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SIMULATION AND PREDICTION OF THE GROUNDWATER LEVEL IN THE SURROUNDED AREA OF THE NEBRASKA MANAGEMENT SYSTEM EVALUATION AREA SITE (MSEA).

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ABSTRACT

An efficient water budget is necessary to develop sustainable practices in irrigated lands and determine future trends. The groundwater level (GWL) can **rise or fall** depending on the time of the year. When **winter ends, and spring begins**, accumulated snow starts to melt, and rainfall starts to fall. Therefore, **water infiltrates** and **raise** GWL. This research predicts the groundwater table from 2056 to 2060 in the surrounding area of the MSEA. Visual MODFLOW Flex was used to simulate the real groundwater-level and forecast the future GWL. Future predictions show that the GWL will increases in a non-irrigated season (winter season) and decreases in a irrigated season. Nevertheless, the decreasing rate is higher than the recharge rate and is approximately 1.02 feet.

OBJETIVES

SIMULATE GROUNDWATER LEVEL FROM 1991 -2014

- Validate a groundwater modeling by comparing simulated data and historical groundwater from 1991 to 2014.

FORESTCAST GROUNDWATER LEVEL FROM 2056-2060

- Predict the groundwater level behavior by simulating GW model from 2056 to 2060.

DATA AND METHODS

I. DATA

1. **HYDROGEOLOGY:** The School of Natural Resources (SNR) of the University of Nebraska-Lincoln provides the test hole data for simulating the aquifer hydrogeology.
2. **GW LEVELS:** The School of Natural Resources (SNR) of the University of Nebraska-Lincoln provides the historical GW level.
3. **WELLS:** The groundwater interactive map of the Department of Natural Resources of Nebraska provides essential data for the irrigations wells.

II. METHODS

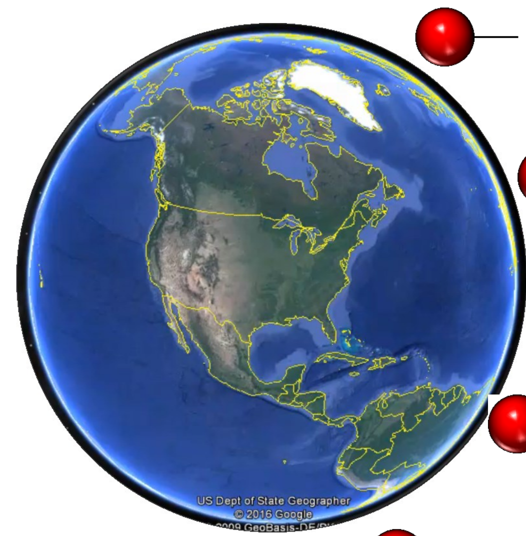
1. **ROCKWORKS V.17**

Model the hydrogeology of the shallow aquifer.

2. VISUAL MODFLOW FLEX 2015.1

Model the groundwater flow in steady and unsteady states.

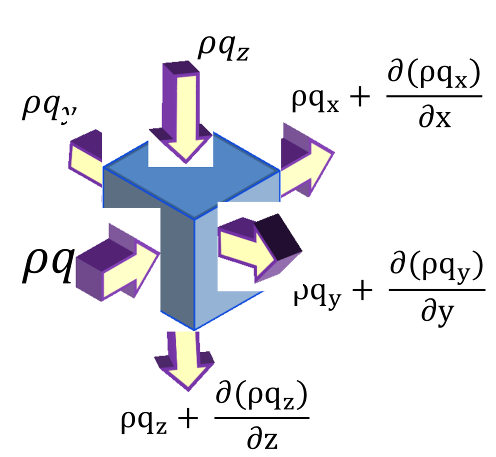
STUDY AREA LOCATION



- **Located** in southeast Buffalo County. Bounded by Wood and Platte River.
- **Irrigated land** (90% Corn and 10% Soybeans)
- **High Plains** (Shallow aquifer). Composed by Sand gravel and interbedded clay deposits.
- Ground Surface Altitude ranges from 2085 ft. in the **west** to 1990 ft. in the **east.**
- **The Shallow Aquifer** is the source of water for most irrigation wells in the study area.

GOVERNING EQUATIONS

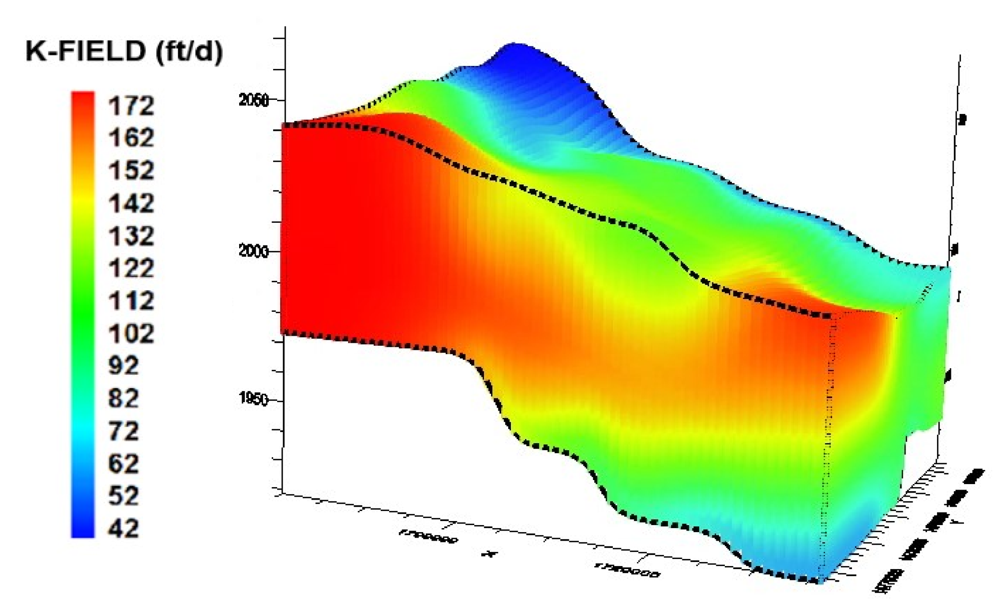
$$\frac{\partial}{\partial x}\left(K_x\frac{dh}{dx}\right)+\frac{\partial}{\partial x}\left(K_y\frac{dh}{dy}\right)+\frac{\partial}{\partial z}\left(K_z\frac{dh}{dz}\right)=S\frac{\partial h}{\partial t}-R$$



1. **CONSERVATION OF MASS:** For any control volume, mass cannot be created or destroyed.
2. The net rate of inflow in the x direction is equal to density times the change in velocity.
3. According to Darcy's Law, velocity is equal to hydraulic conductivity times gradient head.

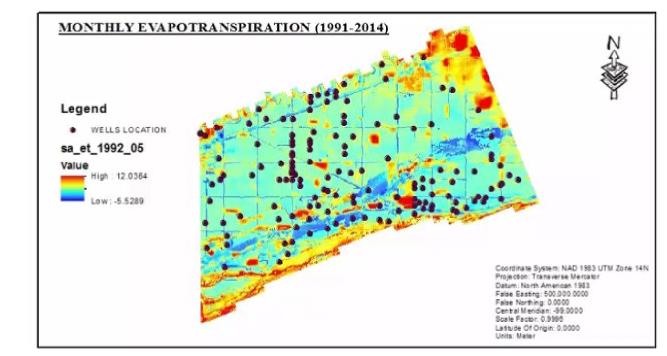
SOIL LITHOLOGY MODEL

1. **LITHOBLENDING**
Lithoblending is a solid modeling method that is used to created solid models. This technique randomly creates a blended lithology model when the zone from a nearby borehole is encounter.
2. **DISTRIBUTED HYDRAULIC CONDUCTIVITY**
Shallow aquifer distributed hydraulic permeability varies from 42 ft./s for gravel to 172 ft./s for sand.

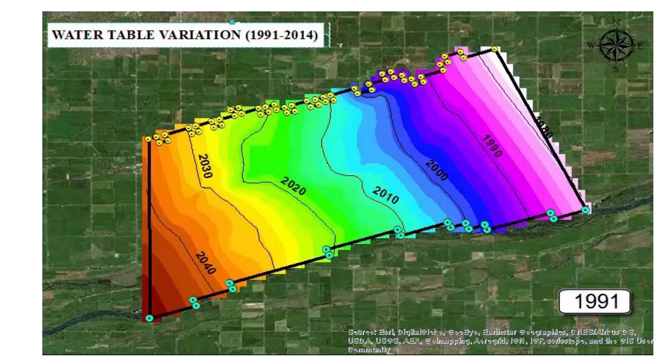


GROUNDWATER MODEL SIMULATION AND RESULTS

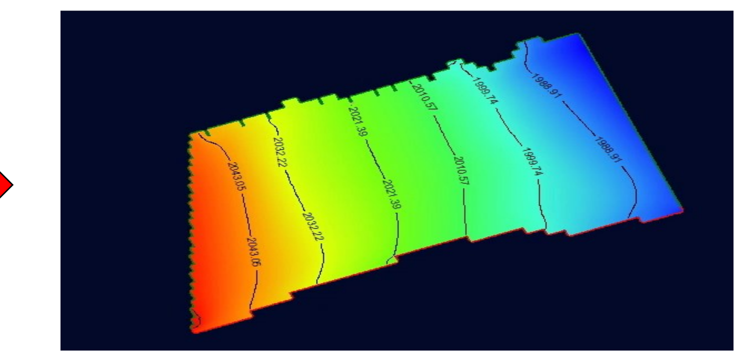
I. Wells Boundary Conditions



II. Boundary Conditions - Rivers



GWL RESULTS



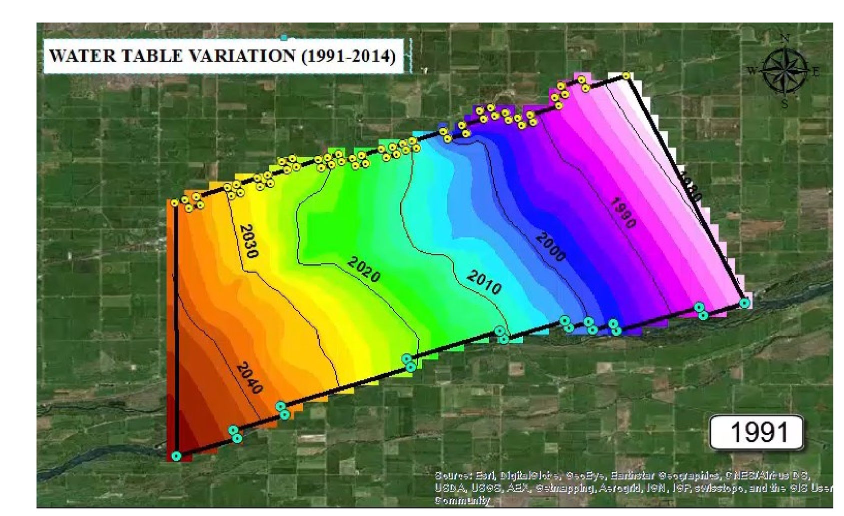
GROUNDWATER MODEL VALIDATION

1. **Actual Evapotranspiration** or water crop use is directly related to the amount of water extracted by wells.
2. Mapping Evapotranspiration at high Resolution with Internalized Calibration (METRIC) is the method used to calculate actual ET.
3. Historical Groundwater map provides the GW elevation for Wood River and Platte River from 1991 to 2014.
4. Groundwater recharge ranges from 1~2 in/yr.
5. Groundwater simulation is an ongoing work.

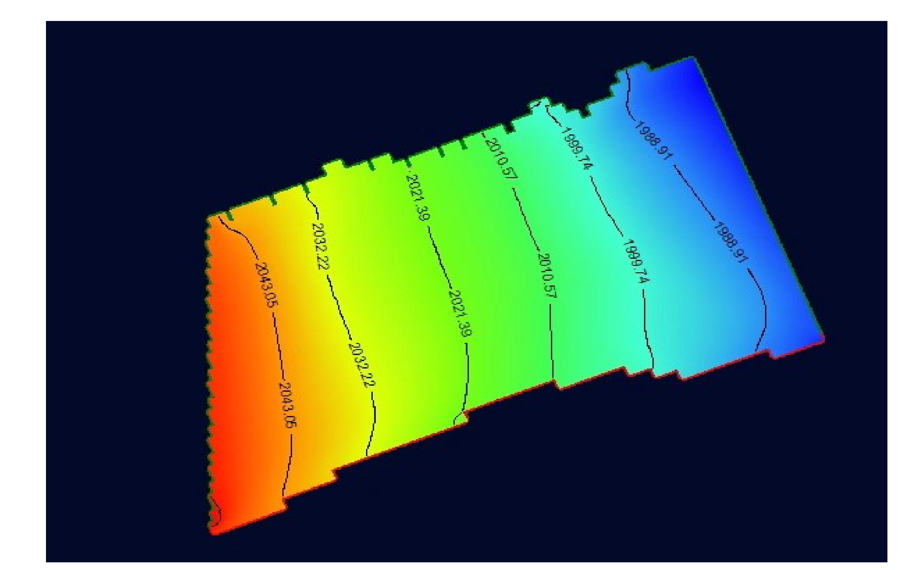
GROUNDWATER MODEL PREDICTION AND RESULTS

PREDICTED BOUNDARY CONDITIONS

HISTORICAL GROUNDWATER MAP



GROUNDWATER LEVEL PREDICTION MAP



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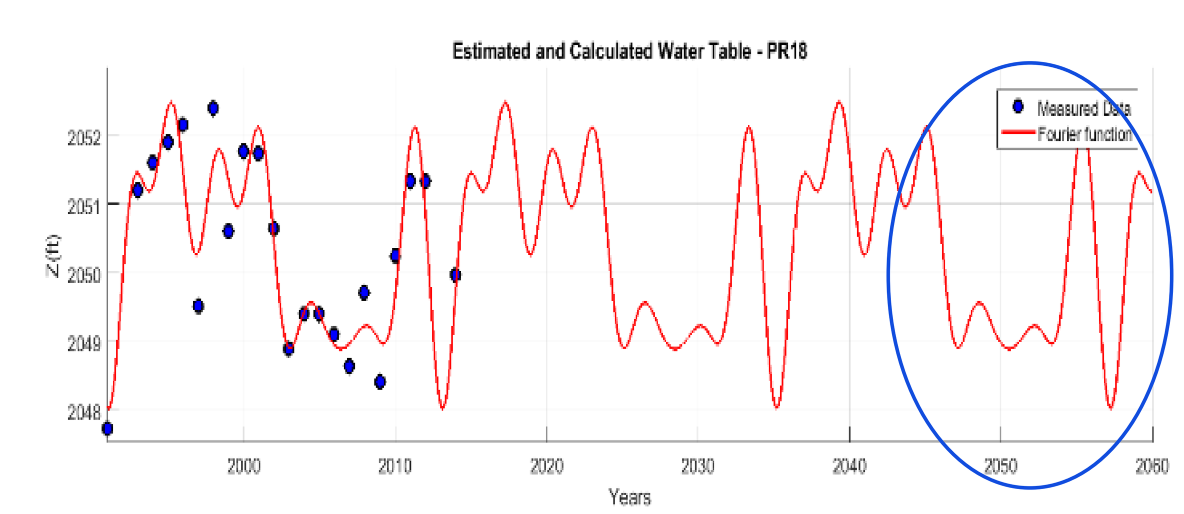

GROUNDWATER MODEL REMARKS

1. Fitted historical groundwater elevation forecast future river elevation from 2056 to 2060.
2. **One-hundred forty-three active wells** (143) extracts water from 2056 to 2060.
3. **The weather research and forecasting model (WRF)** predicts future data variables (ET) and the inverse vadose zone modeling to predict future groundwater recharge.

GROUNDWATER TABLE LEVEL WILL DECREASES ON AVERAGE 1.02 FT. IN THE SURROUNDED AREA OF THE MSEA.

FUTURE WORK AND CONCLUSION

1. GW level permits to develop a sustainable water budget. (i.e., optimal water use).
2. Gravel, sand, clay and silts comprised the hydrogeology of the study area.
3. Groundwater model validation is an ongoing work that seeks the accuracy of the GW model.
4. Future groundwater estimation shows that there is a decreases GW level about 1.02 feet.
5. Contaminant transport modeling over the vicinity MSEA area is the next challenge to face.

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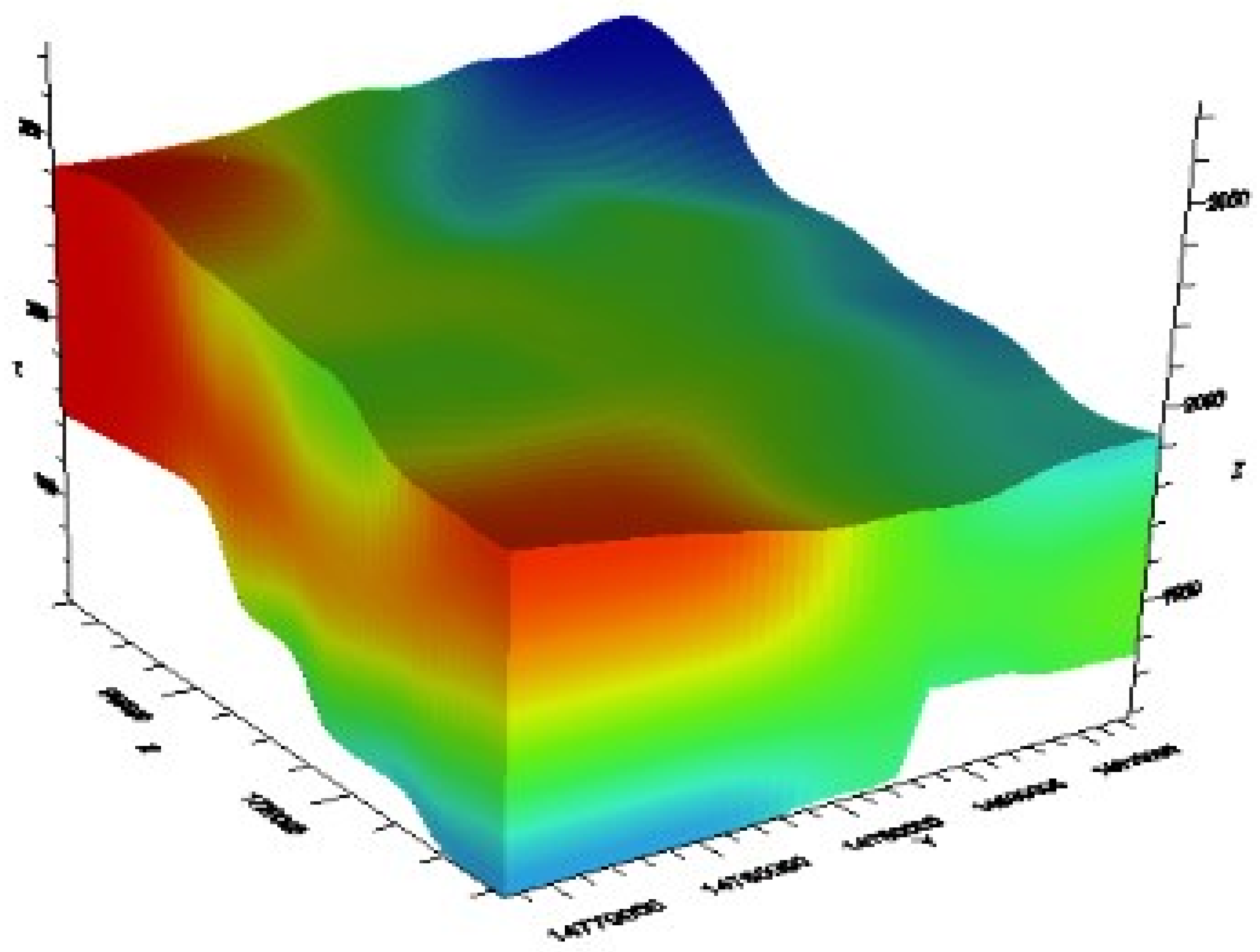

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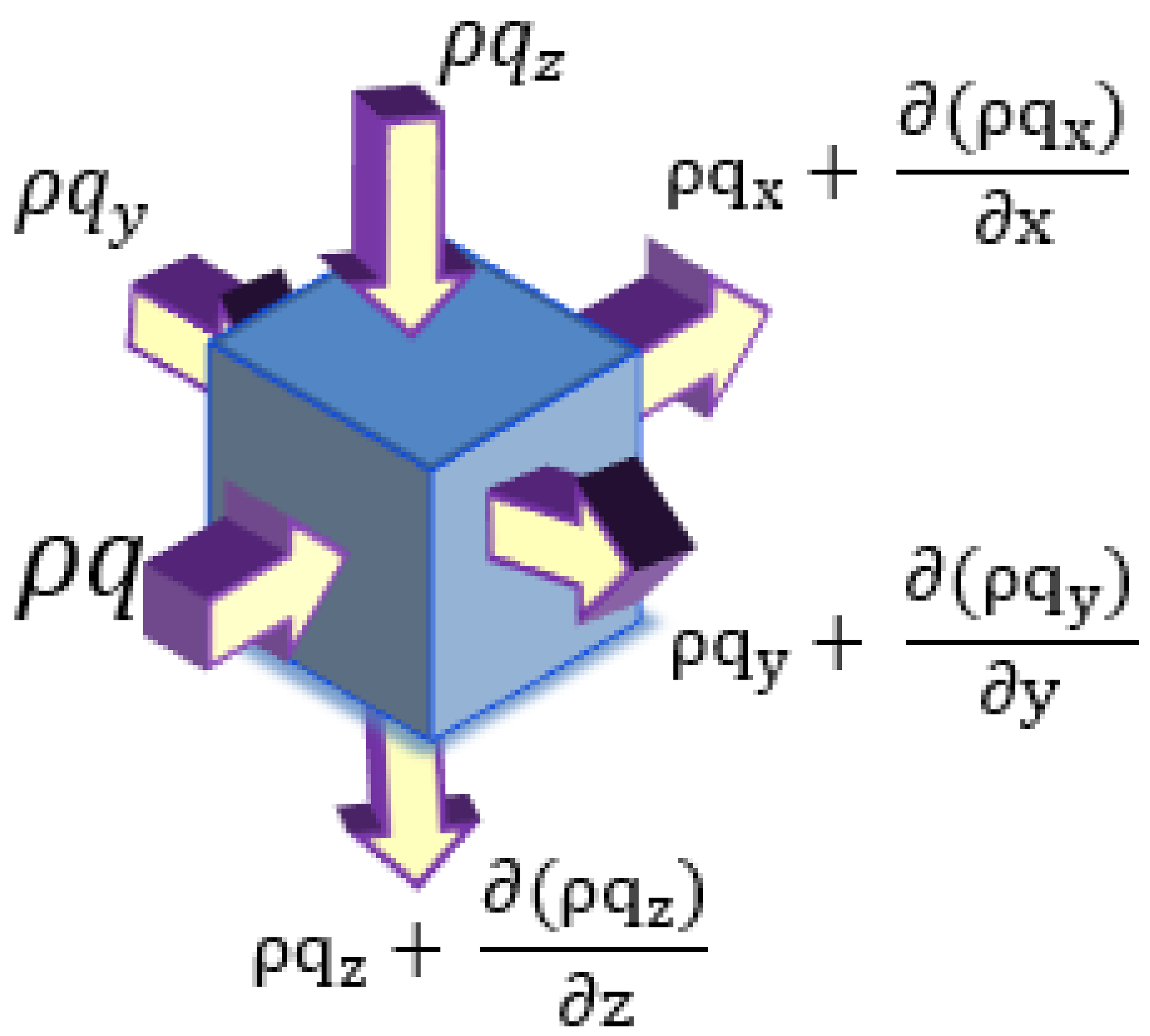

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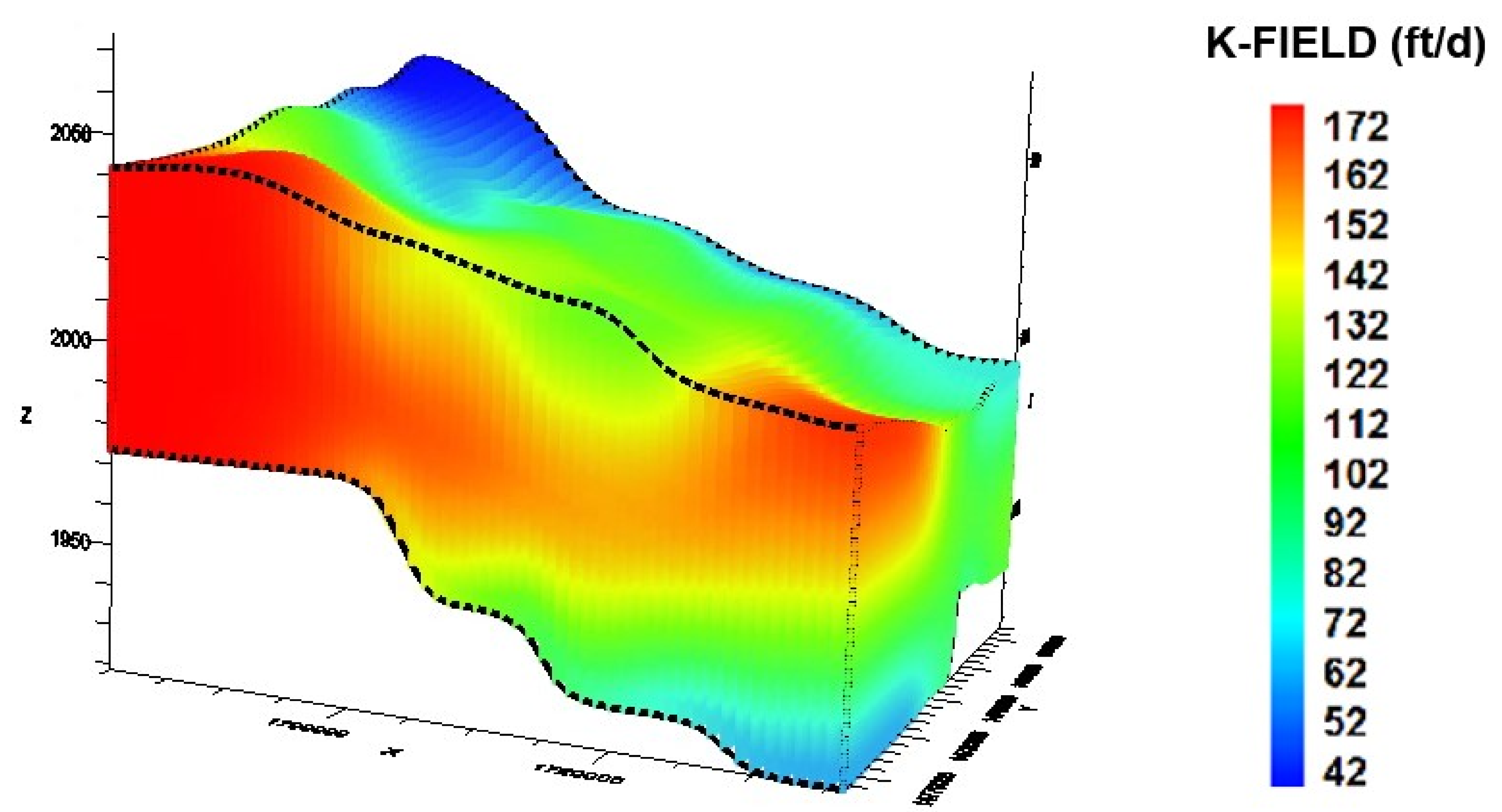

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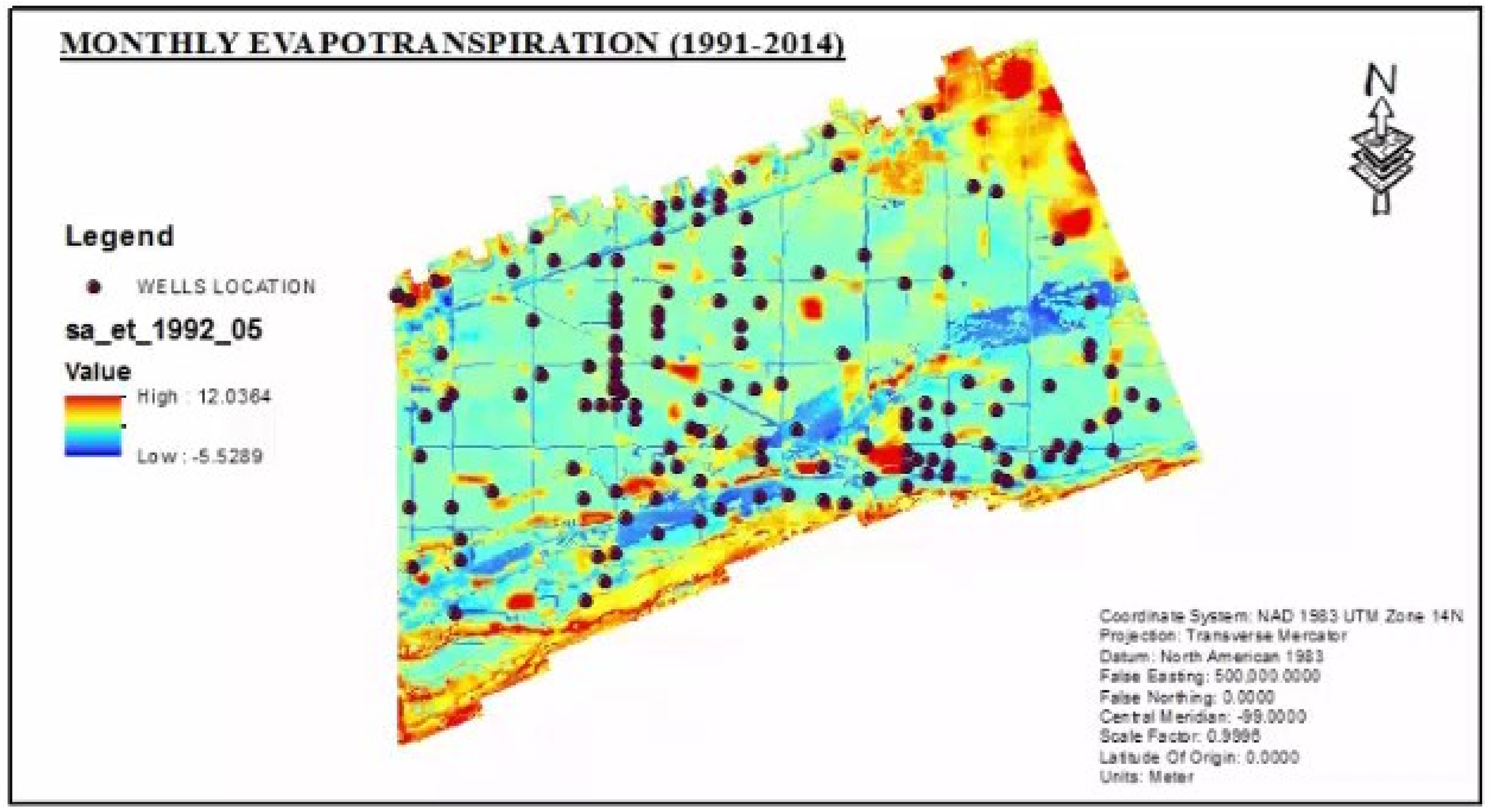

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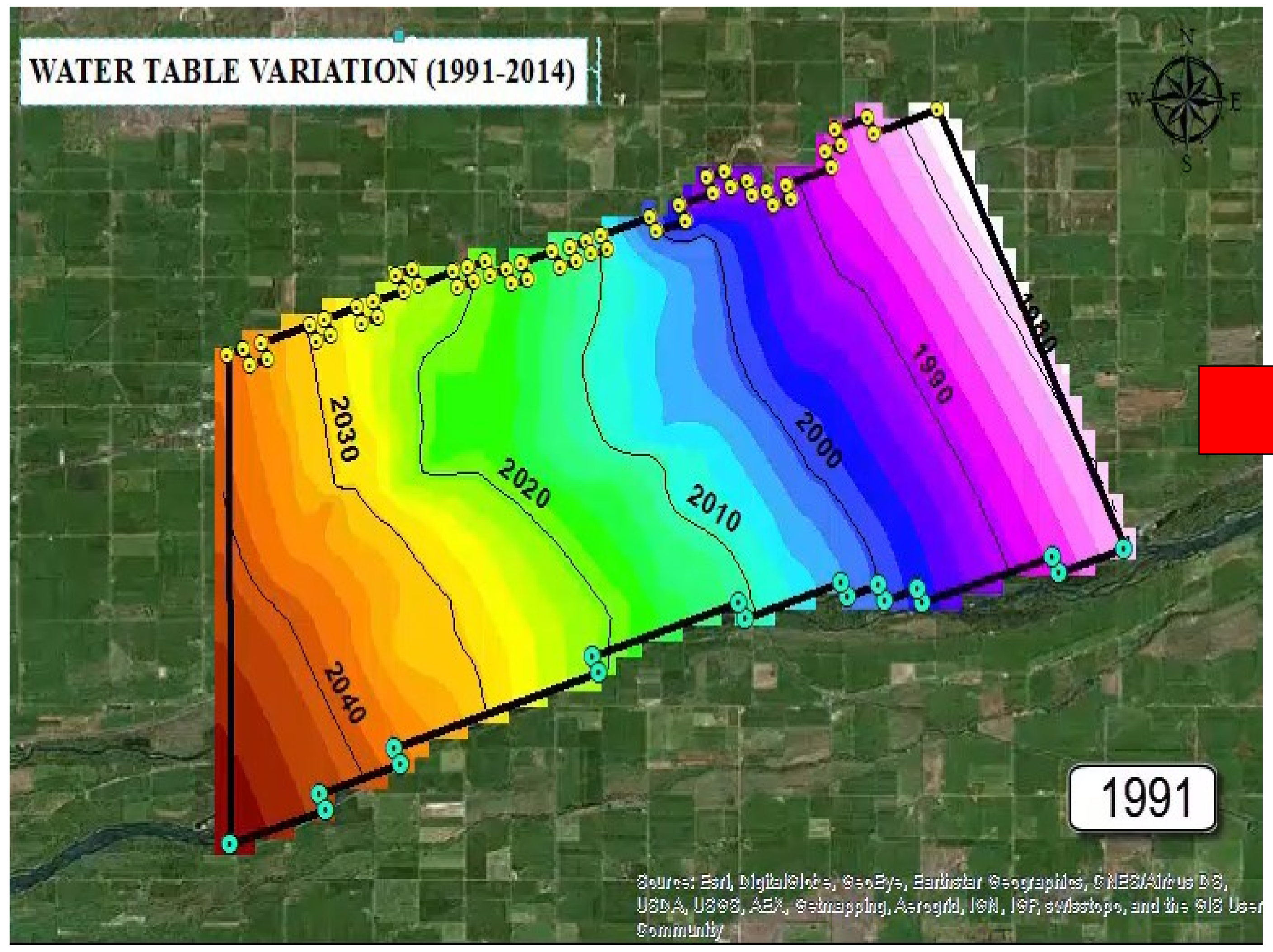

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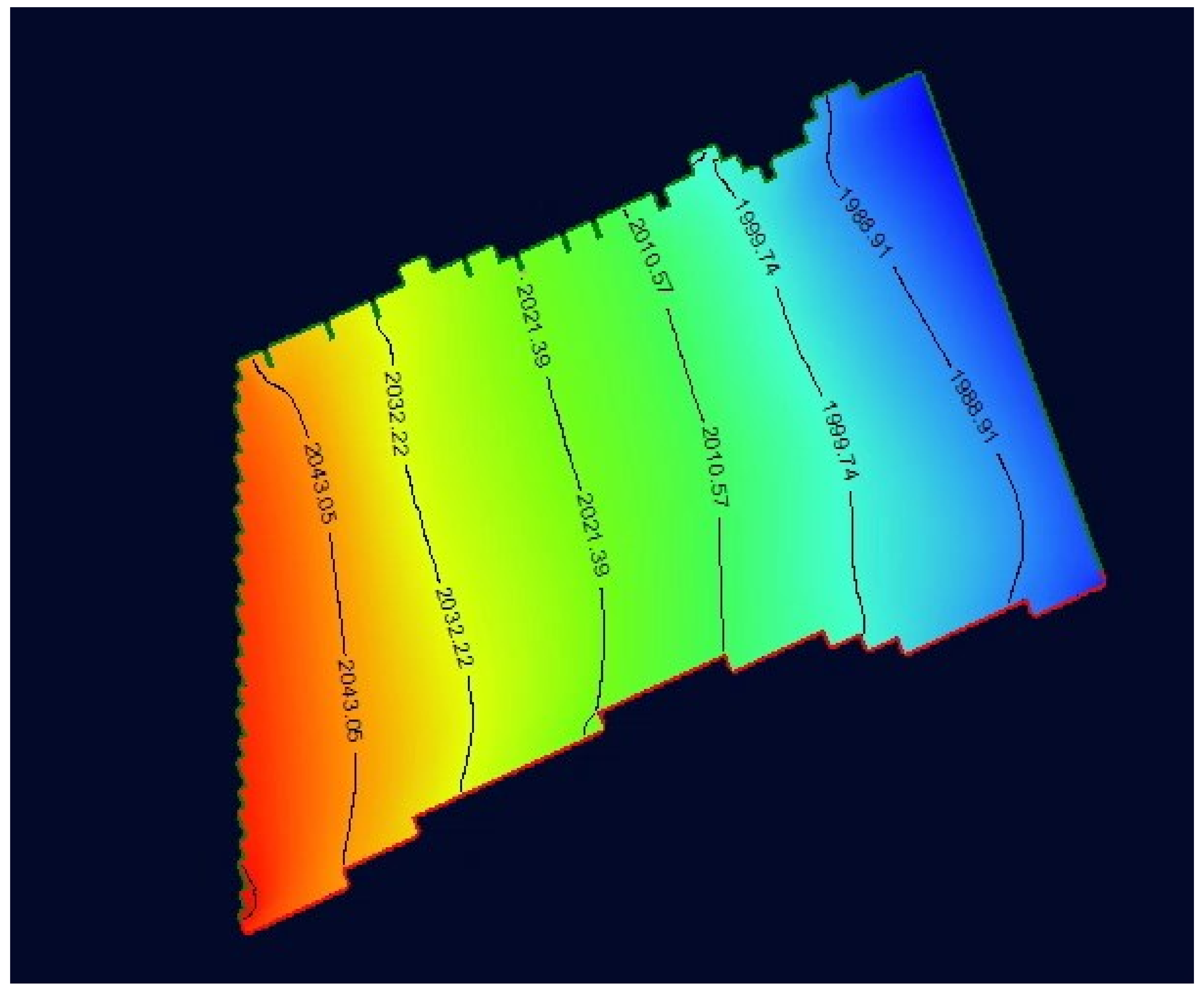

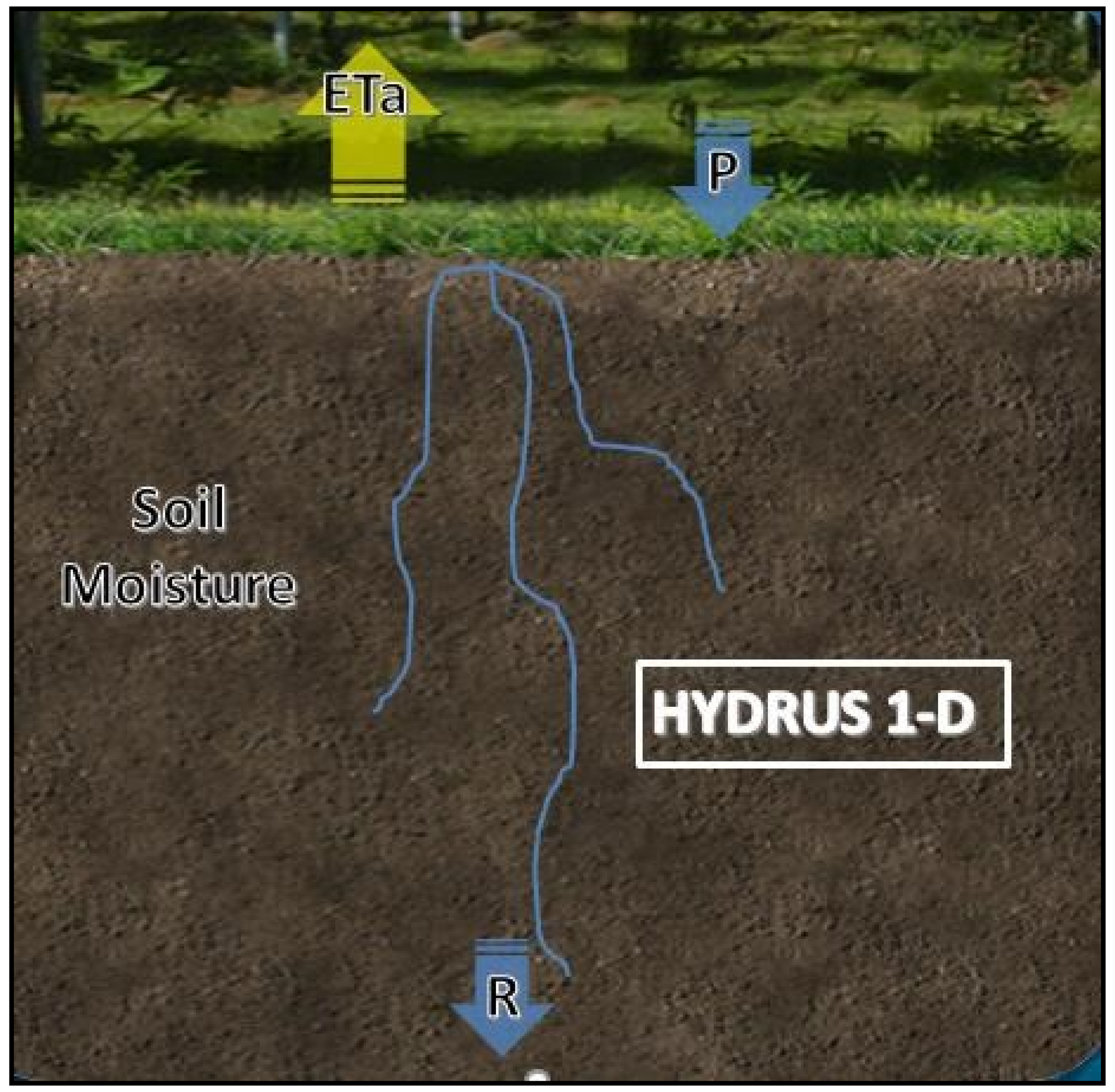

FORESCASTED WELL CAPACITY

- Weather research and forecasting model (WRF).
- Eta = ET + EV
- Vadose zone model to soil moisture data using inverse vadose zone modeling.
- Mass flux that leaves the bottom layer is known as recharge, and the upper layer as actual evapotranspiration.

GROUNDWATER MODEL VALIDATION

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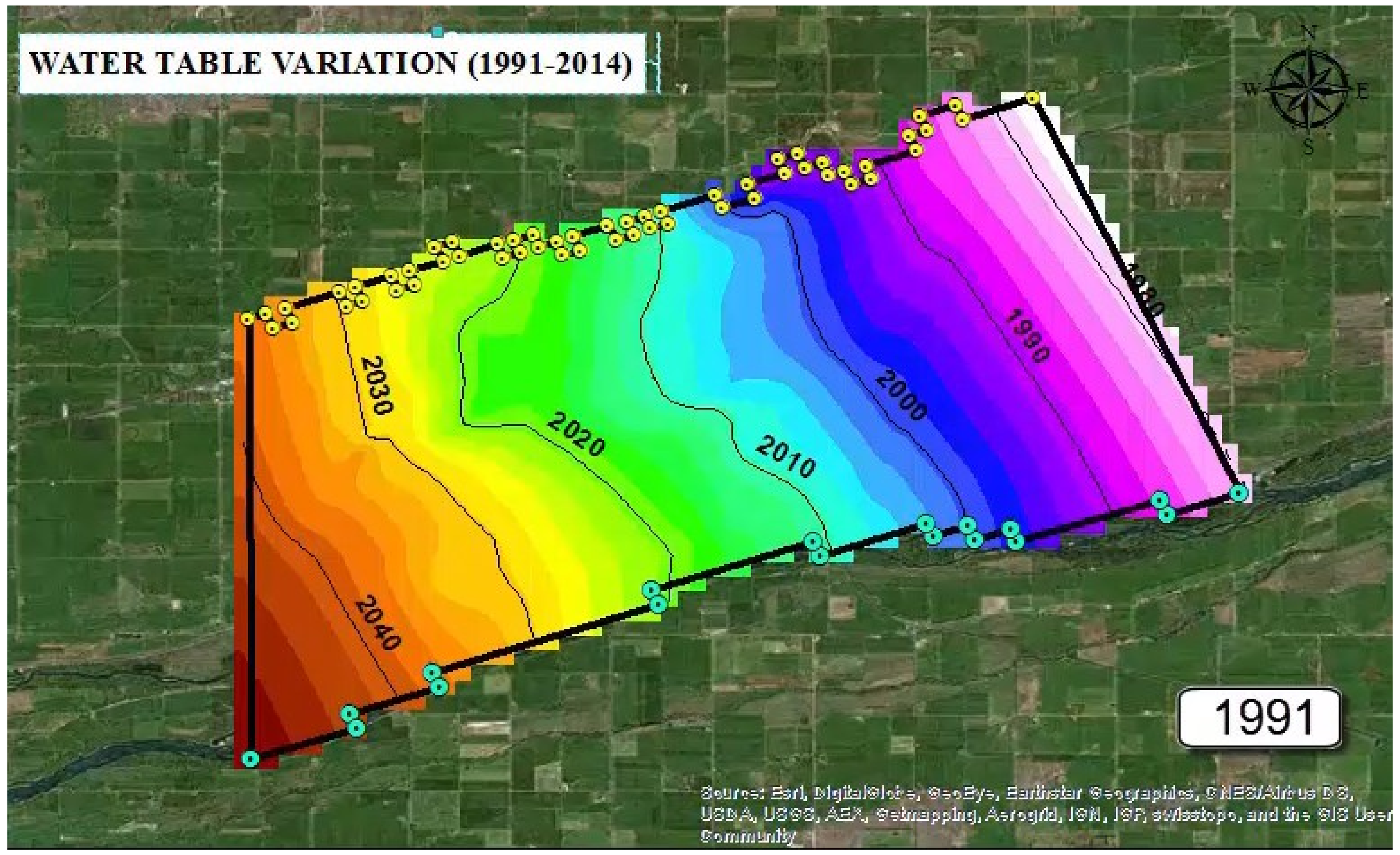

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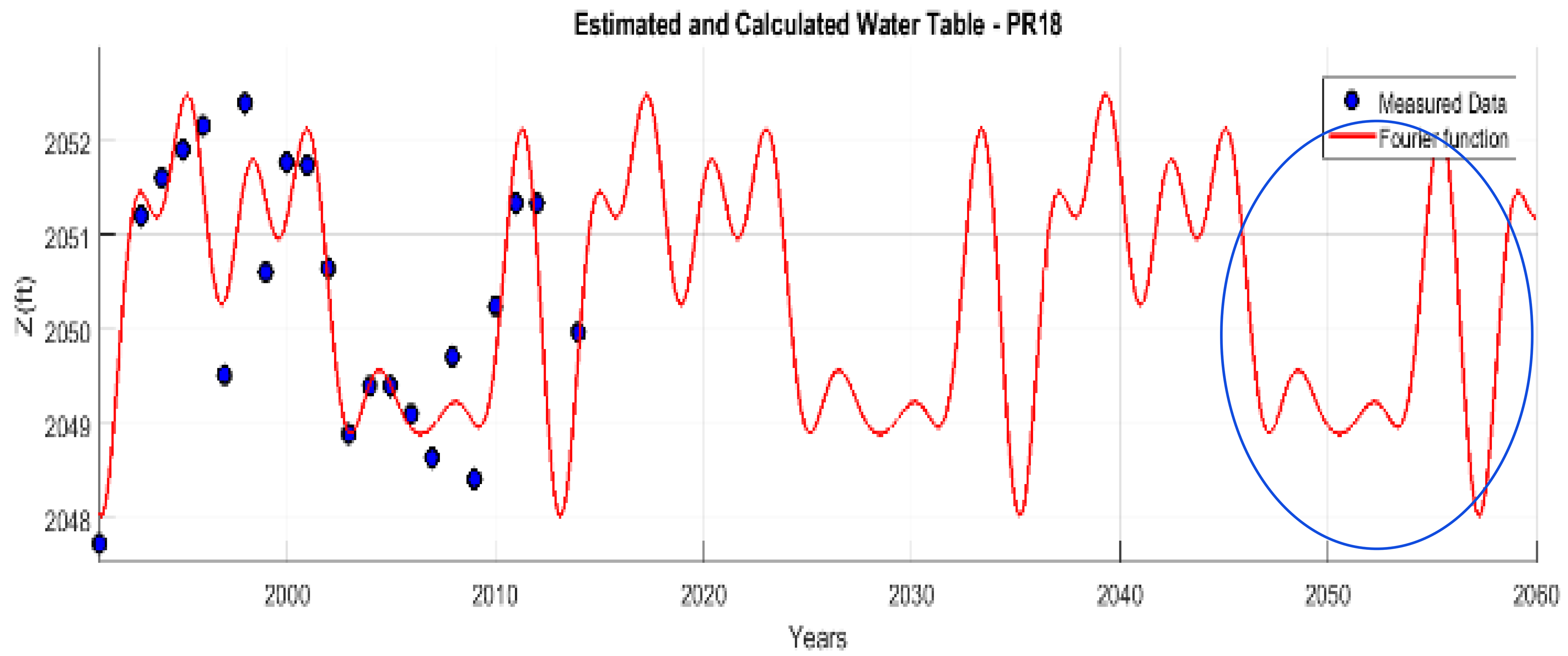
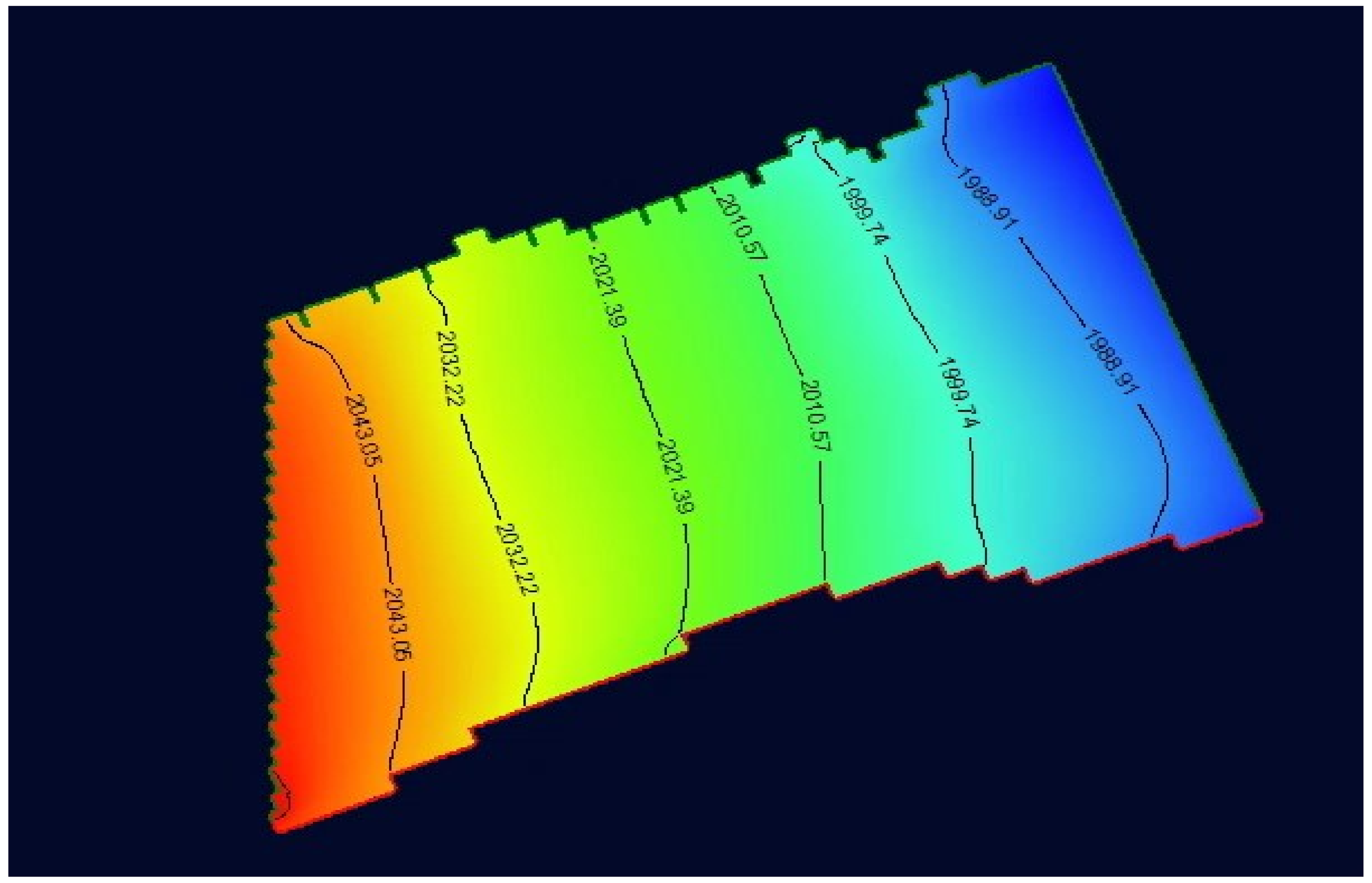


GROUNDWATER LEVEL PREDICTION MAP



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FUTURE WORK AND CONCLUSION

1. GW level permits to develop a sustainable wat mal water use).

2. Sand, gravel, clay and silt comprise the hydrogeology of the study area. Its hydraulic conductivity ranges from 40 t/d to 170 ft./d.

3. Boundary conditions of the rivers, wells and recharge rate are relevant parameters to achieve the sought objectives because they change over the time.

4. Groundwater model validation is an ongoing work that seeks the accuracy of the GW model.

5. Future groundwater estimation shows that there is a decreases GW level about 1.02 feet.

6. Contaminant transport modeling over the MSEA area is the next challenge to face.