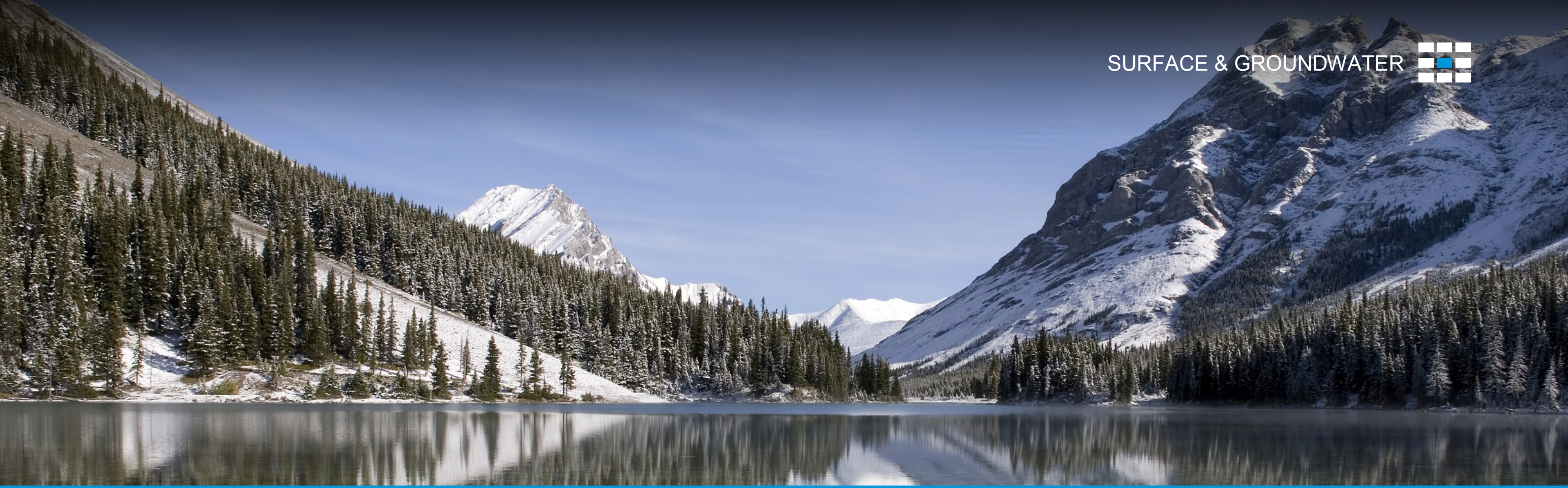


DHI CASE STORY

INTEGRATED HYDROLOGY AND HYDRAULIC MODEL OF THE ELBOW RIVER WATERSHED

Evaluating the future impact of land-use and development policies

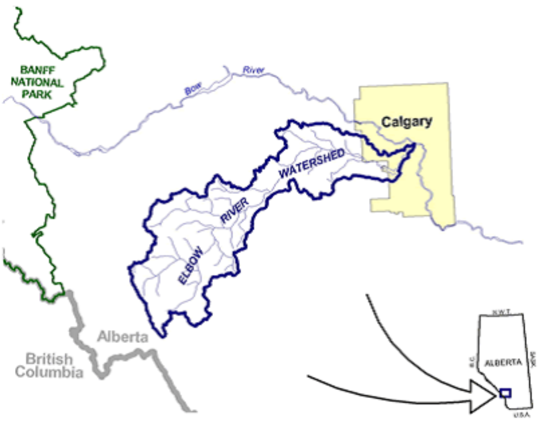
Communities must ensure the long-term sustainability of environmental resources while also taking into account the needs of land developers. In Calgary (Canada), we helped Alberta Environment and Sustainable Resource Development (ESRD) and the University of Calgary develop an integrated dynamic modelling system for the Elbow River watershed. This system will help Alberta ESRD and the University of Calgary understand the potential impact of future land-use and climate change scenarios on the hydrology of the watershed. Since this system was developed using transferrable technology and tools, it can also be used to help other communities evaluate the impact of land-use and development policies.

BALANCING DEVELOPMENT AND THE ENVIRONMENT

Urban planners and city officials are often caught between the expansion pressures of:

- land developers – who want to maximise the value of their holdings
- the general public and environmental advocacy groups – who want to ensure environmentally sustainable development practices

The University of Calgary and Alberta Environment and Sustainable Resource Development (ESRD) initiated a research project to develop an integrated dynamic modelling system. This system – which combines a land-use simulation model and a hydrological model – is designed to improve understanding of the impacts of development on water resources in the Elbow River Watershed.



Location of the Elbow River Watershed

SUMMARY

CLIENT

- Alberta Environment and Sustainable Resource Development (ESRD)
- The University of Calgary

CHALLENGE

Lack of a common tool or methodology that could be used to effectively evaluate the impact of land-use and development policies on the environment and especially water resources

SOLUTION

An integrated, scientifically-grounded modelling system that links our MIKE SHE hydrology model to a cellular automata land-use change model developed by the University of Calgary

VALUE

- Enabled a detailed evaluation of the hydrologic impacts of climate change, land-use changes, and water licensing
- Facilitated stakeholder involvement and understanding of the potential impact of future land-use and climate change scenarios on the hydrology of the Elbow River watershed

LOCATION / COUNTRY

Calgary, Canada

UNDERSTANDING THE IMPACT OF LAND-USE CHANGES

The University of Calgary and Alberta ESRD developed an integrated dynamic modelling system that combined:

- a cellular automata land-use simulation model
- a spatially-distributed and physically-based hydrological model

This was intended to help stakeholders understand the impact of land-use changes on the hydrological processes in the Elbow River Watershed.

We assisted the University of Calgary and Alberta ESRD with the development and calibration of the hydrological model using our MIKE SHE software. Dr. Danielle Marceau and her team of researchers at the University of Calgary selected MIKE SHE (a part of our MIKE by DHI software) because it simulates all the major components of the land-based phases of the hydrologic cycle, including:

- snowmelt
- evapotranspiration (ET)
- overland flow
- river channel flow
- unsaturated flow
- groundwater flow

The MIKE SHE model of the Elbow River Watershed was linked with the cellular automata land-use change model developed by the University of Calgary's Geocomputing Laboratory. The models were linked in order to represent the potential hydrologic impacts of urban growth and land-use change under different climate and policy scenarios.

The hydrologic model incorporated detailed data from land-use maps, topographic maps, soils maps, and groundwater boreholes. We also used water license records throughout the watershed in order to incorporate data on water extractions from surface water and groundwater sources.

We then calibrated and validated the models against more than 40 years of historical streamflow and snowpack data as well as limited groundwater observations. One of the unique requirements of this model was to represent the hydrologic impacts of land-use changes during the previous 40 years. We accomplished this by running the model for a 10-year period with static land-use data. We then implemented the land-use changes for the next 10 years and utilised initial hydrologic conditions from the previous 10-year simulation period.

ENABLING FUTURE CLIMATE CHANGE ANALYSIS

The resultant model demonstrated an impressive calibration to both high flows and low flows throughout the simulation period. It provided a reliable base condition for the University of Calgary's continued work evaluating future land-use and climate change impacts on hydrology.

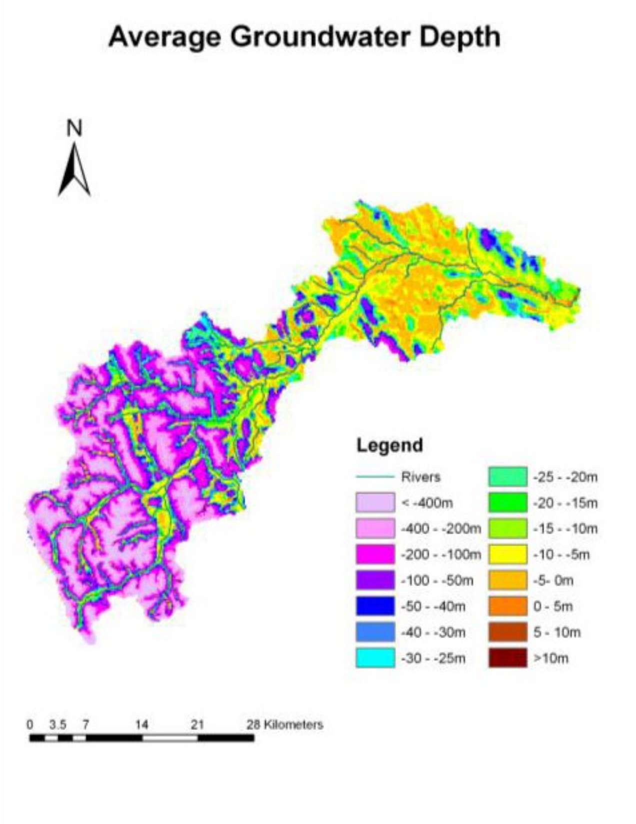
At the end of the project, we supplied a calibrated MIKE SHE model that will provide the basis for a detailed evaluation of the hydrologic impacts of:

- climate change
- land-use changes
- water licensing

We will continue to assist the University of Calgary in their further development of the model and the dynamic integration of MIKE SHE with their cellular automata land-use model. As part of this project, we also provided training on the use of MIKE SHE and transferred the calibrated model to the University of Calgary and Alberta ESRD staff. This will enable them to continue to develop the model and apply it for future climate change analysis. As the system utilises transferrable technology and tools, it can be used to evaluate the impact of

ABOUT THE ELBOW RIVER WATERSHED

The Elbow River Watershed covers a total area of 1,200 km^2 in the province of Alberta, Canada. It is drained by the Elbow River and its tributaries into the Glenmore Reservoir, which services the City of Calgary water supply.



Map showing the simulated groundwater depths throughout the Elbow River Watershed

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