DHI CASE STORY

PROTECTING SILVER CREEK'S RIPARIAN ECOSYSTEM

ECO-HYDROLOGICAL SOFTWARE DOUBLES UP AS A RISK ASSESSMENT TOOL

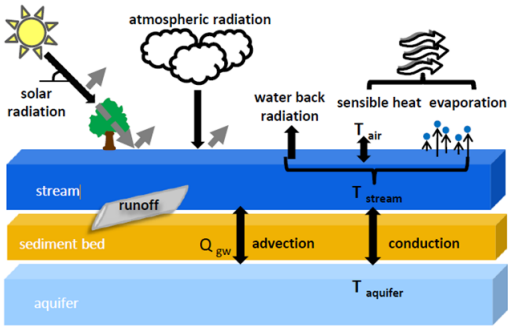
Silver Creek, a river located in central Idaho, has a high density of trout. Remaining unaffected by harsh winters, this spring-fed river is an angler's paradise. However, various factors including high temperatures, intense fishing pressure and low discharges during summer are threatening this fragile aquatic habitat. Keeping in tune with an integrated water resource management approach, we developed a cohesive ecological, hydrological and water quality tool. This tool comprised our generic ecological modelling tool – ECO Lab – in the MIKE SHE modelling framework. This comprehensive tool enables the evaluation of alternative management strategies – to enable sustainable development, while preserving the unique Silver Creek ecosystem.

EXTERNAL FACTORS AFFECT FRESHWATER ECOSYSTEMS

A number of anthropogenic factors including land use change and intensive water use have caused stream habitat deterioration in arid and semi-arid regions. This has contributed to increased stream temperatures— one of the most widespread water quality problems in the northwest U.S.A.

Water temperature is also a critical factor in fish survival – particularly for cold-water salmonids (such as salmon, trout, and chars). Salmonids are an important food resource for humans and other animal species. Moreover, they are highly valued as a recreational resource.

Temperature dynamics (including seasonal variations) determine optimal growth conditions for fish. Moreover, they are important in predicting fish habitat sustainability. Temperature dynamics are in turn influenced by surface water-groundwater interaction. Hence the need has arisen to consider groundwater, surface water and water quality as an integrated system.



A stream temperature model

SUMMARY

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- Poor understanding of the impacts of increasing water use on temperature in a spring-fed ecosystem
- Lack of available options to choose from, for optimal remediation of these impacts
- Unsatisfactory management of freshwater ecosystems like Silver Creek in arid and semi-arid regions
- Meeting regulatory standards like the EU Water Framework Directive and the Total Maximum Daily Limit in the US Clean Water Act

SOLUTION

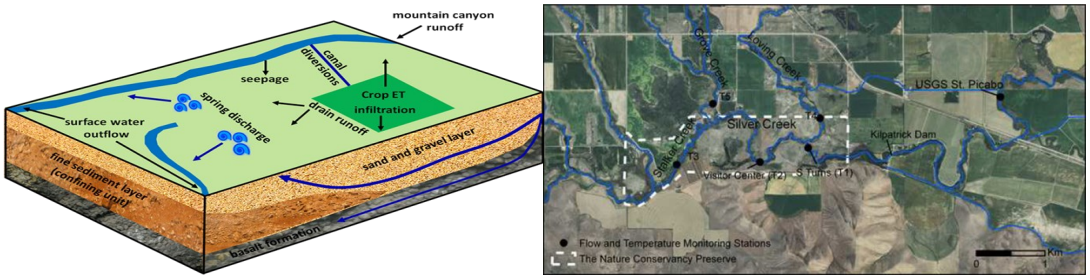
Development of a new and powerful tool (MIKE SHE ECO Lab) for better water management of freshwater ecosystems

VALUE

- Availability of different options to protect fresh water ecosystems
- Empowerment of managers to choose the most suitable strategy for remediation
- Enabling a holistic approach to meet regulatory standards

LOCATION/COUNTRY

Silver Creek– Idaho, United States



The climate is semi-arid with low precipitation and high evaporation. Approximately 60% of the lower valley is cultivated. Of this, 80% is irrigated.

AGRICULTURAL PRACTICES ALSO CONTRIBUTE TO HABITAT DETERIORATION

The effects of intensely irrigated agriculture on stream habitats can be significant. This is because it includes the combined effects of all the factors that impact flow and temperature. Agriculture is by far the largest water user in many semi-arid and arid rural areas. This is mainly due to the high water demand for crops, which is mostly lost to evapotranspiration.

Drainage runoff from fields carries sediments and potentially high thermal loads to the streams. Furthermore, agricultural practices can cause changes in drainage patterns and stream morphology and vegetation. Thus, it became important to find solutions to mitigate these effects and reduce the impacts. In collaboration with The Nature Conservancy, we have carried out an investigation of anthropogenic stresses on the Silver Creek freshwater ecosystem and the impact of alternative water resource management strategies.

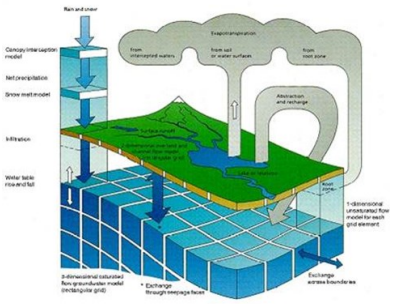
POWERFUL NEW MODELLING TOOL

There is a growing acceptance of the need for an integrated water resource management approach that is embodied in the regulatory standards. This motivated us to develop an integrated hydrological and water quality tool to address problems related to ecological status and restoration. We incorporated a generic ecological modelling tool – ECO Lab – in the MIKE SHE modelling framework. In doing so, we represented a range of water quality and ecological processes with respect to the river, surface water, soil and groundwater. This new and powerful eco-hydrological modelling tool has been developed, demonstrated and evaluated using analytical solutions, laboratory and field data.

MIKE SHE + ECO LAB

MIKE SHE is an integrated hydrological model that includes process models for each of the following and their interactions:

- Evapotranspiration and rainfall
- overland flow
- agricultural drainage
- unsaturated flow
- groundwater flow
- channel flow



ECO Lab is a process equation solver. It calculates the rate of change of any type of state variable given any number of related variables, processes and forcing. ECO Lab relies on other models to calculate flow and transport processes. It also acts as a post-processor at each time step to calculate the process dynamics. In this manner, spatial and temporal predictions of a wide range of water quality and ecosystem response studies can be simulated.

AN EFFICIENT TOOL FOR CATCHMENT MANAGERS AND STAKE HOLDERS

The integrated hydrological and water quality tool developed, allows comprehensive risk assessments and the evaluation of management options for freshwater ecosystems. It simulates hydrological processes, stream temperatures and fish growth. This enables catchment managers and stakeholders to evaluate alternative management strategies on the water balance, temperatures and the fish habitat. They can thus achieve sustainable development while preserving this unique ecosystem. This directly addresses the need of water resource managers – to be able to quantify the changes in ecosystem status caused by changes in catchment management.

ACKNOWLEDGEMENTS

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> *The DHI modeling tools have helped us with difficult management decisions and prioritization of projects at Silver Creek. We now have a clearer picture of the system, the effects of land management changes on the system, and where we need to focus out attention in the future for a better Silver Creek.*
> *Nature Conservancy*

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