



## An Open Source modular platform for hydrological model implementation

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An implementation framework for setup and evaluation of spatio-temporal models is developed, forming a highly modularized distributed model system. The ENKI framework allows building space-time models for hydrological or other environmental purposes, from a suite of separately compiled subroutine modules. The approach makes it easy for students, researchers and other model developers to implement, exchange, and test single routines in a fixed framework. The open-source license and modular design of ENKI will also facilitate rapid dissemination of new methods to institutions engaged in operational hydropower forecasting or other water resource management.

Written in C++, ENKI uses a plug-in structure to build a complete model from separately compiled subroutine implementations. These modules contain very little code apart from the core process simulation, and are compiled as dynamic-link libraries (dll). A narrow interface allows the main executable to recognise the number and type of the different variables in each routine. The framework then exposes these variables to the user within the proper context, ensuring that time series exist for input variables, initialisation for states, GIS data sets for static map data, manually or automatically calibrated values for parameters etc.

ENKI is designed to meet three different levels of involvement in model construction:

- Model application: Running and evaluating a given model. Regional calibration against arbitrary data using a rich suite of objective functions, including likelihood and Bayesian estimation. Uncertainty analysis directed towards input or parameter uncertainty.
  - o Need not: Know the model's composition of subroutines, or the internal variables in the model, or the creation of method modules.
- Model analysis: Link together different process methods, including parallel setup of alternative methods for solving the same task. Investigate the effect of different spatial discretization schemes.
  - o Need not: Write or compile computer code, handle file IO for each modules,
- Routine implementation and testing. Implementation of new process-simulating methods/equations, specialised objective functions or quality control routines, testing of these in an existing framework.
  - o Need not: Implement user or model interface for the new routine, IO handling, administration of model setup and run, calibration and validation routines etc.

From being developed for Norway's largest hydropower producer Statkraft, ENKI is now being turned into an Open Source project. At the time of writing, the licence and the project administration is not established. Also, it remains to port the application to other compilers and computer platforms. However, we hope that ENKI will prove useful for both academic and operational users.