Development of Web-GIS based SWAT Data Generation System

Presented by

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#01. Introduction

#02. Objectives

#03. System Application

#04. Results

#05. Conclusions
Introduction

- The first step for simulating SWAT models: Collecting watershed topographical and meteorological data

- Traditional manual methodologies: Time-consuming process
  - Human error and cost problems
  - Require technical expertise
Introduction

- Real time Web-based GIS have risen due to the burdens of input data gathering and processing.
- Useful way to serve scattered potential users.
- Requires acceptable speed and accuracy.
- A large amount of spatial data processing and display.
- Overcome network bandwidth limitations to provide acceptable access time.
Objectives

- Development of Web-based GIS that was developed to support SWAT model operation
  - using Web-GIS capability for map browsing
  - online watershed delineation
  - topographical (spatial) and meteorological data extraction in real time
Study Area

- Study location map
- Seven counties and watersheds around Paldang lake in Korea
## 2010 International SWAT Conference & Workshops

### Data preparation

#### Operational requirements of input data for SWAT

<table>
<thead>
<tr>
<th>Data classification</th>
<th>Data description</th>
<th>File format</th>
</tr>
</thead>
<tbody>
<tr>
<td>geodatabase</td>
<td>SWAT database</td>
<td>access file</td>
</tr>
<tr>
<td>tables and text files</td>
<td>watershed inlet location table</td>
<td>dBase</td>
</tr>
<tr>
<td></td>
<td>usersoil (attribute of soil texture)</td>
<td>dBase or ASCII</td>
</tr>
<tr>
<td></td>
<td>userwgn (attribute of meteorological station)</td>
<td>dBase or ASCII</td>
</tr>
<tr>
<td></td>
<td>land use lookup table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>soil lookup table</td>
<td></td>
</tr>
<tr>
<td>spatial data sets</td>
<td>DEM</td>
<td>ESRI grid format</td>
</tr>
<tr>
<td></td>
<td>land use</td>
<td>ESRI grid format or shapefile</td>
</tr>
<tr>
<td></td>
<td>soil texture</td>
<td></td>
</tr>
<tr>
<td>weather data sets</td>
<td>weather generator data (location of meteorological station)</td>
<td>dBase</td>
</tr>
<tr>
<td></td>
<td>daily precipitation data table</td>
<td>dBase or ASCII</td>
</tr>
<tr>
<td></td>
<td>temperature data table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>relative humidity data table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>solar radiation data table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>wind speed data table</td>
<td></td>
</tr>
</tbody>
</table>
Digital maps constructed for the system development

- (a) DEM, (b) land use map, (c) soil map

<table>
<thead>
<tr>
<th>Data set</th>
<th>Source</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEM</td>
<td>1 : 25,000 NGIS digital map</td>
<td>altitude</td>
</tr>
<tr>
<td>land use</td>
<td>National Geographic Information Institute land use</td>
<td>8 land use categories¹</td>
</tr>
<tr>
<td>soil texture</td>
<td>generated from Rural Development Administration soil map</td>
<td>184 soil texture categories²</td>
</tr>
<tr>
<td>weather data</td>
<td>Korea Meteorological Administration</td>
<td>mean temperature, precipitation, wind velocity, relative humidity, sunshine duration</td>
</tr>
</tbody>
</table>

¹ URBN, RICE, AGRL, FRST, BERM, WETL, BARL and WATR (land use class of SWAT)
² AnC, AnD, ArB, ArC, BoB, BoC2, SuB, SuC, YJB, YJC, YI etc. (soil class of SWAT)
Generation of SWAT input data sets from the system

- **The weather data collection system**

  - From the Korean Meteorological Administration web site (http://www.kma.go.kr)
  - Real-time daily weather data (*.dbf): precipitation, mean temperature, wind velocity, sunshine duration, relative humidity

- **SWAT database**

  - **Attribute file of soil map**: usersoil
  - **Attribute file of weather station**: userwgn
System outline

Client

Web Browser

Internet

Middleware

HTML

JavaScript

Graphical User Interface

Web Server

- MapServer

Server Side Application

Execution Application

- Watershed Delineation System
- Topographical Data Extraction System
- Meteorological Data Extraction System

File Management

Spatial Data

Server

- Watershed Selection
- Outlet Point Selecting
- Map Control, Query
Detail description of the Web-GIS for SWAT data generation system

Client Side

Web-GIS user interface
- Watershed outlet point selection

Result HTML page
- Result watershed display
- Result extracted spatial data (DEM, land use, soil texture) display
- Extracted SWAT input data and meteorological data download

Server Side

Web-based GIS for SWAT data generation system

Watershed delineation system
- Double-seed array-replacement algorithm (Choi et al. 2003)

Watershed generation

SWAT input data extraction system
- Grid computation

Meteorological data extraction system

Database

DEM (Digital Elevation Model)
- Sink filled DEM

Sink filling function
- Flow direction map
- Stream line map

Spatial SWAT input data
- DEM
- Landuse data
- Soil texture data

SWAT attribute data
- Usersoil, userwgn
- Landuse, soil lookup table
- SWAT database

Meteorological data
- Mean temperature
- Precipitation
- Wind velocity
- Relative humidity
- Sunshine duration
Graphical user interface of the SWAT data generation system

URL: http://ruralwater.snu.ac.kr/16_swat/index_swat.html
Extracted spatial data for the four different watersheds
With delineated watershed containing DEM and land use
Download page for the extracted SWAT input data
Including spatial and weather data

### 1. SWAT Database

<table>
<thead>
<tr>
<th>SWAT MDB File (.mdb)</th>
<th>Usersoil File (.xls)</th>
<th>Userwgn File (.xls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWAT MDB file</td>
<td>Usersoil file</td>
<td>Userwgn file</td>
</tr>
</tbody>
</table>

### 2. Input GIS Data

<table>
<thead>
<tr>
<th>Data Classification</th>
<th>ASCII GRID File (.asc)</th>
<th>Data File (.dbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIS 좌표 파일</td>
<td></td>
<td>Coordinates_file</td>
</tr>
<tr>
<td>수치고도모델 (DEM)</td>
<td>DEM ASCII file</td>
<td>Landuse DBF file</td>
</tr>
<tr>
<td>토지이용도</td>
<td>Landuse ASCII file</td>
<td>Soil DBF file</td>
</tr>
</tbody>
</table>

### 3. Weather Data

<table>
<thead>
<tr>
<th>Data Classification</th>
<th>Data File (.dbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>기상관측소</td>
<td>Weather Generator Data DBF file</td>
</tr>
<tr>
<td>강수량</td>
<td>Rainfall Data DBF file</td>
</tr>
<tr>
<td>온도</td>
<td>Temperature Data DBF file</td>
</tr>
<tr>
<td>상대습도</td>
<td>Relative Humidity Data DBF file</td>
</tr>
<tr>
<td>일조시간</td>
<td>Solar Radiation Data DBF file</td>
</tr>
<tr>
<td>풍속</td>
<td>Wind Speed Data DBF file</td>
</tr>
</tbody>
</table>

### 4. Watershed and Outlet GIS Data

<table>
<thead>
<tr>
<th>Data Classification</th>
<th>Shape File (.shp)</th>
<th>Dbf File (.dbf)</th>
<th>Shx File (.shx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watershed Line</td>
<td>Watershed SHP file</td>
<td>Watershed DBF file</td>
<td>Watershed SHX file</td>
</tr>
<tr>
<td>Outlet</td>
<td>Outlet SHP file</td>
<td>Outlet DBF file</td>
<td>Outlet SHX file</td>
</tr>
</tbody>
</table>
Application of ArcSWAT using extracted SWAT data
Comparison of application of ArcSWAT input data sets between preparing ArcSWAT input data and Web-GIS based SWAT data generation system

User preparing ArcSWAT input data sets
- Multiple step

Data collection or preparation

Preparing ArcSWAT input data
1. ArcSWAT spatial data sets
   - DEM, Land use, Soil
   - User-defined watersheds

2. ArcSWAT tables and text files
   - Geodatabase table
   - Watershed inlet location table
   - Land use and soil look up table
   - Weather generator location table
   - Daily precipitation data table
   - Temperature data table
   - Solar radiation data table
   - Wind speed data table
   - Relative humidity data table

Generated ArcSWAT input data sets
- Spatial data sets
- Table and text files

Application of ArcSWAT input data sets

Web-GIS based SWAT data generation system
- Just one step

User Interface and download page
Conclusions

- The system for Web-based GIS SWAT data generation that can be operated in real-time through the Internet was developed.

- The system is comprised of
  - Watershed Delineation System
  - Topographical Data Extraction System
  - Metrological Data Extraction System

Useful to users who are willing to operate SWAT models for the various watershed management purpose in terms of spatial and weather data providing and preparing.
Thank you for your attention

Questions and Comments?

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