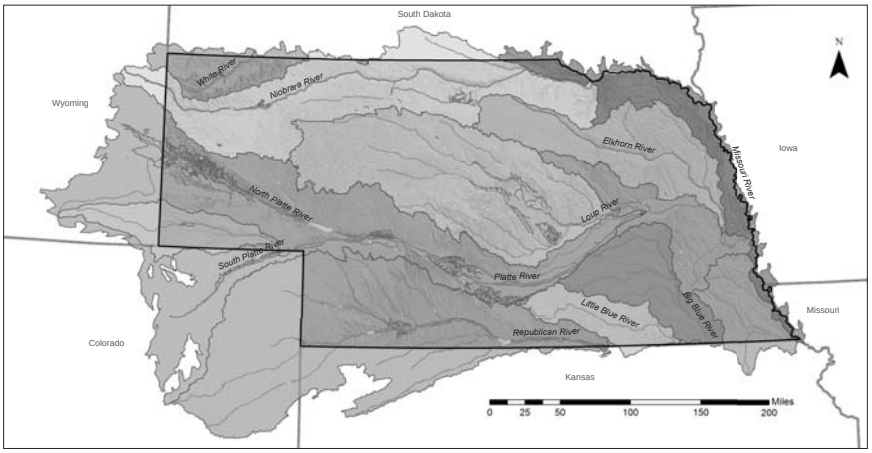
Background and Purpose

Abstract

The Integrated Water Management Division of the Nebraska Department of Natural Resources (NDNR) works to ensure a balance between water supplies and demands and to protect the rights of existing users of surface water and groundwater. Because groundwater and surface water are hydrologically connected, water supply management decisions should take into account the availability and use of both surface and sub-surface water supplies, as well as the interactions between them. This poster explores the path of hydrogeologic data for integrated water management in Nebraska from the collection of data through surface and groundwater monitoring, through model development and integration, to sharing data through NDNR's new INSIGHT website, and finally to the application of data during the integrated management planning process. NDNR's upcoming efforts to address the need for additional data that will continue to refine the picture presented by INSIGHT are also discussed.

NDNR first gathers information from a variety of monitoring networks that collect data such as groundwater, weather, streamflow, and evapotranspiration data. These data are then incorporated into NDNR's groundwater, surface water, and watershed models, which are then integrated together to simulate the flow of water resources through the natural hydrologic cycle in combination with historical anthropogenic activities. Together, these models provide a better understanding of the complex interactions between groundwater systems and other hydrologic components related to water resources. In January 2014, NDNR released INSIGHT, which is a website that makes the results of NDNR's modeling efforts available to the public in an easy-to-use format. INSIGHT provides a basin-by-basin snapshot of water availability throughout Nebraska. The data available on INSIGHT can be used by water managers, including those in Nebraska's 23 Natural Resources Districts (NRDs), to support proactive water supply management decisions. Through the state's integrated management planning and basin-wide planning processes, NDNR and NRDs collaborate to work towards maintaining or achieving a balance between water supplies and demands. Effective water management decisions are based on the best available scientific data; therefore, NDNR continually strives to identify areas where having additional data will help to present a more complete picture of a basin's water supplies or demands.

Nebraska's Major Basins



Legend

- Nebraska boundary
- Other states
- Stream
- Lake/reservoir
- Canal
- White River-Hat Creek Basin
- Niobrara River Basin
- Missouri River Tributaries Basin
- Upper Platte River Basin
- Loup River Basin
- Elkhorn River Basin
- Lower Platte River Basin
- Lodgepole Creek Basin
- Big Blue River Basin
- Little Blue River Basin
- Nemaha River Basin

Nebraska
Department of Natural Resources

NDNR's Role in Water Supply Management

- NDNR works in cooperation with local NRDs to ensure a balance between water supplies and demands and protect the rights of existing water users in each water basin across the state of Nebraska.
- NDNR has jurisdiction over matters pertaining to surface water rights for storage, irrigation, hydropower, manufacturing, and diversion.
- Nebraska's 23 NRDs have jurisdiction over matters pertaining to groundwater rights. In cooperation with the local NRDs, NDNR's Integrated Water Management Division provides groundwater modeling services and develops modeling tools for studying surface water/groundwater interactions and the impacts of water uses.
- NDNR's Integrated Water Management Division works cooperatively with NRDs to develop integrated management plans to manage hydrologically connected surface and groundwater supplies together as one resource.

Why NDNR's Integrated Water Management Division Uses Data and Models

- For studying surface water/groundwater interactions and the impacts of water uses to stream baseflow and groundwater levels.
- To support decisions related to the integrated management of surface water and groundwater supplies.

Terminology

NDNR - Nebraska Department of Natural Resources. Among other responsibilities, NDNR has jurisdiction over surface water appropriations.

Natural Resources Distfict (NRD) - Nebraska's 23 NRDs are local government entities with broad responsibilities to protect natural resources, including jusrisdiction over groundwater.

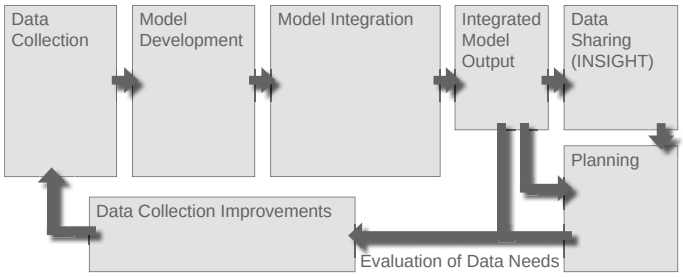
Hydrologically Connected Area/10-50 Area - The state of Nebraska considers an area to be hydrologically connected if pumping a well in that area for 50 years would deplete streamflow by at least 10 percent of the amount pumped.

Integrated Water Management - Integrated water management in Nebraska focuses on managing the availability of hydrologically connected groundwater and surface water supplies together, as a single resource.

Integrated Management Plan - A plan developed jointly by NDNR and an NRD for managing the balance between hydrologically connected surface water and groundwater supplies within a basin.

Poster Flow

This poster explores the path of hydrogeologic data for integrated water management in Nebraska from the collection of data through surface and groundwater monitoring, through model development and integration, to sharing data through NDNR's new INSIGHT website, and finally to the application of data during the integrated management planning process. In addition, NDNR continually strives to identify areas where having additional data will help to present a more complete picture of water supplies and demands.



Surface and Groundwater Data Collection and Application for Integrated Water Management in Nebraska

Carol Myers Flaute (carol.flaute@nebraska.gov), Mahesh Pun, and Jennifer Schellpeper
Nebraska Department of Natural Resources, Integrated Water Management Division

Data Collection

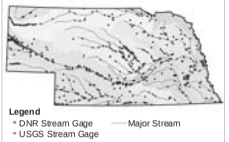
Monitoring Networks

NDNR gathers information from a variety of monitoring networks that collect data such as groundwater, weather, streamflow, and evapotranspiration data. The maps below show the distribution of monitoring points from some of these monitoring networks.

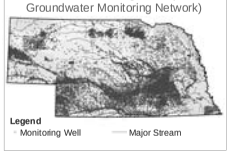
Examples of the Categories of Data Collected through Monitoring Networks

Collection Network	Data Available
National Groundwater Monitoring Network (USGS)	Groundwater Monitoring well data (federal, state, and local networks)
Weather stations (High Plains Regional Climate Center)	Weather data for calculating evapotranspiration
Stream gage programs (USGS and NDNR)	Streamflow data

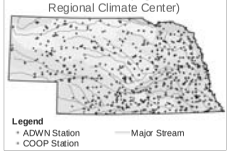
Stream Gages (USGS and NDNR)



Groundwater Monitoring Wells (National Groundwater Monitoring Network)



Weather Stations (High Plains Regional Climate Center)



Other Data

Examples of other data that NDNR uses for integrated water management include land use (CALMIT) and soil (SSURGO) data.

Land Use (CALMIT)

Image courtesy of the Center for Advanced Land Management Information Technologies (CALMIT) at the University of Nebraska-Lincoln

Soils (SSURGO) Of Nebraska (NRCS)

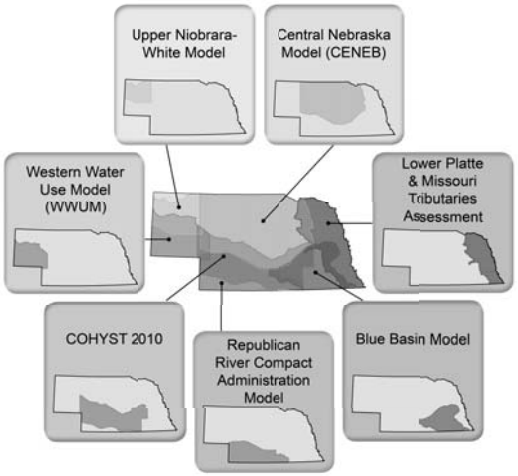
Model Development

NDNR has developed several models to assist with water management across Nebraska by providing a better understanding of regional hydrogeology and water availability. Each model was developed through collaborative efforts with local NRDs and stakeholders.

While the inputs, outputs, and objectives of each model differ somewhat due to specific local data needs and regional hydrogeologic differences, they all provide information about how surface water and groundwater interact and move through the hydrologic cycle. They also help water managers understand how water uses impact water supplies.

Most of the models shown below have been completed and are now being used for integrated water management decisions across the state. The exception is a model for the Lower Platte River and Missouri River Tributaries basins, which is currently under development.

NDNR's Integrated Water Management Model Areas



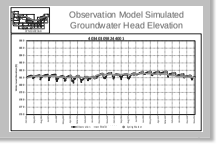
Model Integration

Groundwater Model

A groundwater model simulates aquifer groundwater head elevation and stream baseflow. The effects or impacts of groundwater irrigation on stream baseflow and groundwater levels are studied with groundwater models. These figures are examples of groundwater model output.

Groundwater Head Trend Map

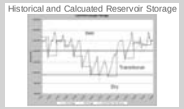
Observation Model Simulated Groundwater Head Elevation



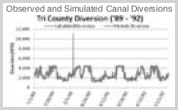
Surface Water Operations Model

A surface water operations model incorporates rules for the operation of reservoirs and canals, surface water appropriations, and priorities in a model simulation that estimates the amount of surface water available to meet crop demands and seepage from reservoirs and canals. These figures are examples of surface water operations model output.

Historical and Calcuated Reservoir Storage



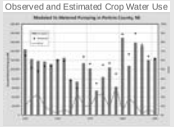
Observed and Simulated Canal Diversions



Watershed Model

A watershed model estimates the crop water requirement for irrigation, as well as groundwater pumping, groundwater recharge, and overland runoff that meets the nearby streams. It accounts for the effects of precipitation on irrigation demand. This figure is an example of watershed model output.

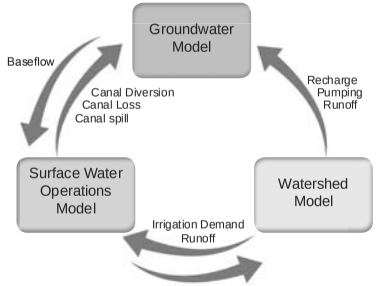
Observed and Estimated Crop Water Use



Interaction and Integration of Models

After incorporating data from weather stations, land use data, and soil data, the watershed model simulates and estimates crop irrigation demands and surface runoff. This information is sent to the surface water operations model and is included in model simulation. The surface water operations model then estimates surface water available for crop irrigation and sends it to the watershed model. The amount of irrigation demand that is not fully met through surface water is assigned as groundwater pumping, and this information is sent to the groundwater model by the watershed model, along with groundwater recharge and overland runoff estimates. Similarly, canal diversion, loss, and spill estimates are sent to the groundwater model by the surface water operations model, and the groundwater model sends simulated stream baseflow back to the surface water operations model.

This sequence of the interaction and integration of groundwater, surface water operations, and watershed models is illustrated by the figure below.



Note that each of NDNR's models (as shown in the "Model Development" section, left) was developed independently, according to local data needs and hydrologic characteristics. For a given area of the state, only the information required to simulate the existing system is replicated in the model for that area; therefore, not all of the modeled areas include all three components of the integrated water management model (e.g., groundwater, surface water operations, and watershed models).

Nebraska To learn more about model development and integration, please attend the presentation ***Integrated Water Management Modeling for Adaptive Management of Groundwater System in Nebraska*** by Mahesh Pun at 1:50 p.m. on Wednesday, October 1 (Session IV A, Groundwater-Surface Water Interactions).

Data Collection Improvements

The need for improved data collection, monitoring, and studies is identified throughout the integrated water management process. For example, efforts to calibrate a model may highlight areas where having more information would lead to a more accurate model. SImilarly, setting goals and objectives for an integrated management plan can help identify where additional data would better inform water supply management decisions.

This section highlights two examples of NDNR's efforts to improve the data available for integrated water management in Nebraska.

INSIGHT Data Enhancement Program (IDEP)

INSIGHT, NDNR's web portal for sharing data related to the balance of water supplies and demands, is built upon the best available data, so collecting additional data on water use and availability throughout the state is essential as NDNR continues to improve INSIGHT. As a result, NDNR has created a new grant program called the INSIGHT Data Enhancement Program (IDEP). The purpose of IDEP is to provide financial support to NRDs for new or improved data collection and data transfer projects that will be beneficial for building the next level of INSIGHT.

Examples of the kinds of water supply, water use, and data transfer projects that IDEP may fund include:

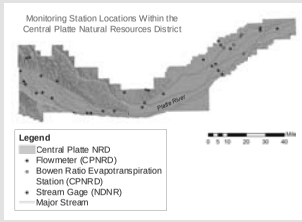
- Water supply data collection (e.g., stream gages, return flow monintoring)
- Water use data collection (e.g., non-regulatory well meters, reservoir monitoring)
- Data transfer improvements

Collaboration with Central Platte NRD

NDNR often partners with local NRDs to improve data collection efforts in their area. For example, NDNR recently signed an inter-local cooperative agreement with the Central Platte NRD to add new telemetry stations on 80 groundwater wells (Central Platte NRD) and 20 surface water stations (NDNR). The intent of the surface water stations is to track small pumpers diverting water, as well as return flows where they are not currently measured. Central Platte NRD also maintains a network of Bowen Ratio stations to monitor evapotranspiration data.

This map shows the current locations of monitoring stations within the Central Platte NRD. Many more stations will be added as a result of the inter local cooperative agreement.

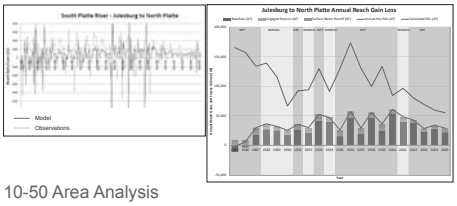
Monitoring Station Locations Within the Central Platte Natural Resources District



Integrated Model Output

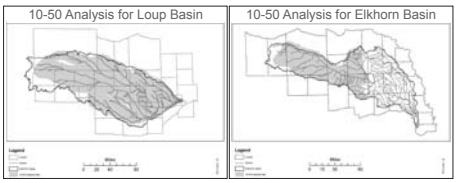
When interacting together, the groundwater model, surface water operations model, and watershed model operate as an integrated water management model. The figures below represent examples of some of the output from the integrated water management model that is taken into consideration for making water supply planning and management decisions.

Stream Reach Baseflow Depletion/Accretion



10-50 Area Analysis

This analysis identifies the areas where groundwater and surface water are hydrologically connected.



Nebraska Department of Natural Resources

To learn more about 10-50 Analysis, please visit the poster ***Development of a Modeling Tool for Determining Fully Appropriated Areas in Nebraska*** by Ruopu Li *et al.*

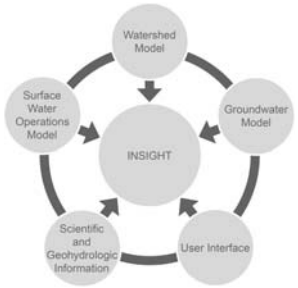
Data Sharing (INSIGHT)

INSIGHT

An Integrated Network of Scientific Information and GeoHydrologic Tools

INSIGHT is a web-based tool that provides a series of maps that are directly linked to basin-specific data on water supply and demand, providing a visual, easily accessible snapshot of NDNR's modeling results and related data on water supplies and demands.

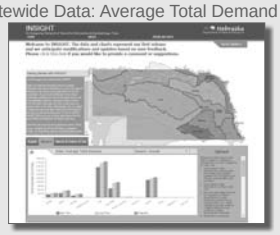
INSIGHT can aid NRDs and other water managers in understanding current and future demands, evaluating the effectiveness of water management strategies, and assessing critical areas of water shortage.



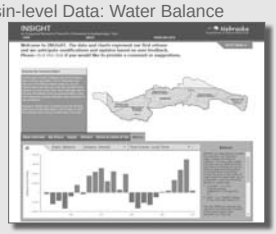
INSIGHT Visuals

Insight presents water availability data at statewide, basin, and sub-basin scales. These images provide examples of INSIGHT's user interface and visual representations of data.

Statewide Data: Average Total Demand



Basin-level Data: Water Balance



Nebraska Department of Natural Resources

To learn more about INSIGHT, please attend the presentation ***INSIGHT: Development of a Web-based Water information System*** by Brandi Flyr at 3:50 p.m. on Wednesday, October 1 (Session VI A,Groundwater Management).

Planning

Integrated Management Planning

NDNR collaborates with NRDs and local stakeholders to develop integrated management plans, or IMPs. Under state statutes, NRDs can be required or voluntary.

IMPs are required in areas that have been designated as fully appropriated or overappropriated, meaning that demands for water in those areas meet or exceed the available supply. The objective of required IMPs is to either maintain an existing balance between supplies and demands or to return an out-of-balance area to balance.

Voluntary IMPs follow the same general outline as non-voluntary IMPs, but they are proactive in that they aim to address potential future water supply problems before they occur.

IMPs Depend on Best Available Data

How does geohydrologic data influence water management decisions during the development and implementation of an IMP? Consider the following examples:

- Evaluation of the impacts of pumping on stream baseflow
- Identification of areas with:
  - Significant groundwater drawdown
  - Low groundwater recharge
  - Extensive groundwater pumping

IMPs require ongoing monitoring and are re-evaluated when new data become available.

IMPs Identify Additional Data Needs

The goals and objectives of an IMP can help identify situations where having additional data would lead to more informed, effective management decisions. As a result, IMPs can lead to new data collection, monitoring efforts, and studies.

Nebraska Department of Natural Resources

To learn more about Integrated Water Management in Nebraska, please attend the presentation ***Ten Years of Integrated Water Management in Nebraska*** by Jennifer J. Schellpeper at 3:30 p.m. on Wednesday, October 1 (Session VI A , Groundwater Management).

Evaluation of Additional Data Needs