Development of a network based hydrological analysis system

Assela Pathirana, Srikantha Herath and Katumi Musiake
University of Tokyo

Objectives:

To design a new data model for representing hydrological processes in a network environment.

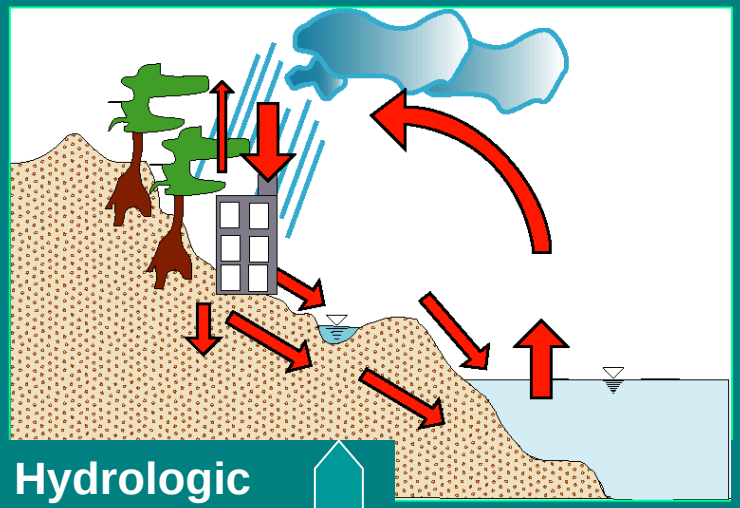
To utilize database and WWW technologies for implementing a remotely accessed multi-user hydrological information system.

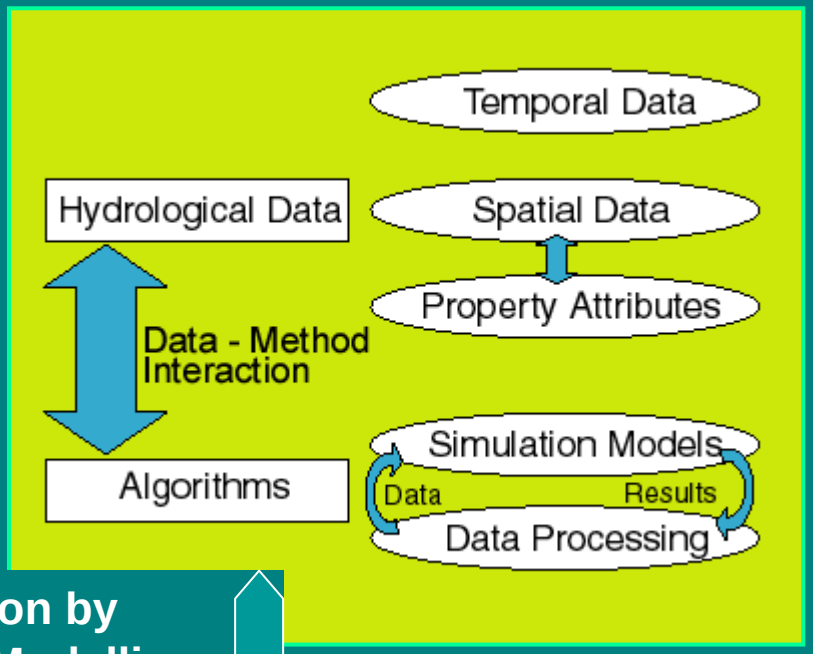
Introduction

Physically based Hydrological simulation

- Physically based hydrological models are used to model the hydrological processes at any location using governing equations.
- They need regional information, therefore lot of data and computing power. Further much expertise is needed to use them properly.
- However, these have diverse uses in many areas like water resource planning, flood prediction and mitigation, etc. Hence there is a need to bring these models to a wider audience.

The Design Problem





Hydrologic Processes

Encapsulation by Simulation Modelling

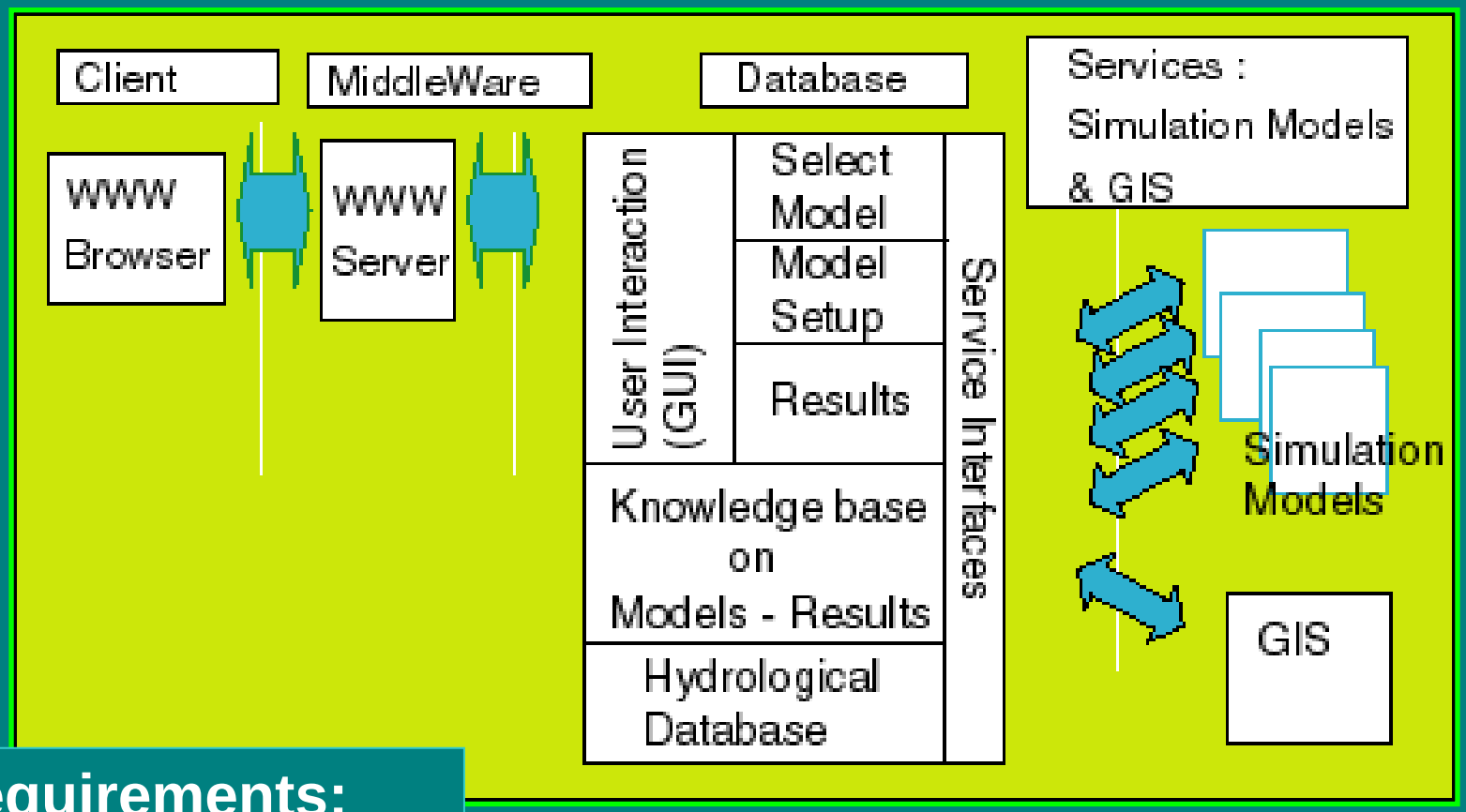
- **Traditional approach - to treat simulations individually.**
- **A new framework is needed to re-model the traditional approach to suit a multi-user environment**
- **WWW has a lot of restrictions. Security, user state, etc.**

Approach:

Information oriented - relational database.

To utilise available modelling resources easily.

System Implementation



Requirements:

- **Efficient Data delivery with advance query system.**
- **User friendly on-line simulation with input validations.**
- **Generic simulation interface - can accommodate many Simulation Models.**

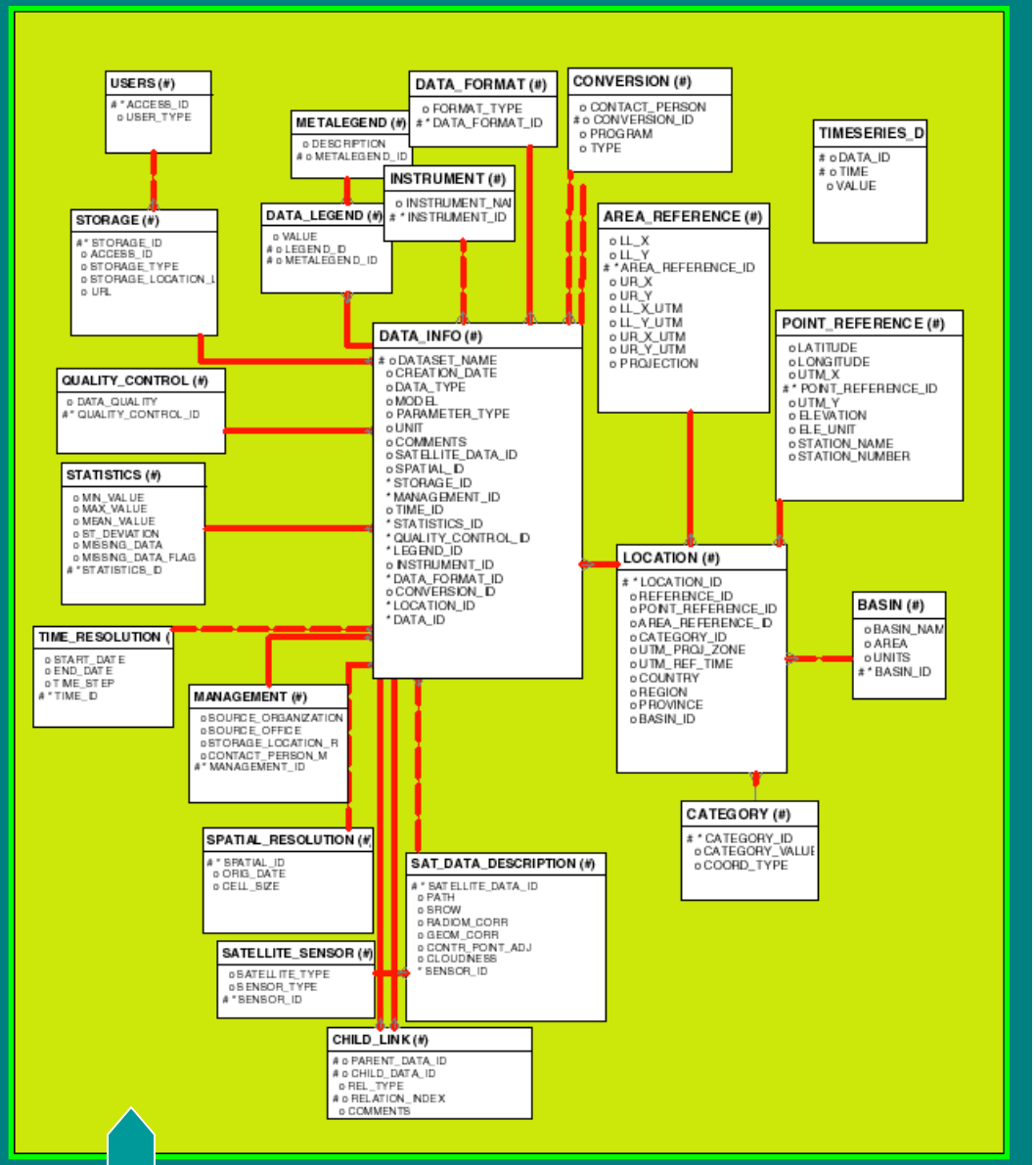
Hydrological Database

- Temporal Data
- Spatial Data
- Property Attributes

The Meta Data Model

Information on Data

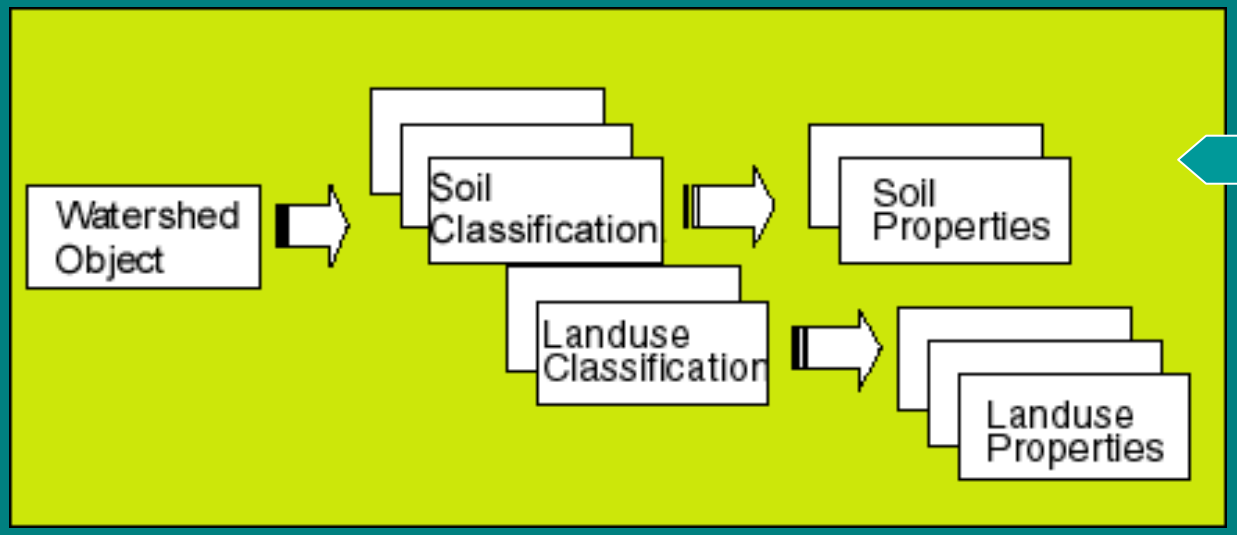
- Data related
  - Statistics
  - Quality
  - Durations
- Location related
  - Geographical
  - Political
  - Hydrological
- Management related
  - Storage
  - Access
  - Conversions



The meta data model of the database

Linking data in a hydrological hierarchy

- Relational database organise data in key-based structure which is not adequate to represent hydrological relations
- New hierarchical classification which is **'hydrologically sensible'** was introduced.



A small example

It was understood that this model can be applied both for data objects as well as algorithms like simulation models

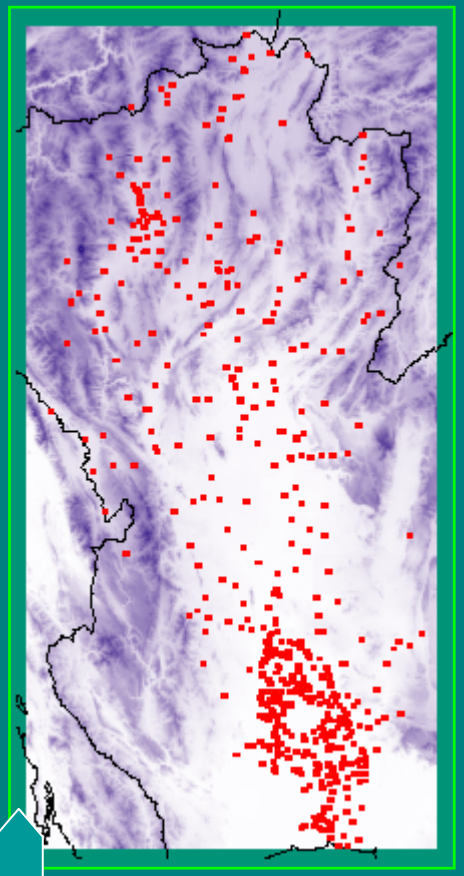
Demo 1 : Hydrological Database

- Contents :
  - Search the database
  - Examine and download results
  - Navigate hydrological hierarchies

(Note: Live version made a detour here to demonstrate the above ponts.)

An Application of the Database

Large-scale Double-mass curve analysis for rainfall data quality assessment



Rain-gauges in Chao-Phraya basin Thailand

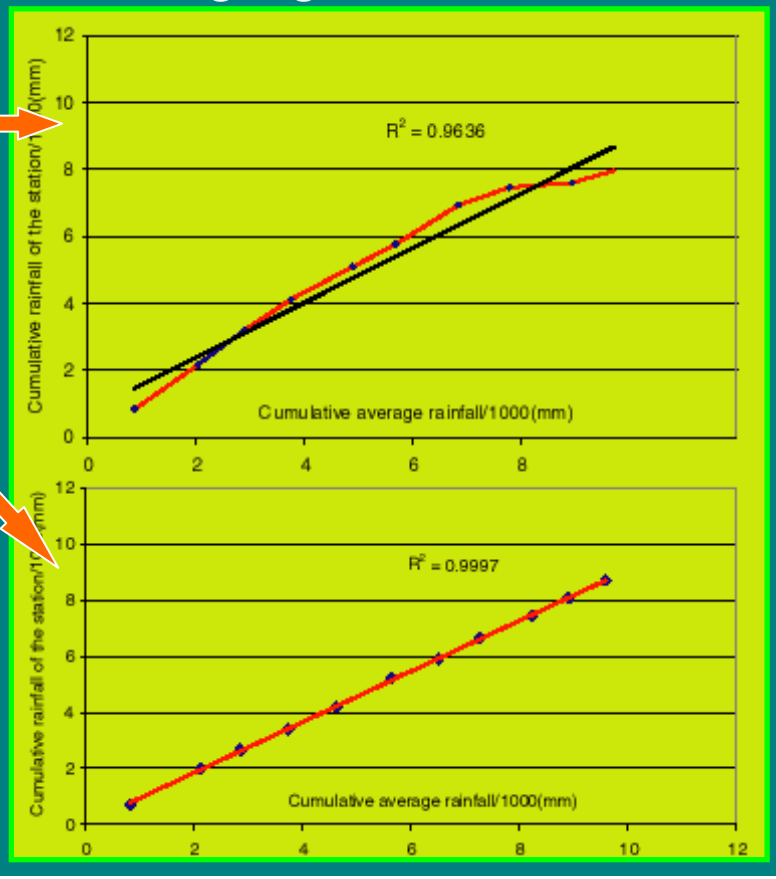
Closest 5 rain-gauge stations for each station were calculated. 245 stations were available for analysis.

Double-mass curves were obtained for 1980 through 1990 and goodness of straight-line fit was calculated using chi-square fitting algorithm.

Range of R^2	Number of data sets
0.94 - 0.95	1
0.95 - 0.96	4
0.96 - 0.97	2
0.97 - 0.98	3
0.98 - 0.99	26
0.99 – 1.0	209

Tabulated Results

Two examples



This analysis is used as a convenient way of locating possible 'bad' record sets.

An application of the Simulation system

- A simple storage based distributed model (Herath et.al., 1995) was linked to the system to assess its workability.
- Trial simulations were performed for Ebi-river basin.
- Simulation period 1992-1995
- Data : Hourly rainfall records, potential evaporation data daily values distributed hourly.

Ebi- river basin, Japan

Demo 2 : Simulation Interface

- Contents :
  - How model is set-up
  - The model results

(Live version made a detour here to demonstrate the above ponts.)

Conclusions

- Database approach is able to capture hydrological processes in terms of data and algorithms
- Existing simulation models can successfully utilised to provide simulation services for a network based hydrological information system
- WWW interfacing allows the remote users to gain access to hydrological data and computational resources.
- Linking of data and methods can be organised in hierarchies that are more meaningful for the hydrologist than traditional database relations.

Epilogue

- During the two years since implementation of this system, there has been an explosive growth of internet tools as well as database technology. Many requirements of this system are now commercially available!
- Today there are many alternative sets of tools, for this type of projects. Even for FREE!
- Last several years have seen a number of operational projects that utilize database technology to disseminate hydrological information on the Internet.

The contribution from the work

- *Resources:*
  - A prototype hydrological database which is operation
  - A simulation interface that can be used as it is to run any grid based distributed simulation model.
- *Knowledge:*
  - How to organize hydrological data and models in more hydrologically sensible way and how to implement that concept on top of a traditional relational environment.
  - It is possible to do hydrological simulations on the WWW, for multiple users, still using models written in the conventional way.