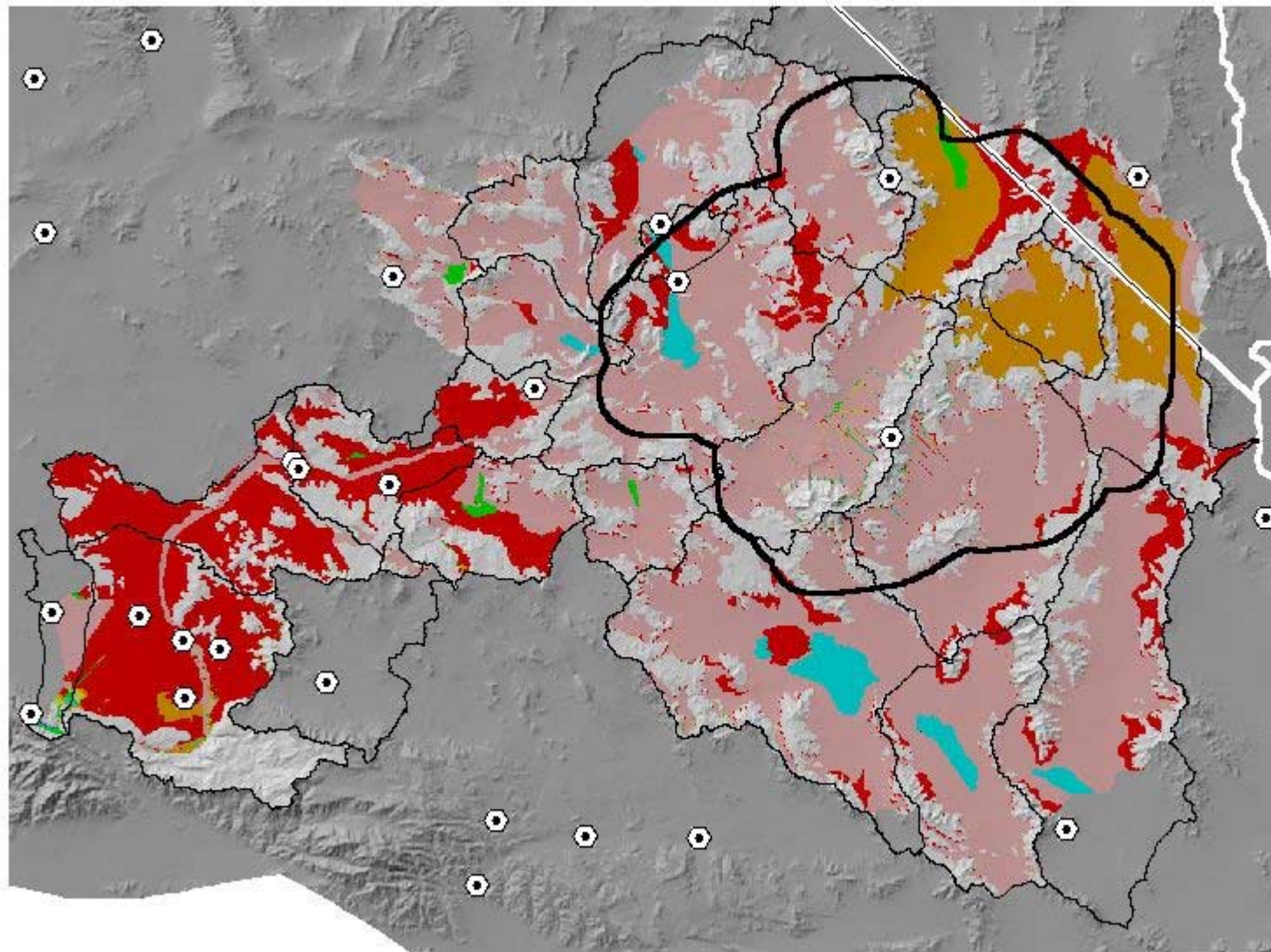
Modeled Water Content: February 12, 1980

Soil Layer 4: 1.0 - 3.0 meters



Modeled Water Content: February 12, 1980

Soil Layer 5: 3.0 - 6.0 meters



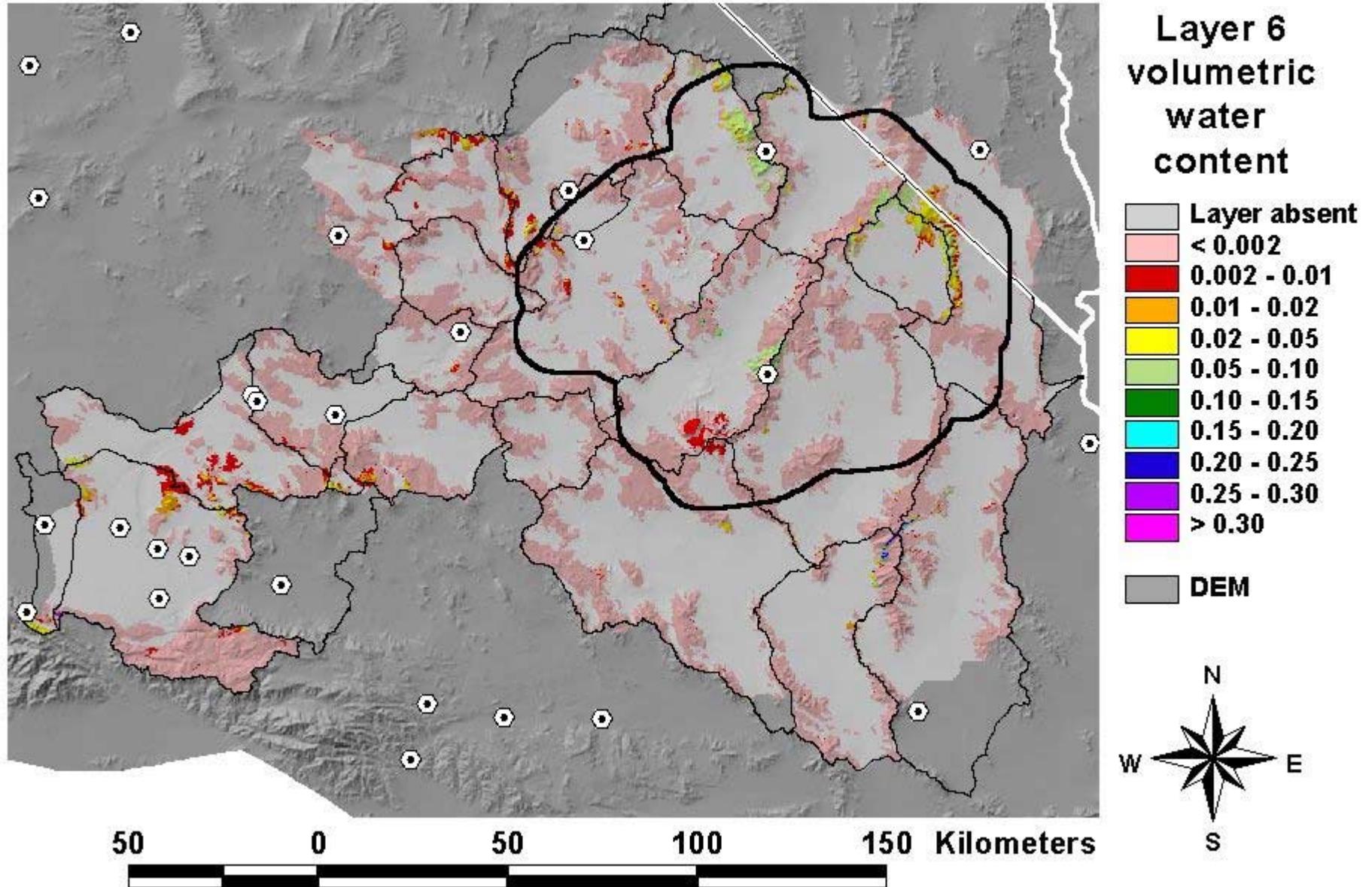
- Layer 5 volumetric water content**
- Layer absent
 - < 0.025
 - 0.025 - 0.050
 - 0.050 - 0.075
 - 0.075 - 0.100
 - 0.10 - 0.15
 - 0.15 - 0.20
 - 0.20 - 0.25
 - 0.25 - 0.30
 - 0.30 - 0.35
 - > 0.35



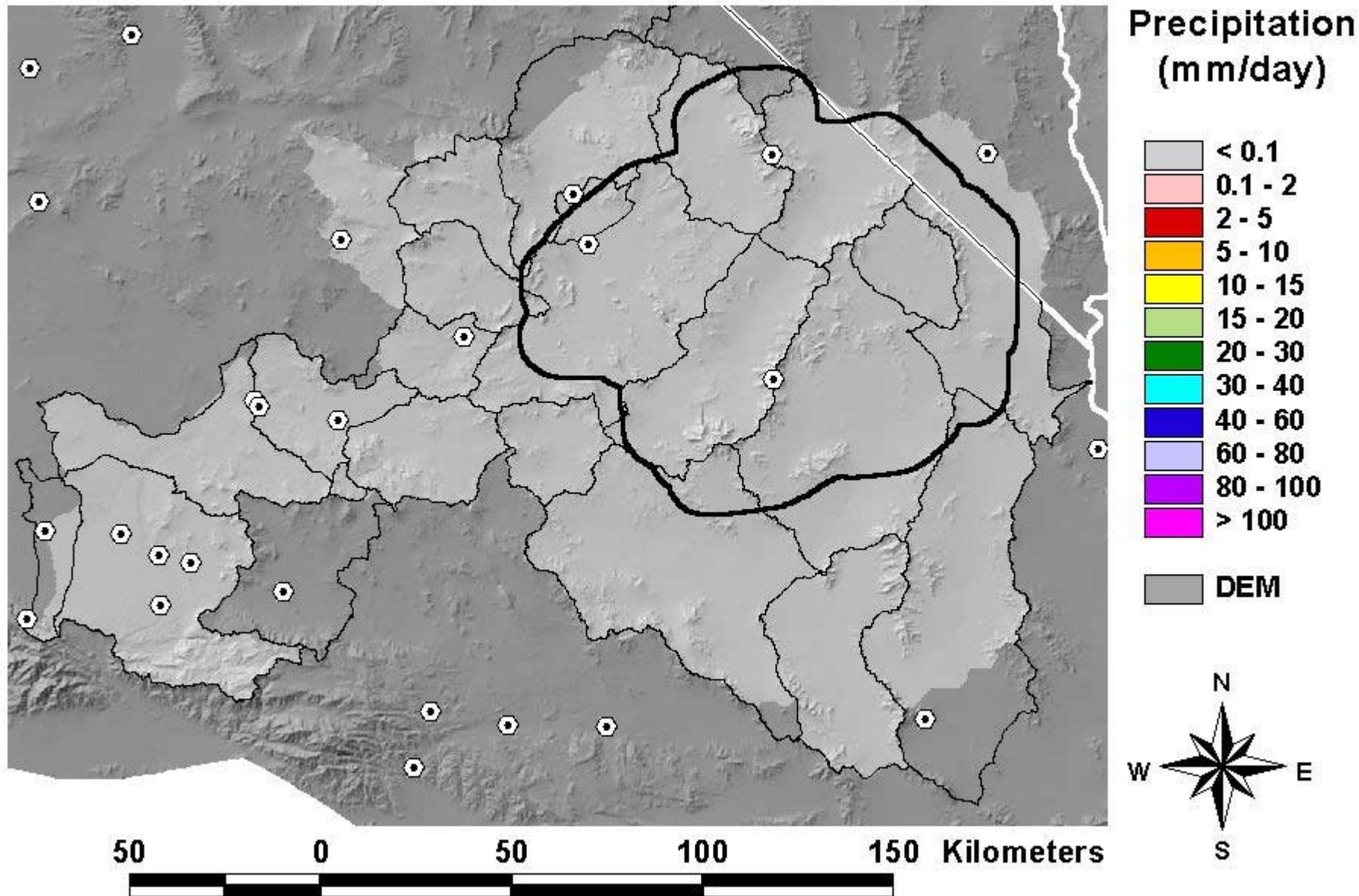
50 0 50 100 150 Kilometers

Modeled Water Content: February 12, 1980

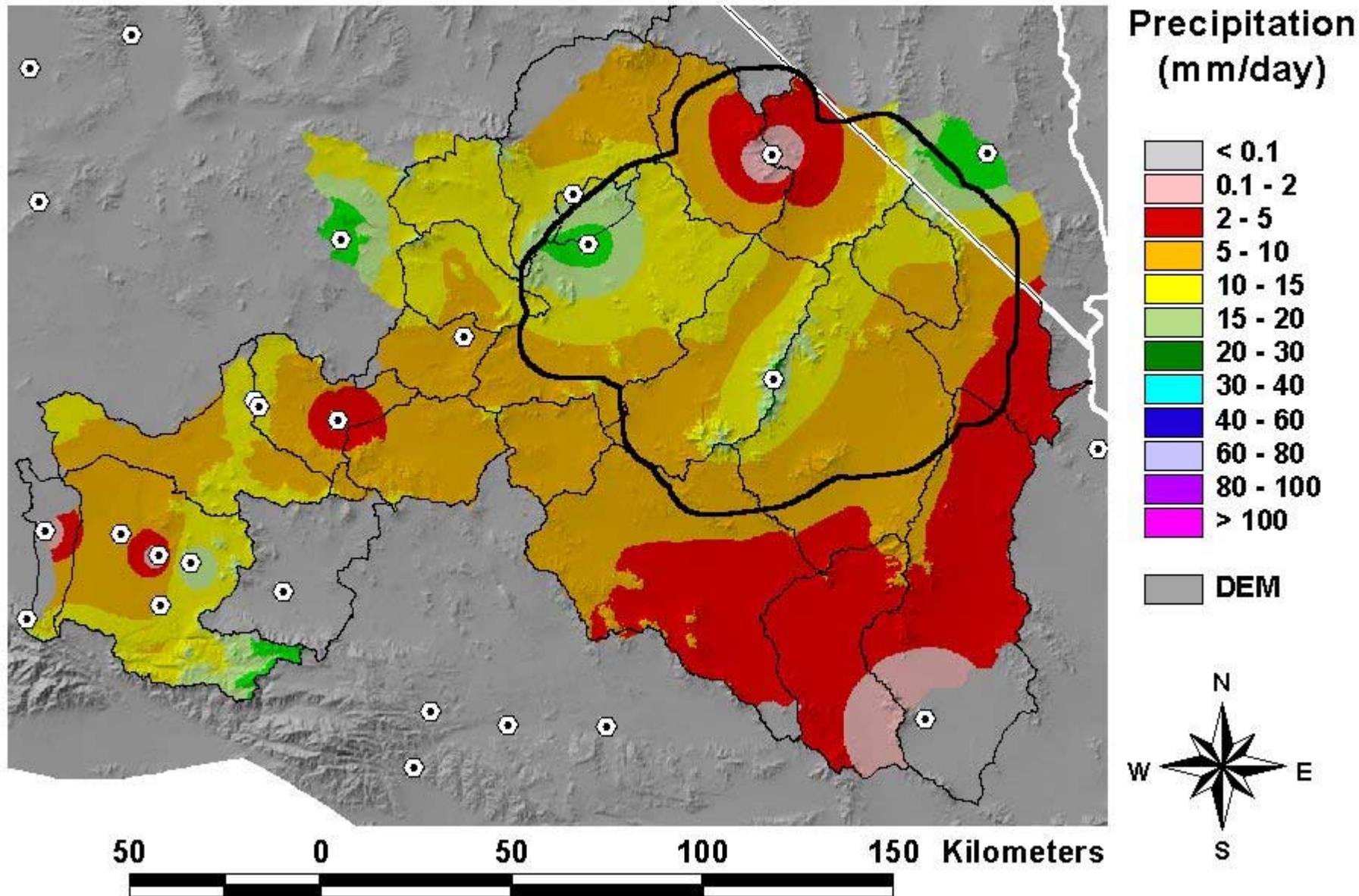
Rock Layer: 0.0 - 2.5 meters



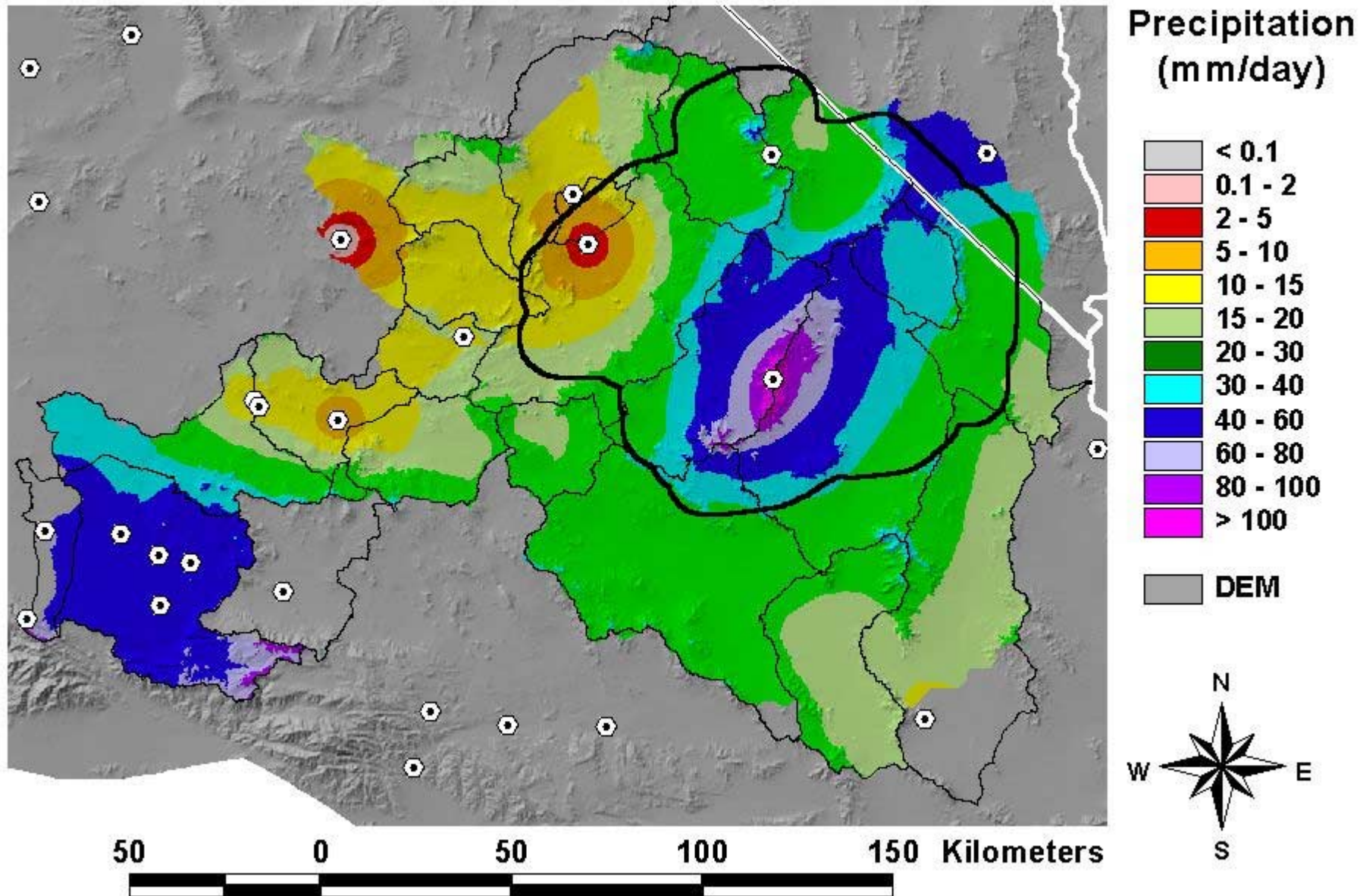
February 12, 1980 Modeled Precipitation



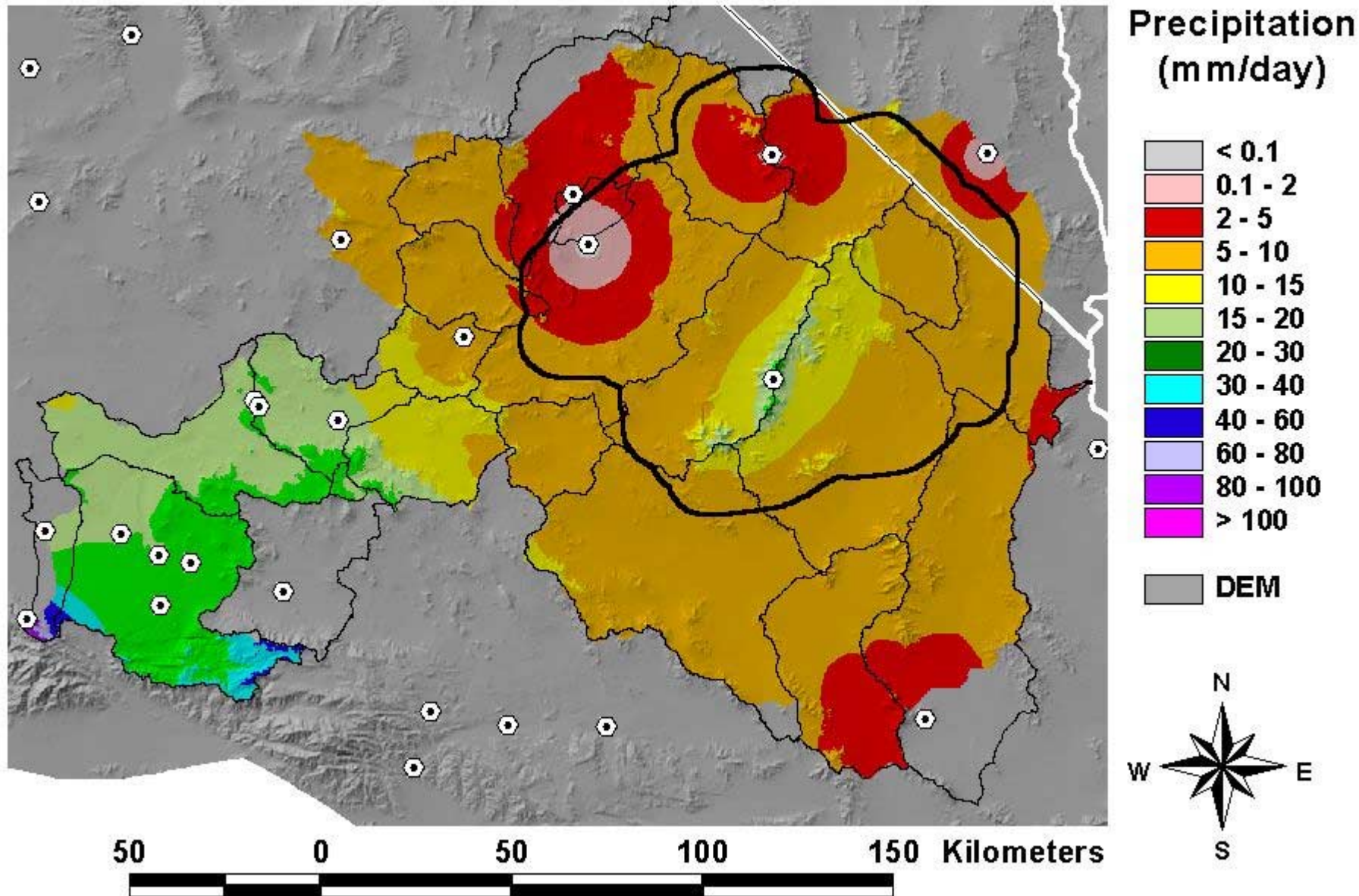
February 13, 1980 Modeled Precipitation



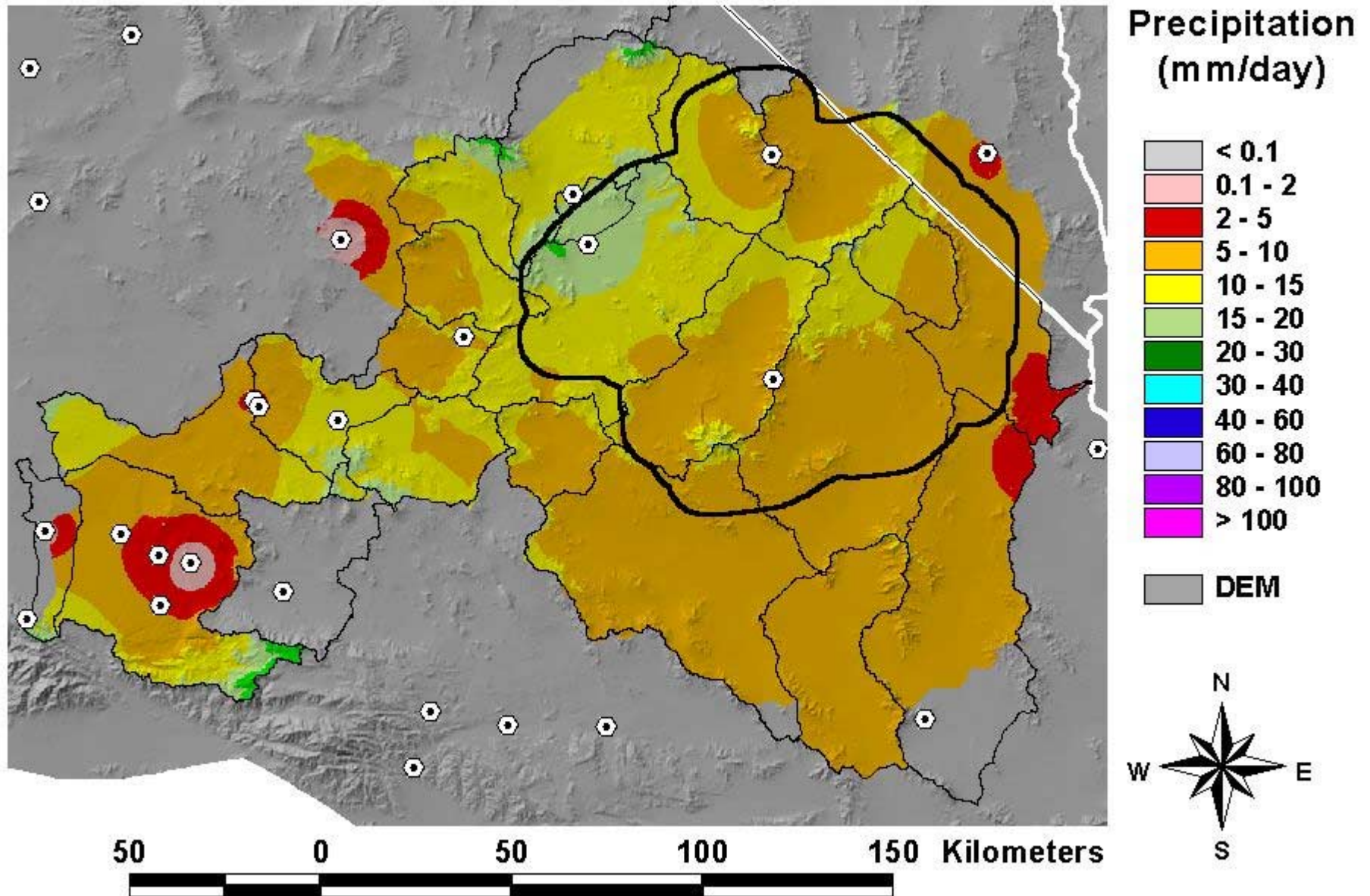
February 14, 1980 Modeled Precipitation



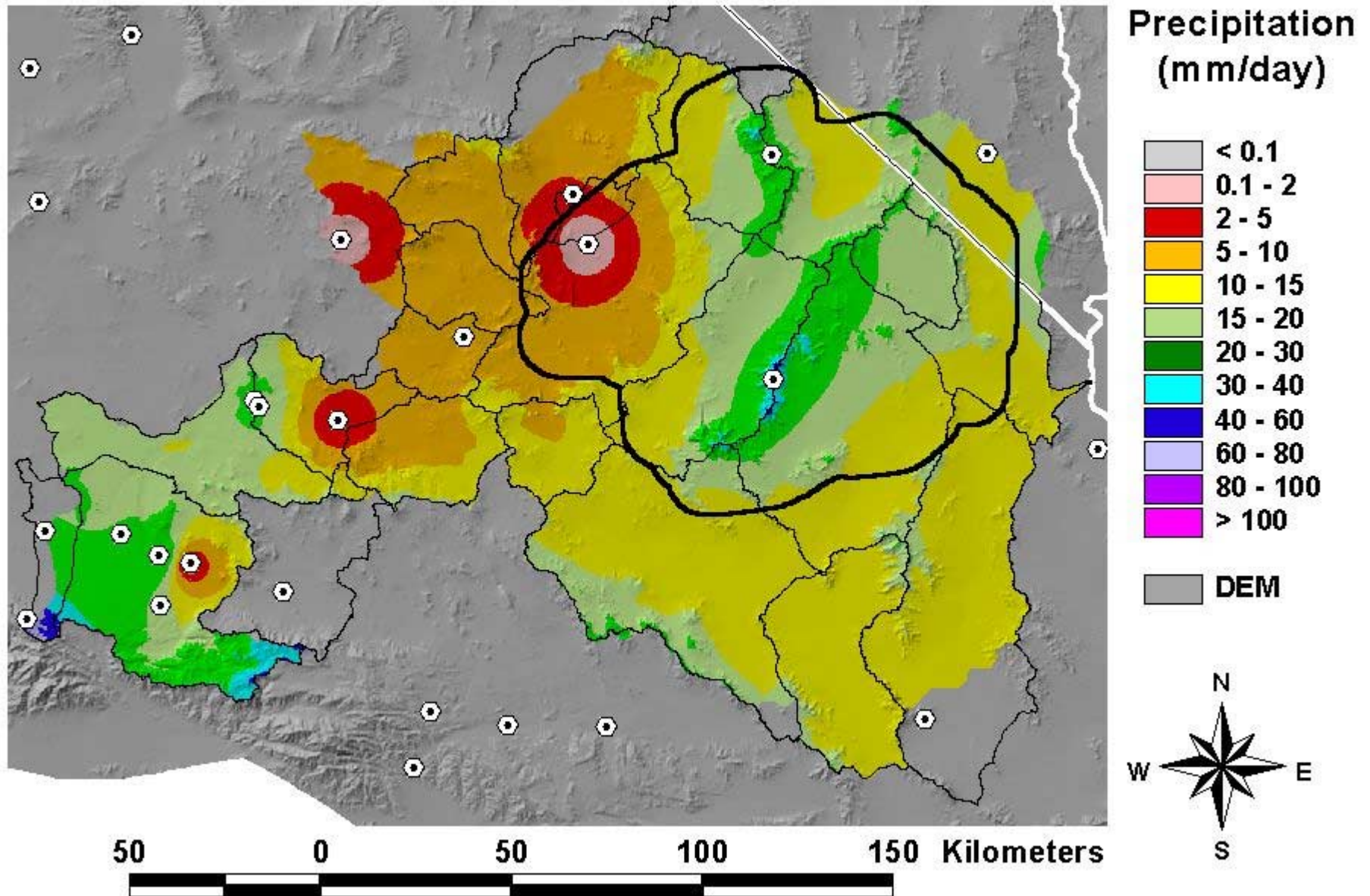
February 15, 1980 Modeled Precipitation



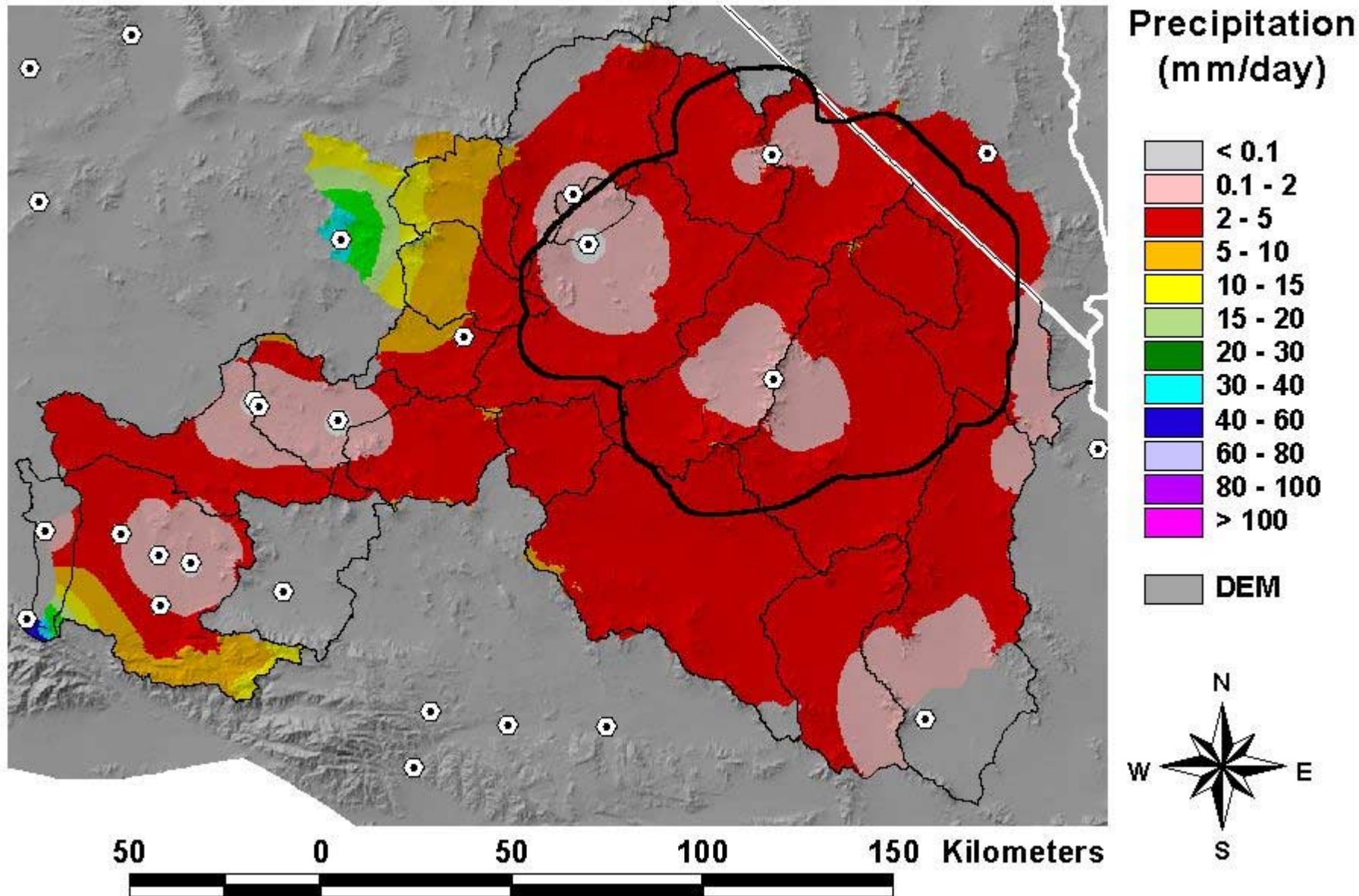
February 16, 1980 Modeled Precipitation



February 17, 1980 Modeled Precipitation

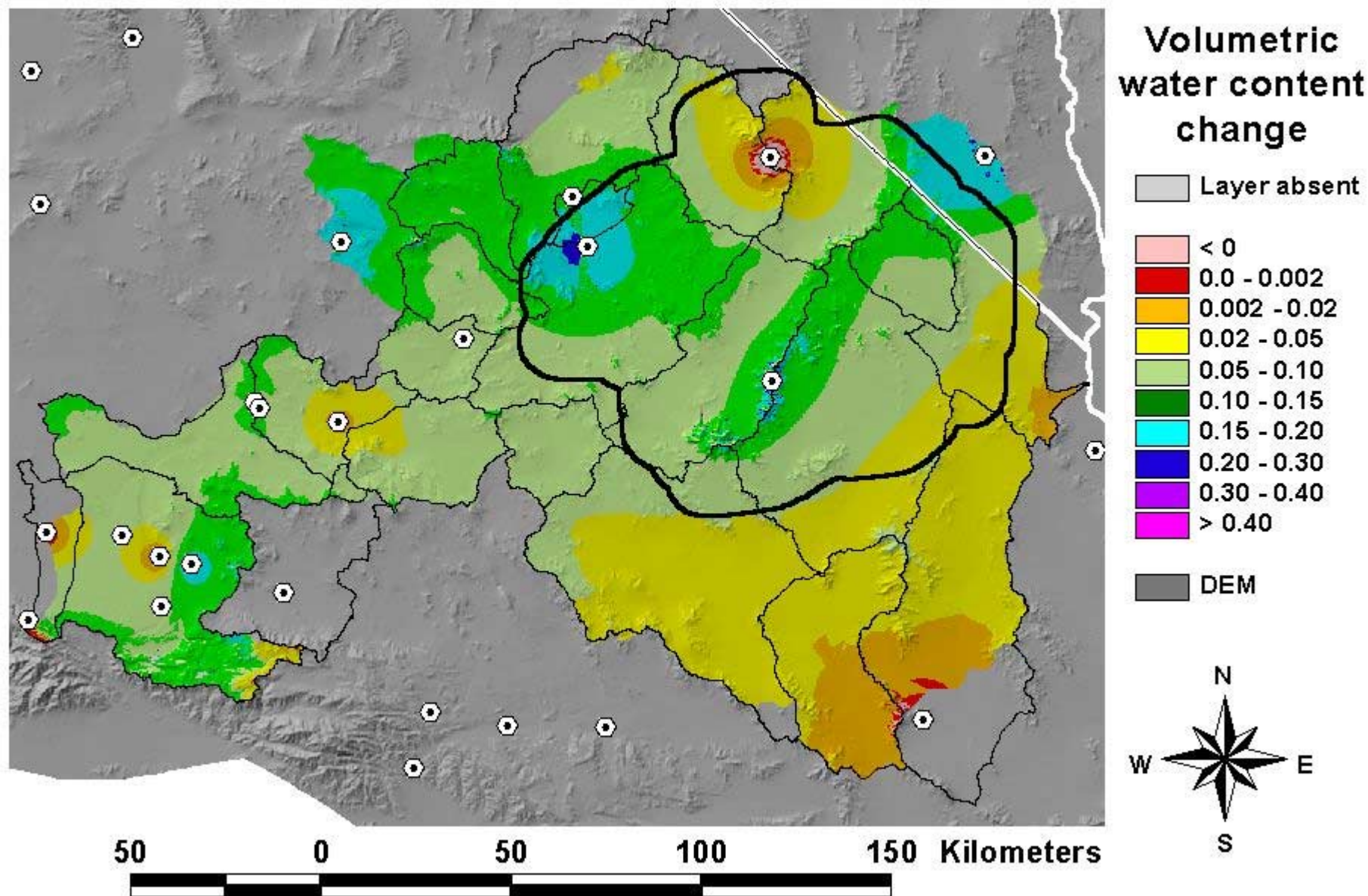


February 18, 1980 Modeled Precipitation



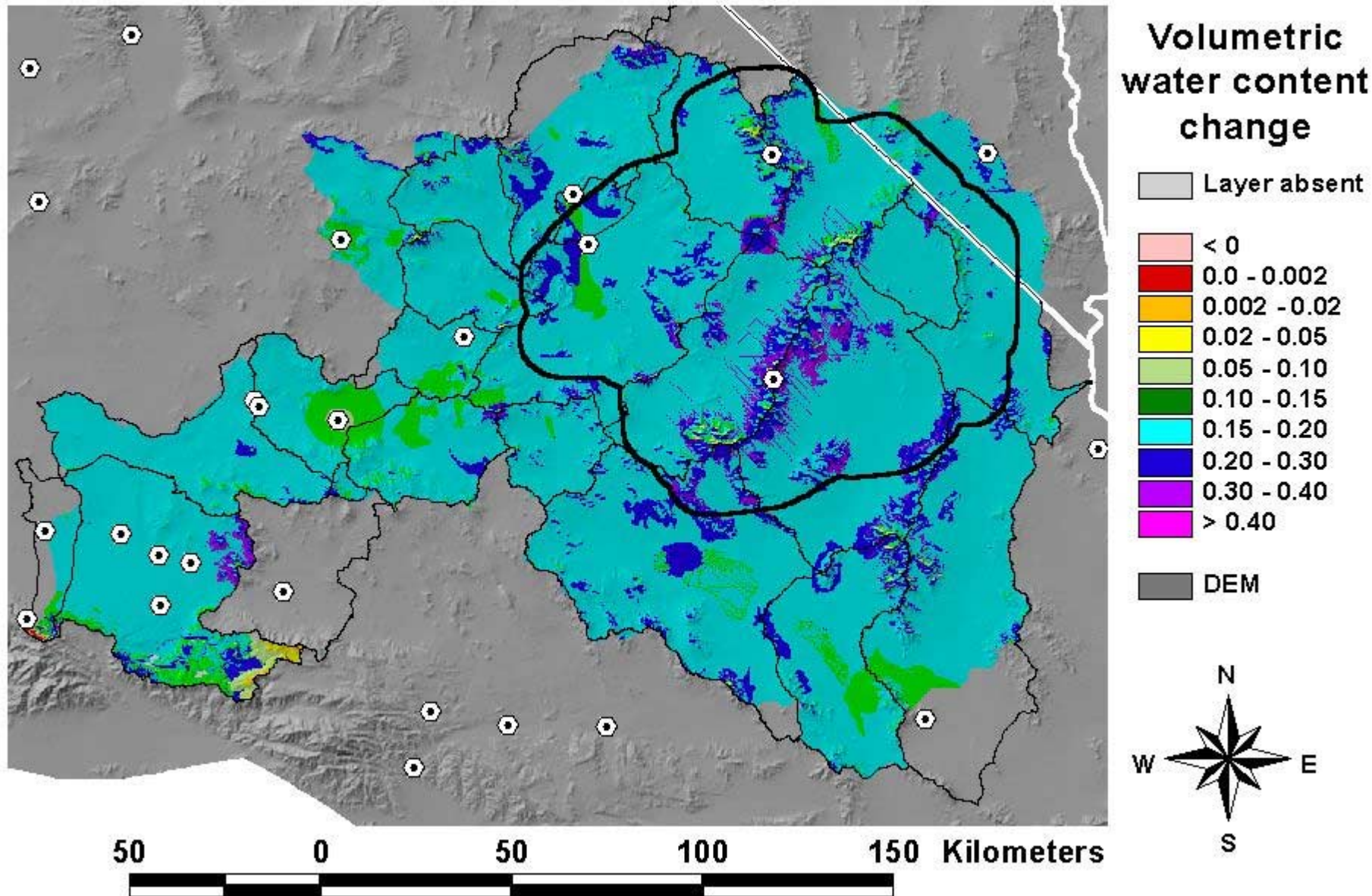
Modeled Water Content Change: February 13 - 12, 1980

Soil Layer 1: 0.0 - 0.1 meters



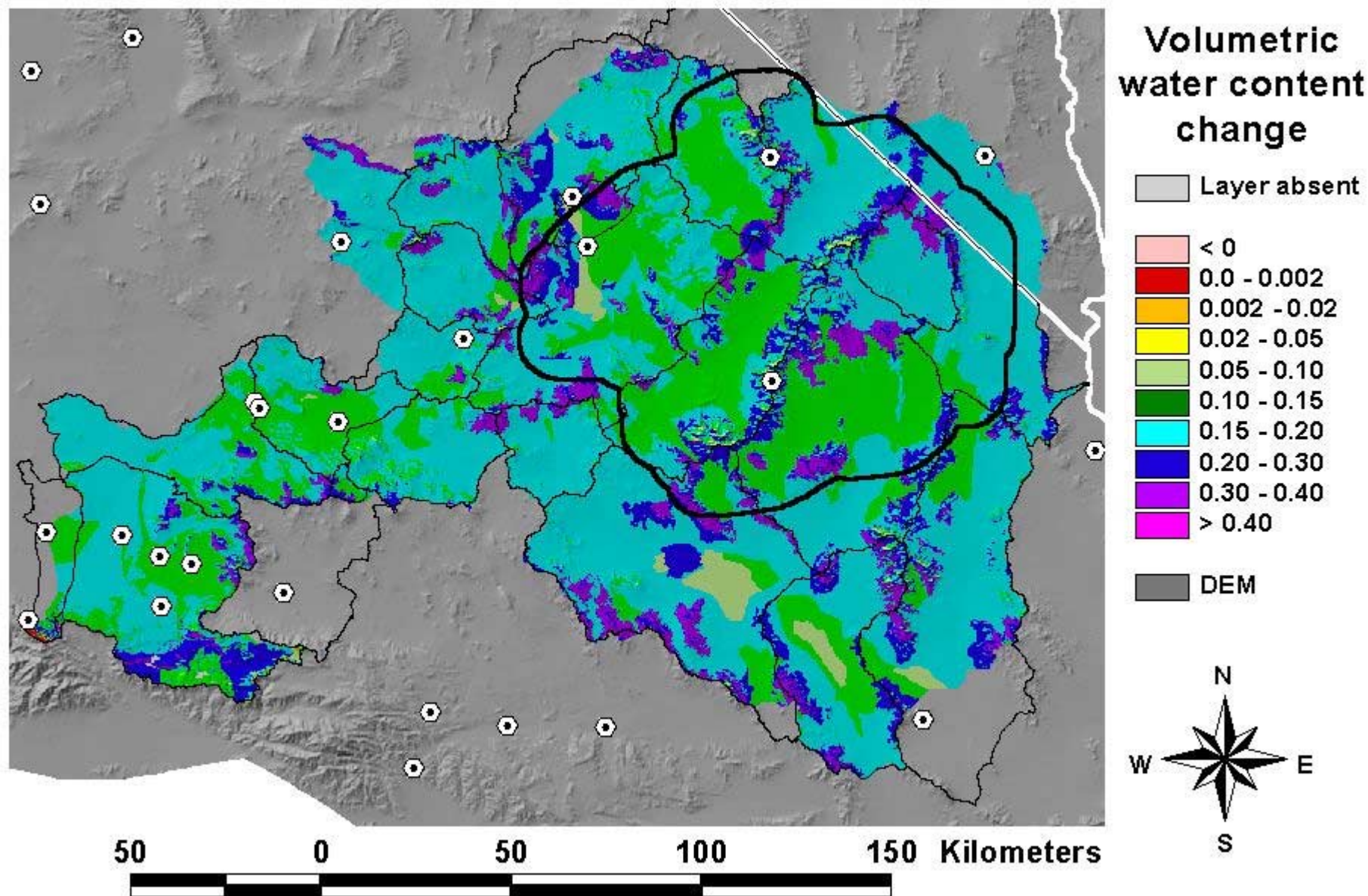
Modeled Water Content Change: February 14 - 12, 1980

Soil Layer 1: 0.0 - 0.1 meters



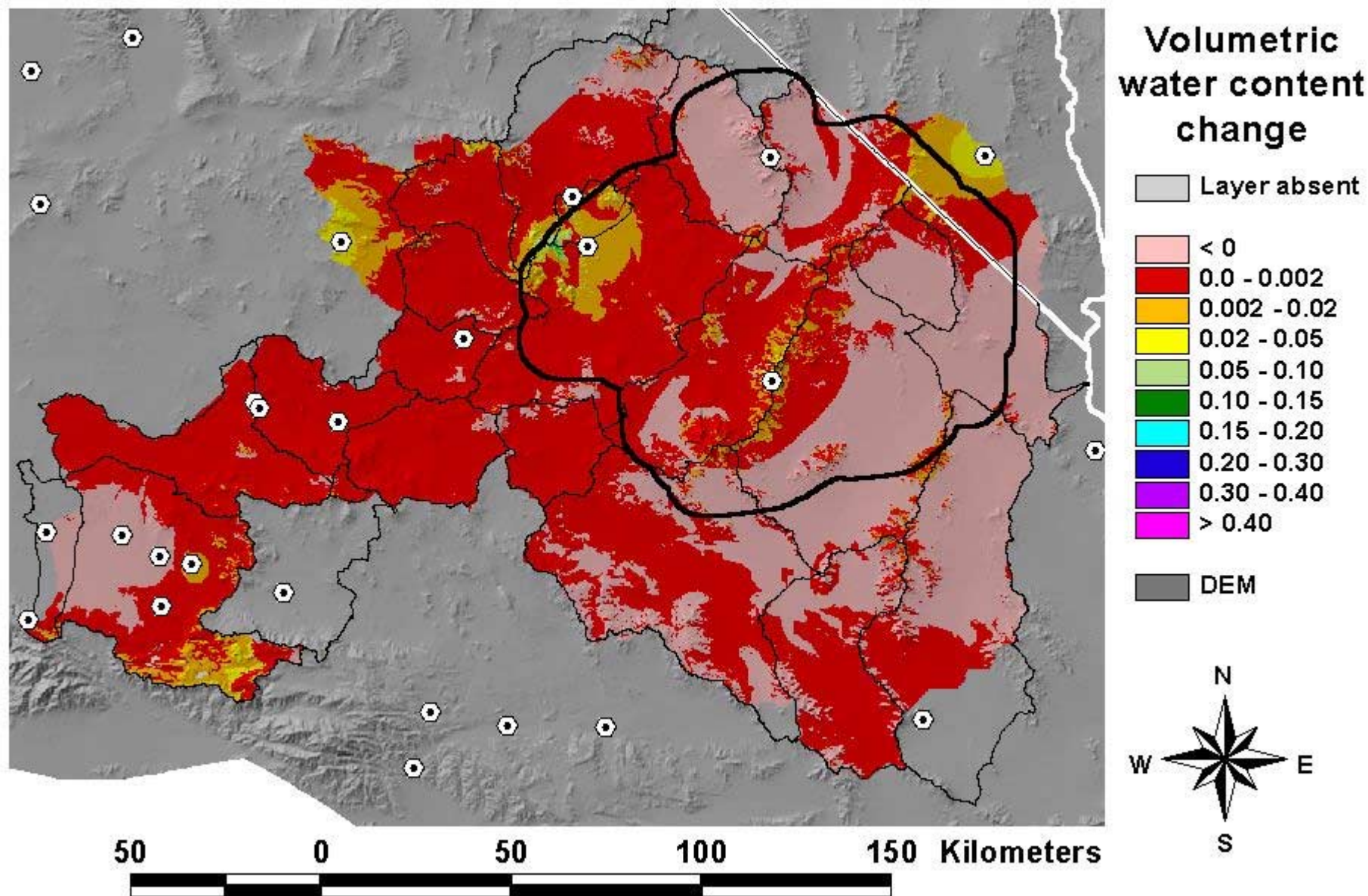
Modeled Water Content Change: February 18 - 12, 1980

Soil Layer 1: 0.0 - 0.1 meters



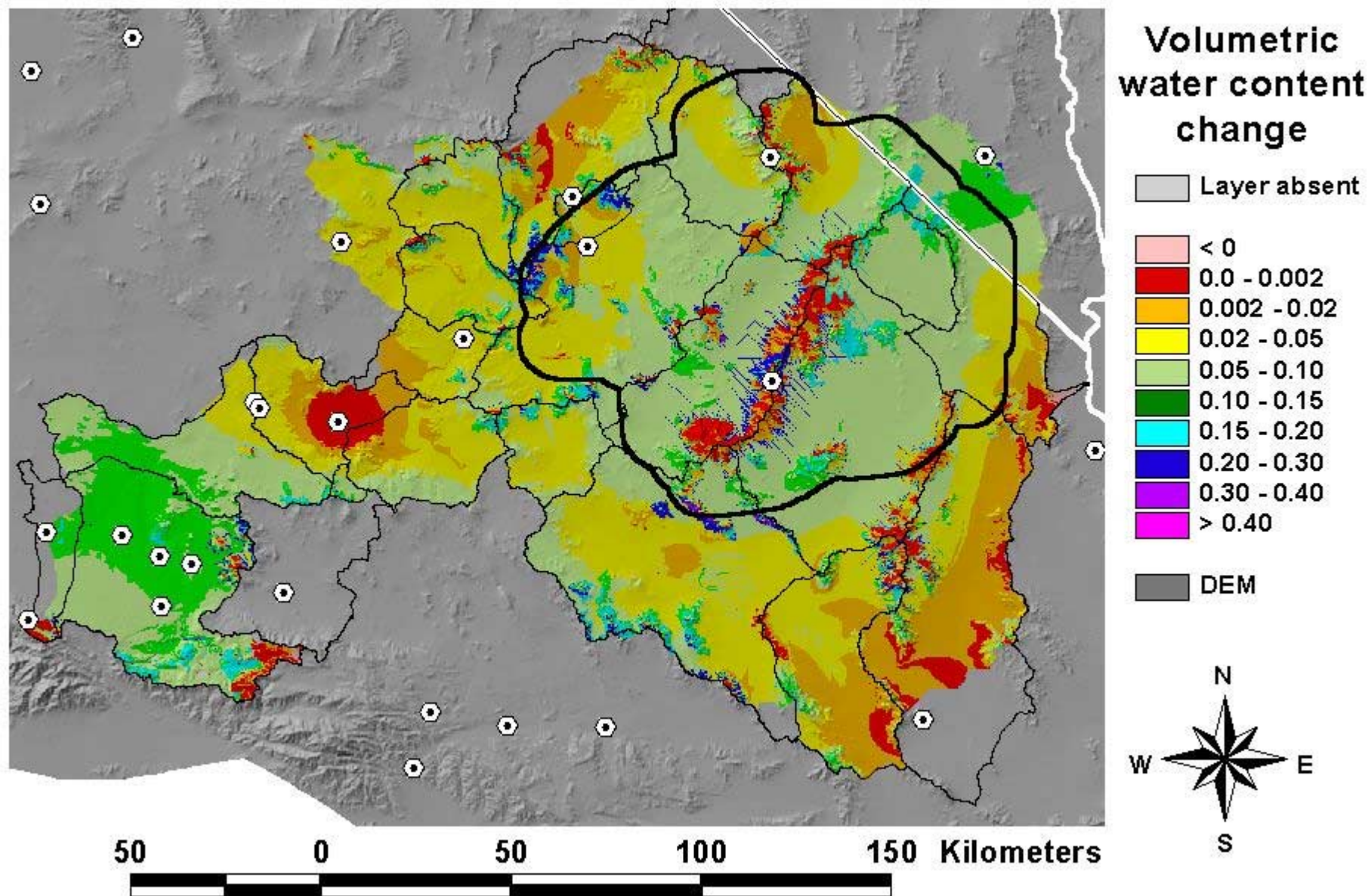
Modeled Water Content Change: February 13 - 12, 1980

Soil Layer 2: 0.1 - 0.3 meters



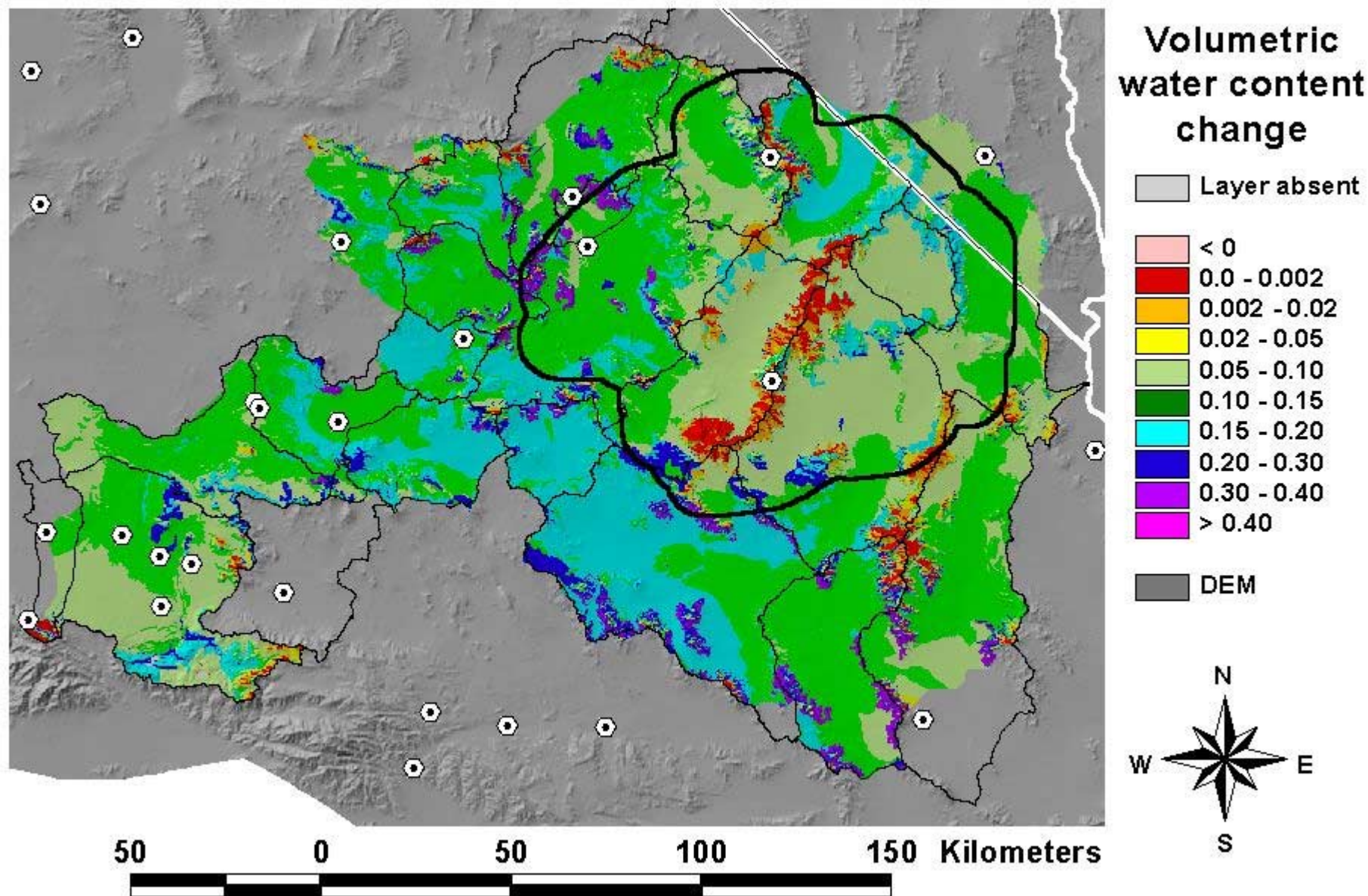
Modeled Water Content Change: February 14 - 12, 1980

Soil Layer 2: 0.1 - 0.3 meters



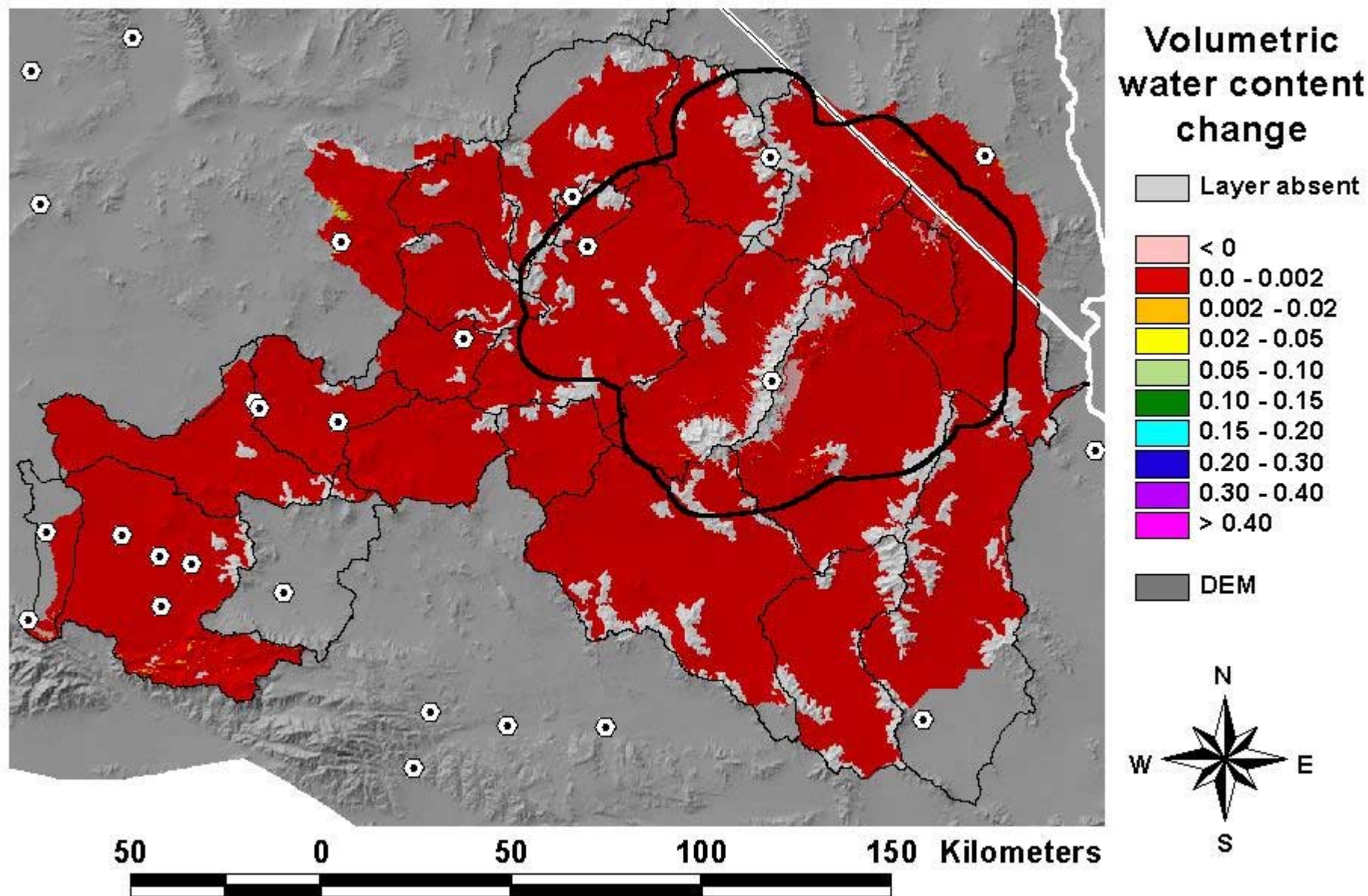
Modeled Water Content Change: February 18 - 12, 1980

Soil Layer 2: 0.1 - 0.3 meters



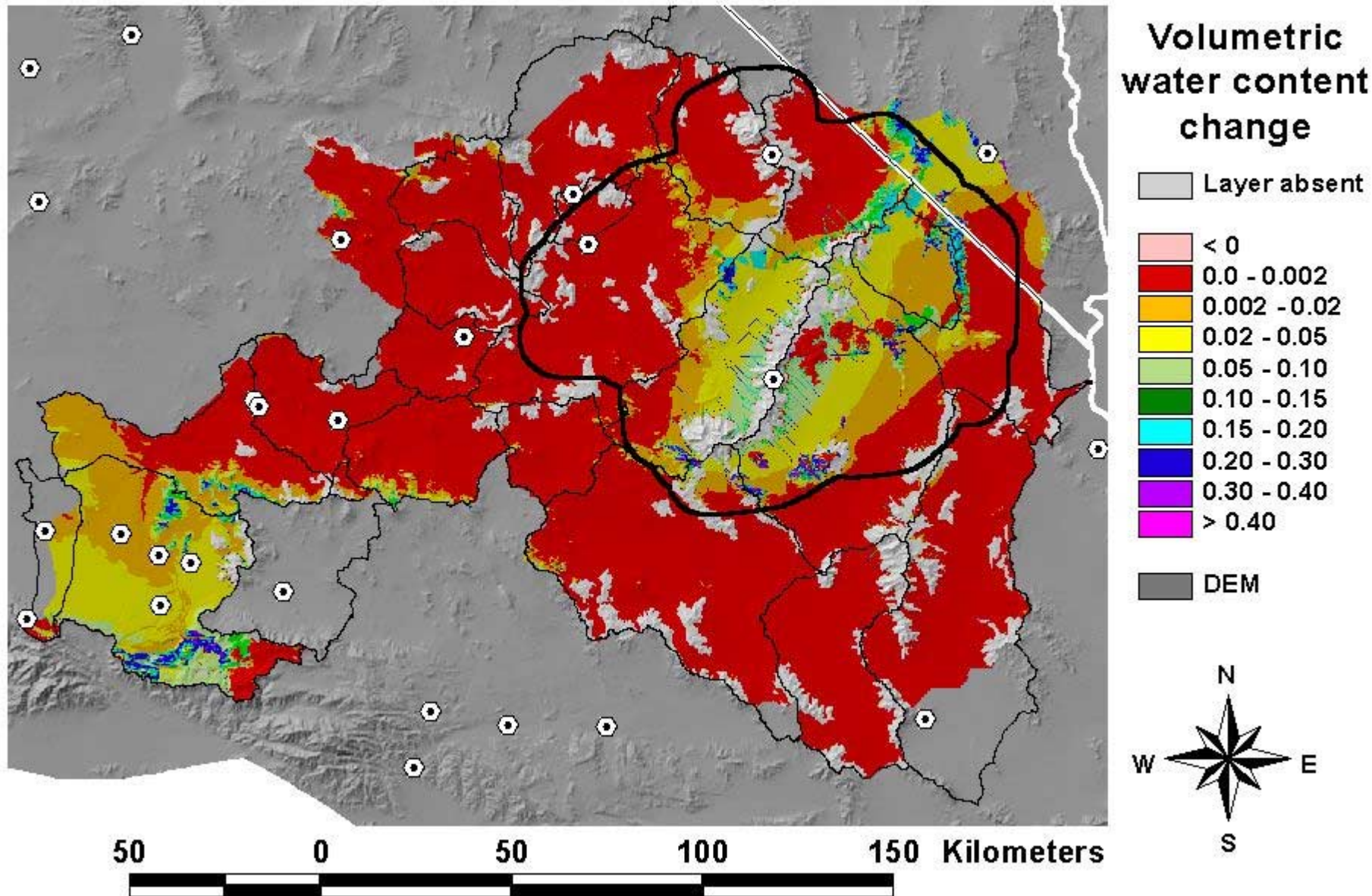
Modeled Water Content Change: February 13 - 12, 1980

Soil Layer 3: 0.3 - 1.0 meters



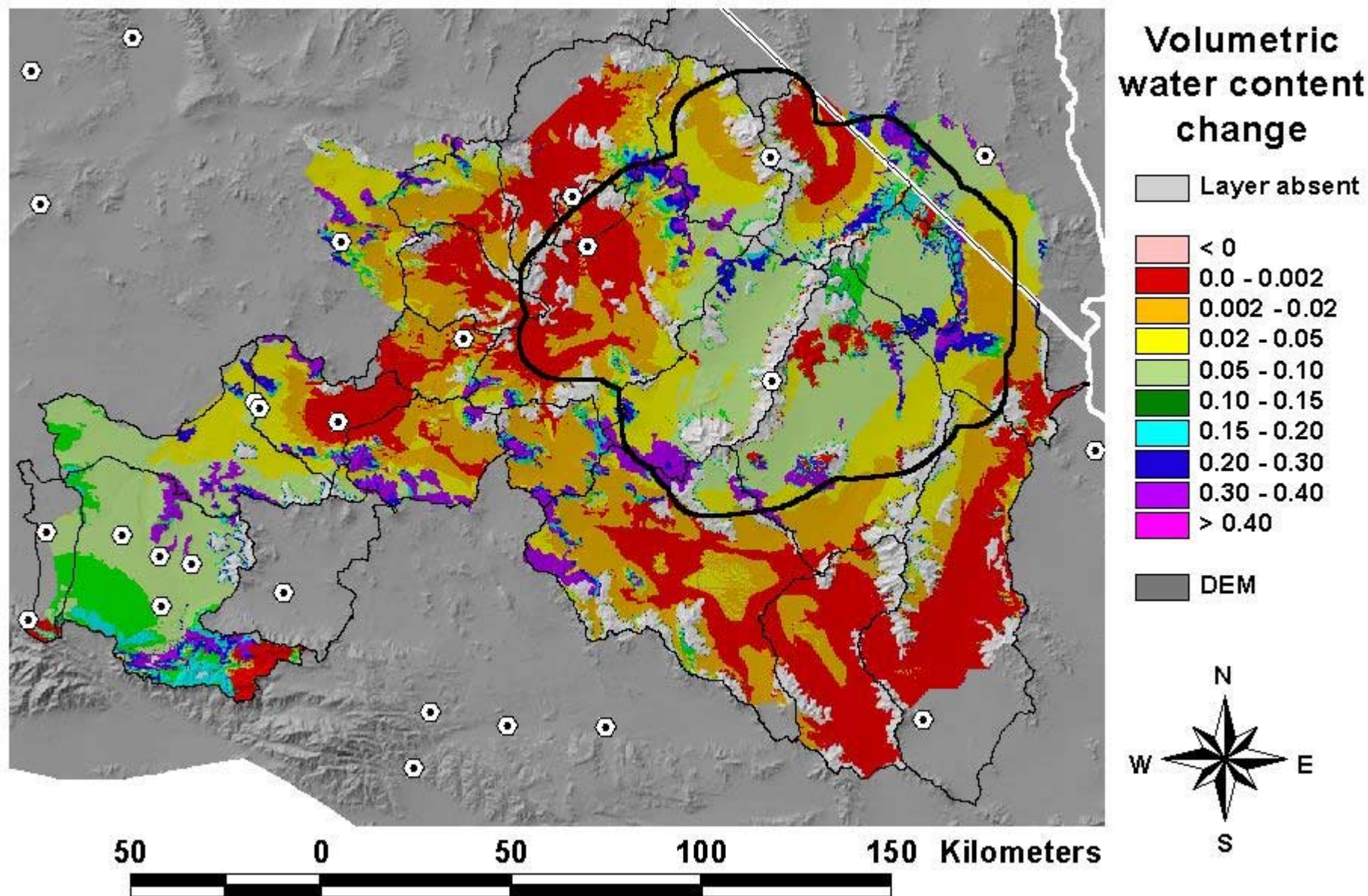
Modeled Water Content Change: February 14 - 12, 1980

Soil Layer 3: 0.3 - 1.0 meters



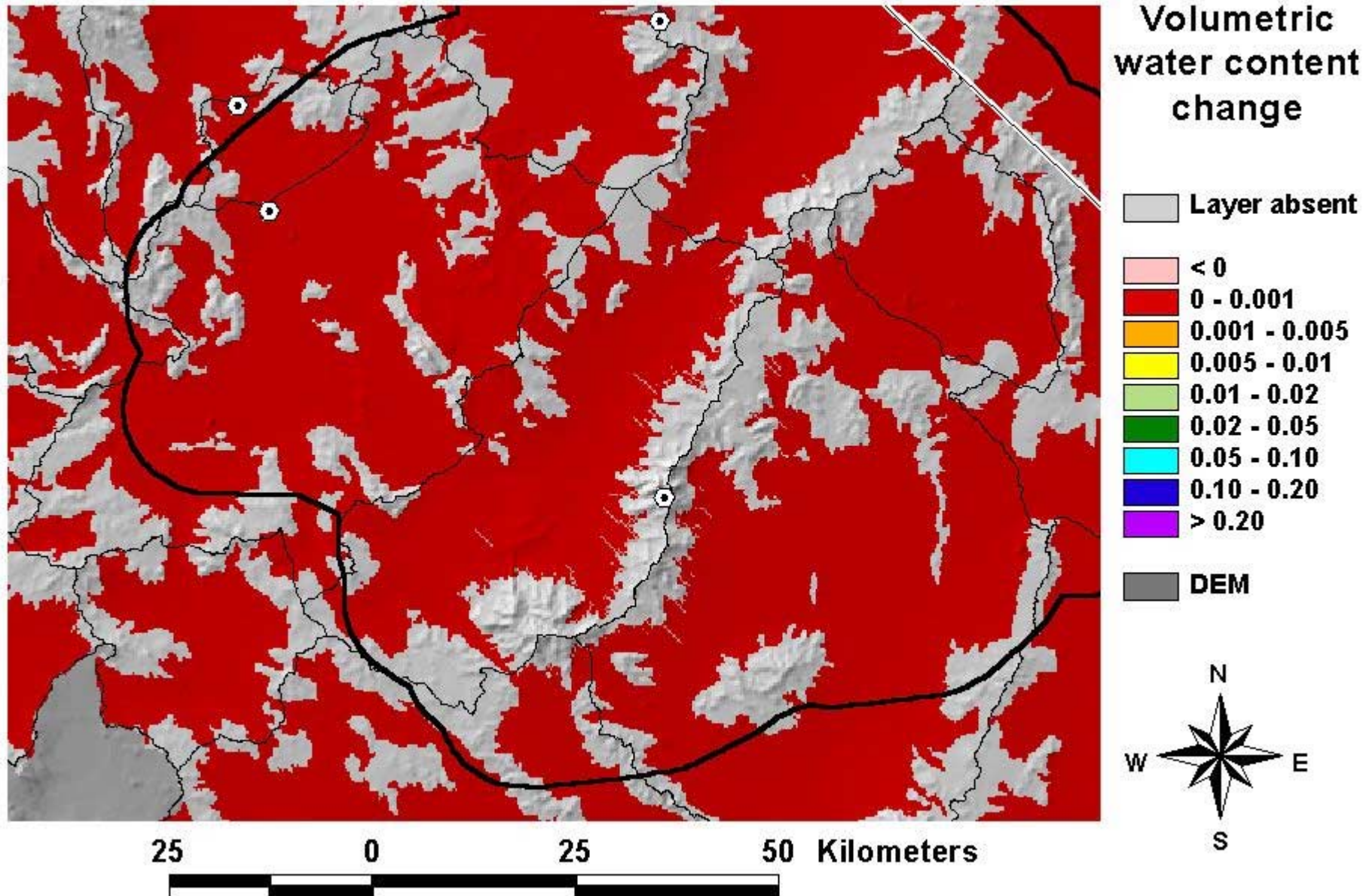
Modeled Water Content Change: February 18 - 12, 1980

Soil Layer 3: 0.3 - 1.0 meters



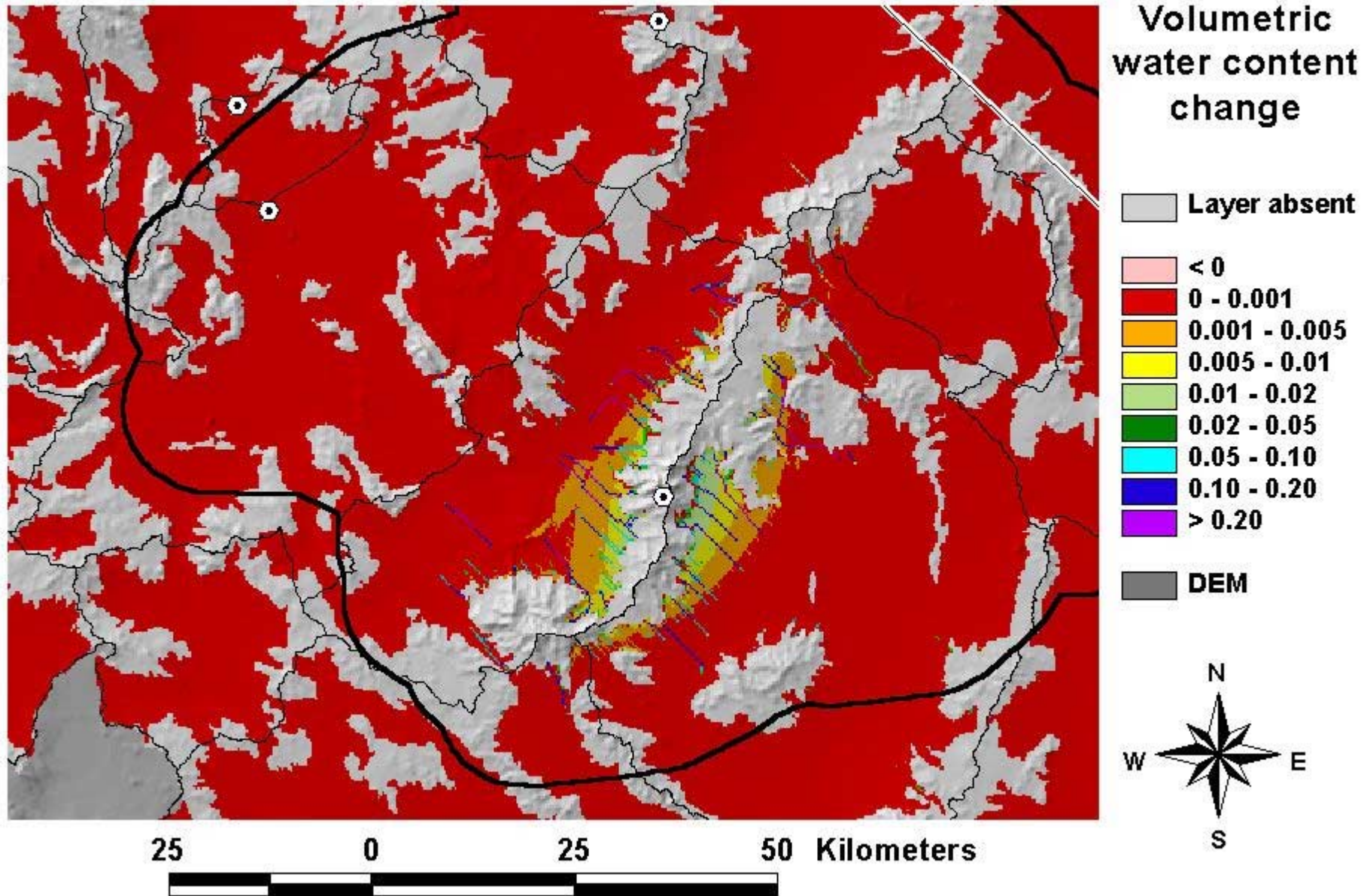
Modeled Water Content Change: February 13 - 12, 1980

Soil Layer 4: 1.0 - 3.0 meters



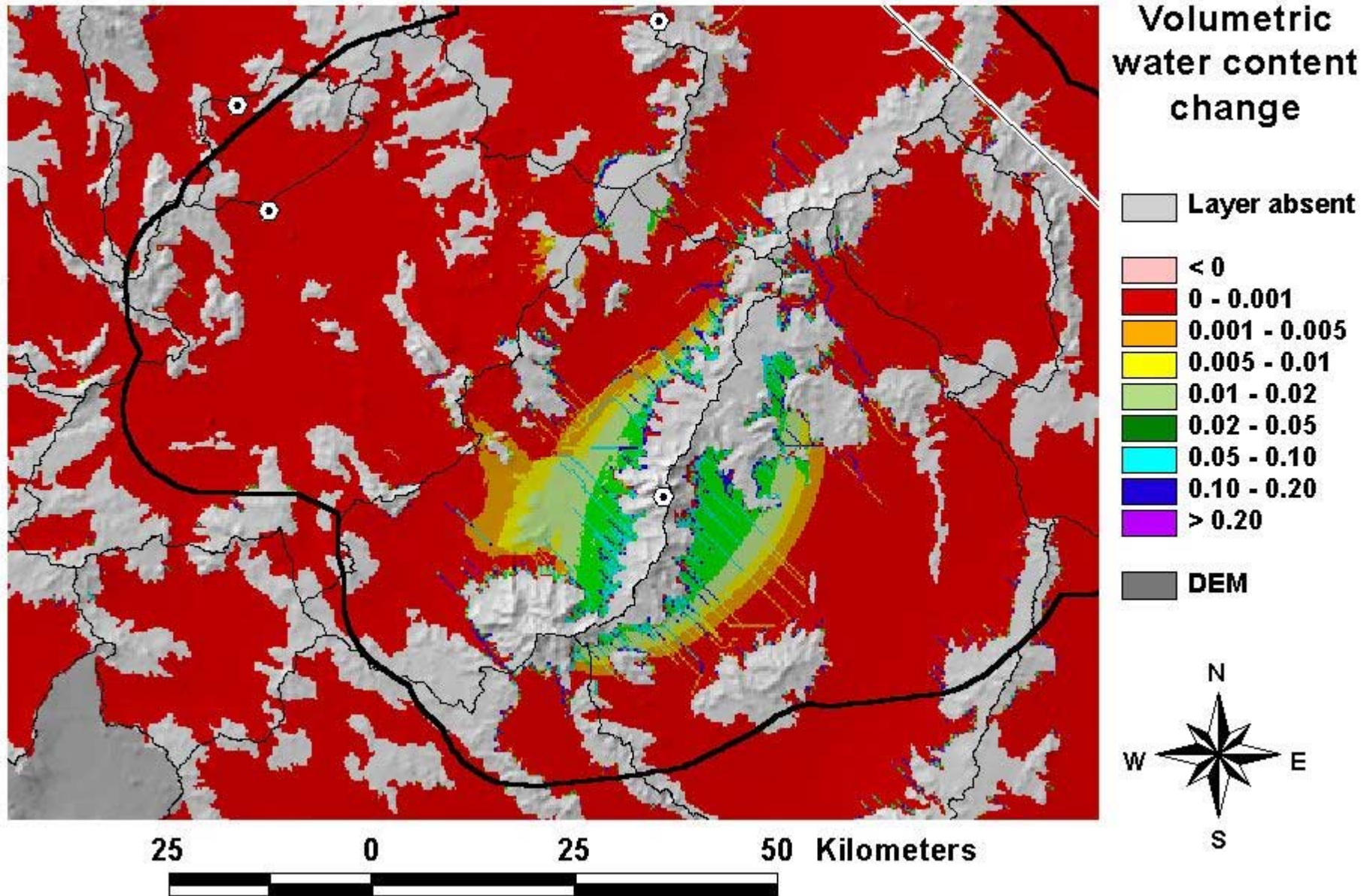
Modeled Water Content Change: February 14 - 12, 1980

Soil Layer 4: 1.0 - 3.0 meters



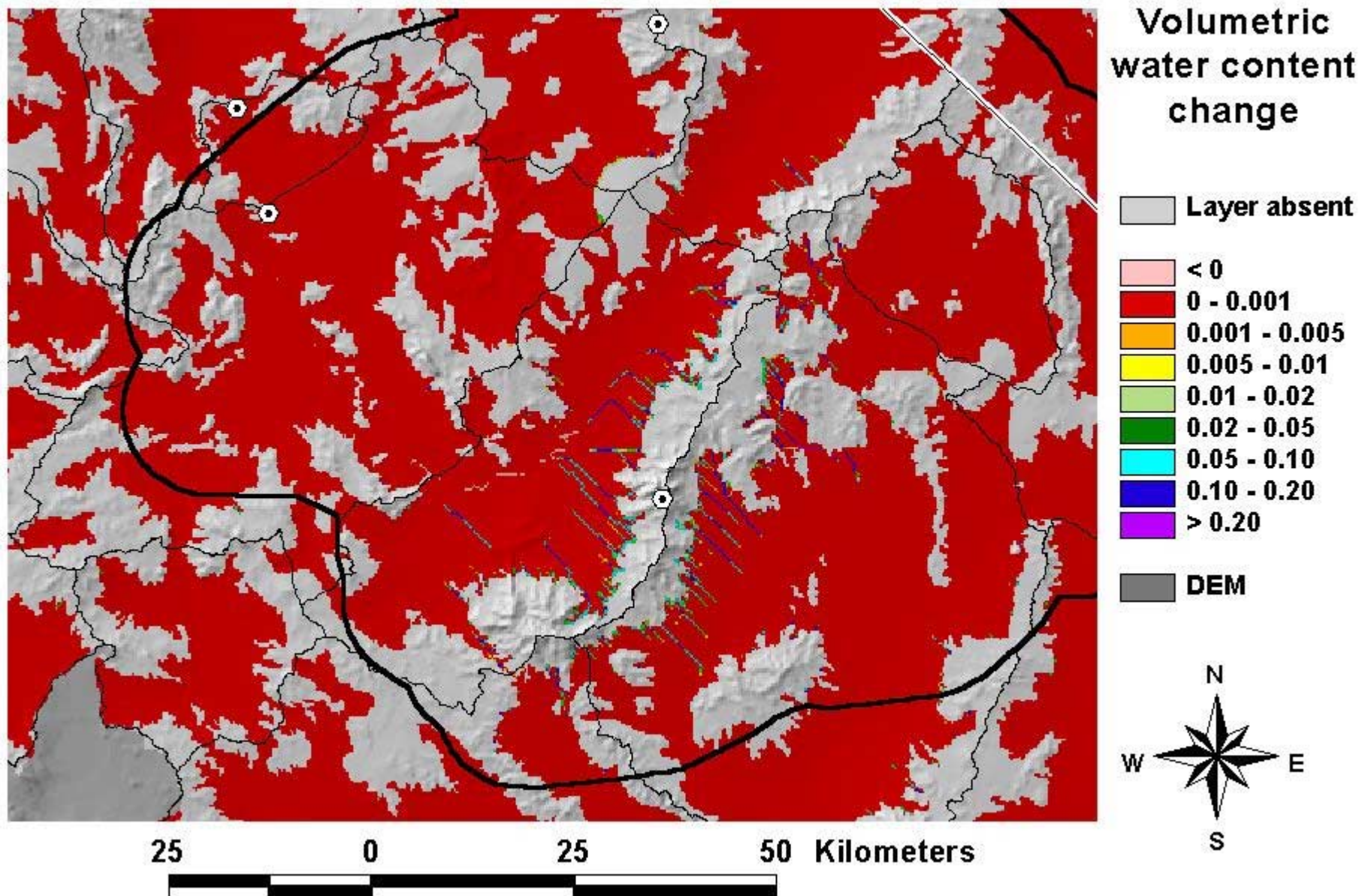
Modeled Water Content Change: February 18 - 12, 1980

Soil Layer 4: 1.0 - 3.0 meters



Modeled Water Content Change: February 18 - 12, 1980

Soil Layer 5: 3.0 - 6.0 meters



Providence Mountains (view from Clipper Valley)



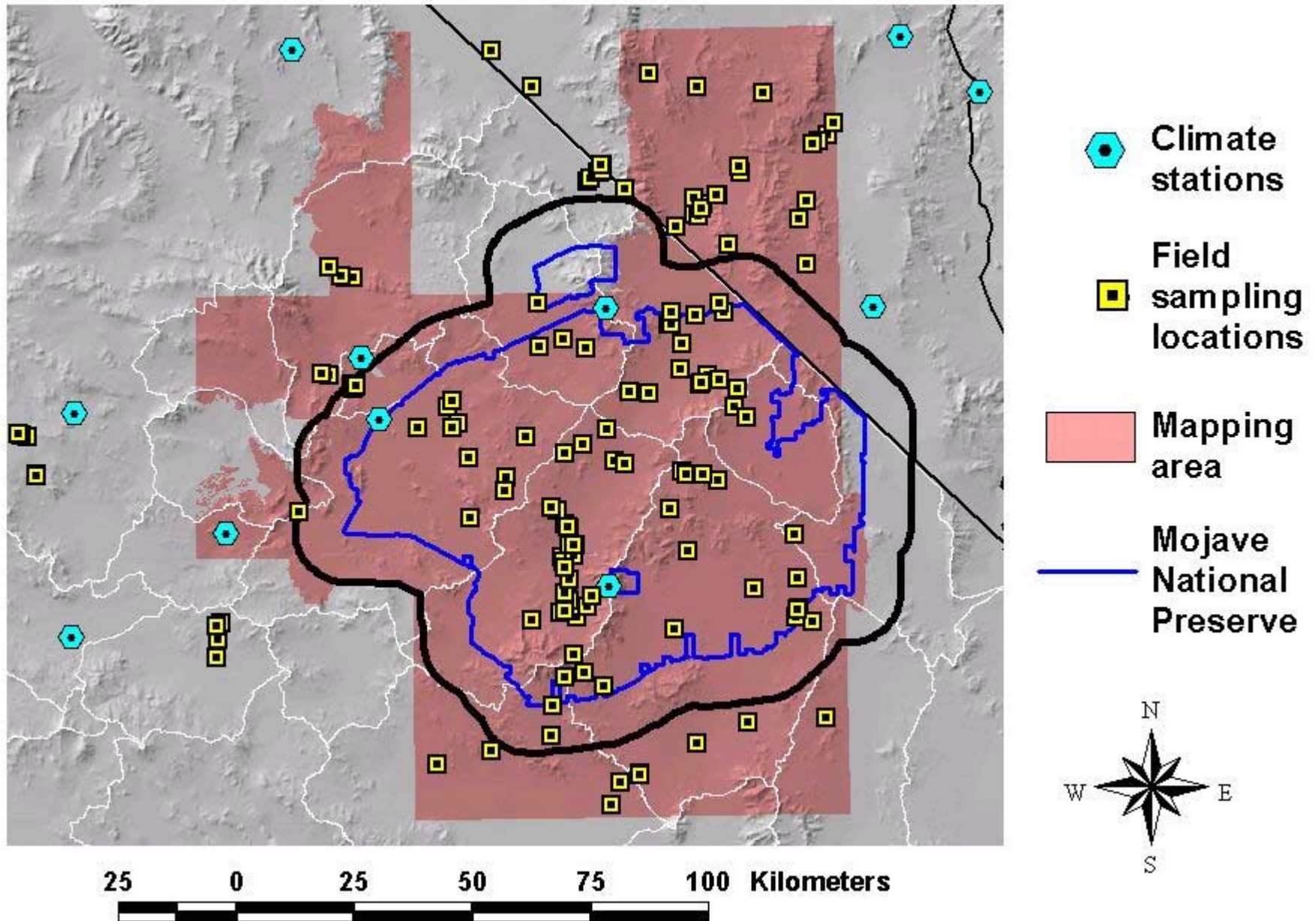
Round Valley (view towards north)



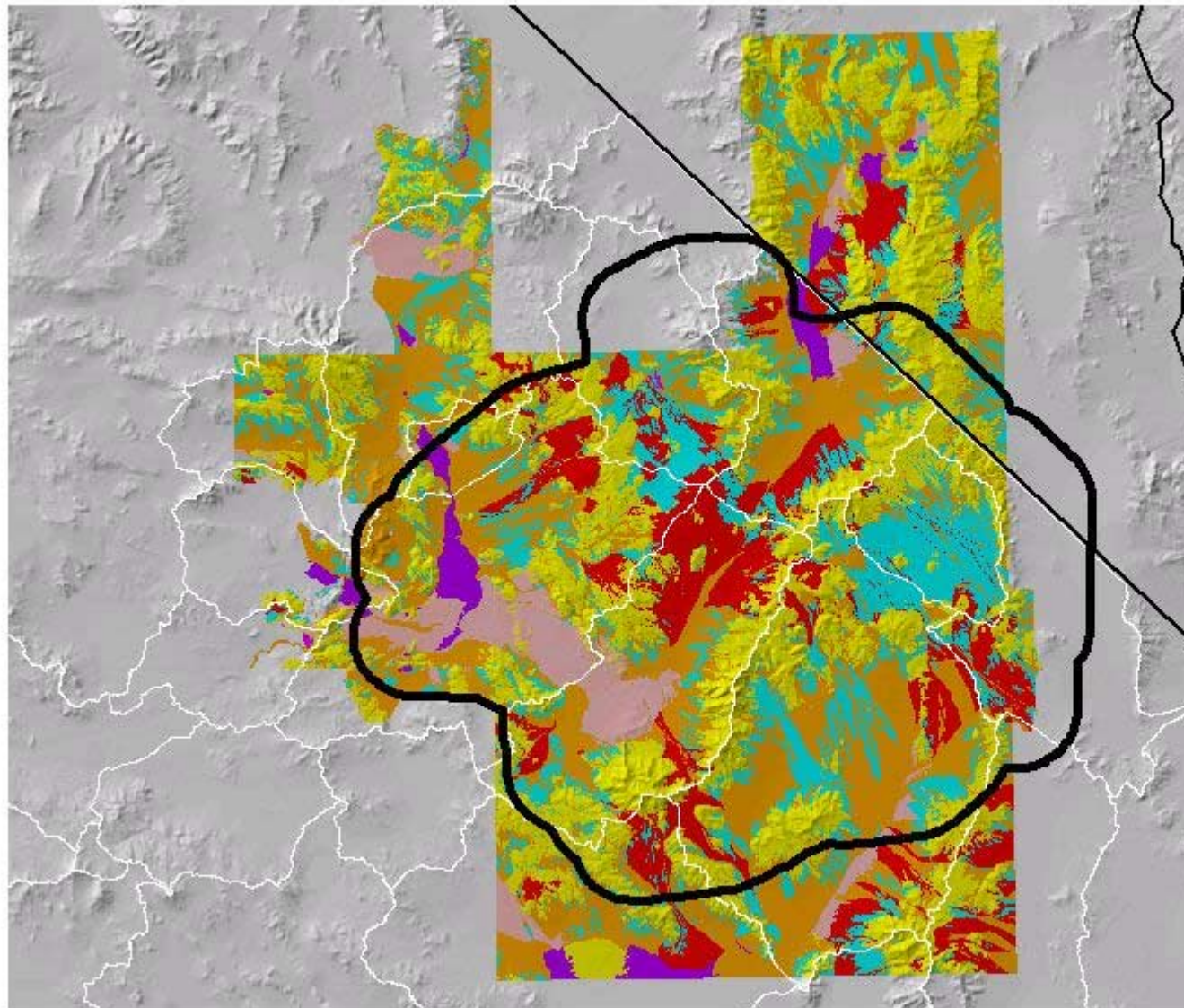
Caruthers Canyon



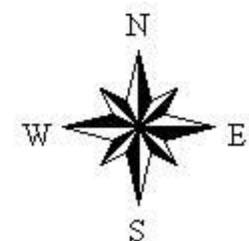
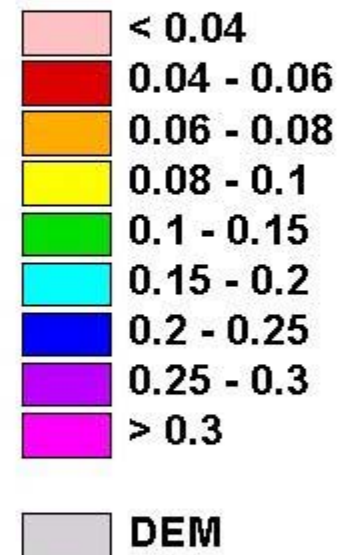
Mojave Desert Region Geology and Soils Mapping



Mojave Desert Region Geology and Soils Mapping



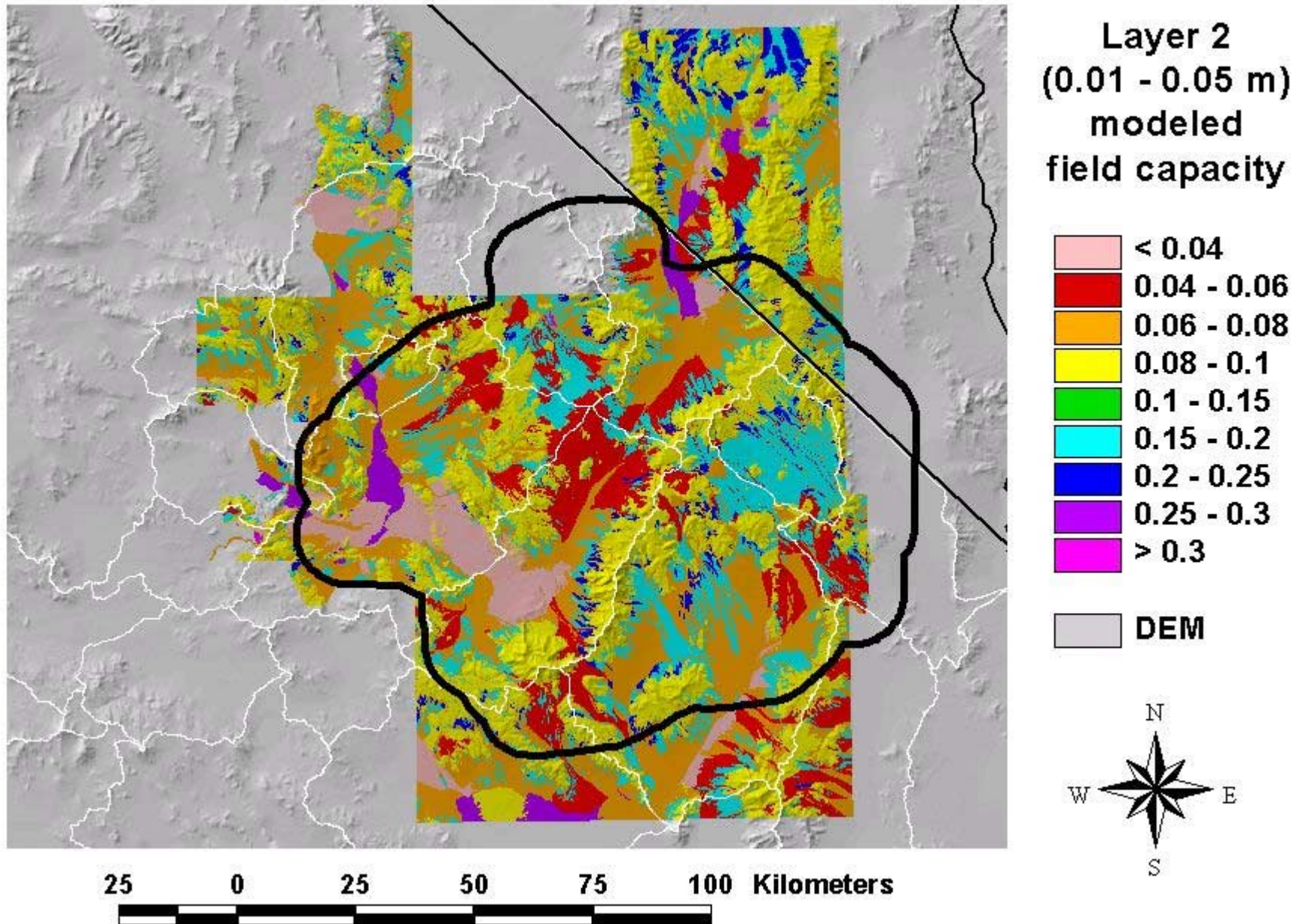
Layer 1
(0 - 0.01 m)
modeled
field capacity



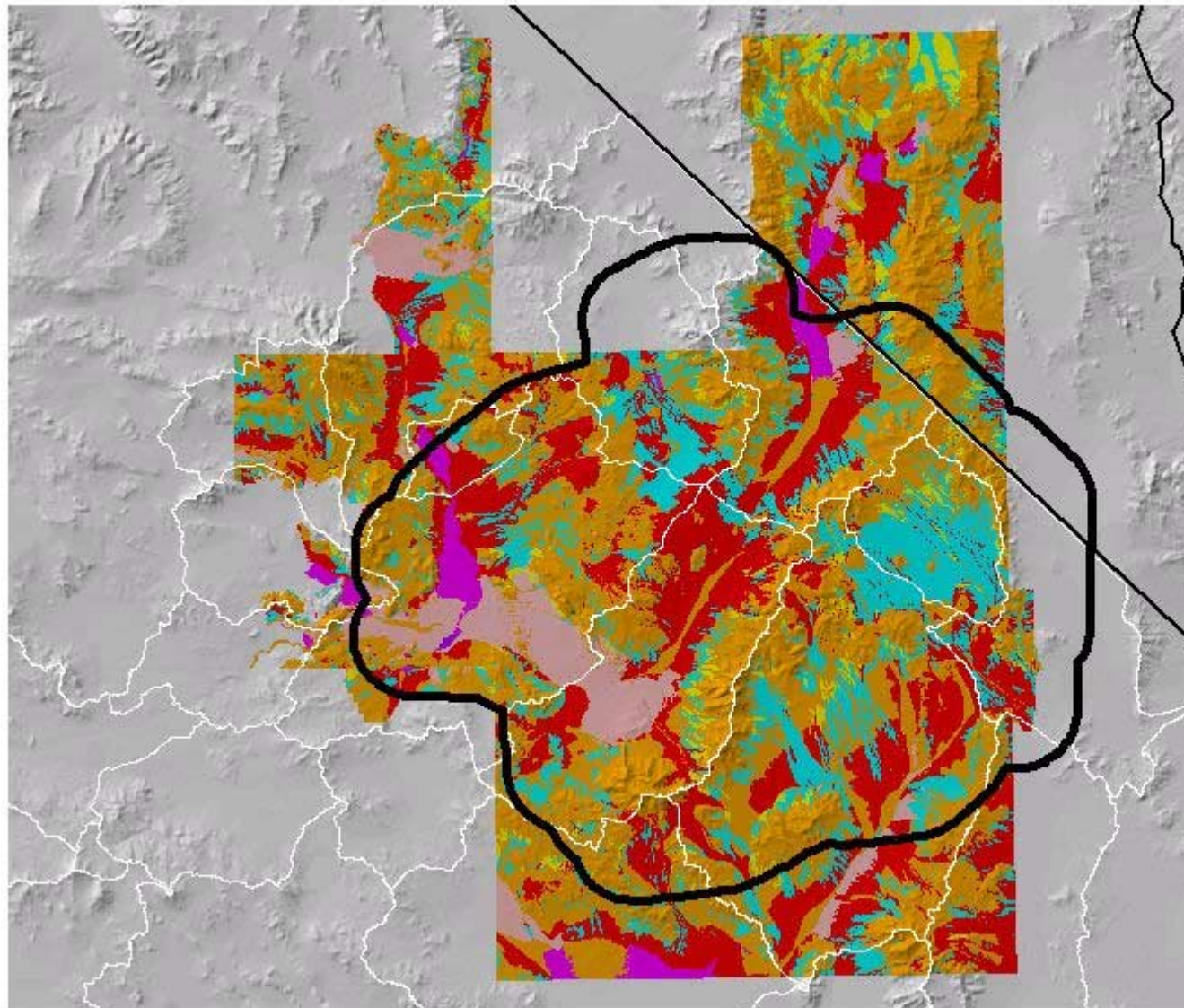
25 0 25 50 75 100 Kilometers



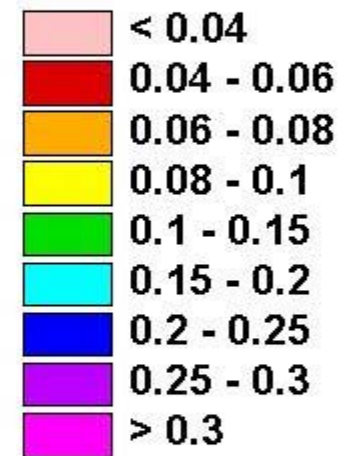
Mojave Desert Region Geology and Soils Mapping



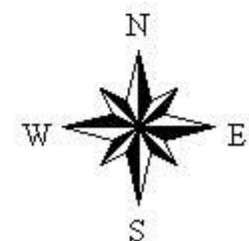
Mojave Desert Region Geology and Soils Mapping



Layer 3
(0.05 - 0.10 m)
modeled
field capacity



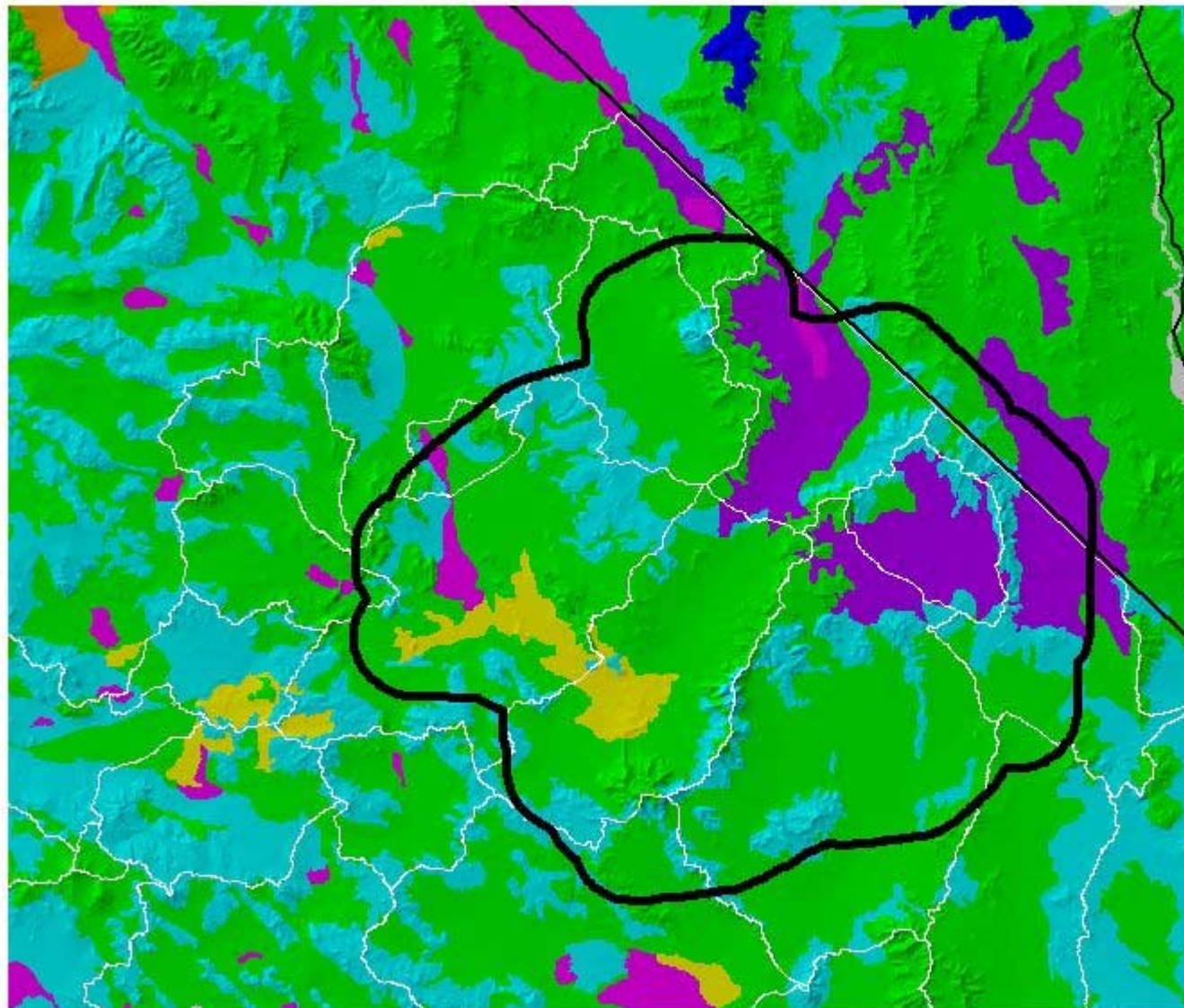
DEM



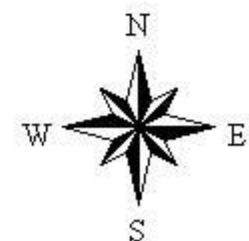
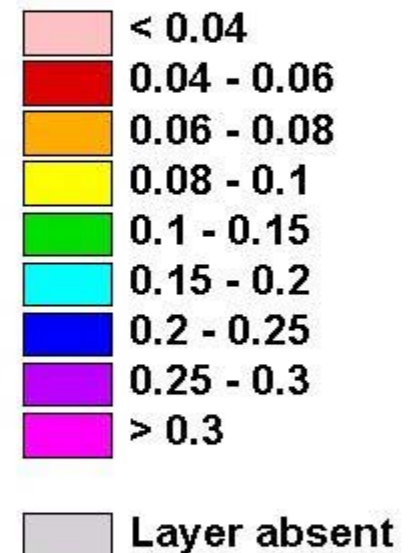
25 0 25 50 75 100 Kilometers



Mojave Desert Region Geology and Soils Mapping



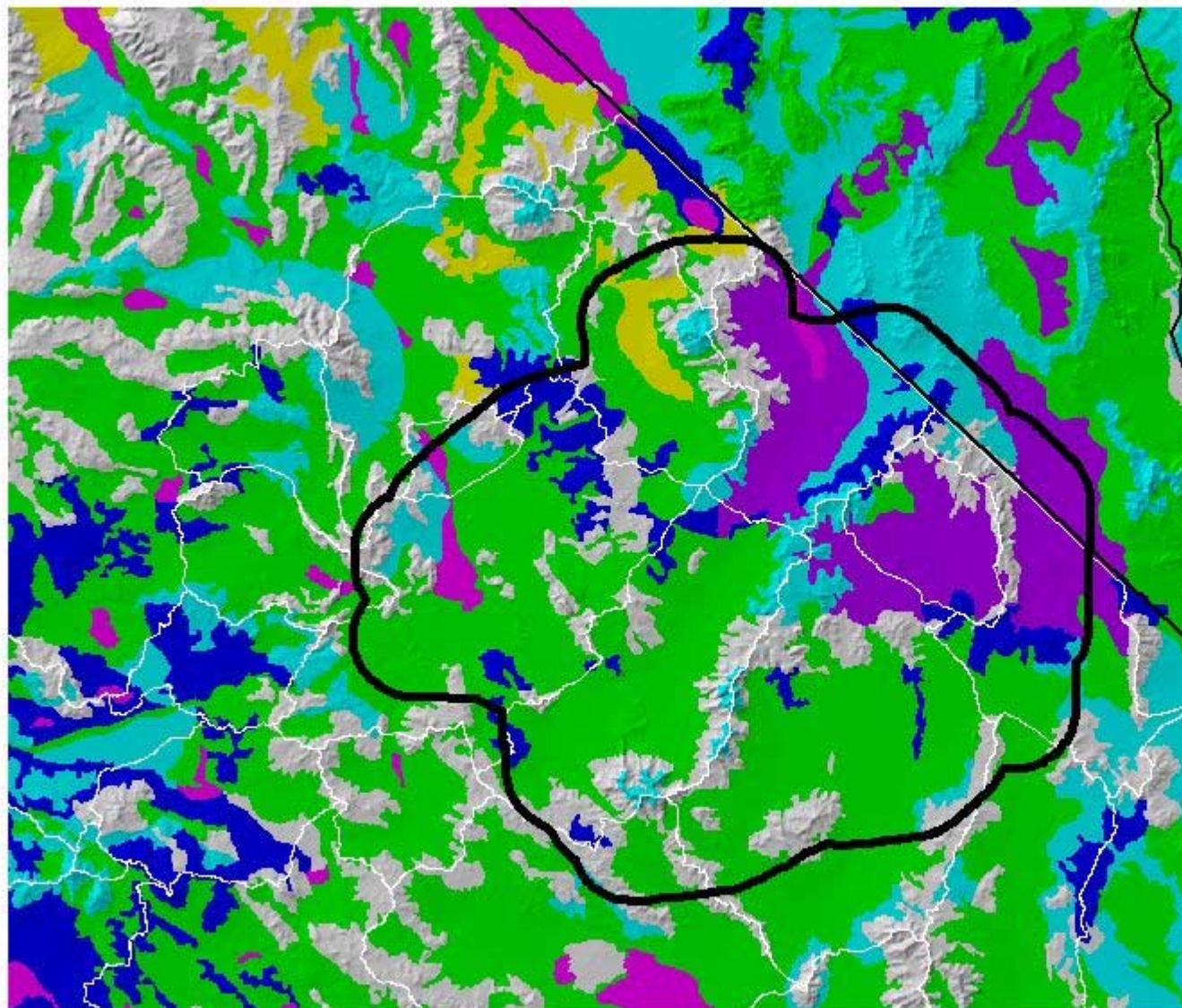
STATSGO
layer 1
modeled
field capacity



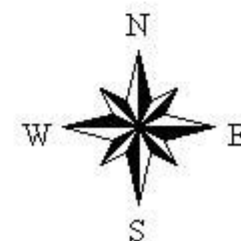
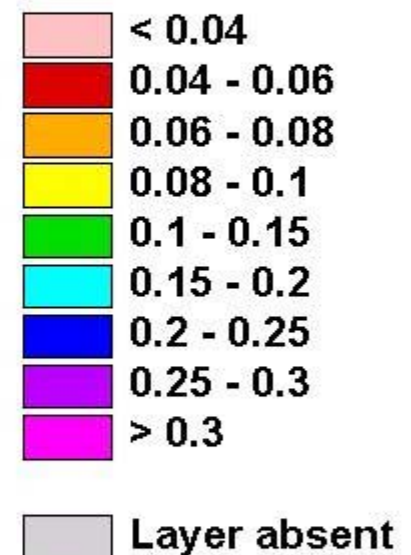
25 0 25 50 75 100 Kilometers



Mojave Desert Region Geology and Soils Mapping



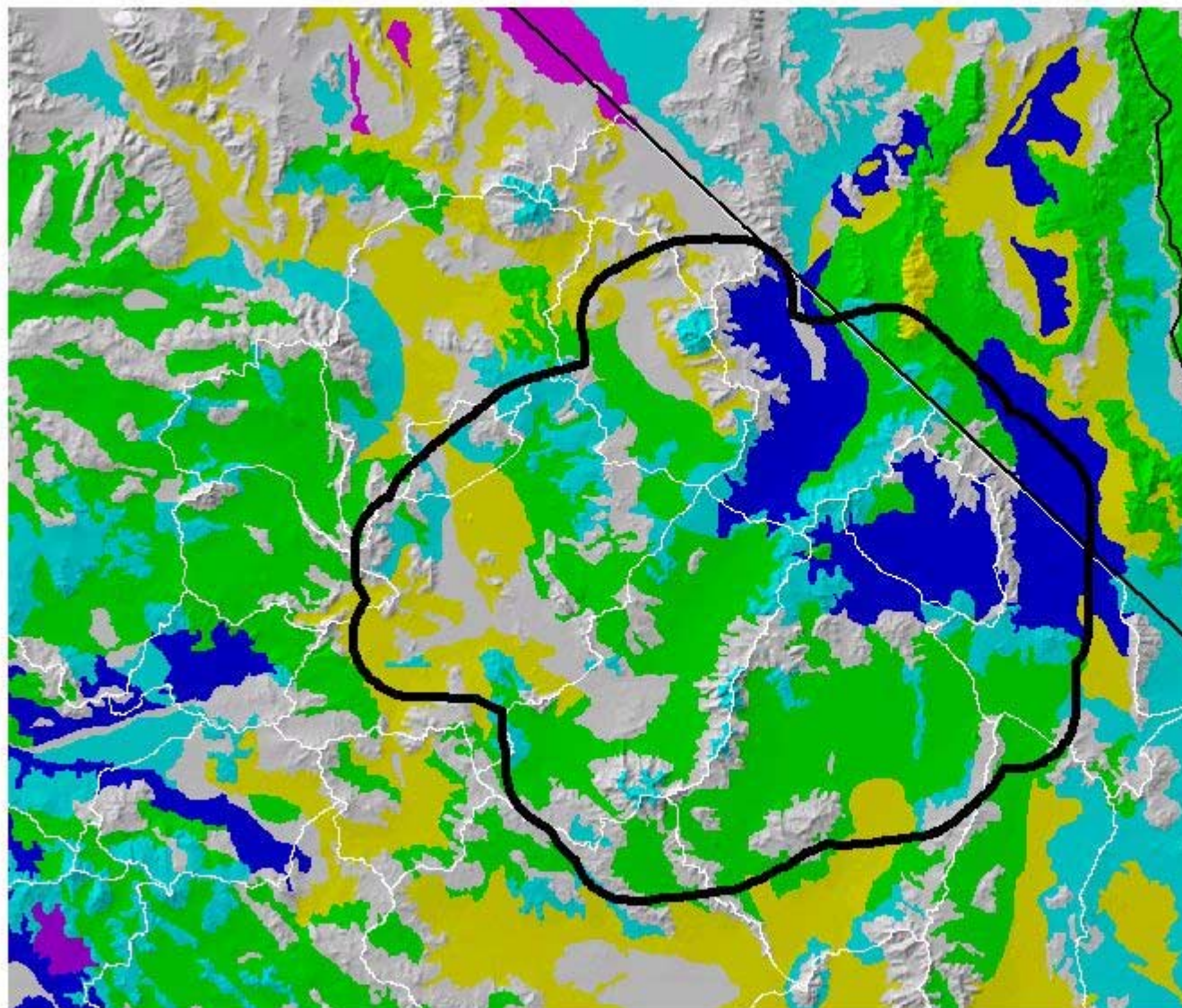
STATSGO
layer 2
modeled
field capacity



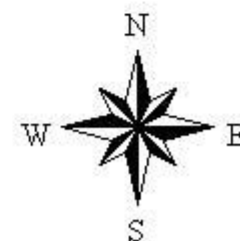
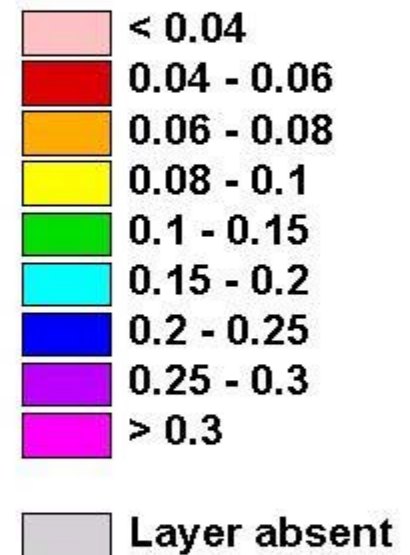
25 0 25 50 75 100 Kilometers



Mojave Desert Region Geology and Soils Mapping



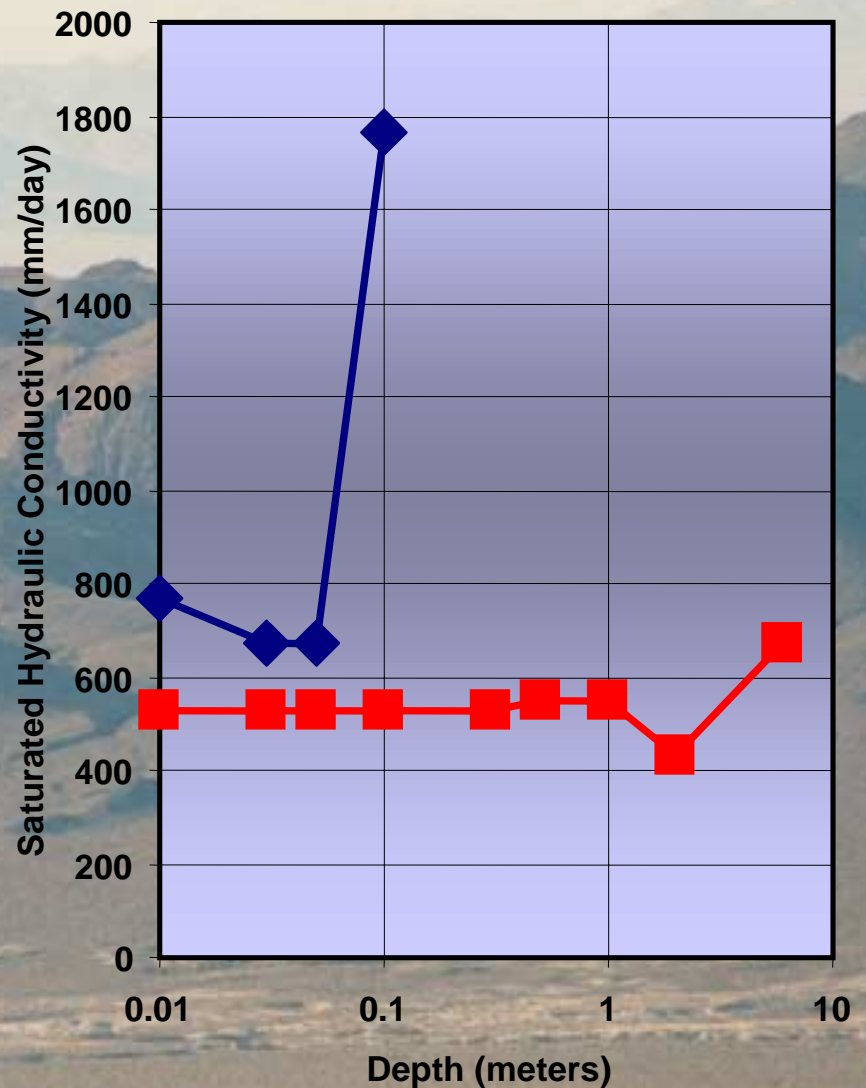
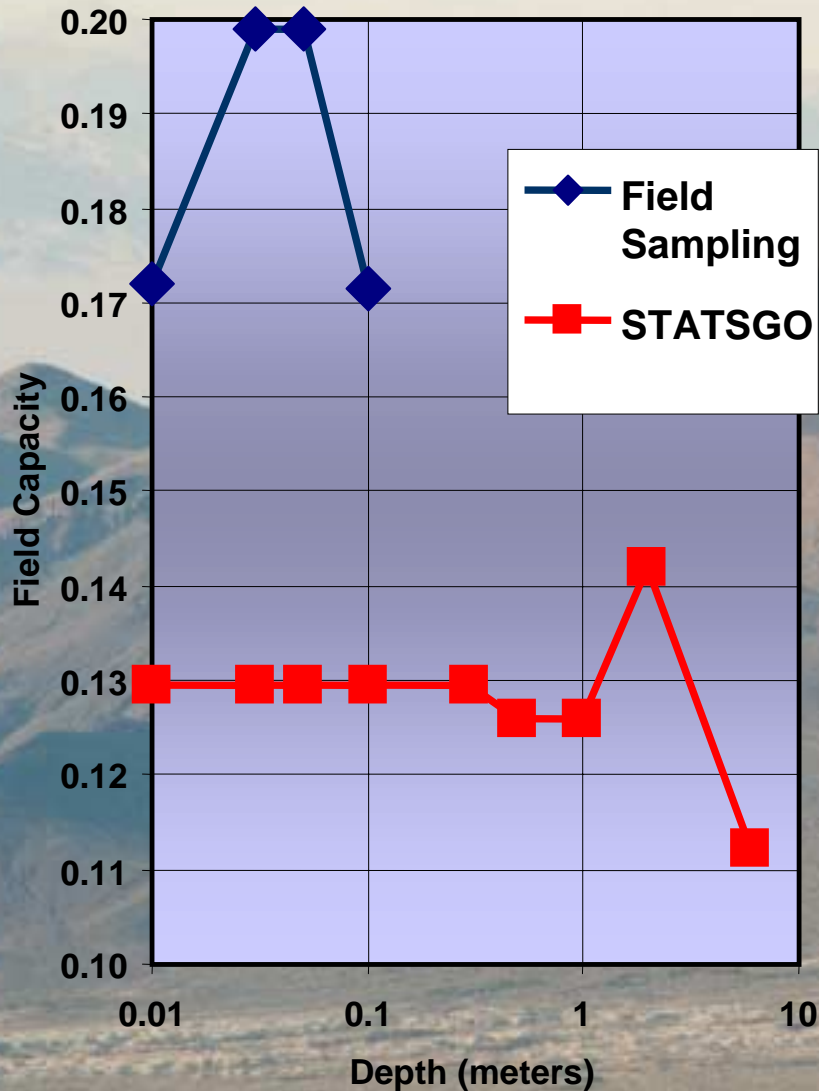
STATSGO
layer 3
modeled
field capacity



25 0 25 50 75 100 Kilometers

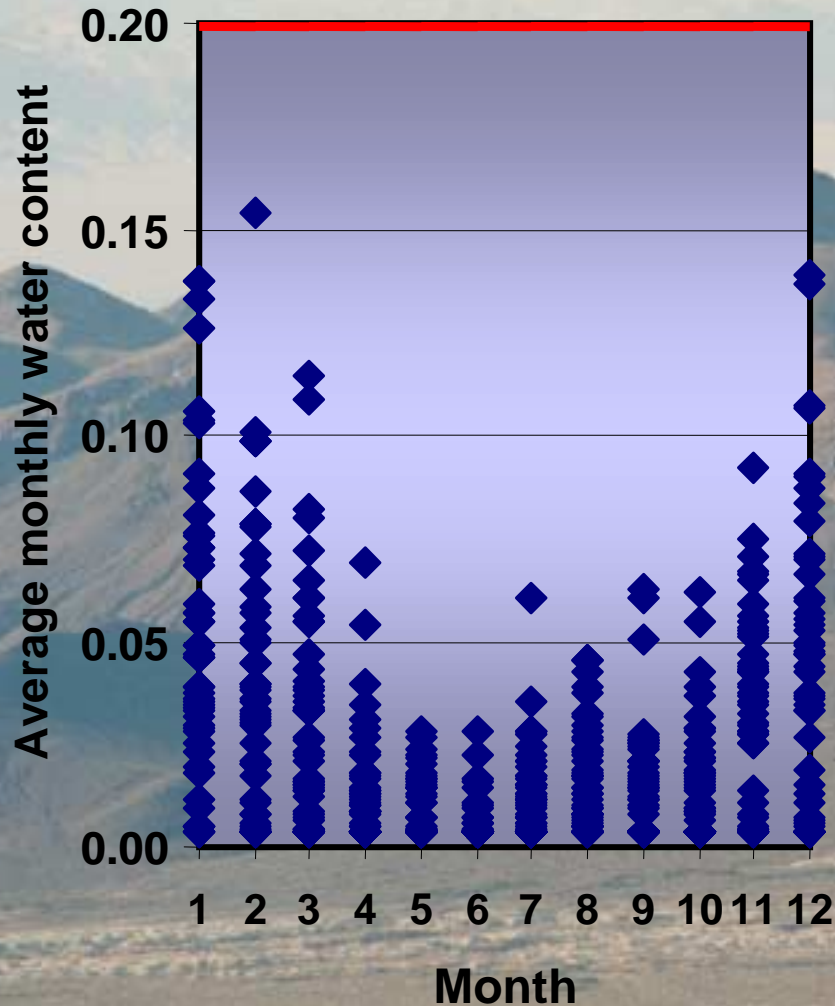


Comparison of Estimated Soil Properties Obtained From Field Sampling and STATSGO (one location)

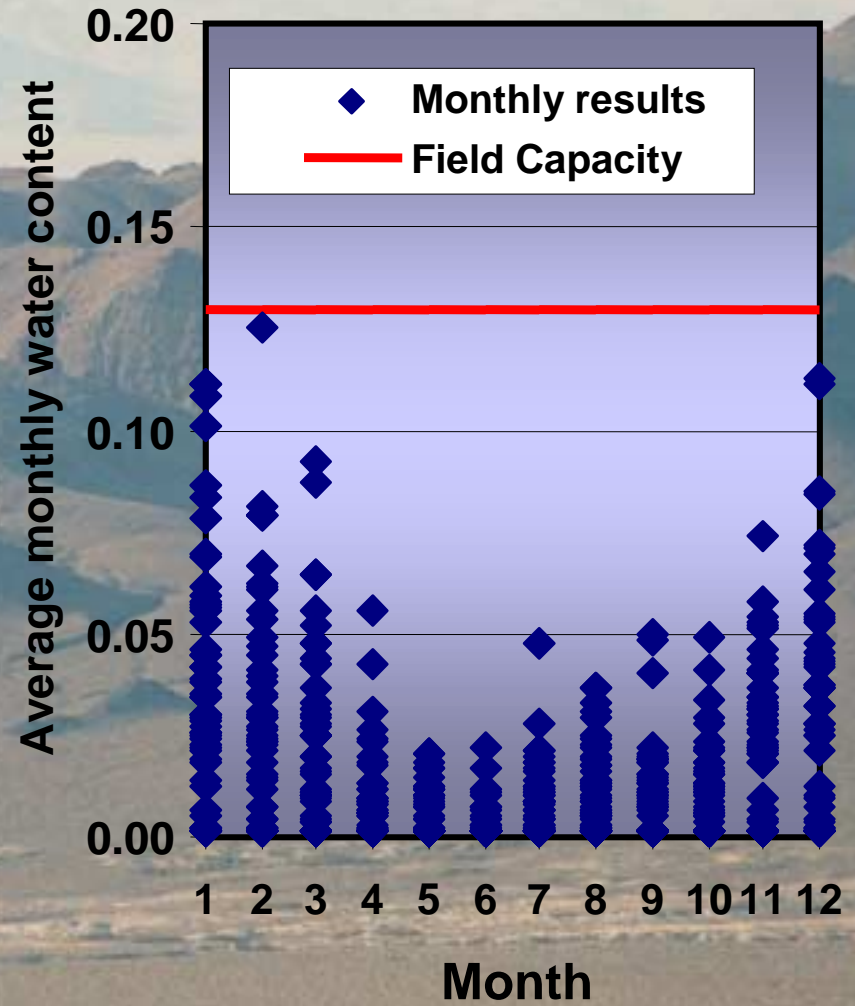


Model Comparison: 1950-1999 Average Monthly Water Content for Soil Layer 2 (0.01 – 0.03 meters)

Field Sampling Model

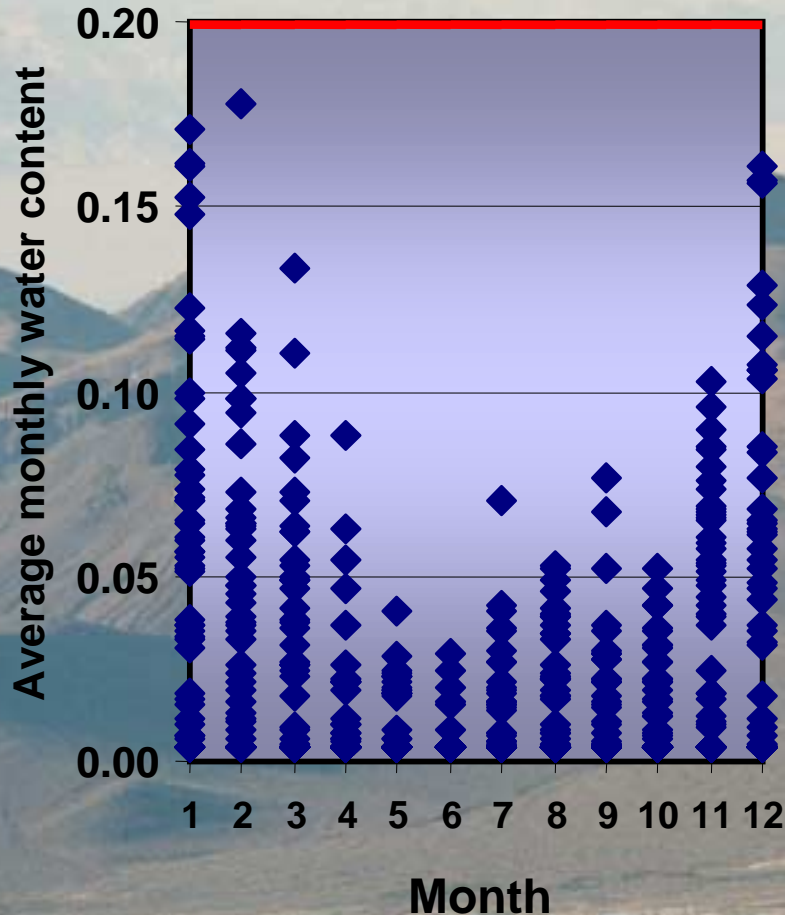


STATSGO Model

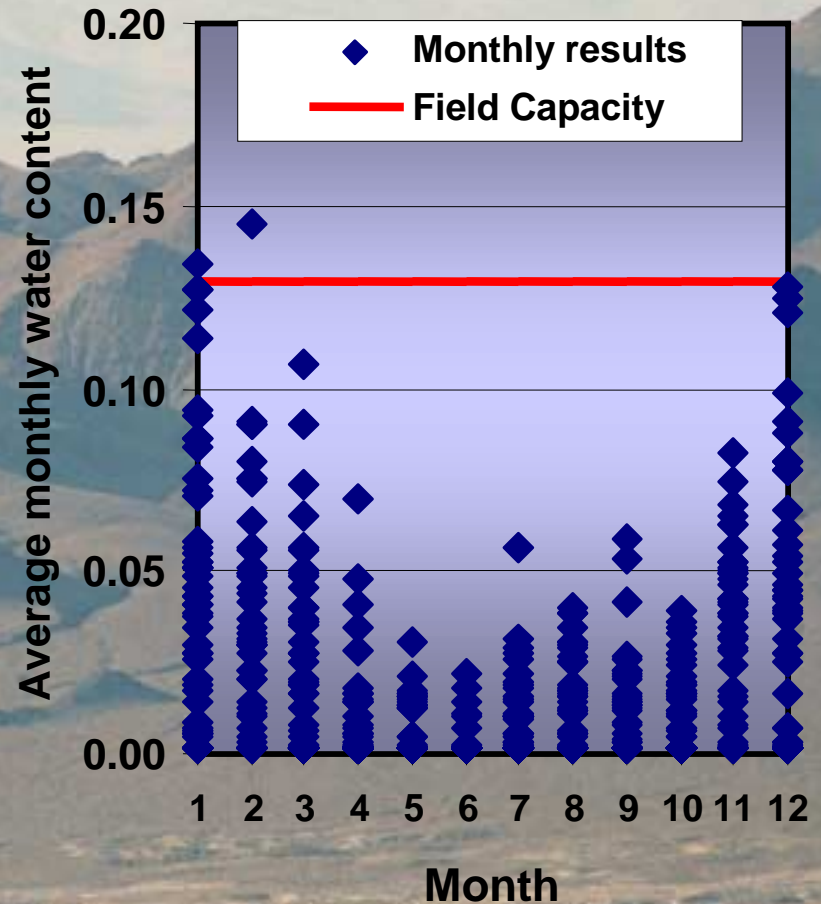


Model Comparison: 1950-1999 Average Monthly Water Content for Soil Layer 3 (0.03 – 0.05 meters)

Field Sampling Model

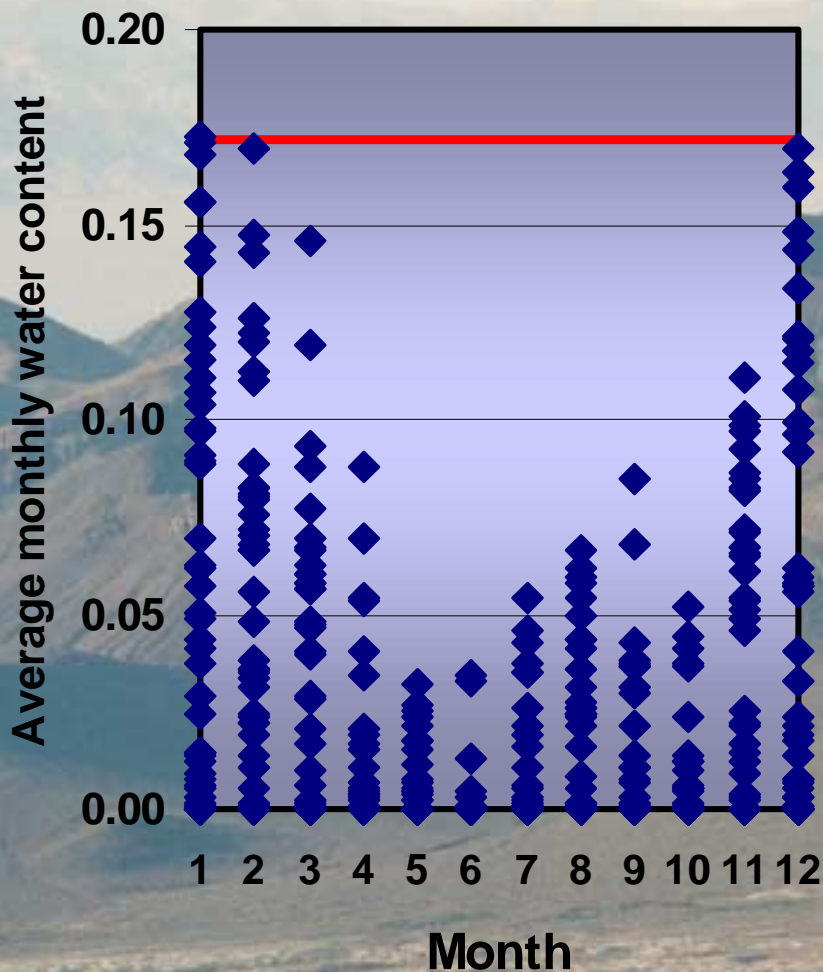


STATSGO Model

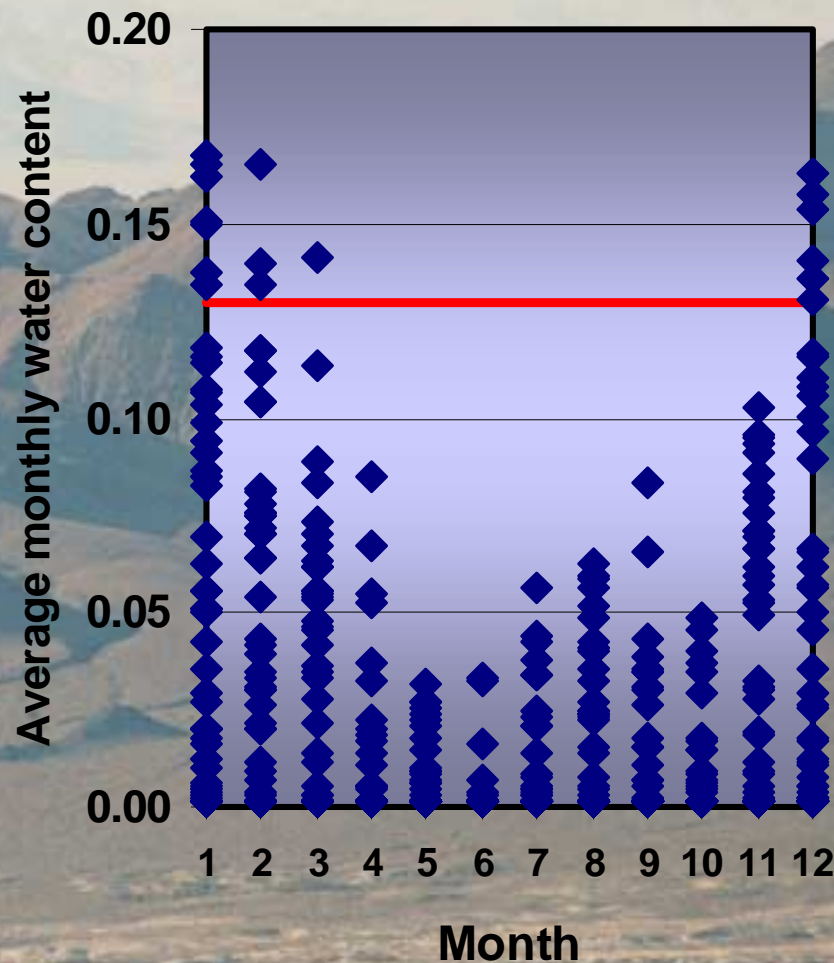


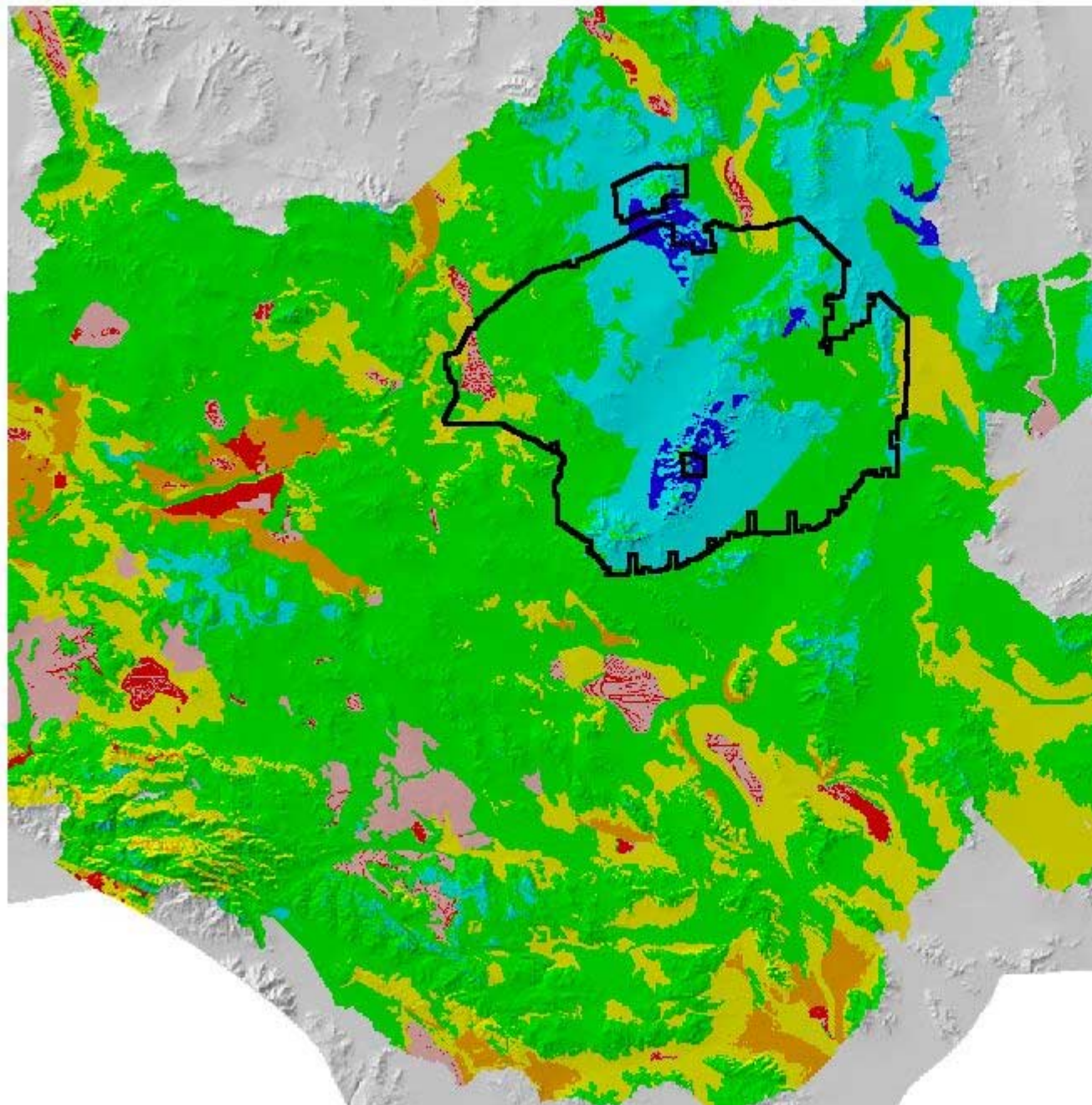
Model Comparison: 1950-1999 Average Monthly Water Content for Soil Layer 4 (0.05 – 0.10 meters)

Field Sampling Model



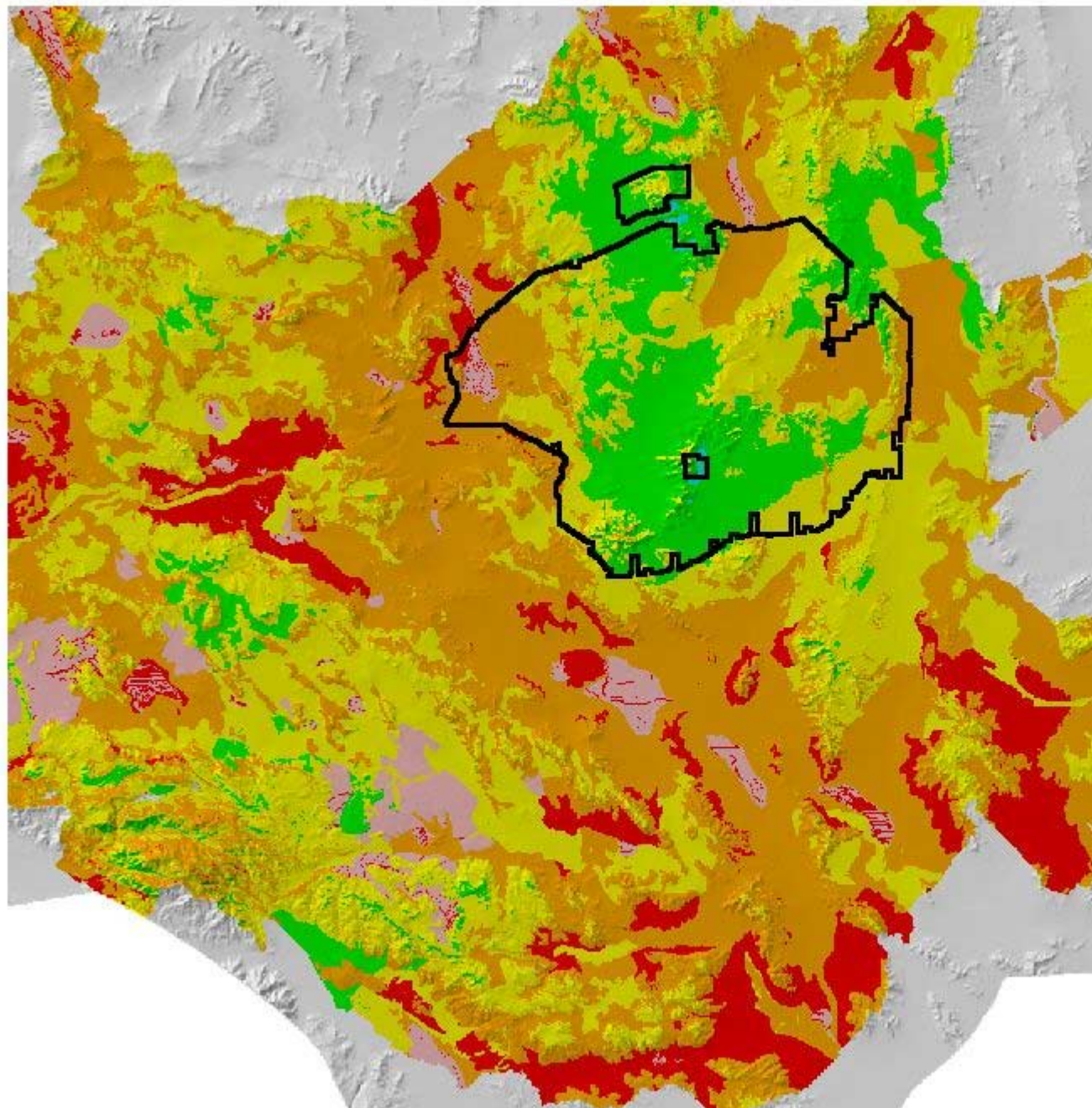
STATSGO Model





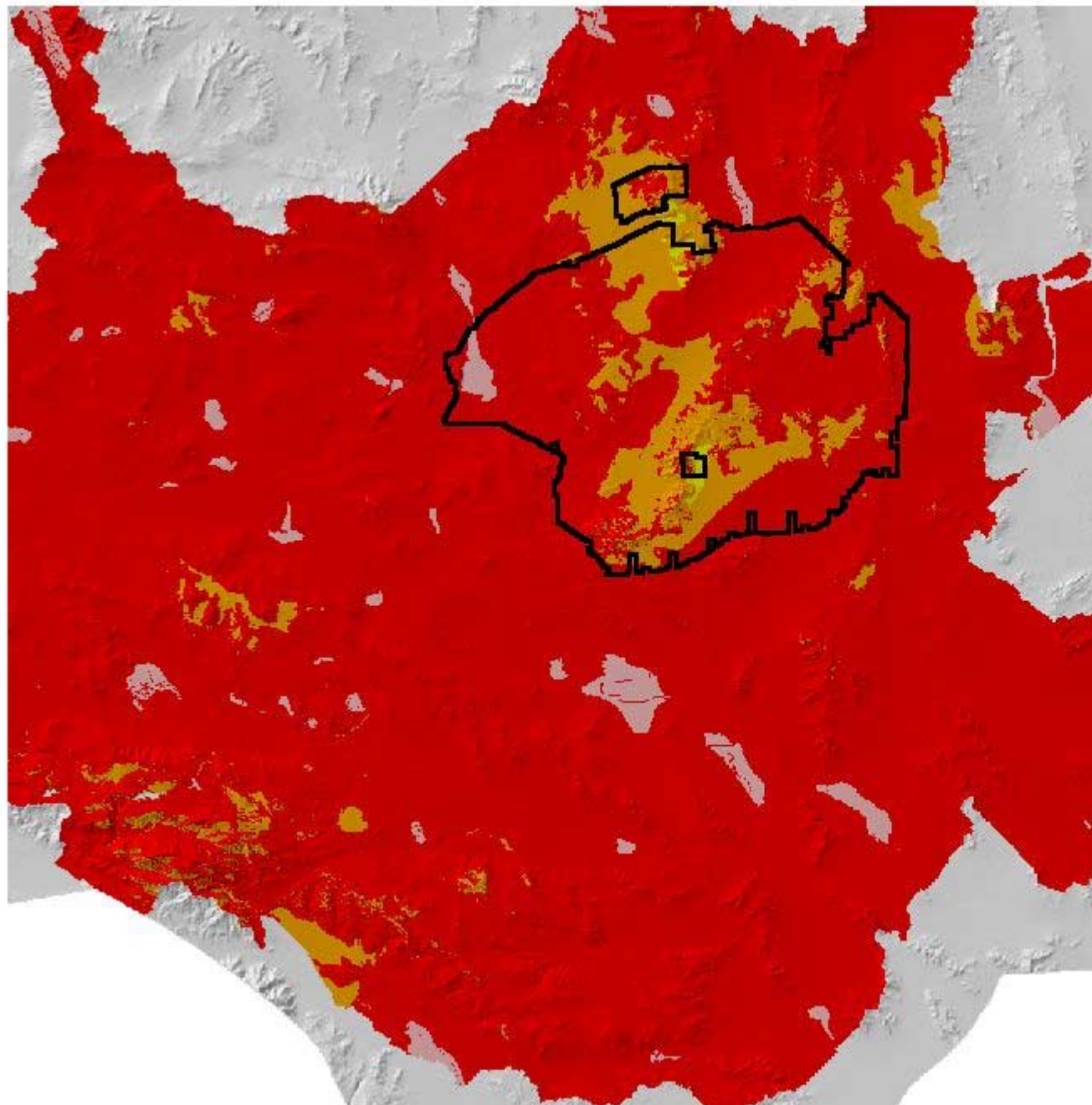
**Average annual
number of
wetting cycles
(0.01 - 0.03 m)**





**Average annual
number of
wetting cycles
(0.03 - 0.05 m)**





Average annual number of wetting cycles (0.05 - 0.10 m)



Summary:

- **Climate is the most critical input for deterministic soil moisture modeling.**
- **Soil thickness, topography, and bedrock permeability are the most important watershed characteristics controlling soil moisture.**
- **Field capacity can be used as an indicator of wetting cycles, but these results have a higher sensitivity to soil properties.**
- **For the 1950-1999 simulation using STATSGO soils, wetting to field capacity is restricted to upper 1 meter of soil profile for most locations.**
- **Updated soil properties from field mapping and sampling, in conjunction with model recalibration, is needed to reduce model uncertainty.**



