**IWR SCHOOL 2017**

**MATHEMATICAL METHODS FOR QUANTUM CHEMISTRY**

# Developing a Framework for Operation Optimization of Irrigation Systems

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Modeling & Simulation Laboratory

WARM

**WARM Team**

**WAter Resources and disaster Managements**

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# OUTLINE

- CONTEXT
- CASE STUDY: BAC HUNG HAI IRRIGATION SYSTEM
- WORK PACKAGES
- WARM TEAM

# CONTEXT: Water and Agriculture in Vietnam

- **Agriculture: an important sector of Vietnam's economy:**

  - 2014: agriculture, forestry and fishing: 18.12% of GDP.

  - 2014: ~ 50% of the employed labor force was engaged in those areas.

- **Agriculture in Vietnam is driven by many factors:**

  - consequences of climate change (flooding, drought and salinization).

  - competition with agricultural products imported from China and other countries in ASEAN.

  - reduced competitiveness as a 'low cost' producer in the international market

  - change the way of using water: increase of water use in growing high value crops, increase of water use in industrial and service sectors.

=> **Water demands for agriculture** (also for industry and cities) **increase** while **the quality of usable water decreases**.

# CONTEXT: Challenge and Important Task

- **Irrigation systems** are **the key for food safety in Vietnam**.
- Water is scarce and shared resource => **conflicts among water demands**.

**Challenge:** how to balance **water availability** and **demand, economics environmental requirements.**

=> It is very important to have an **intelligent support system to help administrators and decision makers**

to make wise decisions in the interest of

**optimizing the operation of irrigation systems according to multiple objectives** (economical objective, the satisfaction of different government policies, the minimization of negative effects of water use on the natural environment and so on)

# CONTEXT: Problem and the Role of Modeling & Simulation

- **Irrigation systems consists of a complex network of canals** (primary, secondary, etc) supplying water to several areas, and infrastructures: pump stations, gates, reservoir, store,....

- **Common Problem:** determine the best operation procedure corresponding to a given scenario of water need and availability, along that satisfying a set of ecological and/or economical constraints

- **Modeling & Simulation:** to model and simulate the real system so that we could test and analyze the impact of different factors and/or operations on the system.

# CONTEXT: Existing Softwares and Drawbacks

- **Computational models (softwares) have been increasingly developed,** and **have been successfully applied to model many hydraulic systems** such as rivers, lakes, estuaries and coastal areas.

- Three types of models:

  - **1D model :** MIKE 11, ISIS, Duflow, SOBEK, VRSAP, KOD1, HydroGIS, MK4 and SAL.

  - **2D model :** MIKE 21, TLEMAC, SOBEK, MIKE 3.

  - **3D model :** Delft 3D and TELEMAC.

- **Drawbacks:**

  - Commercial softwares: the cost is huge !

  - Developed by foreigner organizations: it may NOT suitable for Vietnam.

  - "Black-box" models: only see the inputs/outputs, cannot modify the models to suit the case studies in Vietnam.

  - Different softwares may support different inputs/outputs: difficult to share and reuse models between institutions in Vietnam.

# CONTEXT: Objective of the Project

- The goal that we aim at here is not only to develop an intelligent support system but **to develop a framework for intelligent support systems** that

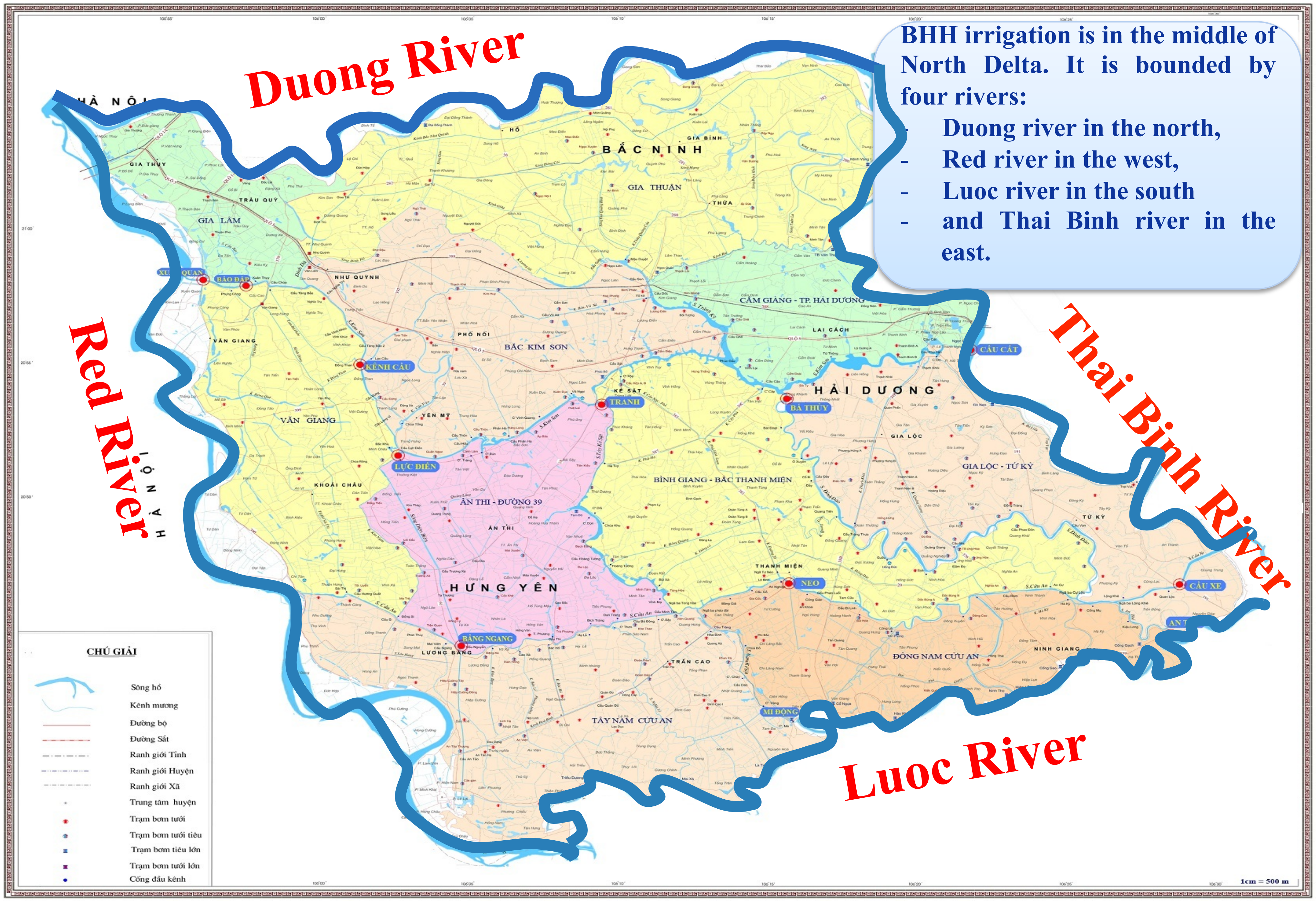
  - (1) could be applied for optimizing the operation of different irrigation systems in Vietnam and also in other countries that have similar agricultural infrastructure and culture as Laos, Cambodia,

  - (2) could integrate different models developed by different softwares.

- Case study: Bac Hung Hai Irrigation (BHHI) system in Vietnam.

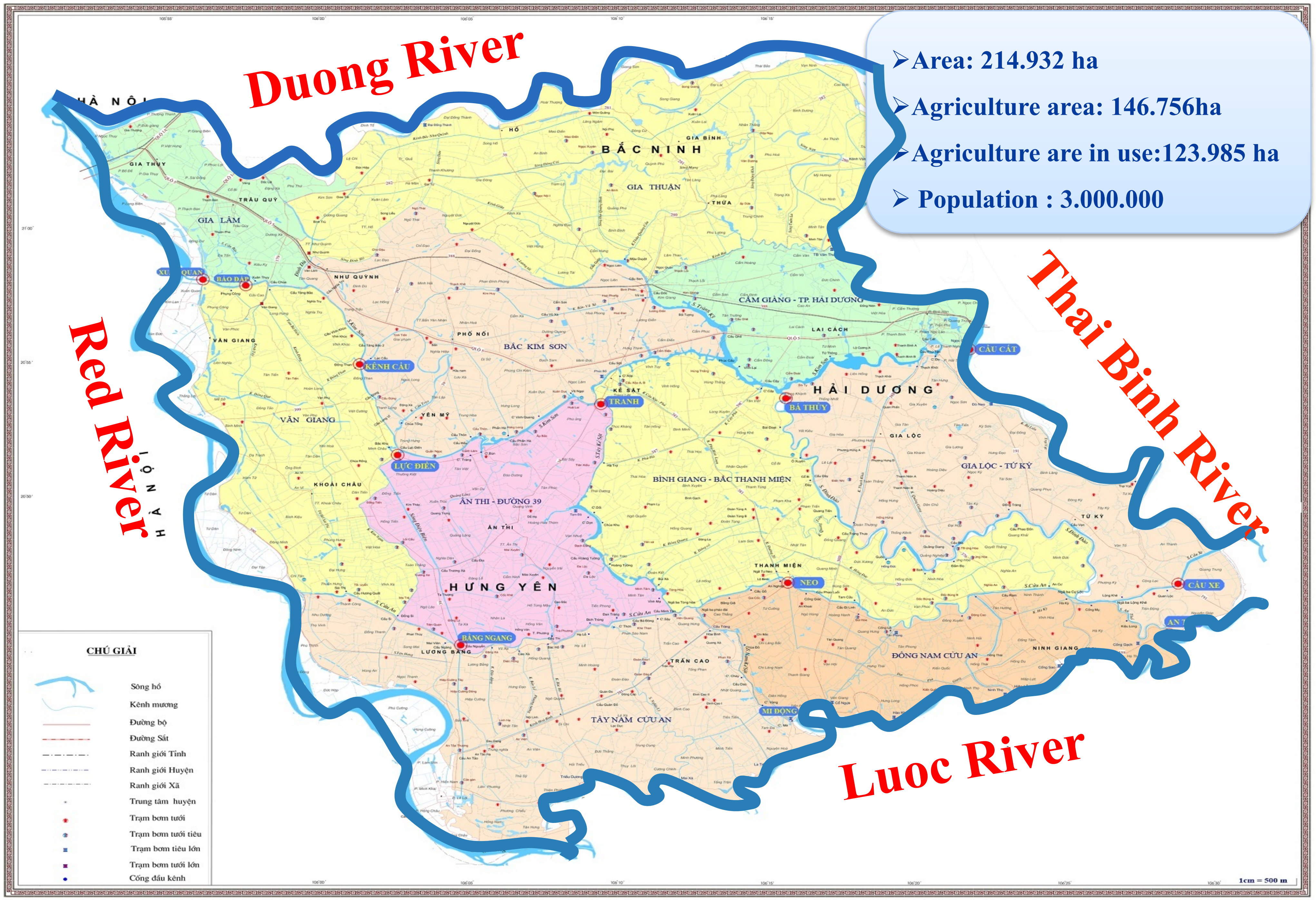
# CASE STUDY: Bac Hung Hai Irrigation System in Vietnam

## BHH IRRIGATION SYSTEM

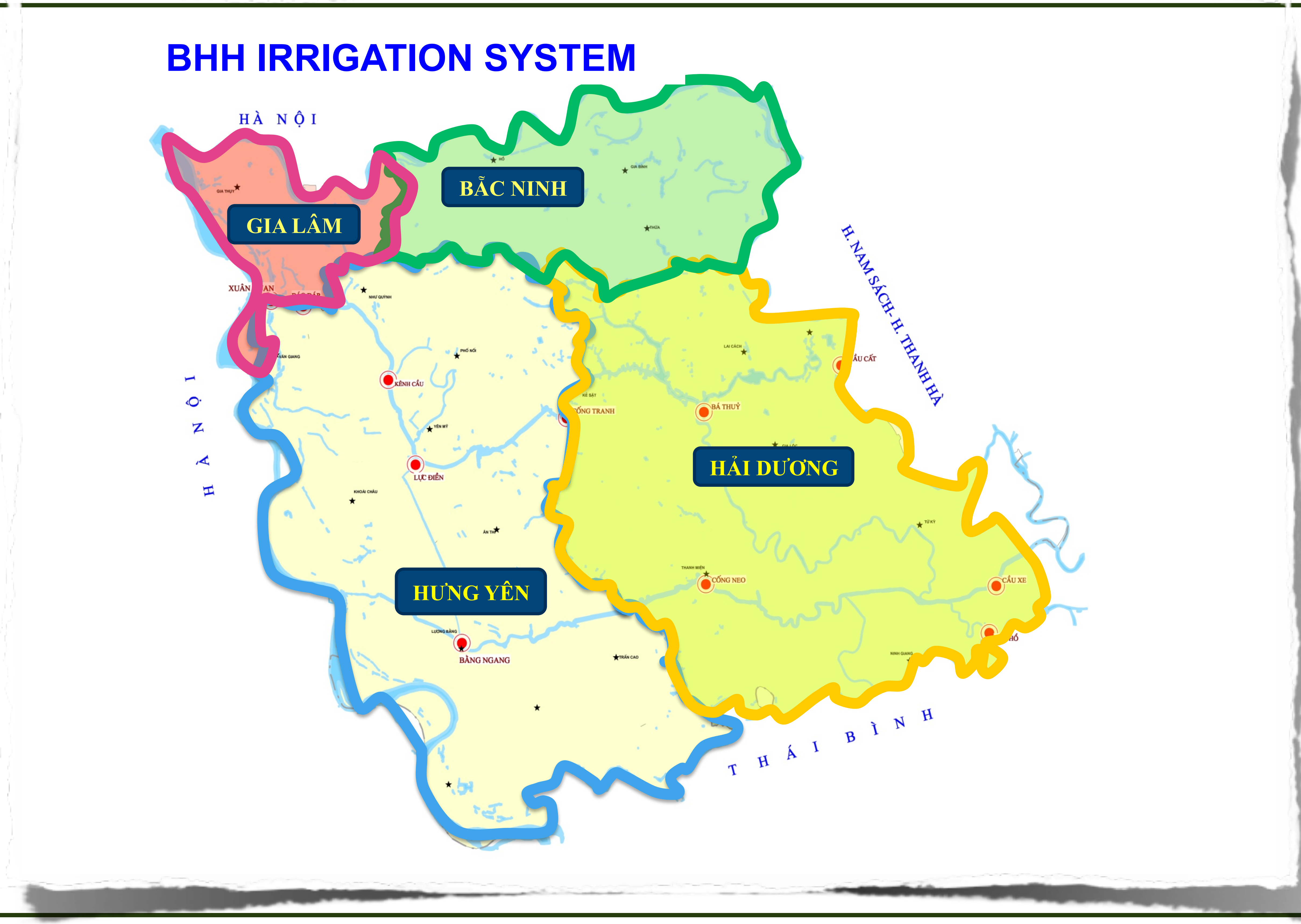


# CASE STUDY: Bac Hung Hai Irrigation System in Vietnam

## BHH IRRIGATION SYSTEM



# CASE STUDY: Bac Hung Hai Irrigation System in Vietnam



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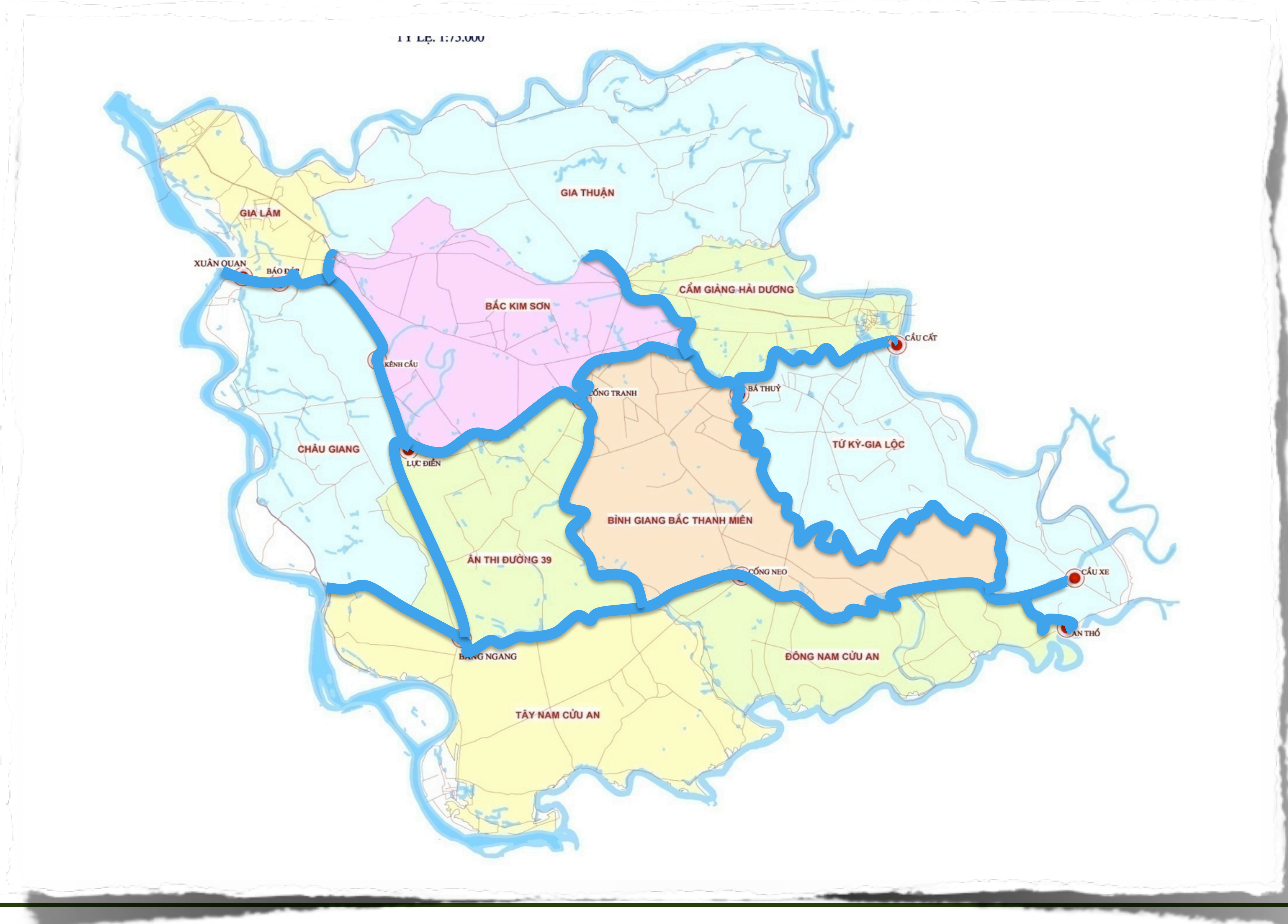

# CASE STUDY: Bac Hung Hai Irrigation System in Vietnam

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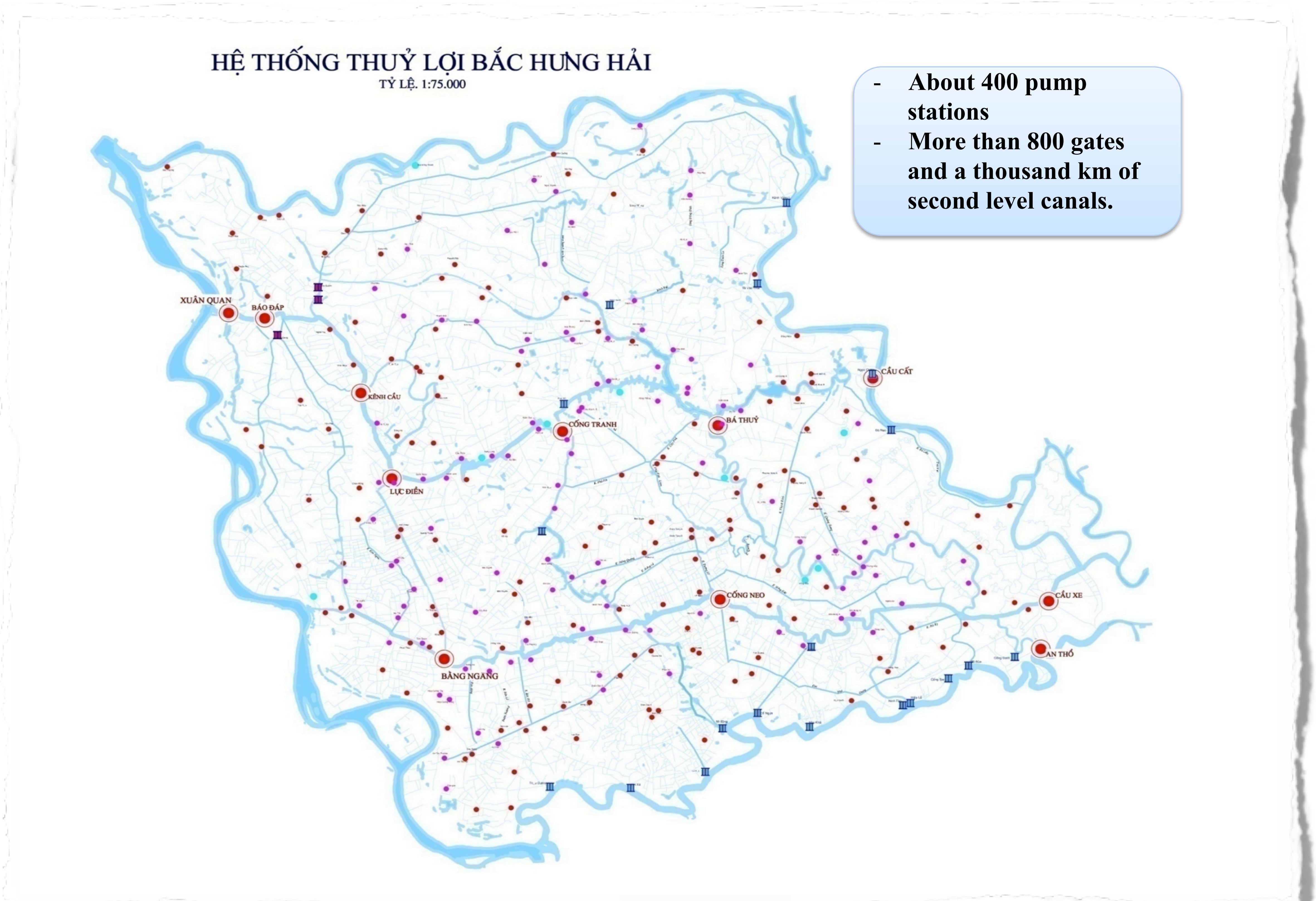
Role: Intake gate
4 sub-gates of size 3,5mx4m
1 shipping gate of size 5mx8,5m
Height: 1,0m

# CASE STUDY: Bac Hung Hai Irrigation System in Vietnam




- About 400 pump stations
- More than 800 gates and a thousand km of second level canals.

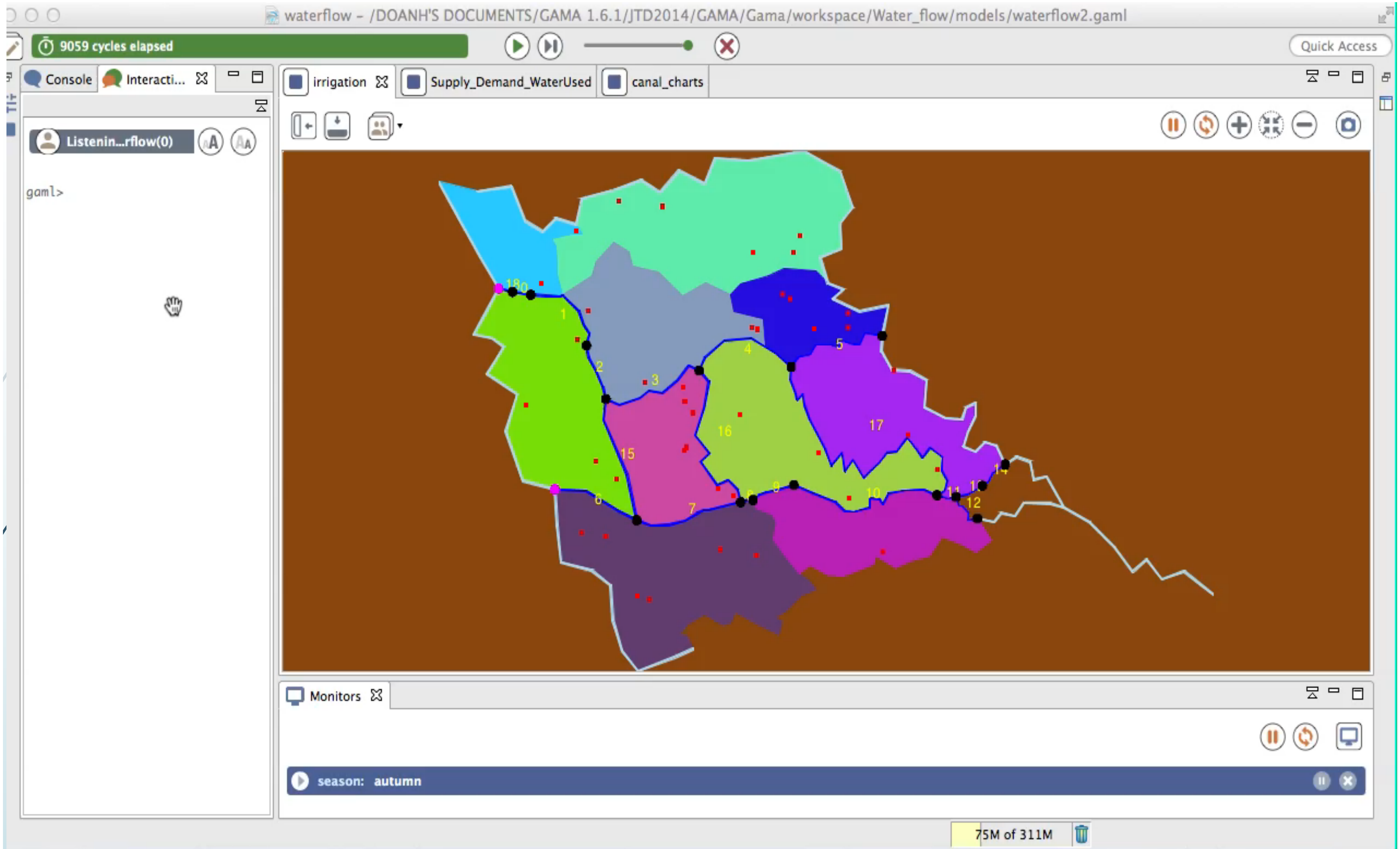
# CASE STUDY: Bac Hung Hai Irrigation System in Vietnam

(a)

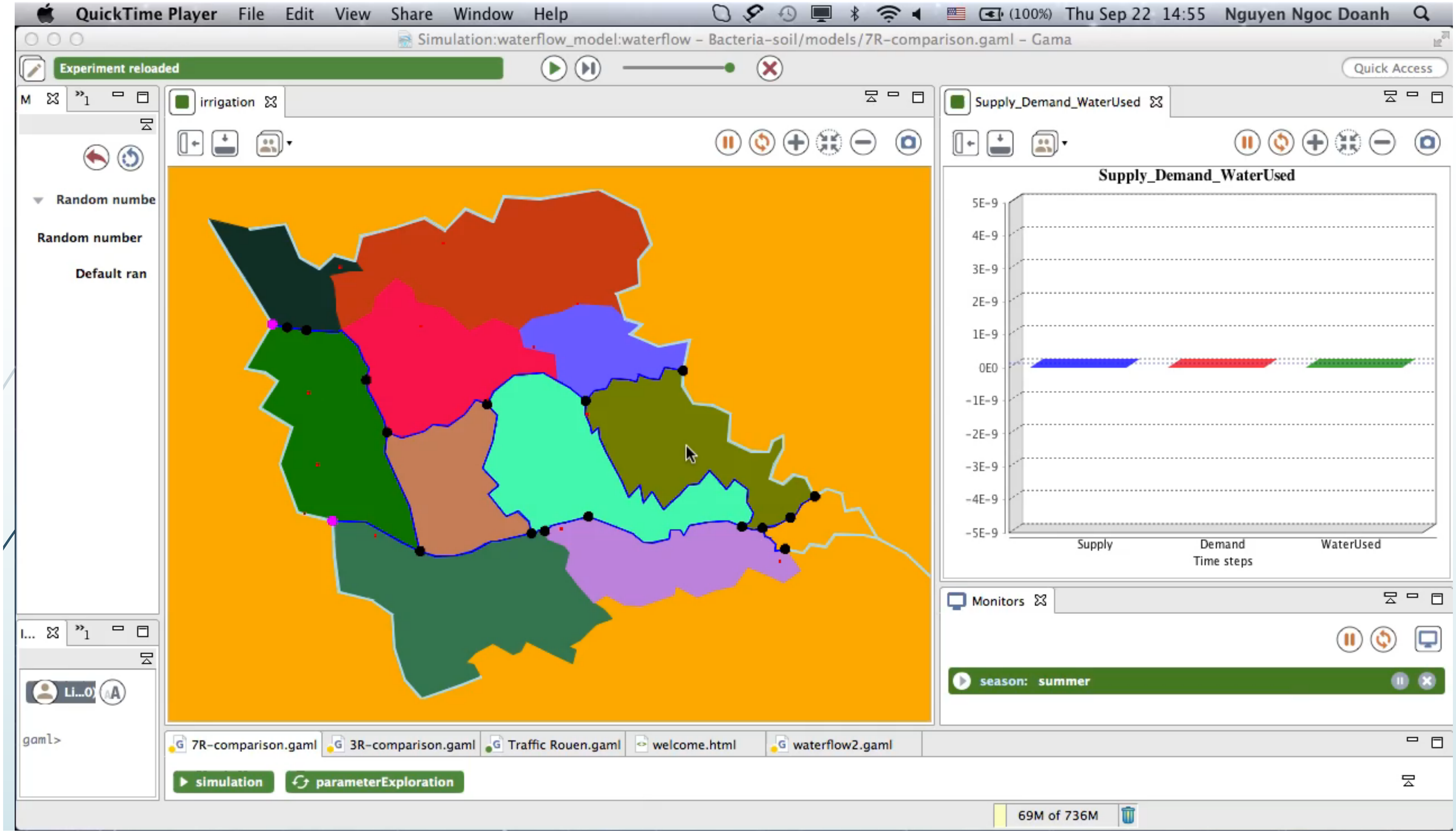

(b)


(c)

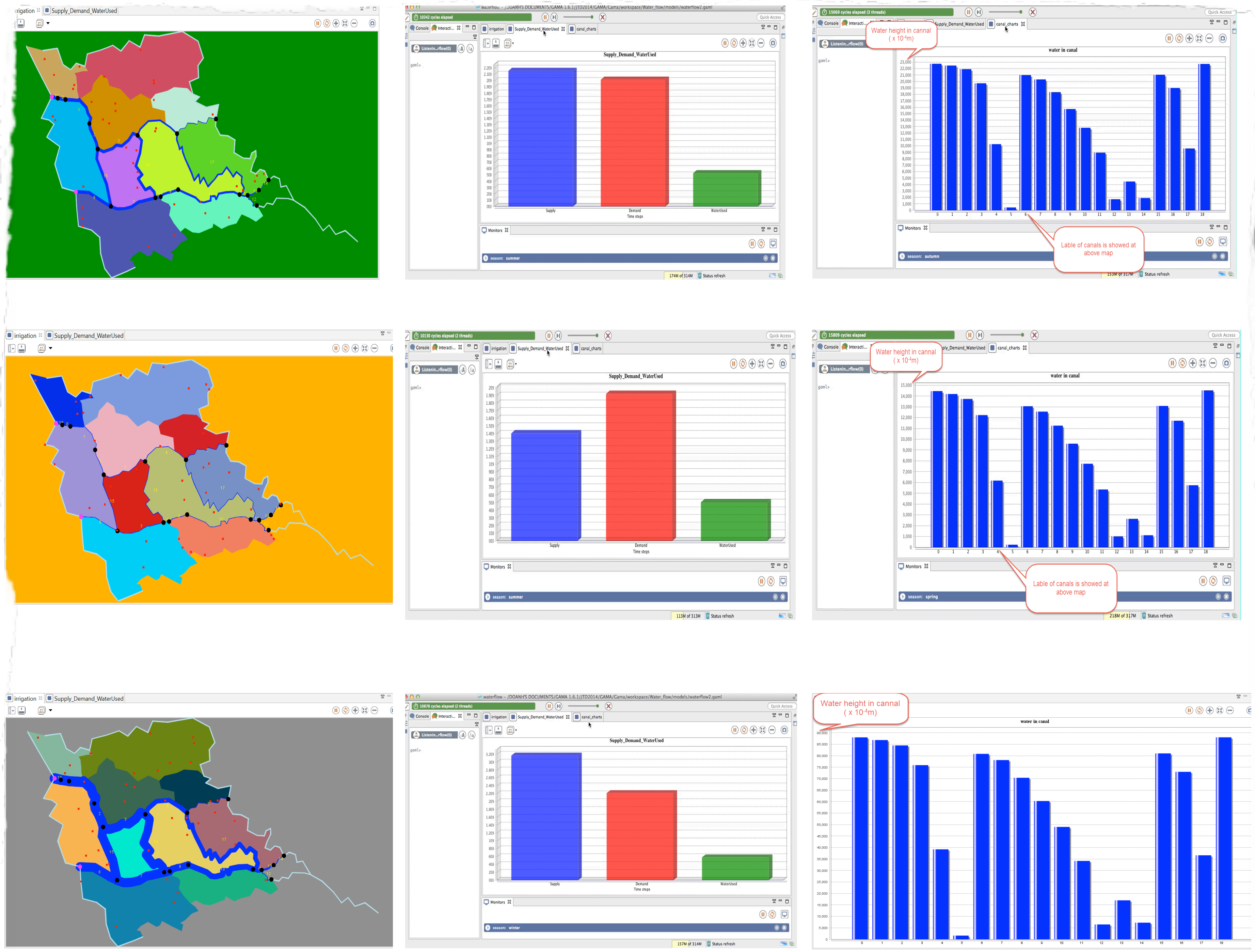
# CASE STUDY: A Simulation



# CASE STUDY: A Simulation



# CASE STUDY: A Simulation




(a) (b) (c)

**Figure:** *Simulation results corresponding to different scenarios: on top is about the normal situation; in the middle is about drought and in the bottom is about flooding. Panel (a) is the overview of the BHHI system; panel (b) is about supply, demand and used waters; and panel (c) is about water levels in canals.*

# THE PROJECT: Work-packages

**WP1 - Data analysis**:

- collect raw data from different sources then clean, select, transform,
- model this data to discover useful information to support decision making and to provide necessary input data for the modeling and simulation work package.

**WP2 - Modeling and Simulation**:

- support an experimental equipment (computer models) in order to better understand the studied irrigation system and to test different scenarios.
- use hybrid modeling and simulation in which different types of models (*hydrologic model, hydraulic model, mass balance model and agent-based model*) will be created and implemented.

**WP3 - Operation Optimization**:

- verify/evaluate if the current operation of BHHI is optimized then to propose better solutions if needed;
- do operation optimization of BHHI in some extreme cases (flooding, drought and salinization).

# THE PROJECT: Work-packages

**WP1 - Data analysis**:

Responsible: Lai Hien Phuong and Nguyen Thanh Tung

**WP2 - Modeling and Simulation**:

Responsible: Nguyen Ngoc Doanh and Nguyen Trong Khanh

**WP3 - Operation Optimization**:

Responsible: Nguyen Thi Ngoc Anh and Bui Thi Cuc

The two experts, Ngo Le An and Pham Van Chien, are involved in all work packages

# WARM TEAM

**WARM Team**

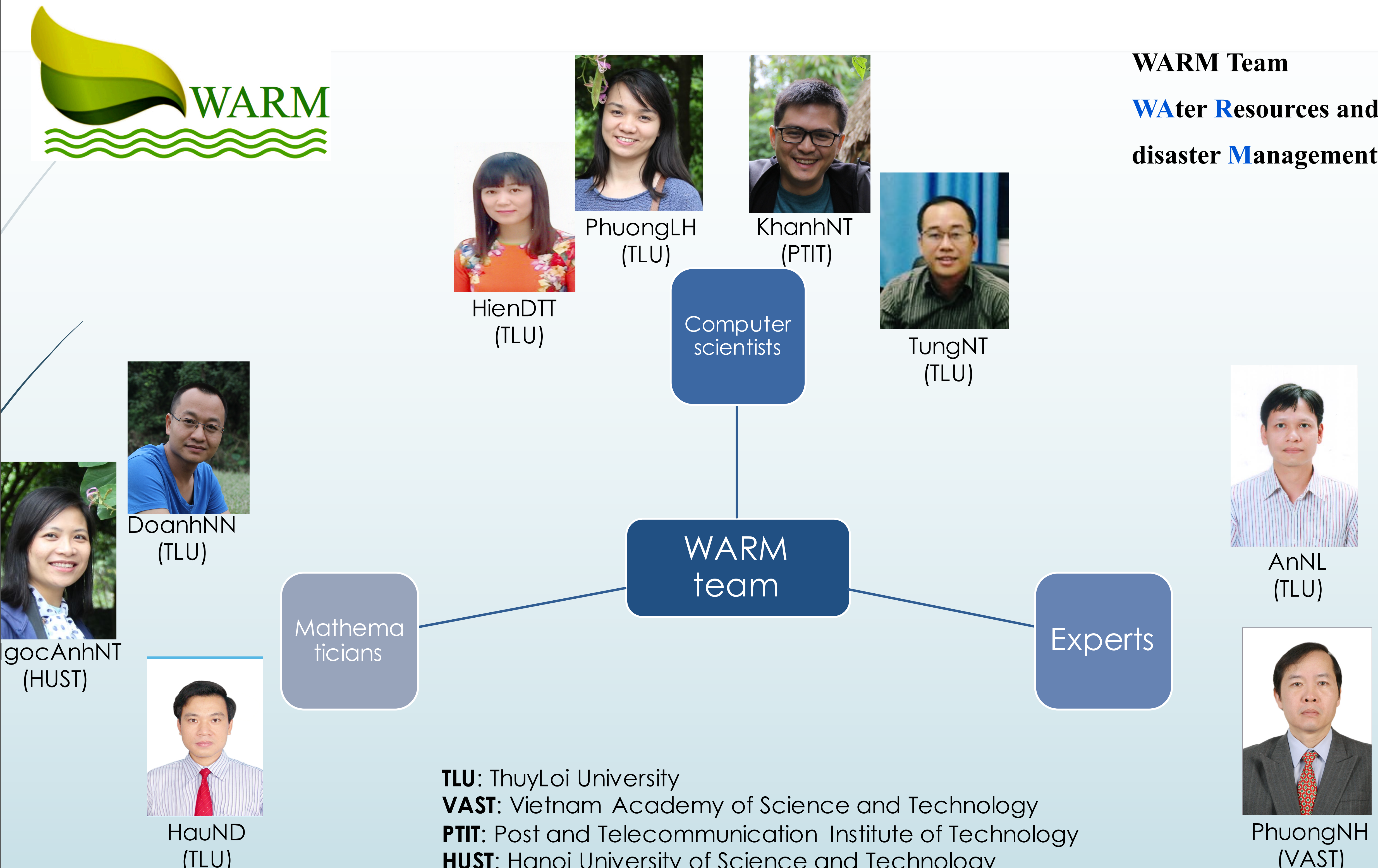
**WAter Resources and**

**disaster Managements**

The WARM research team was created on the 15th of April 2016 under collaboration between different institutions in Vietnam:

- Three faculties of ThuyLoi University:
  - + Faculty of Computer Science and Engineering,
  - + Faculty of Hydrology and Water Resources,
  - + Faculty of Water Resources and Engineering.
- School of Applied Mathematics and Informatics/Hanoi University of Science and Technology.
- Department of software engineering/Post and Telecommunication Institute of Technology.
- Faculty of Mathematics and Informatics/Hanoi National University of Education.
- Institute of Geographical Physics/Vietnam Academy of Science and Technology.
- and UMMISCO Vietnam, UMI 209 IRD, France.

# WARM TEAM




**WARM Team**

**WAter Resources and disaster Managements**

**TLU**: ThuyLoi University
**VAST**: Vietnam Academy of Science and Technology
**PTIT**: Post and Telecommunication Institute of Technology
**HUST**: Hanoi University of Science and Technology

# THANKS

## THANKS FOR YOUR ATTENTION !