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

Nguyen Duy BINH
Faculty of Information Technology
Nguyen Anh TUAN
Hoang Le HUONG
Faculty of Natural Resources & Environment
HANOI UNIVERSITY OF AGRICULTURE, HANOI, VIETNAM

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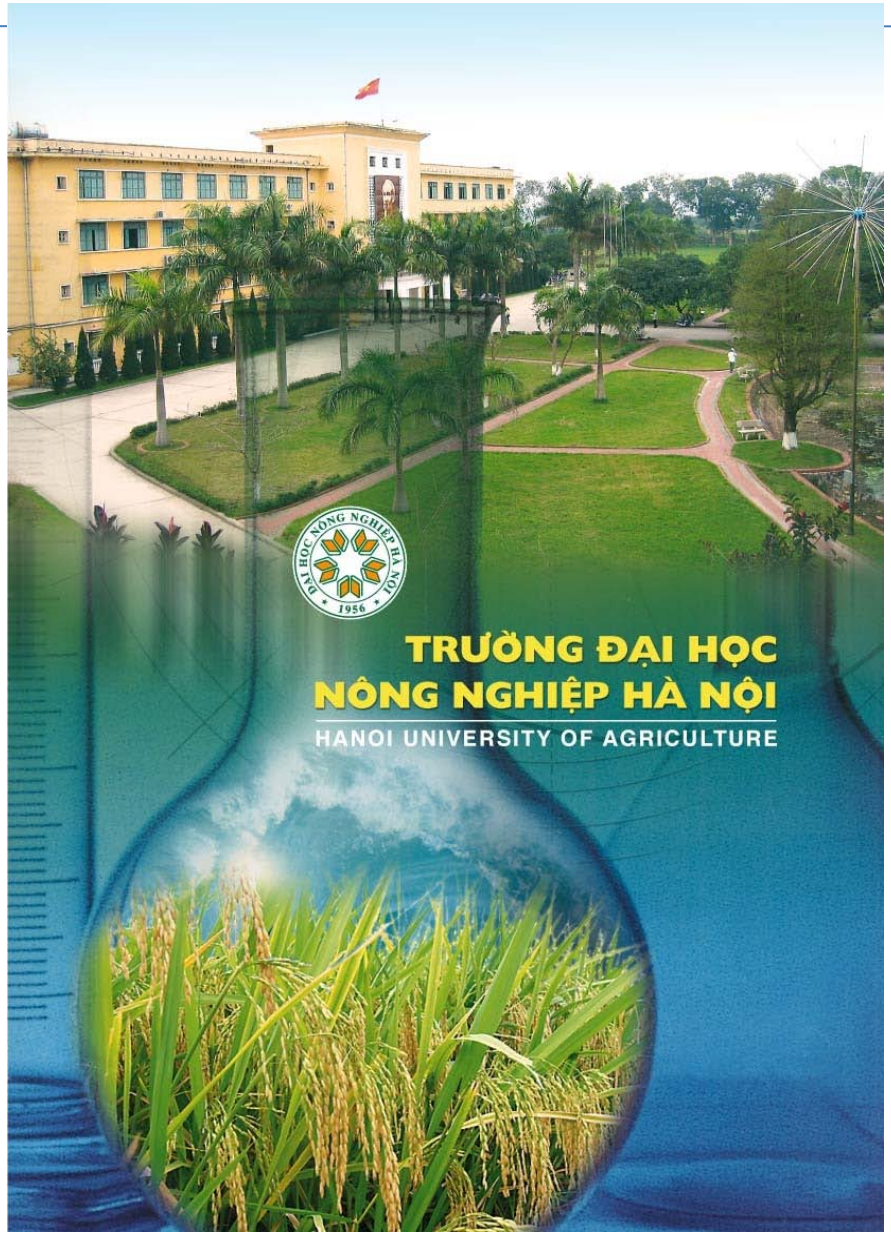
1. about Hanoi University of Agriculture (HUA)

- 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



www.hua.edu.vn

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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.

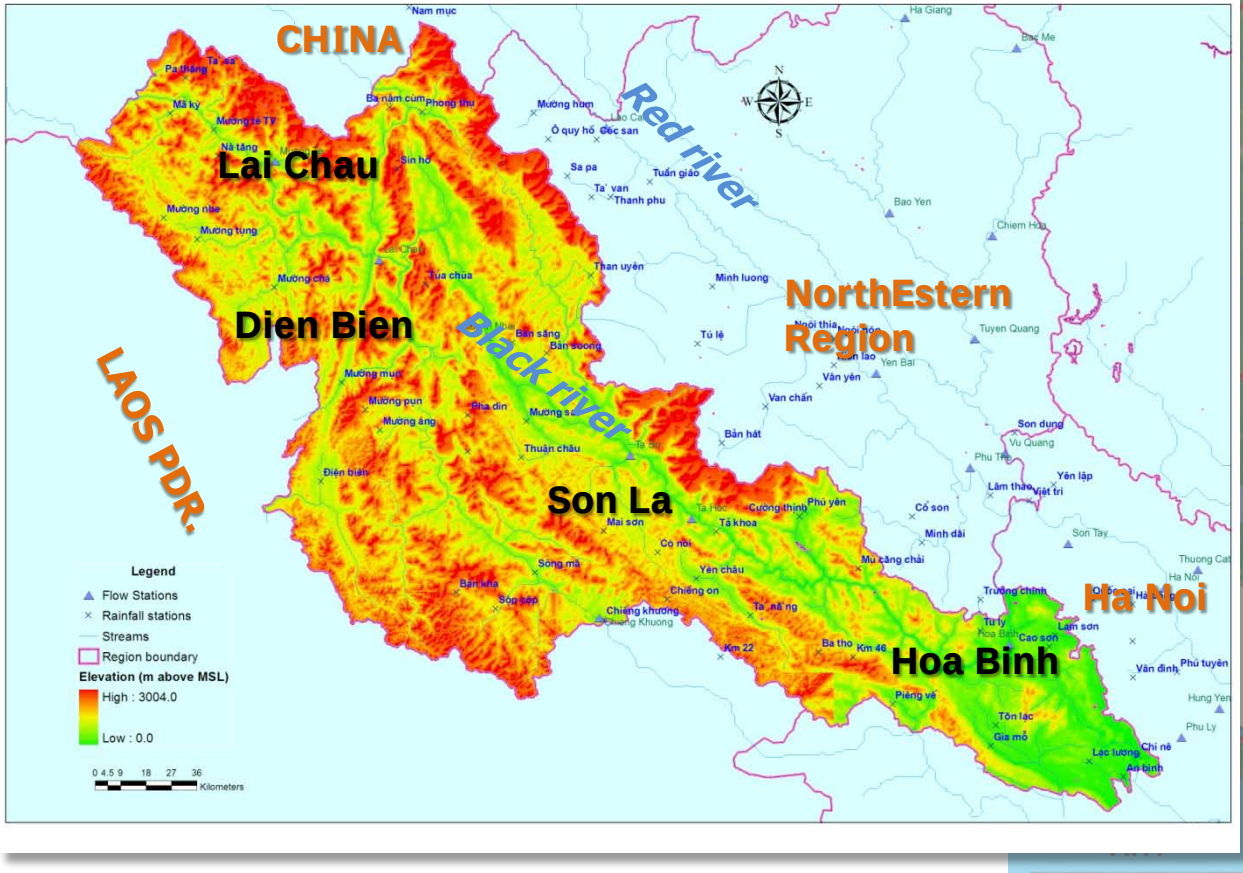
The study area: Northwestern region

Area 38,739 km^2,

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

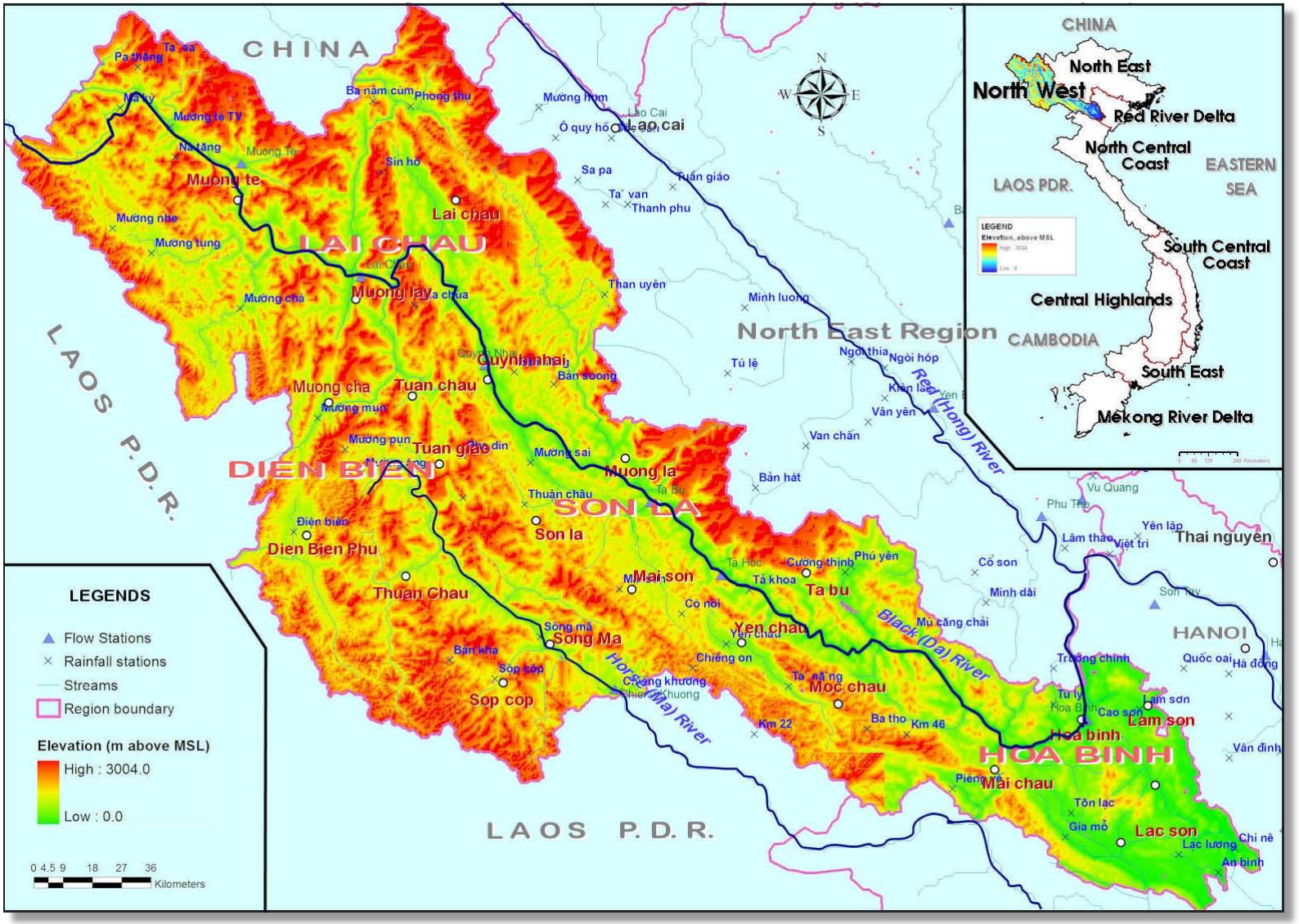
Input Data :

(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).

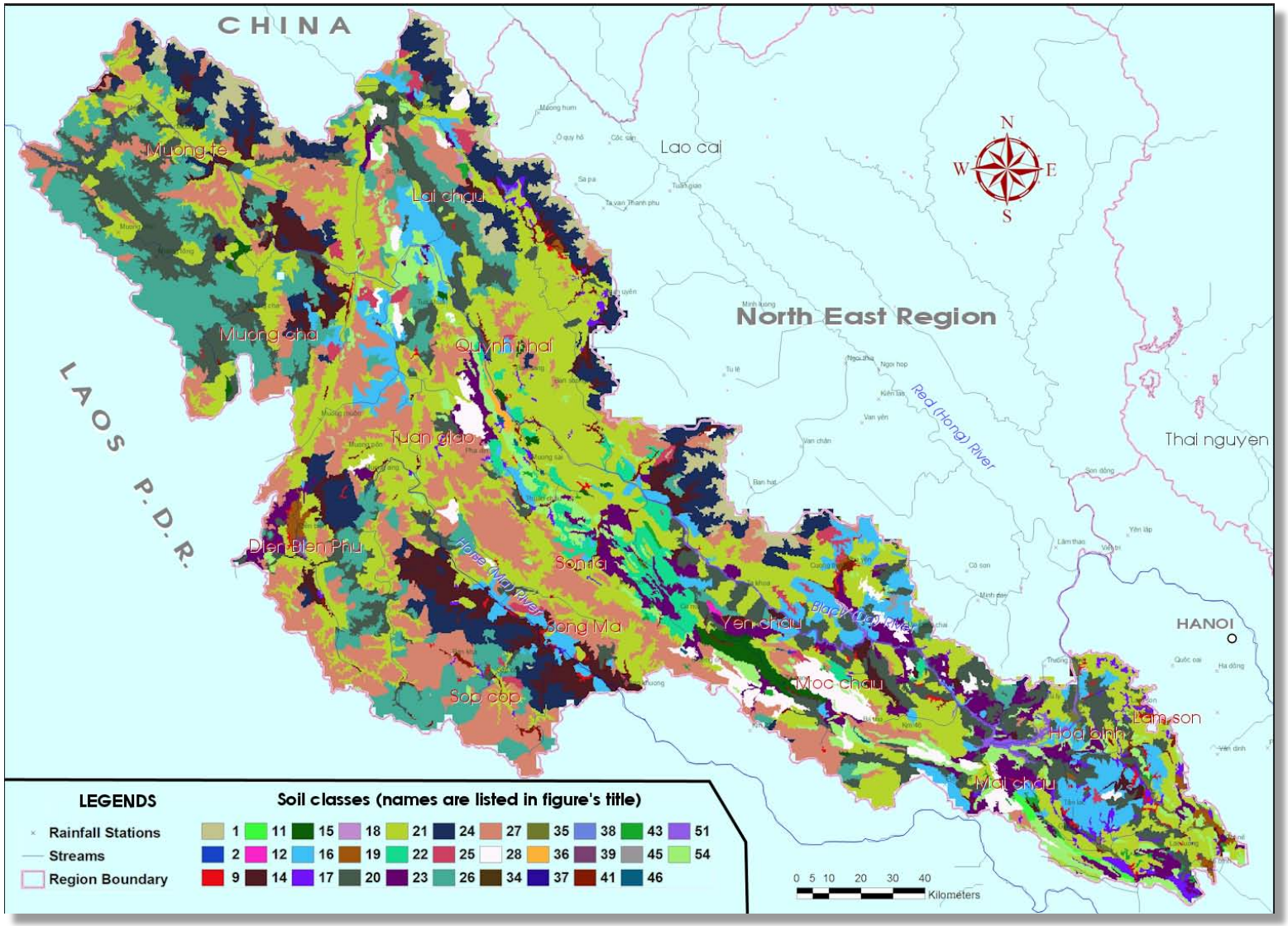
Data Sources:

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)

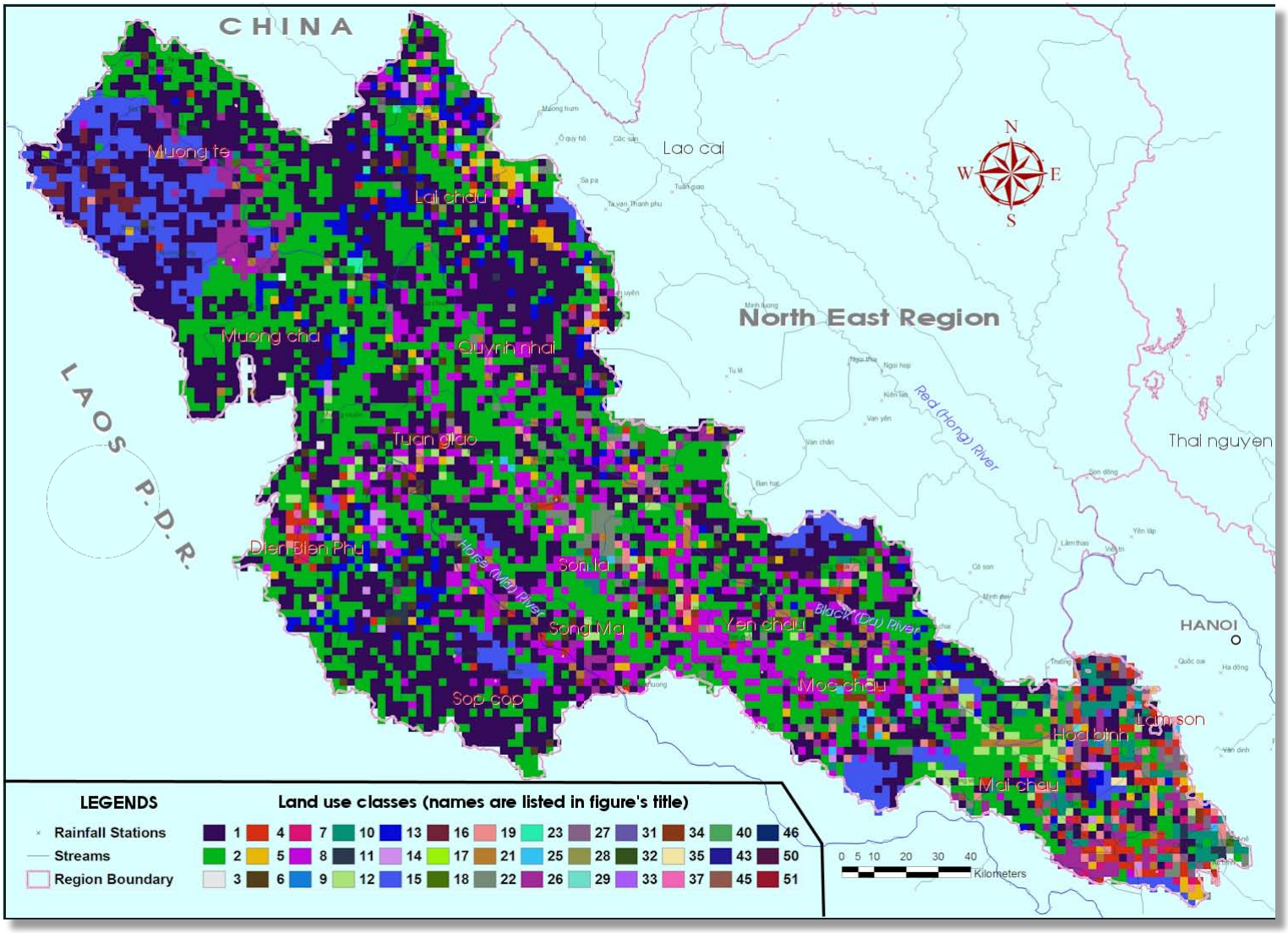
Topography, 90-m grid



Soil Data


CHINA
LAOS P.D.R.
Muong te
Lai chau
Lao cai
Muong cha
Quynh nhai
Tuan giao
Dien Bien Phu
Son la
Song Ma
Sop cop
Yen chau
Moc chau
North East Region
Red (Hong) River
Thai nguyen
HANOI
Lam son
Hoa binh
Mai chau
N
W
E
S
LEGENDS
Rainfall Stations
Streams
Region Boundary
Soil classes (names are listed in figure's title)
1 11 15 18 21 24 27 35 38 43 51
2 12 16 19 22 25 28 36 39 45 54
9 14 17 20 23 26 34 37 41 46
0 5 10 20 30 40
Kilometers

Land use, 250-m grid



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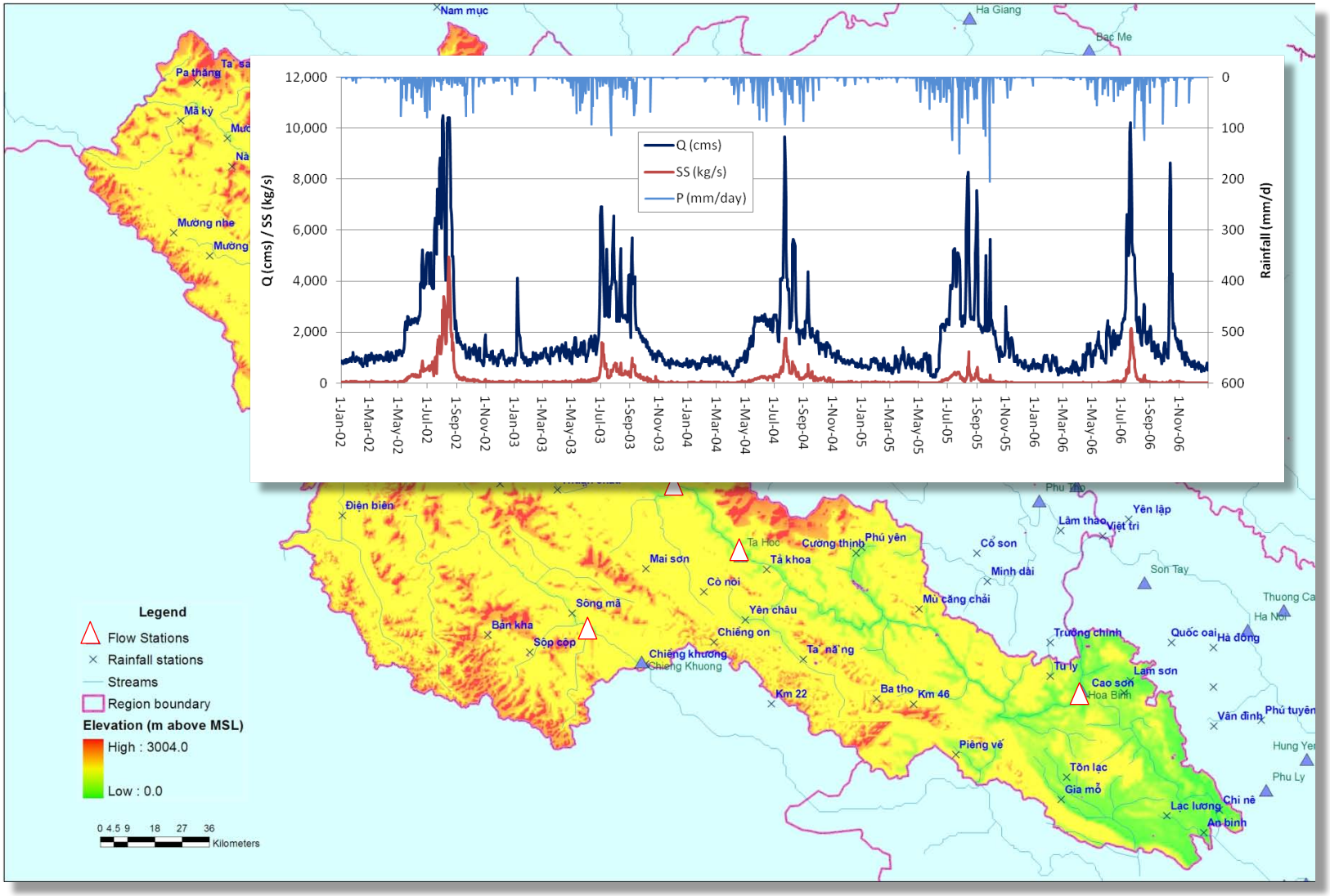
Hydrometeorological Data



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;

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

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

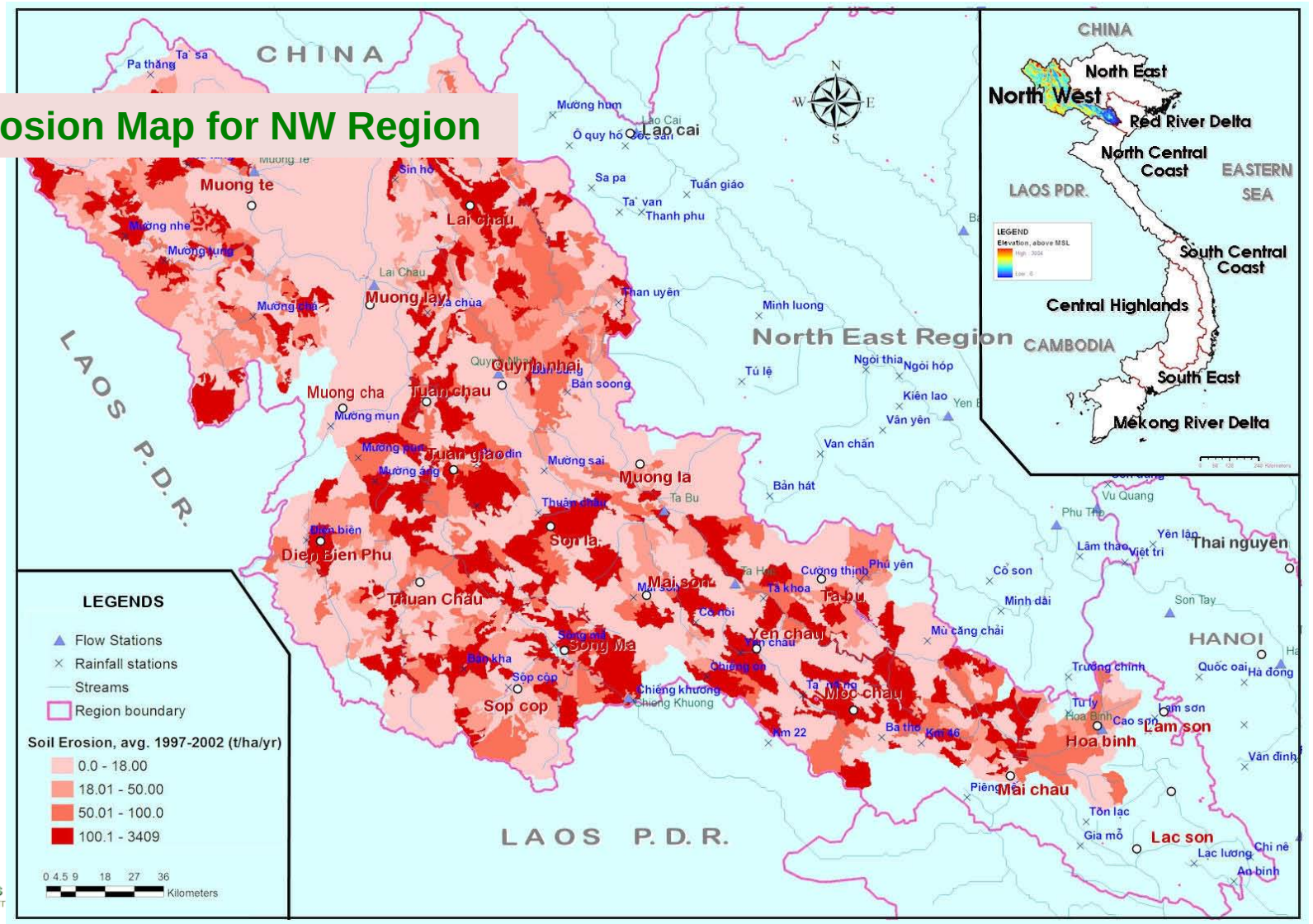
huge amount of data requires skills in GIS (ArcGIS, DEM, dbf, etc.), in programming, in hydrology and soil science (to assess reliability of data), etc.

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



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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 fu

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

www.iwr.msu.edu/rusle/

www.nu.edu/landform/

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:

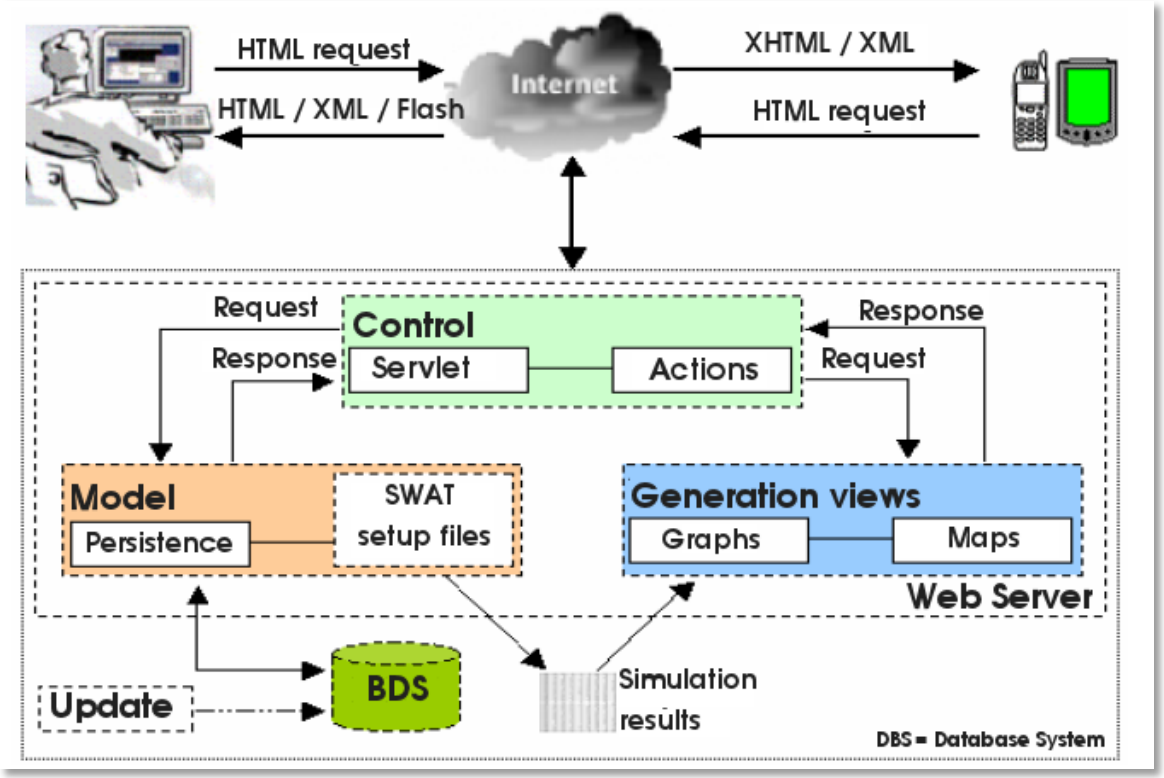
(a) PHP programming language;

(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.)

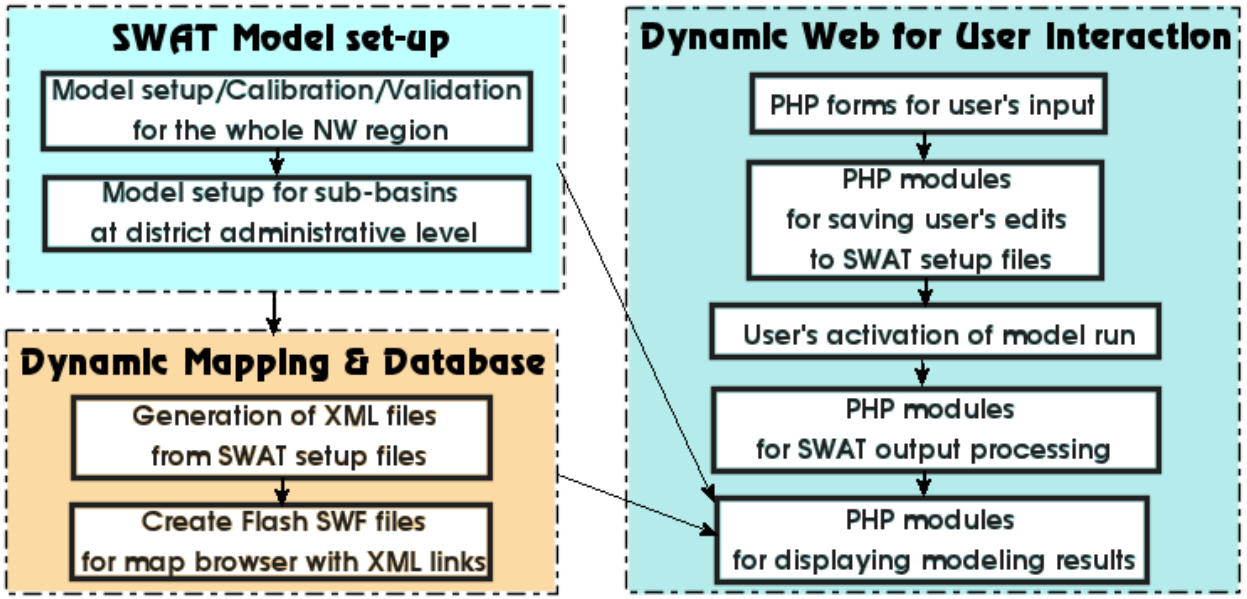
Website Architecture



Adapted from Pavan et al. (2009)

4. Dynamic Website (contd.)

Map/information request and display

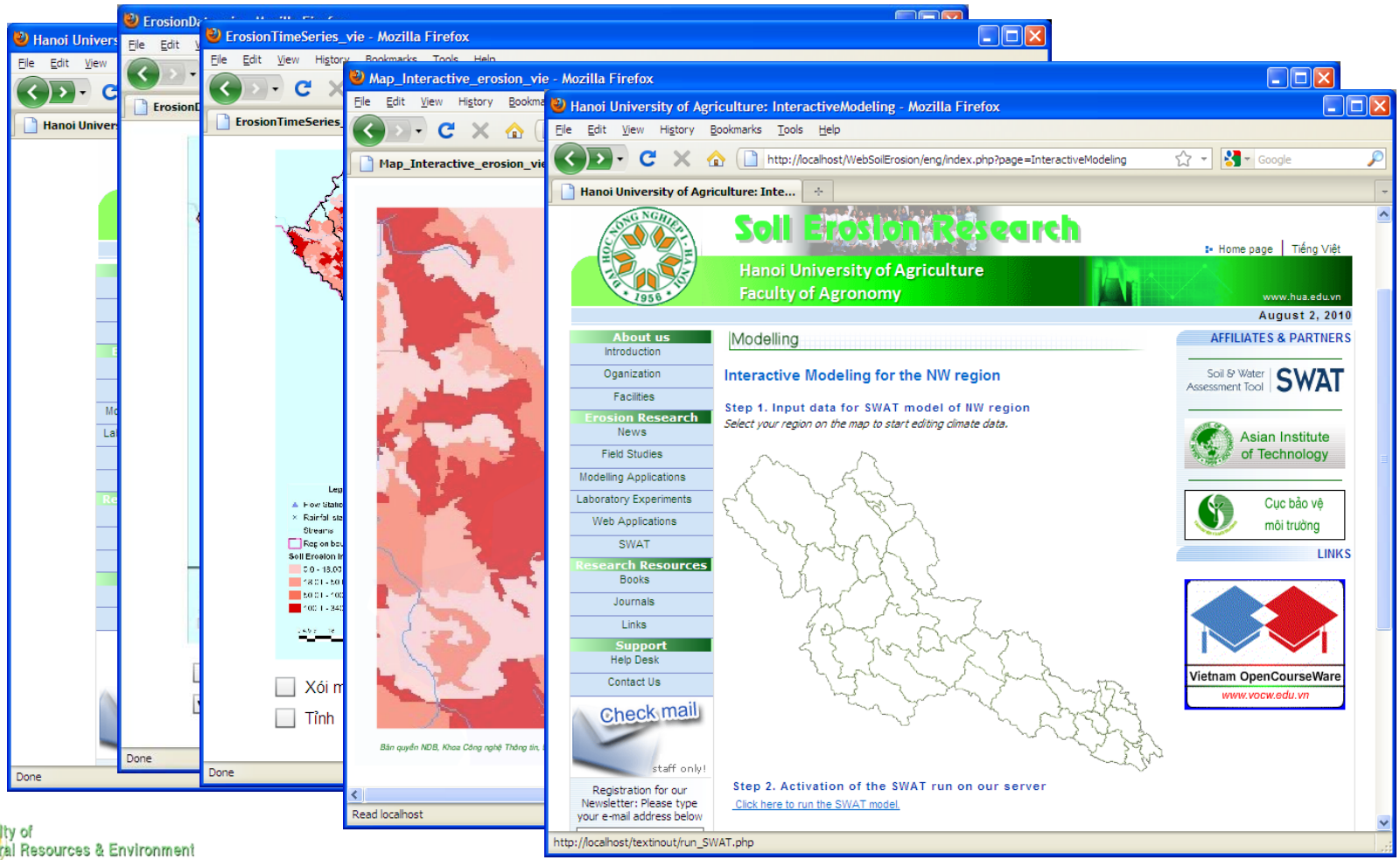


Sample Flash Map

Map_Interactive_facilities1.swf

4. Dynamic Website (contd.)

Dynamic Website



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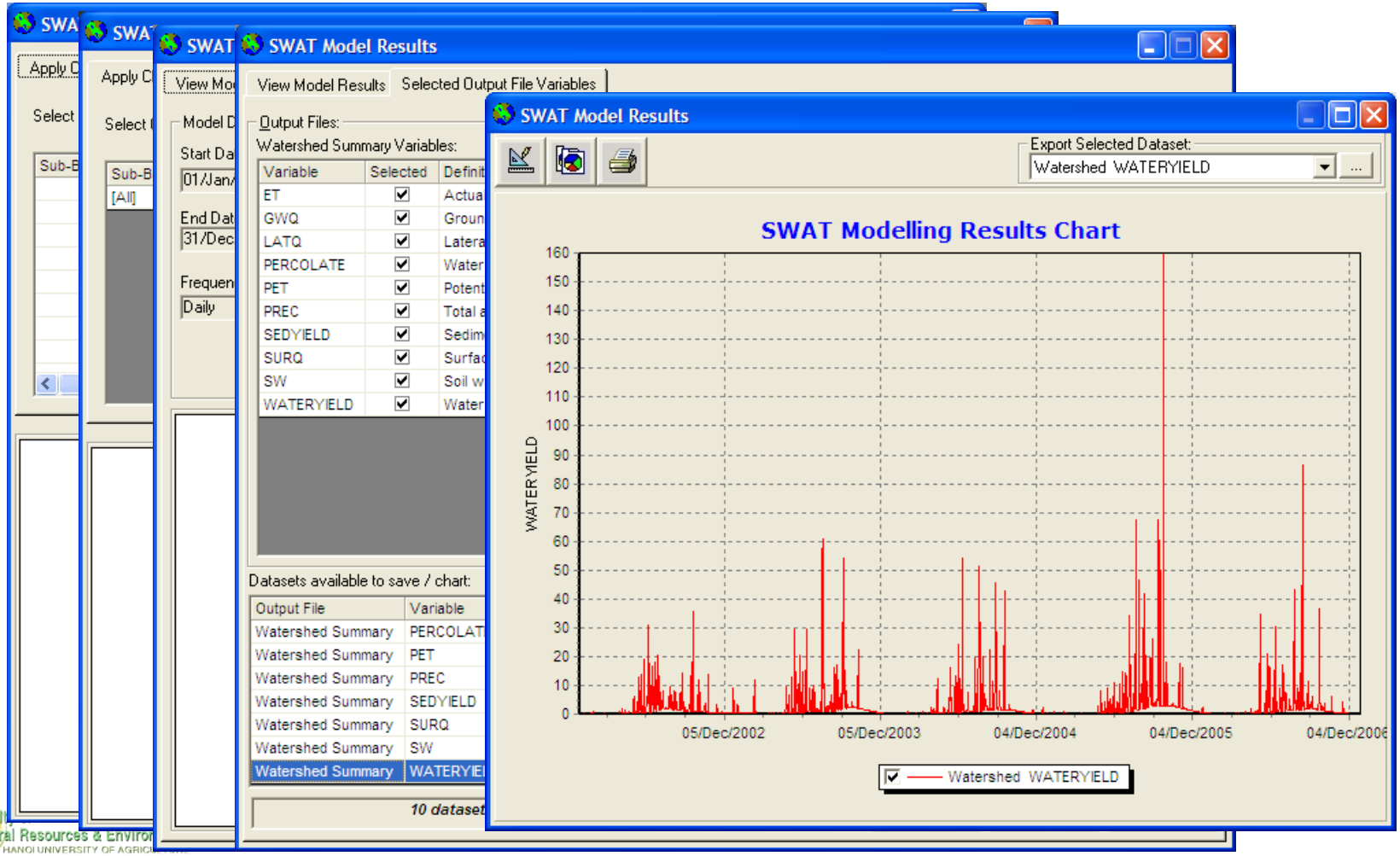
4. Dynamic Website (contd.)

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

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