

SwatCube

An OLAP approach for Managing Swat Model results

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Introduction

- Data Warehouse and On-line Analytical Processing (OLAP) technology is being used in
 - financial services, retail and other market oriented applications
- Application in Water Resources management is comparatively new
- OLAP has been used for analysis and visualization of SWAT Model results to support high performance querying

Need

- Analyzing SWAT output presents a challenge because of large data volumes generated that are not conducive to fast data analysis and retrieval
- OLAP server facilitates the rapid and flexible exploration and complex analysis of SWAT model results stored in the data warehouse which is typically modelled using *multidimensionality*

On-Line Analytical Processing(OLAP)

- Traditional **RDBMS** are a **two dimensional** structure, which do not allow multidimensional view
- Data warehouse are based on data structure called “**Multidimensional**”. Each dimension represents the **theme of interest**
- In multidimensional model, data is organized as an **n-dimensional cube or hypercube**
- Data Cubes allow you to look at complex data in a simple format
- OLAP has ability to discern new or unanticipated relationships between variables, the ability to identify the parameters necessary to handle large amounts of data, to create an unlimited number of dimensions, and to specify cross-dimensional conditions and expressions”

On-Line Analytical Processing(OLAP) Contd...

- OLAP technology is different from transactional database(OLTP) approach
- The key multidimensional concepts include: **dimensions, members, measures, facts** and **data cubes**
- The common OLAP architecture usually comprises three components:
 - **Multidimensionally structured database,**
 - **OLAP server** and
 - **OLAP client** that accesses the database via the OLAP server

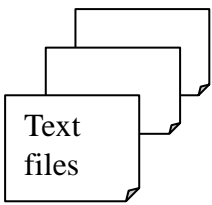
Design And Implementation of SwatCube

Tier 1

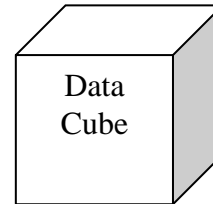
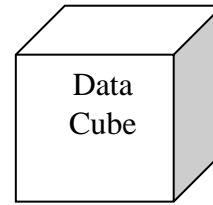
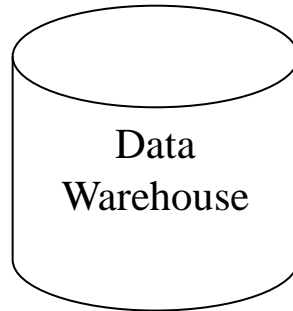
Tier 2

Tier 3

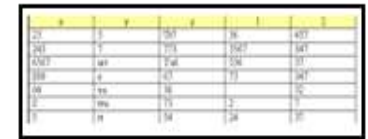
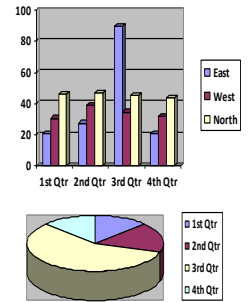
Tier 4



ETL Tools



Report and
Visualazataion



Q1	Q2	Q3	Q4
10	15	20	25
20	25	30	35
30	35	40	45
40	45	50	55
50	55	60	65
60	65	70	75
70	75	80	85
80	85	90	95
90	95	100	105

Swat Model Result

Data Sources

DBMS

OLAP Server

OLAP Clients

Tier 1

ETL is responsible to obtain the data from operational systems or external systems, to converse and clean into a data warehouse according to needed format and form.

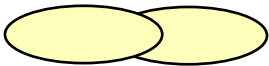
Flat files



Operational Spatial Database



other sources



Data Extraction, Transformation and Loading (ETL)

Data sources include the existing operational system data resources and other external data sources according to requirement of analysis and decision-making

Hydrological data for India from ArcSwat Model has been used as a case

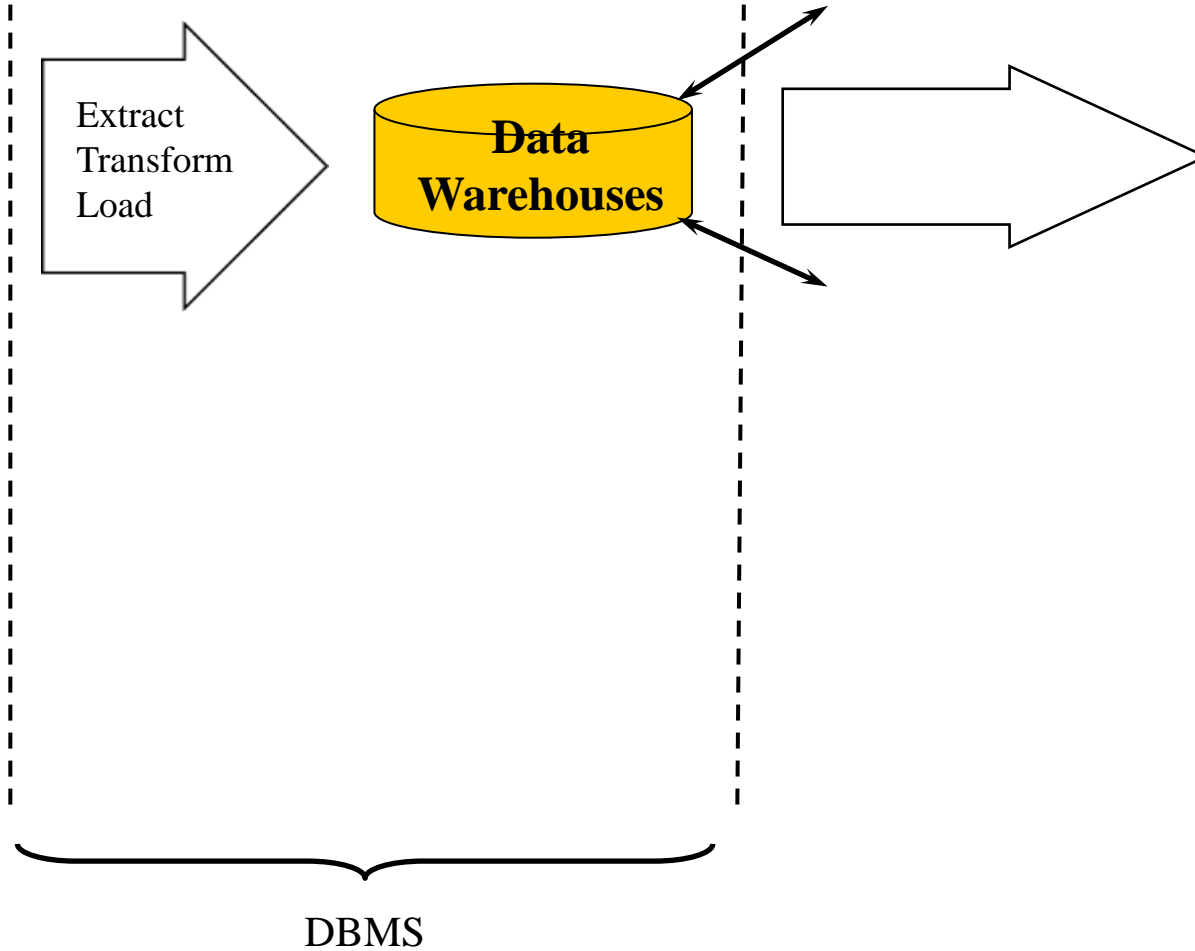


Data Sources

First tier : Data Sources

- SwatCube demonstrates its capability by taking SWAT model generated outputs on the Indian River basins
- SWAT model results have been generated for Indian River basins for observed, baseline, MC and EC scenario for basin to the watershed at the lowest level
 - IMD (Indian metrological Department)
 - A1B (IPCC),
 - A2 and B2 (IPCC)

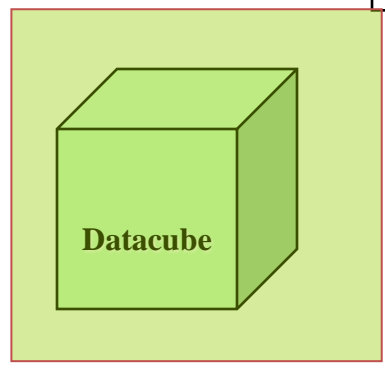
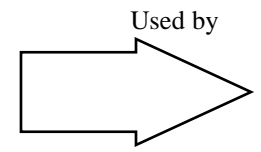
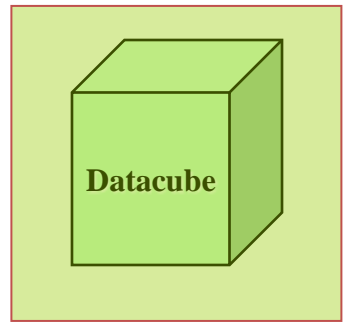
Tier 2



Second tier : Data Warehouse

- The second tier is data warehouse in which data of interest is loaded after being extracted, cleaned, and transformed from tier one
- ETL tool has been used to convert SWAT model generated Reach and SubBasin monthly and daily results as a text files into CSV format
 - CSV data uploaded in data warehouse by using used SQL Server Integration Services (SSIS)
- According to data warehouse flexibility only daily data for watershed hydrological unit of SWAT model result has been uploaded in warehouse.
 - Time is by day and space is by watershed.
 - Furthermore, time is summarized by week, month and year

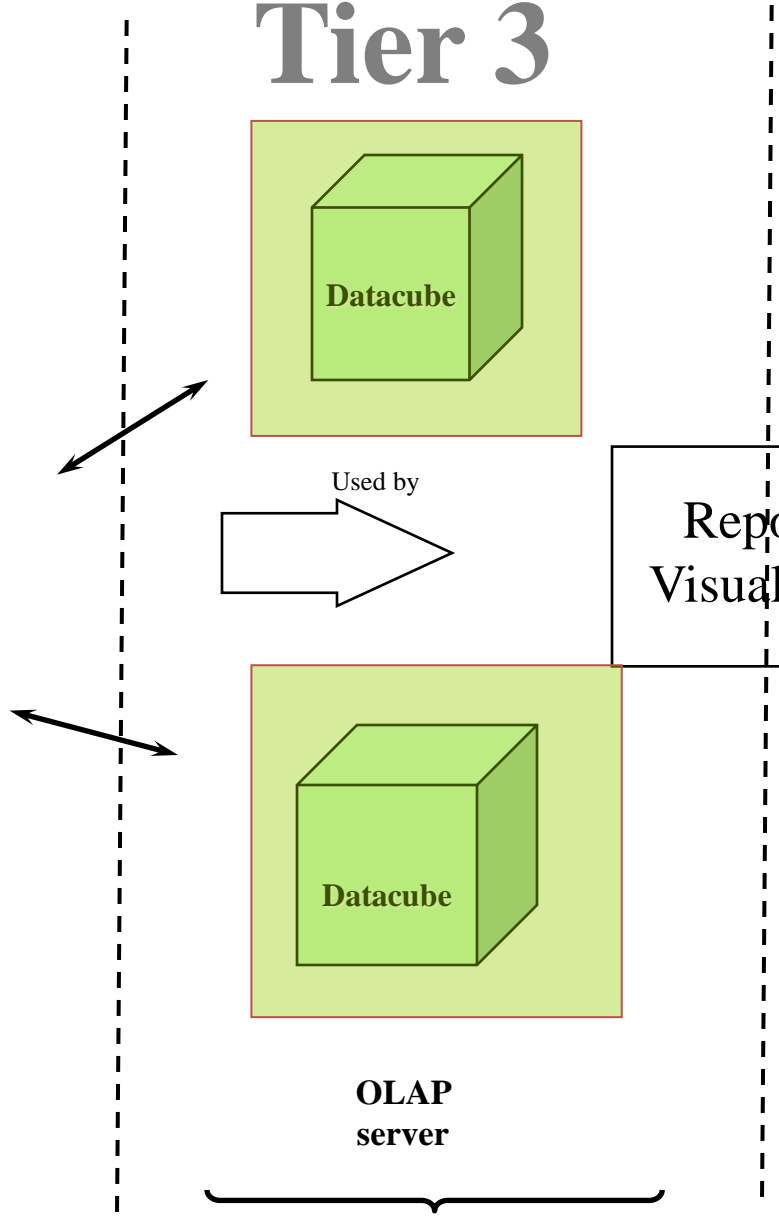
Tier 3



**OLAP
server**



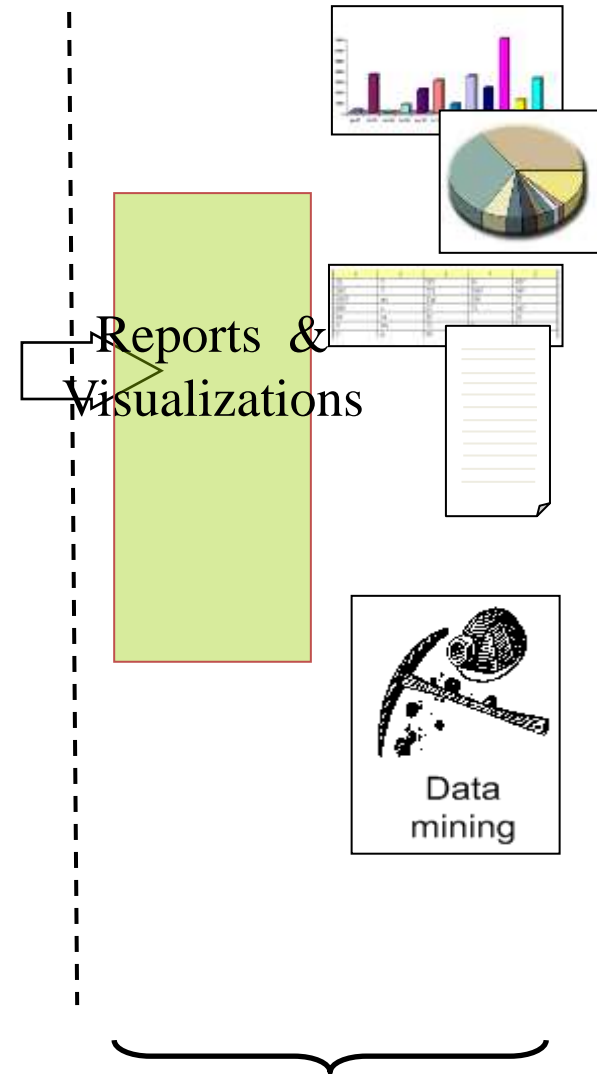
OLAP



Third tier : OLAP Server

- The OLAP data cube is generated according to the logical model of data warehouse
- A SQL Server Analysis services provide full fledged OLAP functionalities based on multidimensional data model

Tier 4



Clients (Front-End Tools)

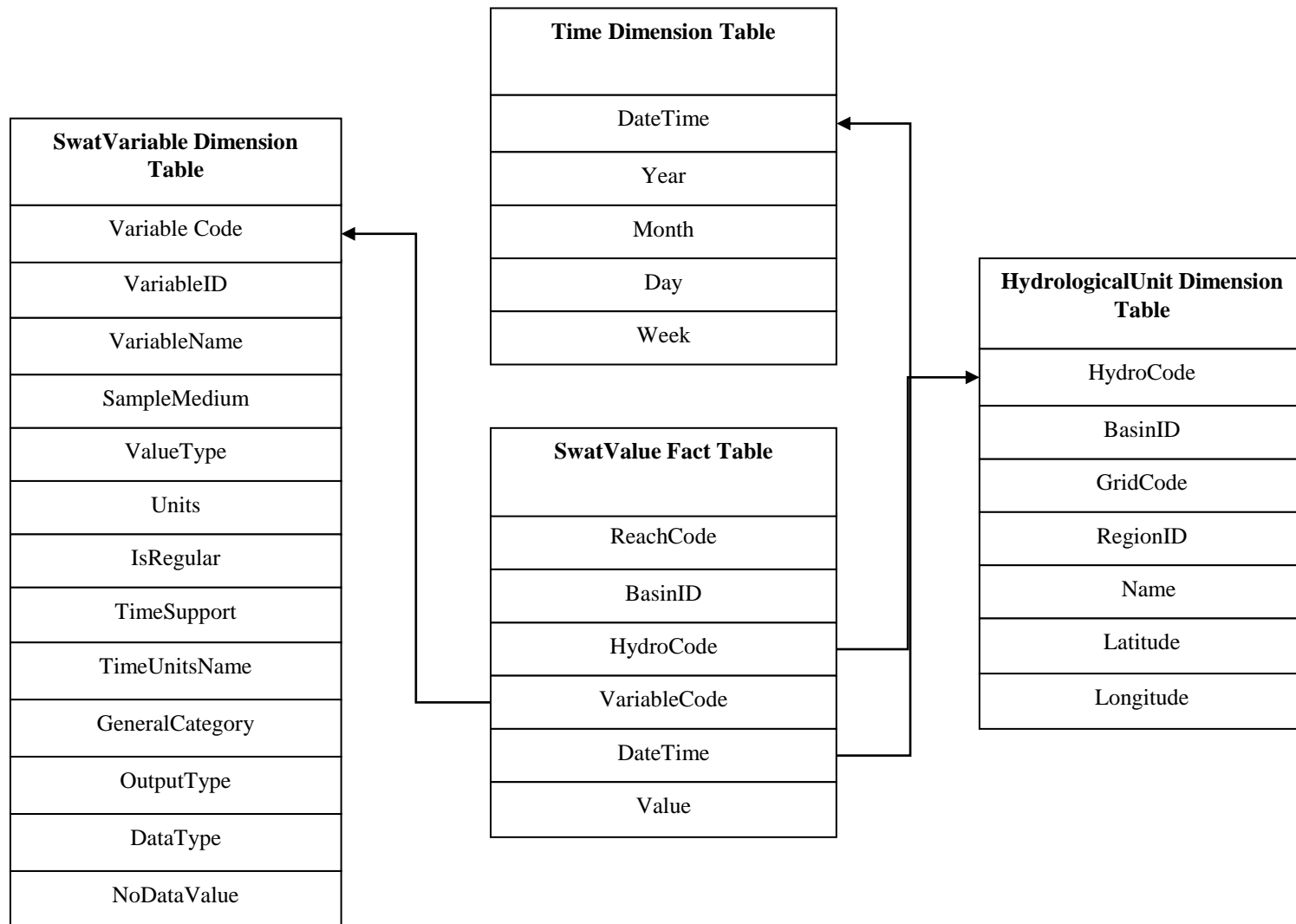
Fourth tier : OLAP client

- The fourth tier is an OLAP client which provides user interface for reporting, interactive analysis and/or data mining
- allows the user to explore and analyze the data using different operators such as drill-down, roll-up, drill-across and swap
- ASP.NET technology has been used to create user interface which accesses SQL Server Analysis Services (SSAS) using ADOMD.NET Client dynamic link library and reads cube metadata like dimensions, hierarchies and levels

DATABASE DESIGN METHODOLOGY

- SwatCube uses a *star schema* to represent the multidimensional data model. The database consists of a single fact table and a single table for each dimension
- Each tuple in the fact table consists of a pointer (foreign key – often uses a generated key for efficiency) to each of the dimensions that provide its multidimensional coordinates, and stores the numeric measures for those coordinates
- Each dimension table consists of columns that correspond to attributes of the dimension

Star schema organization of the multidimensional data



Demo of SwatCube

<http://gisserver.civil.iitd.ac.in/swatcube>

Conclusions and Future Work

- The present work uses OLAP to analyse SWAT model result output to allow rapid analysis and easy navigation
- Data warehouse and OLAP can be path breaking technology in Water Resources management
- Number of Dimension can be added to any extent
- Lined up work include Spatial Online Analytical Processing (SOLAP) in current prototype which will provide huge advantage in complex analysis
- SOLAP will be coupling GIS, Data Warehouse (DW) and OLAP technology

Thank You