

**Applications of Modelling and Web Technologies
for Soil Erosion Assessment
in North Western Region of Vietnam**

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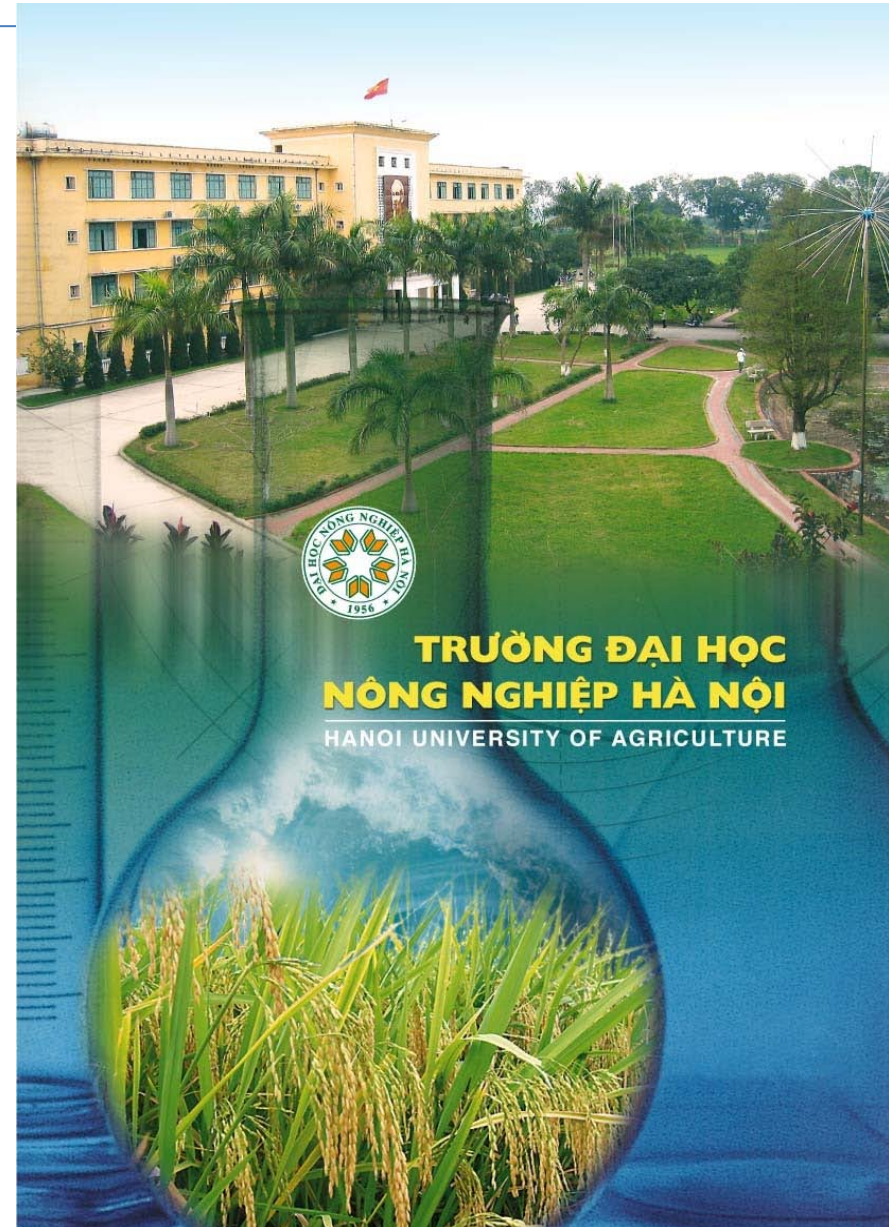
HANOI UNIVERSITY OF AGRICULTURE, HANOI, VIETNAM

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2. **Introduction** to the study
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1. about Hanoi University of Agriculture (HUA)

- HUA was **established in 1956** as VN leading agriculture university
- Number of students in 2010: **23,100 undergraduates and 1,700 graduates**
- **11 faculties** including Fac. of Natural Resources 7 Environment and Fac. of Information Technology
- HUA to be developed into a **multi-specialization education** university



2. Introduction to our Hydrological & Erosion Modeling project

it's an **on-going** research project (**2009-2010**)

main features:

modelling of **hydrology and sediment** transport for the Northwestern region of VN (NW)

uses SWAT (**Soil & Water Assessment Tool, USA**),

erosion risk maps for NW region

dynamic website to disseminate modelling results to the public

it's a **large area** SWAT application which can be extended to the whole of North VN to estimate erosion and sediment transport.

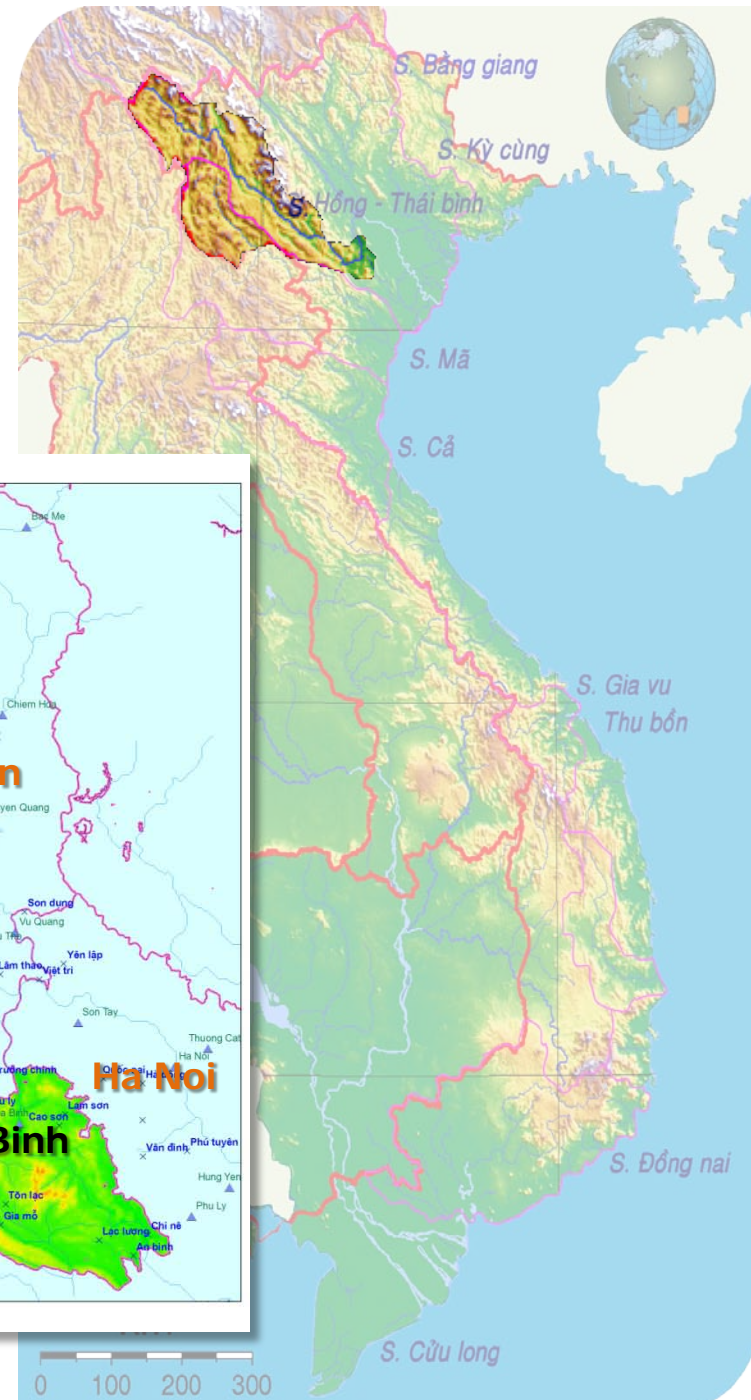
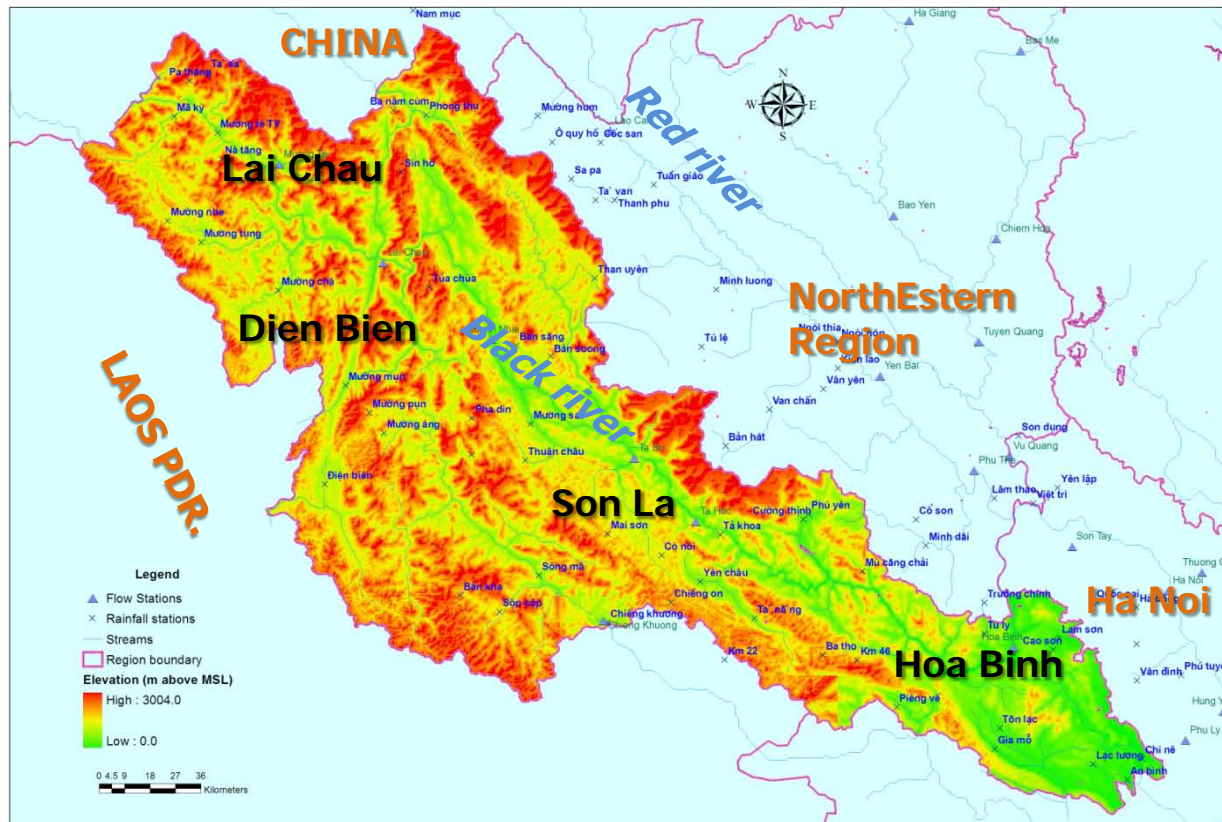
The study area: Northwestern region

Area 38,739 km²,

Mountain,

Poverty,

Soil degradation - Erosion



3. Modeling Study

Software for Soil Erosion Modelling

There are **many softwares available for soil erosion estimation**, empirical formulas: USLE, RUSL2, MUSLE, etc.; or distributed models: WEPP, EPIC, GUEST, CREAMS, EUROSEM, etc.

Distributed or physically-based models

allow simulation of soil loss over time and normally include a hydrological components but require big volume of input data and normally involve GIS interface.

We select **SWAT (Soil and Water Assessment Tool)** which is a semi-distributed model and belongs to open-source software category.

3. Modelling Study

SWAT (Soil and Water Assessment Tool)

maintained by the Agricultural Research Service of the US Department of Agriculture (USDA)

SWAT2005 (Neitsch et al., 2005) is a distributed-parameter model designed to compute long-term runoff and nutrient export from rural watersheds, especially those dominated by agriculture

GIS interfaces available in ArcGIS (ArcSWAt2005) and in OS GIS (MapWindow)

SWAT is being used extensively in the World including MRC to assess the impact of global **climate change** on water supply and quality

<http://swatmodel.tamu.edu/>

Modelling procedure

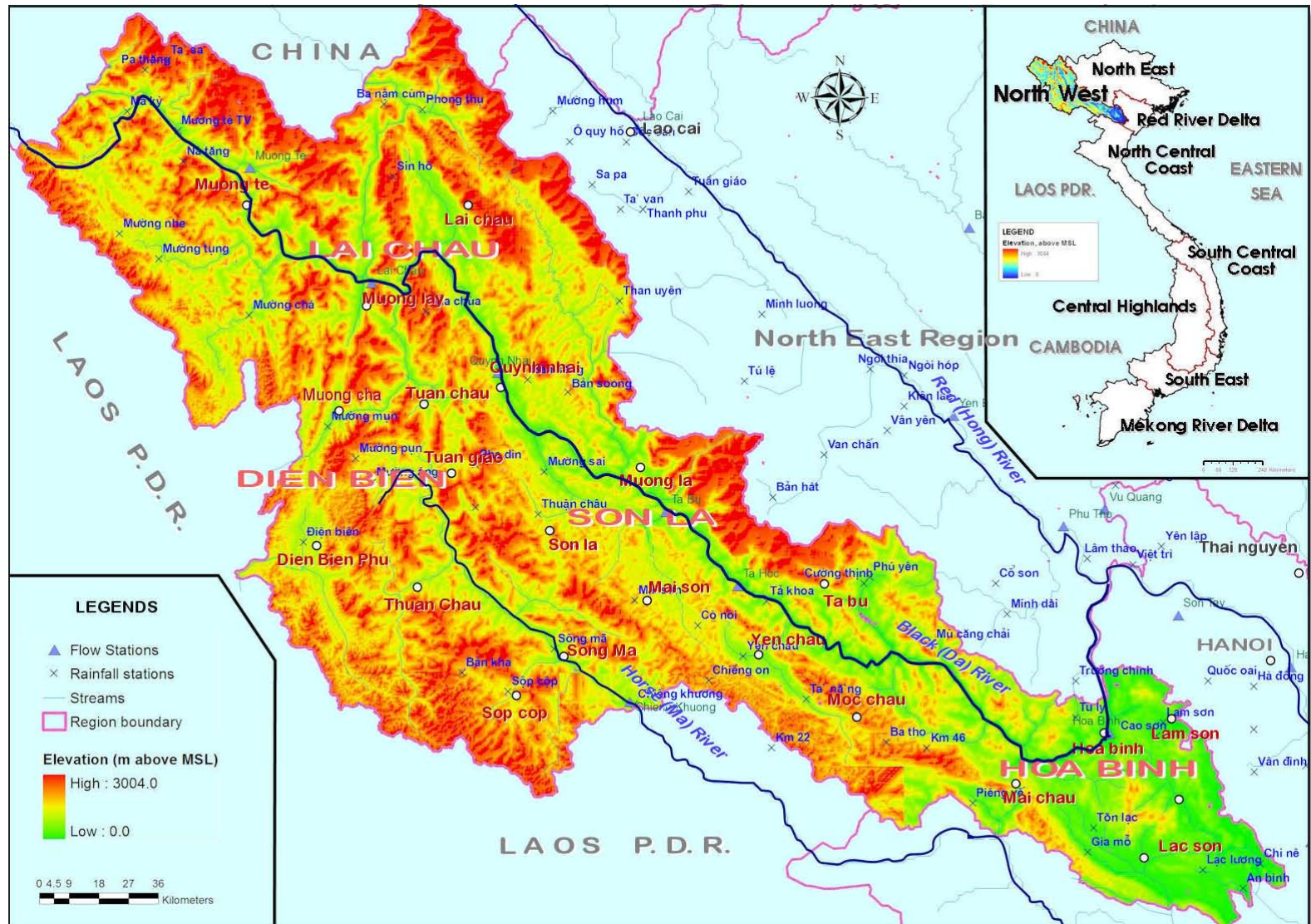
Input Data :

- (a) topography, DEM, 90-m resolution;
- (b) land use, 250-m grid, 1995 data;
- (c) soil grid, 90-m grid, 1995 data;
- (d) climate time series (daily rainfall, monthly solar radiation, air temperature, air humidity, and wind speed);
- (e) agricultural management; and
- (f) hydrological monitoring data (flow data at 5 hydrological stations).

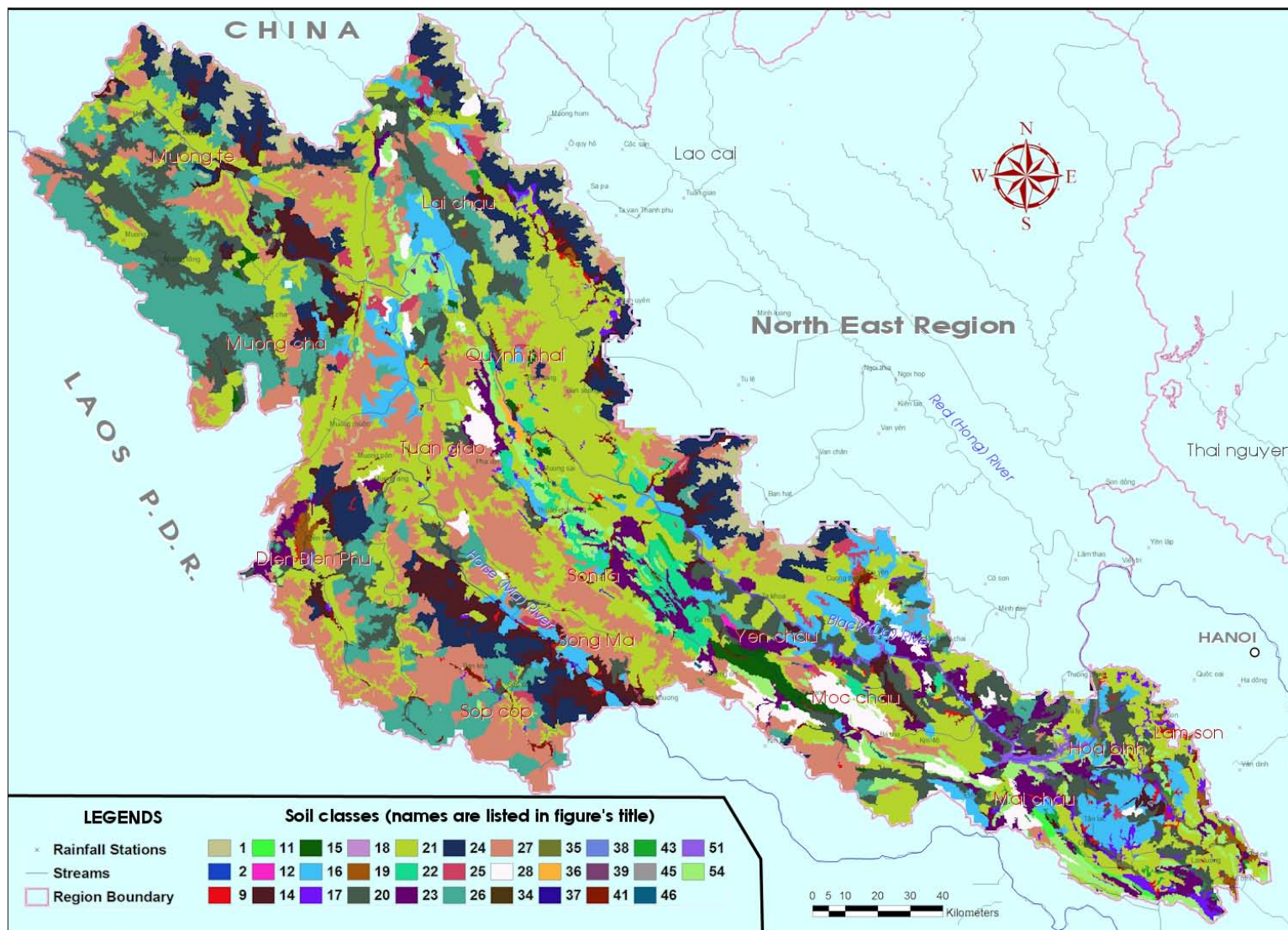
Data Sources:

VN Ministry of natural Resources & Environment (MONRE), derived from MRCS modelling projects (Rossi et al., 2007), and 9-year hillslope research project at Hoa Binh (Ziegler et al., 2007)

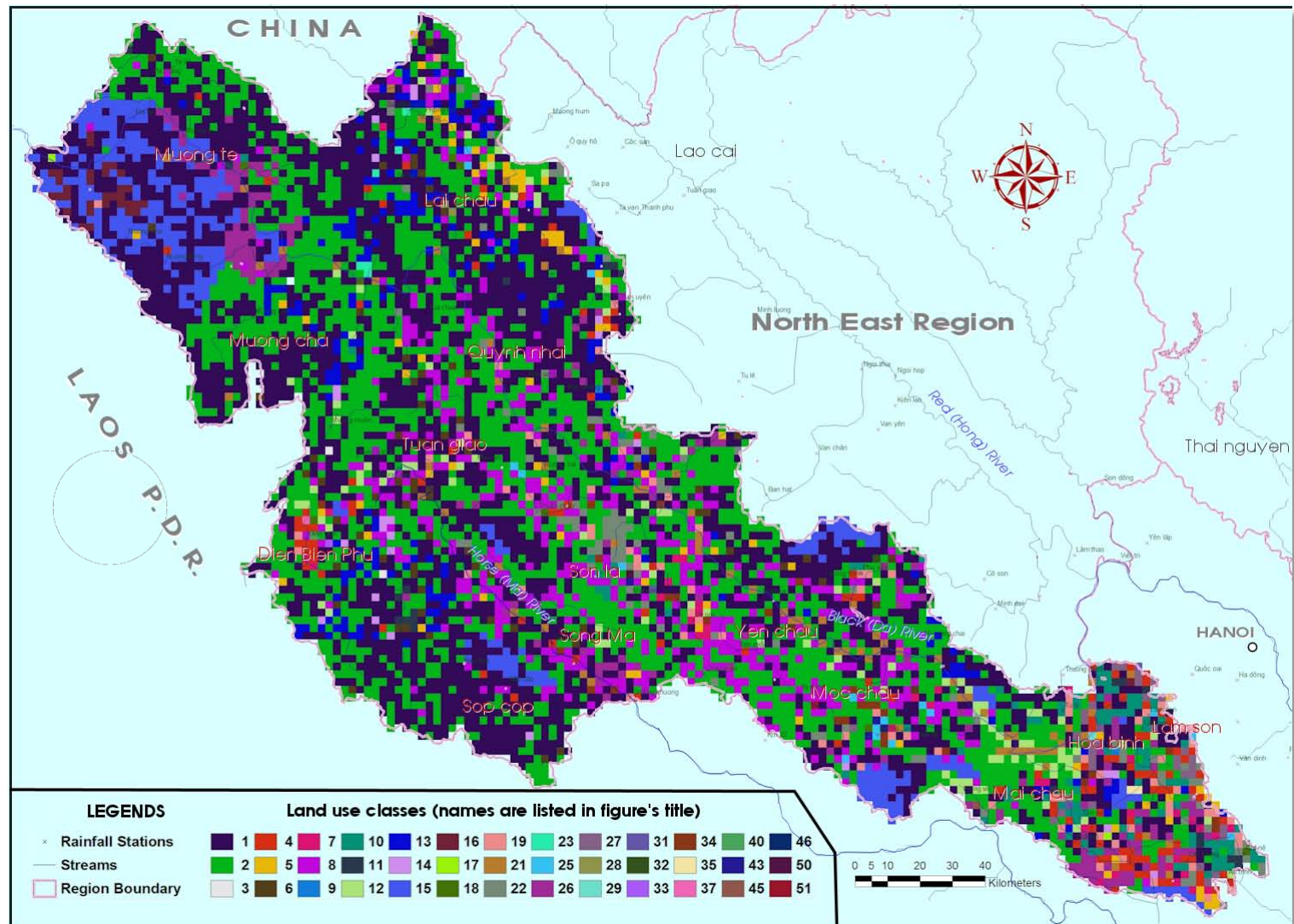
Topography, 90-m grid



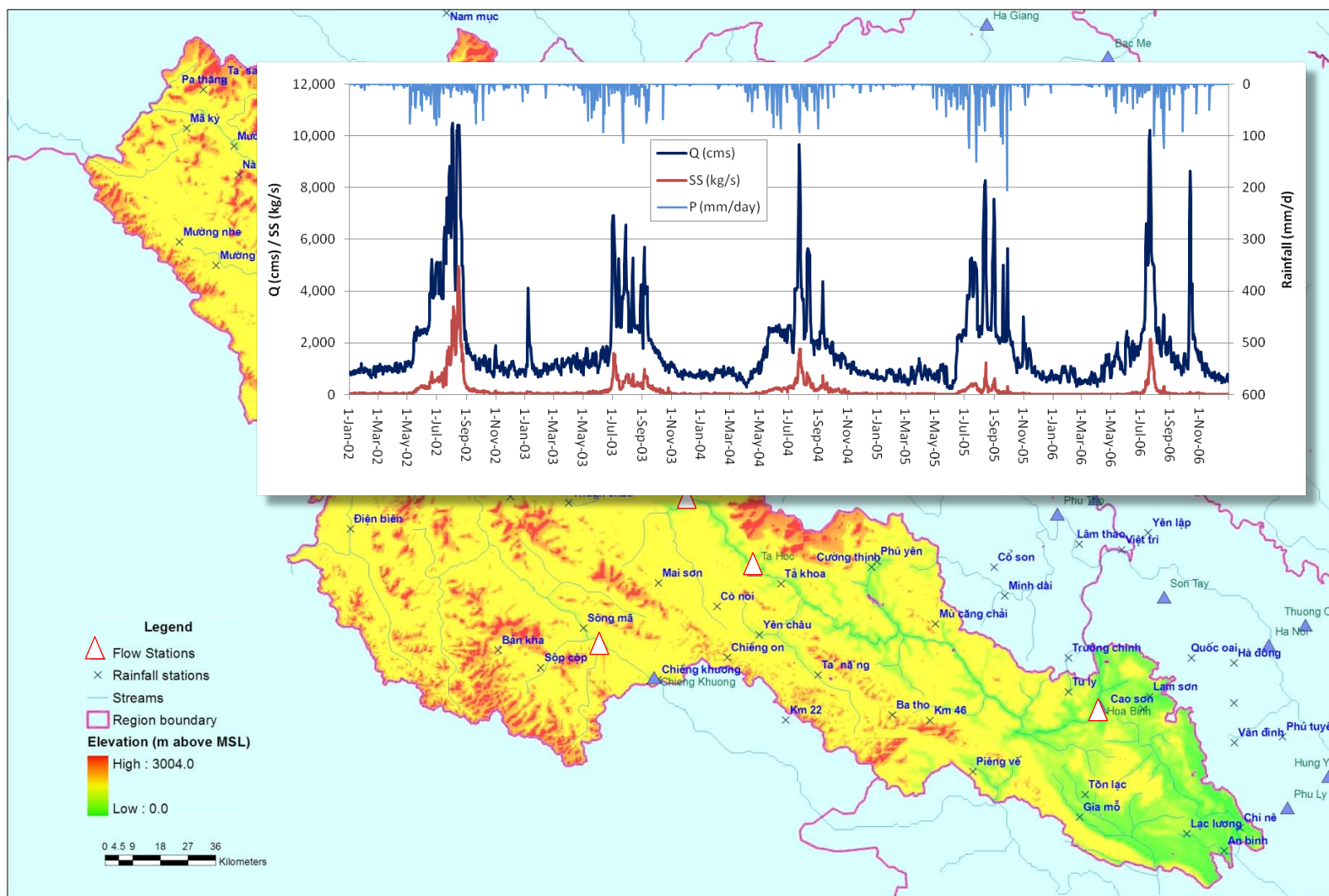
Soil Data



Land use, 250-m grid



Hydrometeorological Data



Modelling procedure (contd.)

Use **ArcSWAT2005**: for configuration and model set-up:

Watershed configuration: 133 sub-basins

Overlay DEM, landuse grid and soil grid in GIS to get hydrological response units (HRUs)

Inputting **climate time series**: 92 rainfall series

Inputting **inflow from China**: assumed based on flow data from Muong Te hydrological station and on manual adjustments (trial-and-error method).

Modelling procedure (contd.)

calibration:

using daily flow monitoring data from hydrological stations during 1998-2005;
fitting simulation flow with measured flow by adjustment of CN, roughness coefficient values;

$$\%Bias = \frac{100 \times \left(\sum_{j=1}^n \text{Simulated}_j - \sum_{j=1}^n \text{Measured}_j \right)}{\sum_{j=1}^n \text{Measured}_j}$$

validation:

using daily flow monitoring data from hydrological stations during 2006-2008;
comparison simulation with measured flow to assess the model performance;

applications: for estimation of flow, soil erosion, sediment delivery for 1997-2008 to produce soil erosion risk maps

Main issues

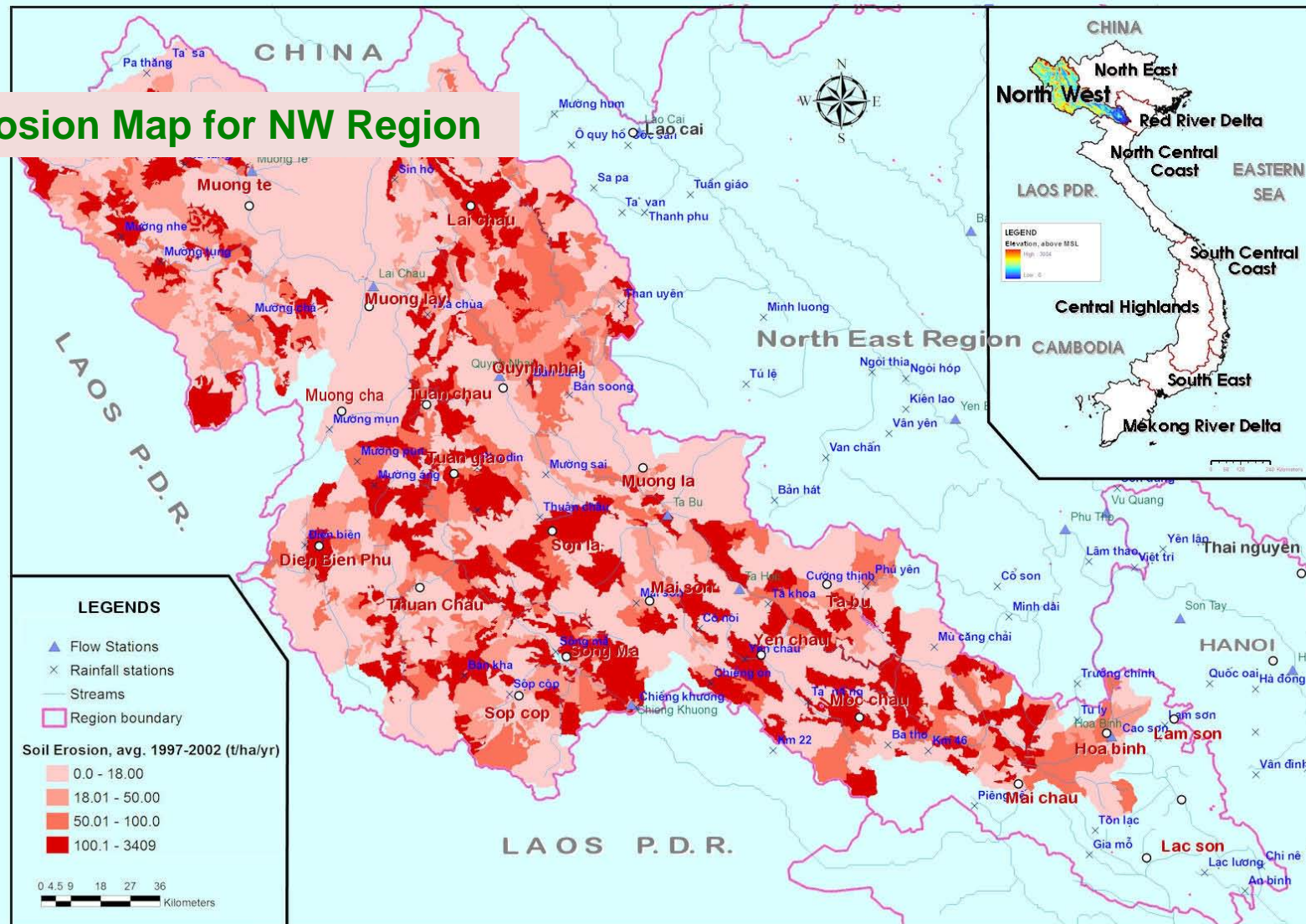
huge amount of data requires skills in GIS (ArcGIS, DEM, dbf, etc.), in programming, in hydrology and soil science (to assess reliability of data), etc.

dealing with changes in time of land use and infrastructures have impacts on monitored flow data.

slope classification in ArcSWAT at present uses only 5 classes. It should allow more classes for soil erosion.

Results

Soil Erosion Map for NW Region



4. Dynamic Website for dissemination of the modeling results

Website is an effective method for **raising CC awareness** (it is available now on mobile phones and we expect it will be easily accessed with mobile phones in a very near future).

There are few websites which allow user to calculate/simulate soil loss:

www.iwr.msu.edu/rusle/

www.nu.edu/landform/

WILSIM Web-based Interactive Landform Simulation Model

Home Beginning User Advanced User

WILSIM NEWS

- Nonlinear version with fractal dimension plot is up!! Check it out under Advanced User!! (9/13/04)
- Snapshots available
- Hypsometric curve available
- Request Source Code
- Stay tuned for current updates!

Other links:
NSF Home
NIU Home
Geography Home
CSCI Home

Welcome to the Web-based Interactive Landform Simulation Model (WILSIM) Website!

WILSIM is designed as an educational tool to help you understand how landforms evolve under different scenarios you select.

Begin your exploration and please don't forget to take the post-test and fill out the user survey.

Enjoy!

Project Team

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4. Dynamic Website for dissemination of the modeling results (contd.)

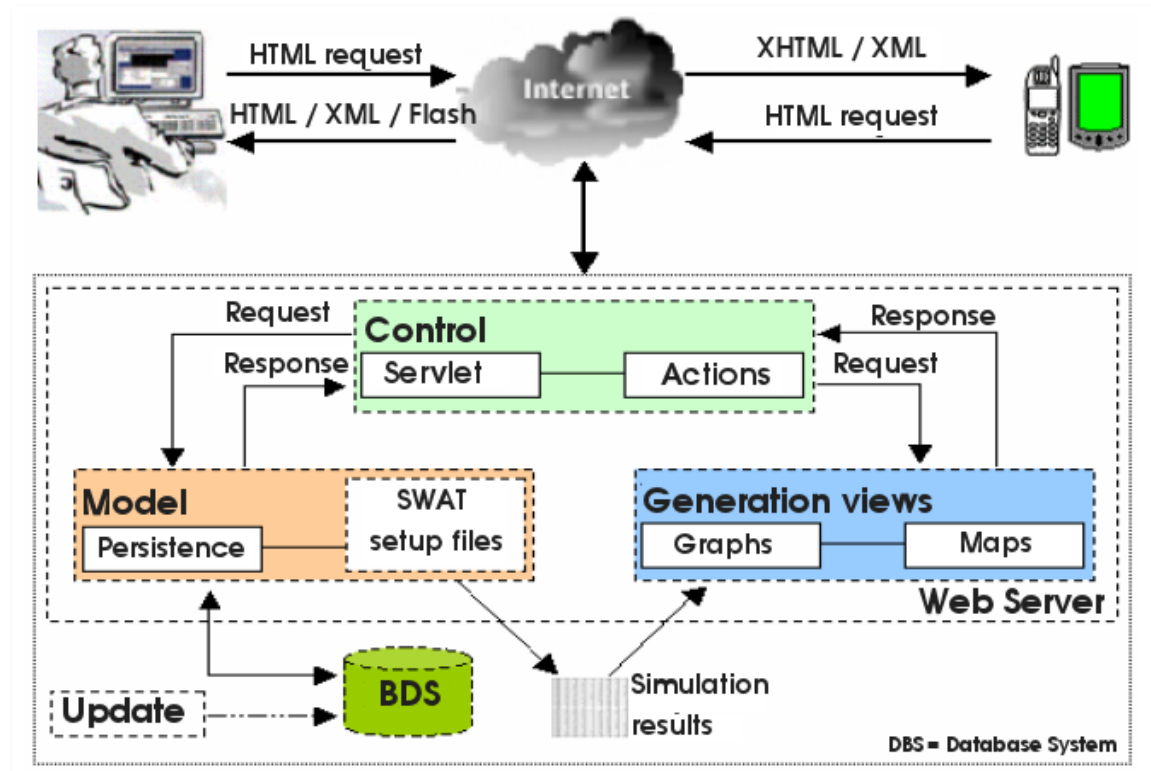
Dynamic web should have (a) interaction with users, 2) dynamic data retrieving, 3) dynamic activation model run, and 4) cost-effectiveness for development (Pavan et al., 2009)

Computer resources for website development:

- (a) PHP programming language;
- (b) Adobe Flash with ActionScripts language, XML and JavaScripts for GIS web component;
- (c) SWAT model set-ups (with ArcSWAT2005) for each of 133 sub-basins;

4. Dynamic Website (contd.)

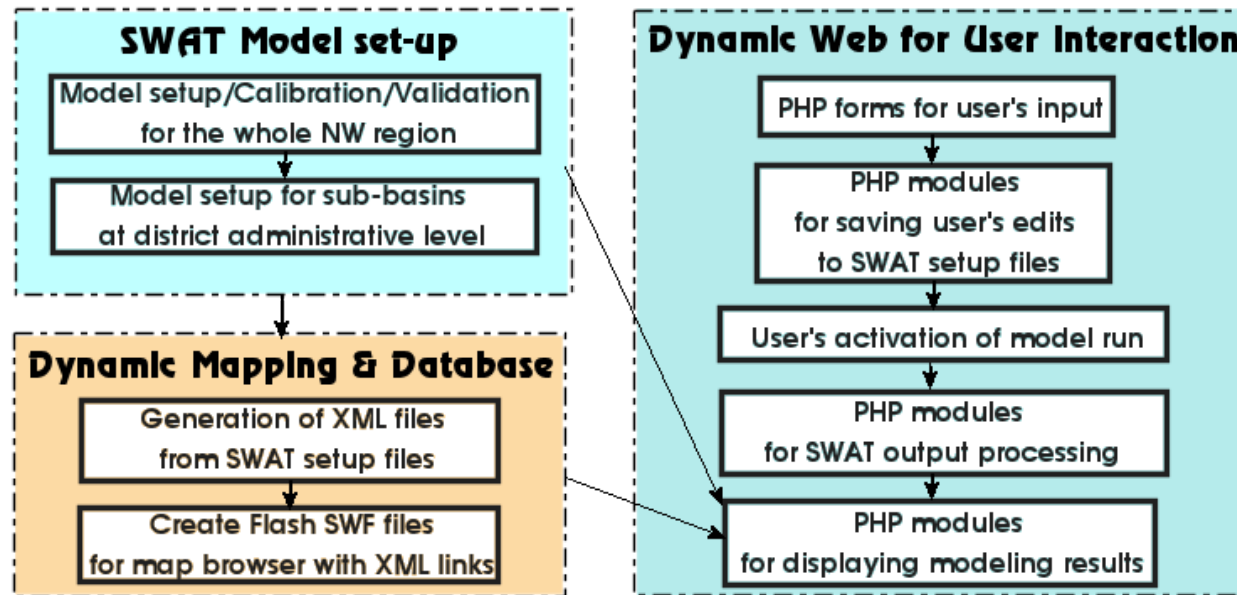
Website Architecture



Adapted from Pavan et al. (2009)

4. Dynamic Website (contd.)

Map/information request and display



Sample **Flash Map**
Map_interactive_facilities1.swf

4. Dynamic Website (contd.)

Dynamic Website

The screenshot displays a web browser window showing the 'Hanoi University of Agriculture: Interactive Modeling' website. The website features a green header with the university's logo and name. The main content area is titled 'Soil Erosion Research' and includes a section for 'Interactive Modeling for the NW region'. This section contains a map of the Northwest region of Vietnam, with a legend indicating different levels of soil erosion risk (Low, Moderate, High, Very High). The website also includes a sidebar with navigation links such as 'About us', 'Erosion Research', 'Research Resources', and 'Support'. A 'Check mail' button is visible in the sidebar. The footer of the website mentions 'Vietnam OpenCourseWare' and provides a URL: www.vocw.edu.vn.

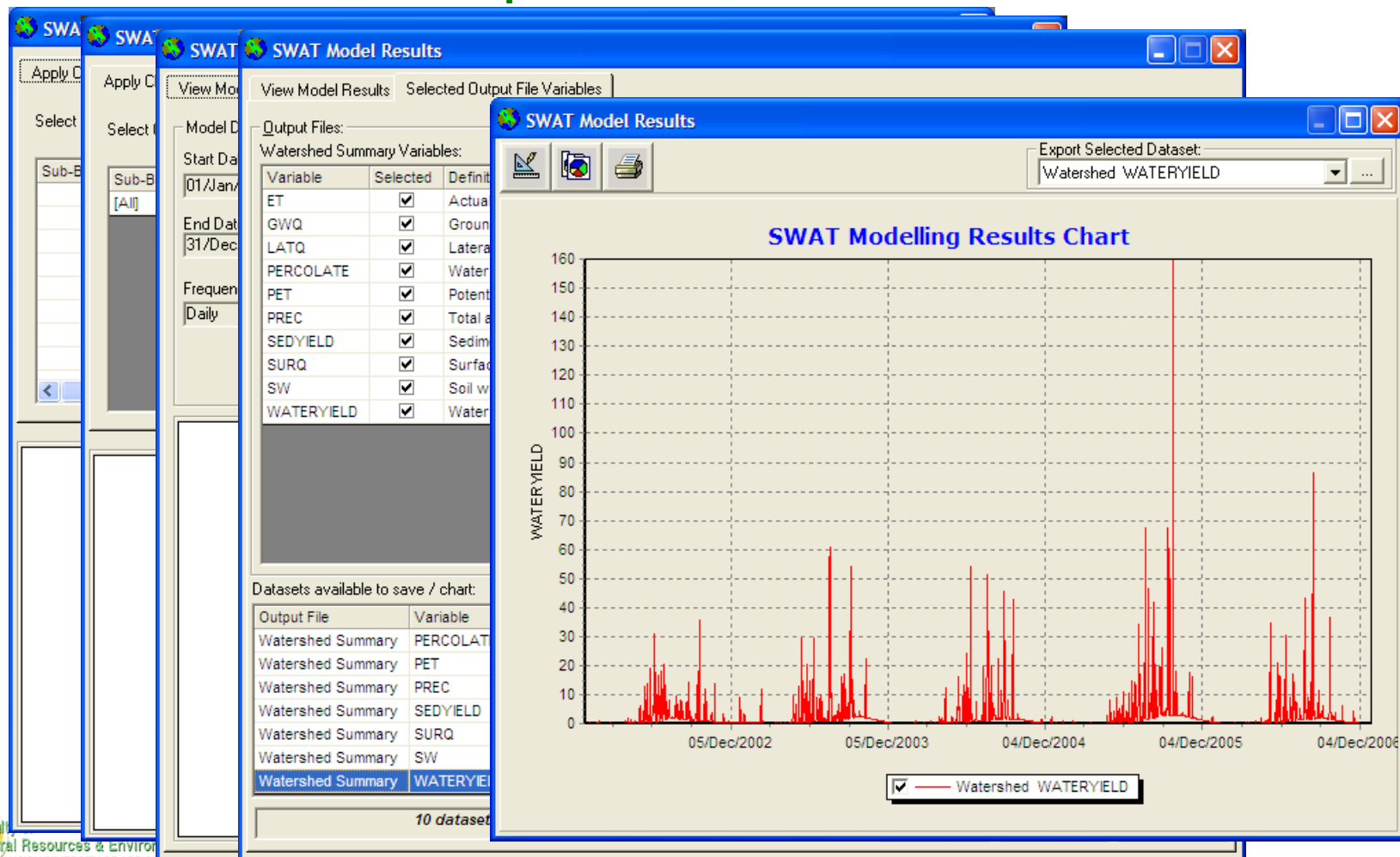
Below the main website window, there are three smaller windows showing different views of the interactive modeling tool:

- ErosionTimeSeries_vie - Mozilla Firefox:** This window shows a map of the Northwest region of Vietnam with a legend indicating different levels of soil erosion risk (Low, Moderate, High, Very High).
- Map_Interactive_erosion_vie - Mozilla Firefox:** This window shows a map of the Northwest region of Vietnam with a legend indicating different levels of soil erosion risk (Low, Moderate, High, Very High).
- Hanoi University of Agriculture: Interactive Modeling - Mozilla Firefox:** This window shows the main website interface, including the header, navigation sidebar, and the main content area with the interactive modeling tool.

In the bottom left corner, there is a logo for the 'Faculty of Natural Resources & Environment' at 'HANOI UNIVERSITY OF AGRICULTURE'.

4. Dynamic Website (contd.)

Interface for User's CC Impact Assessment



5. Conclusions

SWAT model with GIS interface was applied successfully to generate **soil erosion risk maps for Norhtwestern region of VN.**

Model **data requirements** proved to be the main issue for the study

Dynamic website which allows users to evaluate themselves effects of CC on water resources and soil erosion may be an **effective measure for raising public awareness on CC issue**

The concept using **dynamic web may be extended** to other model applications (modelling of the environment, ecology, hydrology, etc.)

Thank you for your attention