SECOND INTERNATIONAL WORKSHOP

3E Nexus Initiative For Sustainable Development in Asia Countries

CLIMATE CHANGE IMPACT ASSESSMENT ON THE SOIL SALINIZATION PROCESS OF AGRICULTURAL LAND IN TIEN HAI DISTRICT, THAI BINH PROVINCE

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RESEARCH MOTIVATION

- **Climate change**: global issue
  Sea-level rise: clear indicator

- **Vietnam**: one of 10 countries suffering most serious impacts of sea-level rise.

- **Impacts*:*** Vietnam's agricultural land and economy

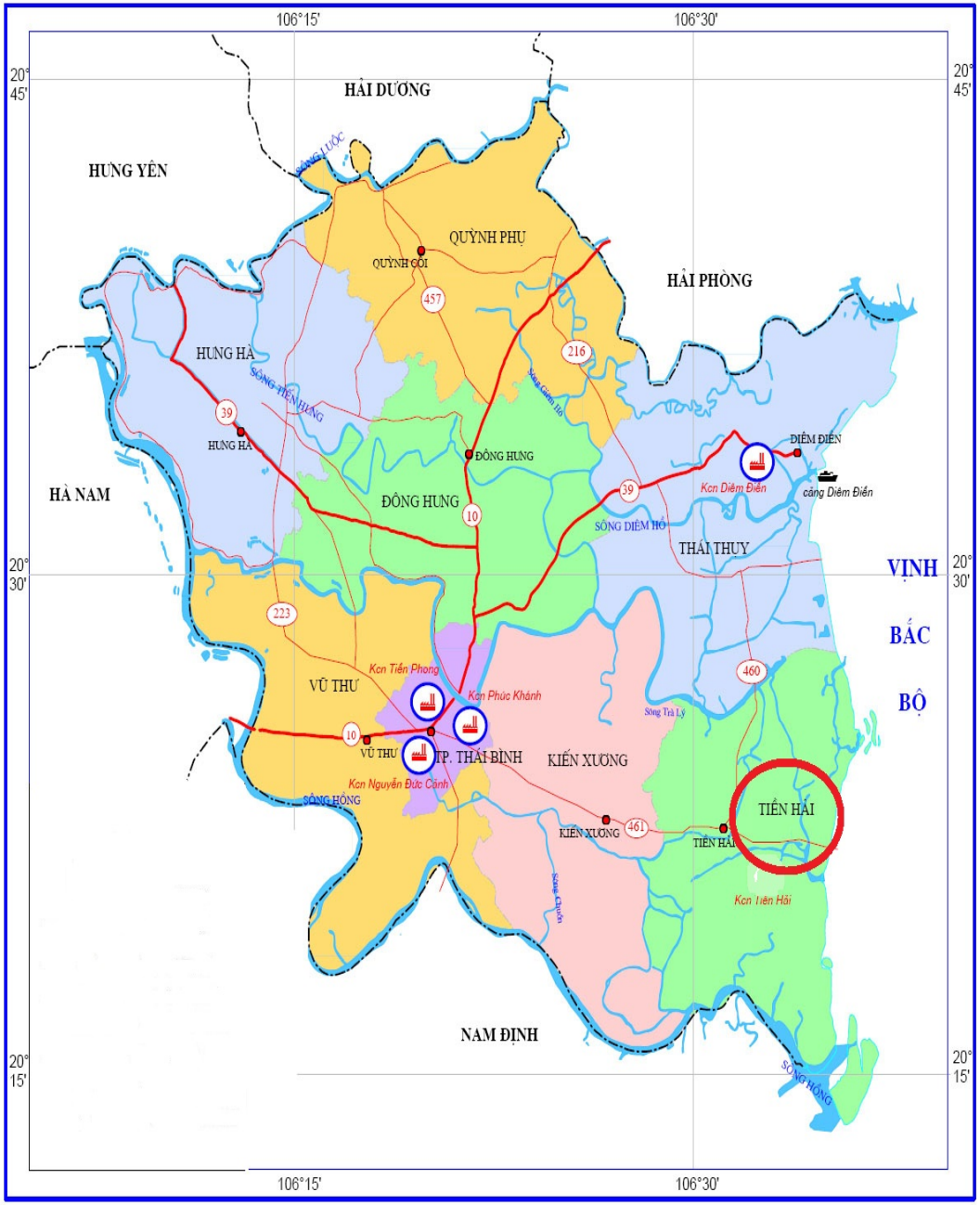
Thai Binh Map

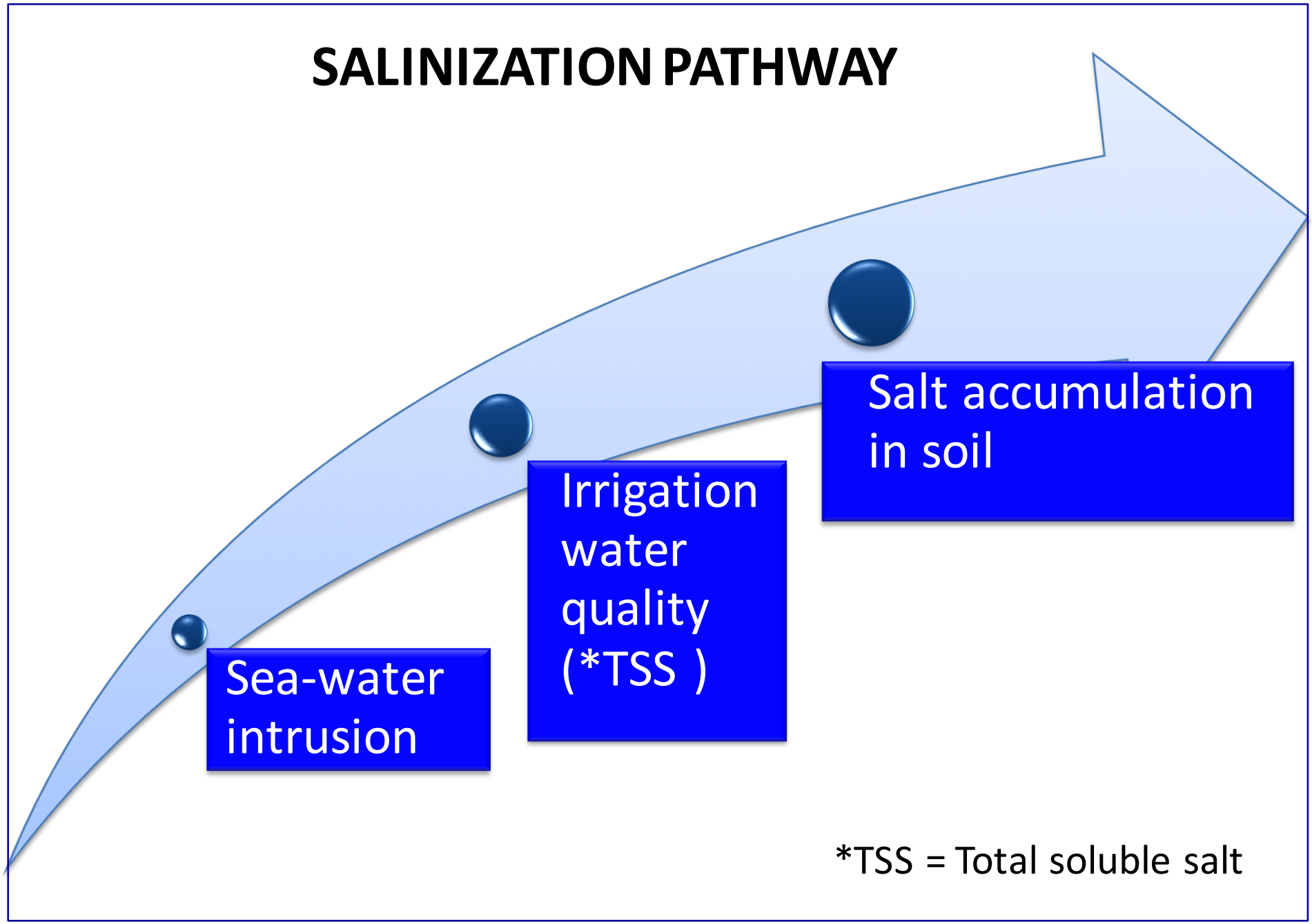
Thai Binh province:
- Primary granary (rice field) in the north
- More than 50 km of the sea-shore

Tien Hai District = Coastal area

Climate change | Sea-level rise

Serious impacts on the agriculture
-soil environment-

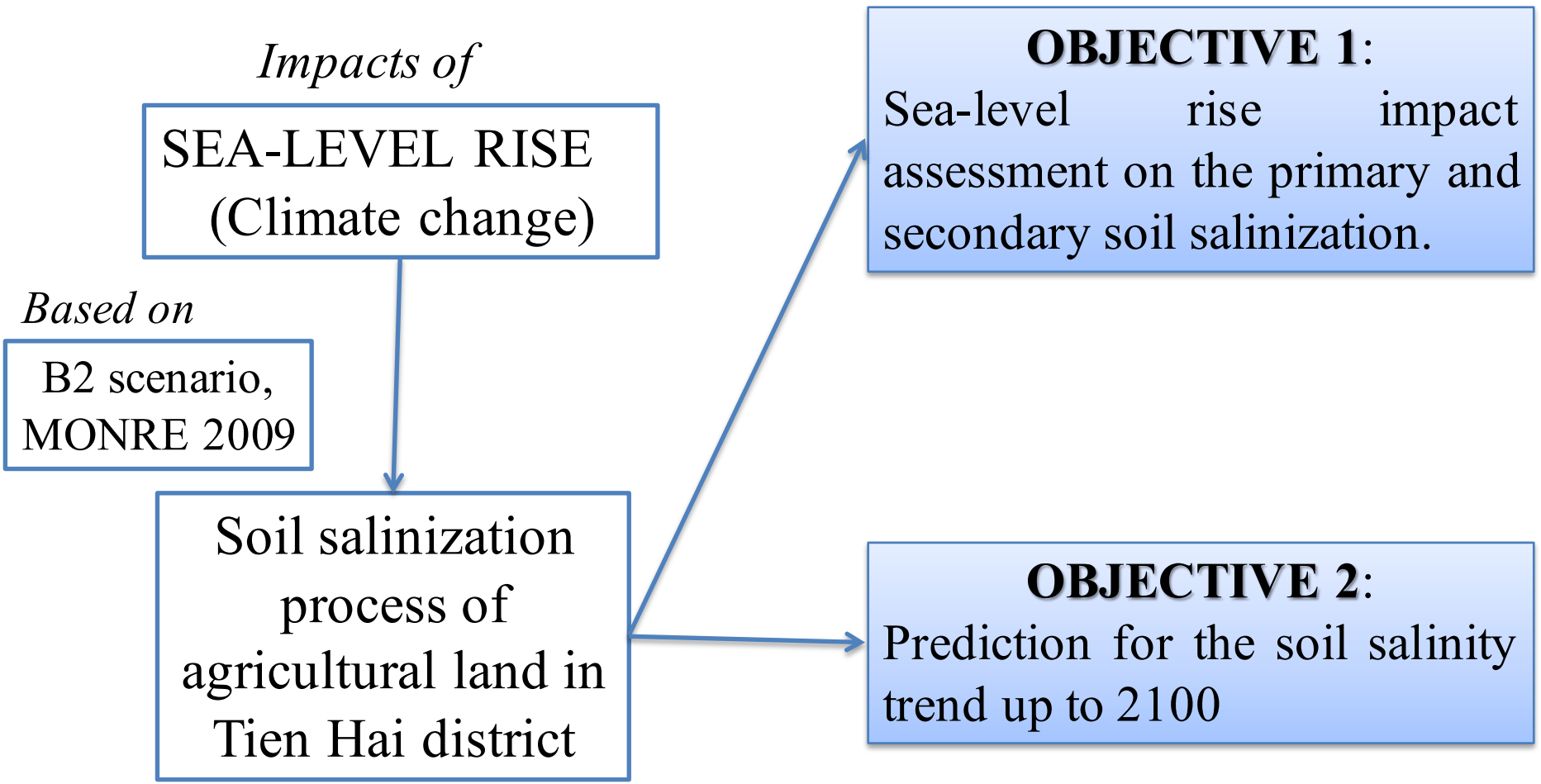



SALINIZATION PATHWAY
Sea-water intrusion
Irrigation water quality (*TSS)
Salt accumulation in soil
*TSS = Total soluble salt

"Climate change impact assessment on the soil salinization process of agricultural land in Tien Hai district, Thai Binh province" is:

PRACTICALLY ESSENTIAL

I. OBJECTIVES



SCIENTIFIC BASIC

Climate change and Sea-level rise scenario, MONRE 2009

- **B2 scenario** = Medium emission scenario
- Sea-level rise (in cm)

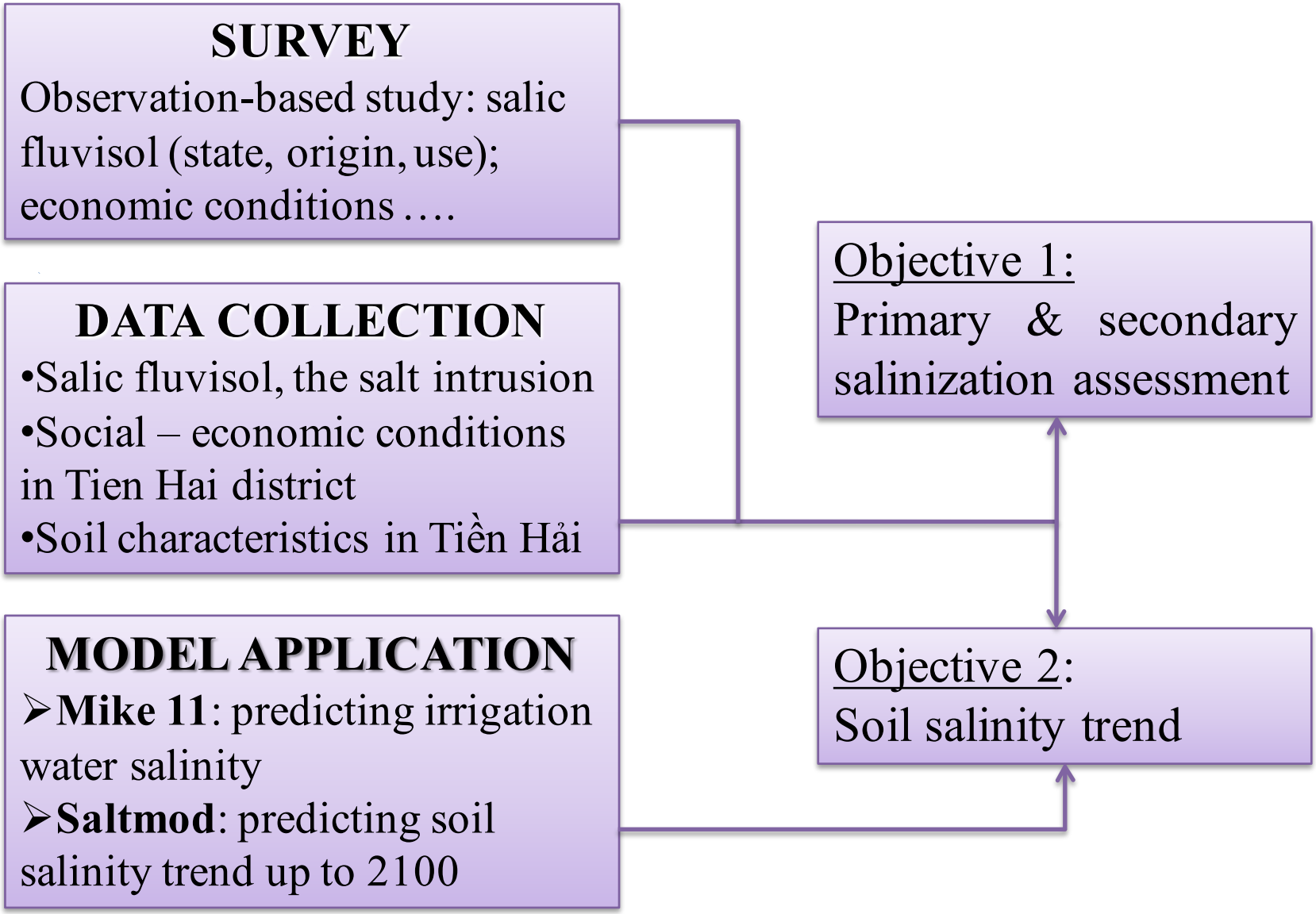
The increase of sea-level (cm) in comparison with the period 1980 - 1990

Scenario	**Time scale of the 21st century**					
	2050	2060	2070	2080	2090	2100
B2	30	37	46	54	64	75

RESEARCH TARGET

Rice-cultivated land
in Tien Hai District,
Thai Binh Province

II. STUDY METHODS



MIKE 11 MODEL

- Specialized simulation of the water flow, water quality
- One-side dynamics
- Principle: Saint Venant equations

Advantages

- Friendly with users
- Wide application in Vietnam

TO PREDICT IRRIGATION WATER'S SALINITY

SALTMOD MODEL

Advantages

- Simple operation for users
- Input data: usually common/ possible estimation/easy calculation

Popularization

- Common in Europe (Netherlands) and several nations (Egypt)
- In Vietnam: new one

  Yet being applied in some researches about the change of soil salinity in the aquaculture condition in Cuu Long River Delta

TO PREDICT SOIL SALINITY TREND UP TO 2100

III. RESULTS AND DISCUSSION

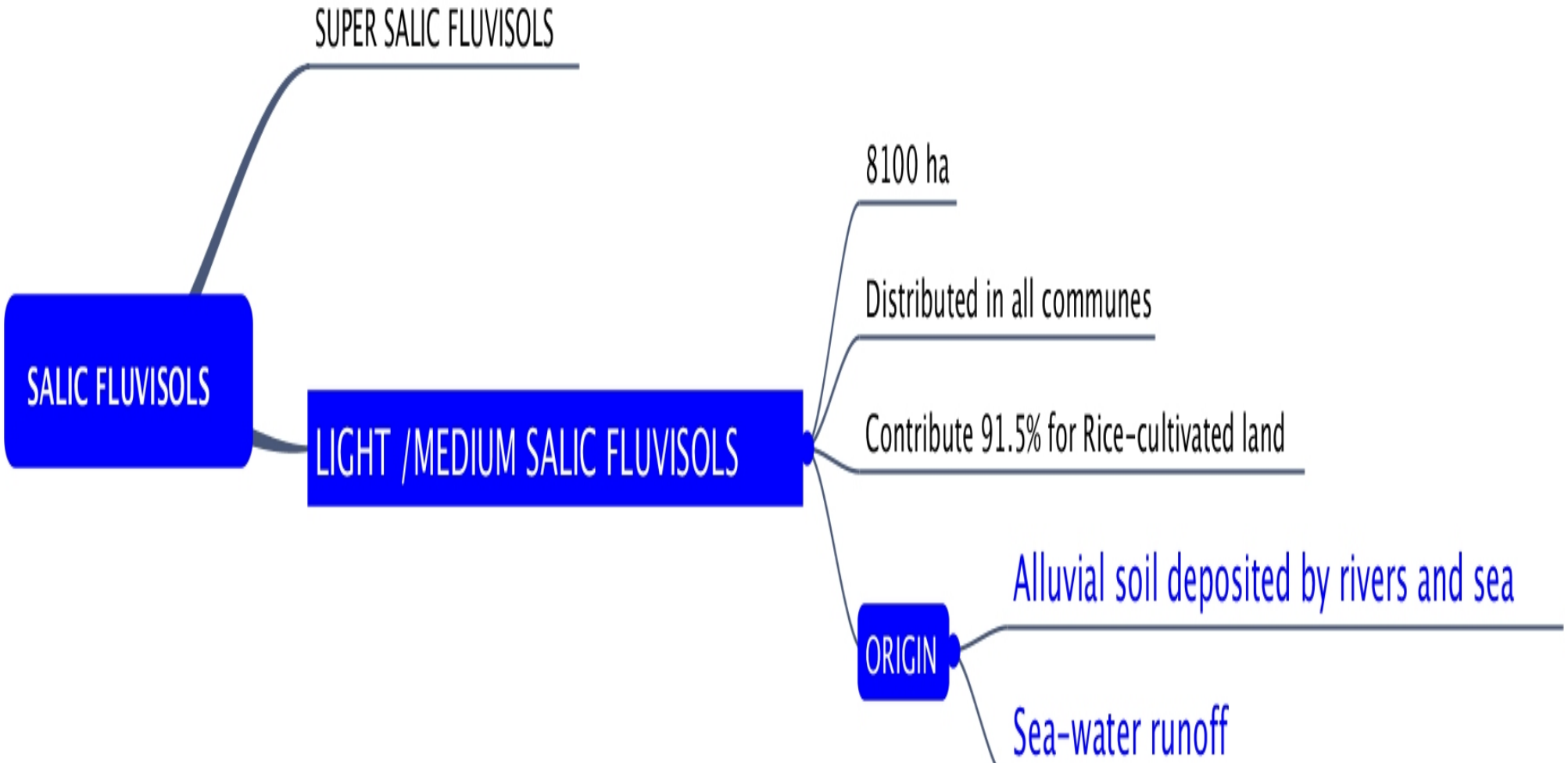
1. Sea–level rise impact on the soil salinization of rice-cultivated land in Tien Hai District

- *Primary soil salinization*
- *Secondary soil salinization*

2. Forecasting the salinity trend of Tien Hai rice-cultivated land up to 2100

- *Mike 11 application for the prediction of the irrigation water salinity*
- *Saltmod application for the prediction of the rice-cultivated land's salinity trend*

1. Sea–level rise impact on the soil salinization of rice-cultivated land in Tien Hai District



SEA-LEVEL RISE IMPACT ON THE PRIMARY SOIL SALINIZATION

- The land is covered by **dyke systems** with the **height 2-3m**

  →No sea-water overflowing as sea-level rise

  →Tough penetration / transmission of sea water

- Salinity of groundwater

  →Holocen formation (qh2) 0.3g/L – 18.3 g/L

  → Hydrological factors; Sea factors

  → Sea-level rise may cause impacts on the salinity ?

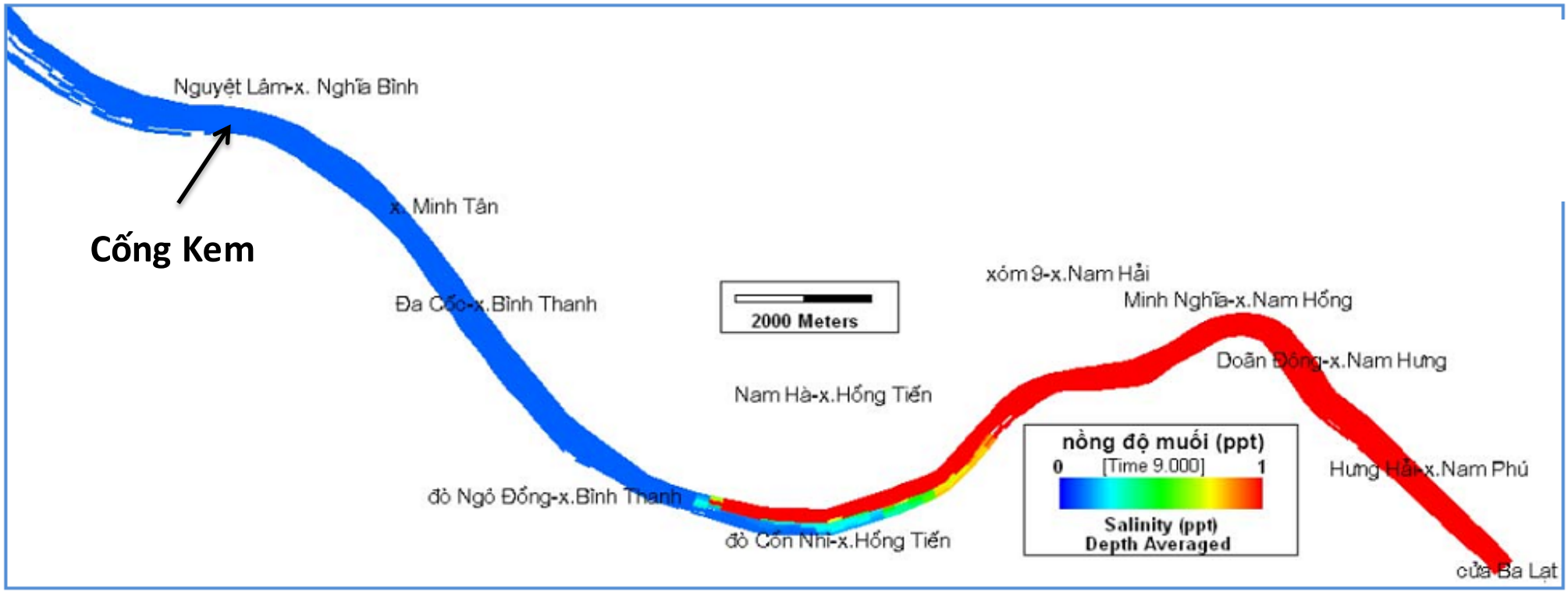
  → Need particular and specified research to conclude

SEA-LEVEL RISE IMPACT ON THE SECONDARY SOIL SALINIZATION

a) Irrigation water in Tien Hai, currently:

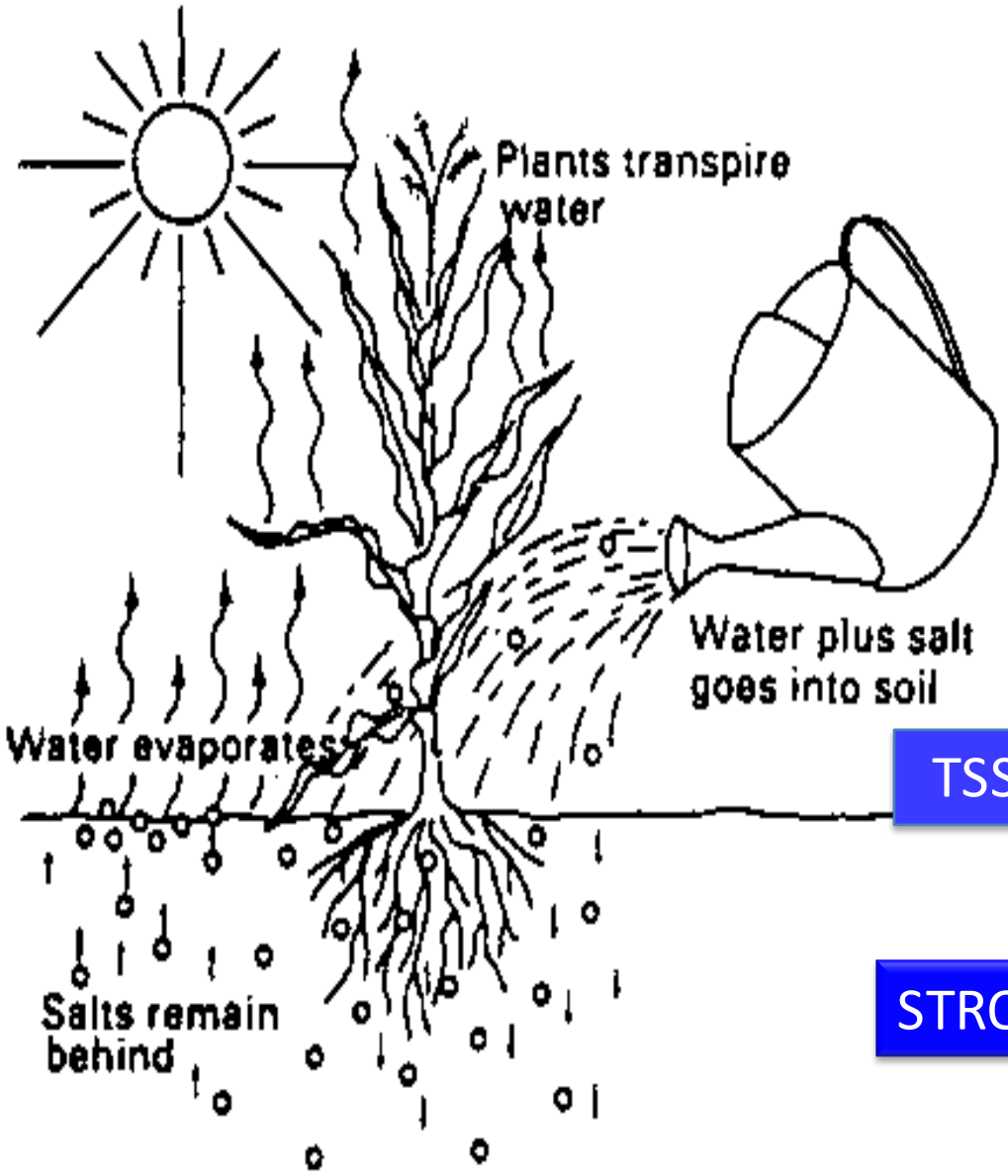
- Kem sewer (21 km from Ba Lat estuary)
- TSS = (200mg/L – 500mg/L)

As sea-level rises 0.75 m (2100), the limit of sea-water intrusion may exceed "Kem sewer" → TSS in the irrigation water will increase



SEA-LEVEL RISE IMPACT ON THE SECONDARY SALINIZATION

a) Irrigation water



SALT ACCUMULATION IN SOIL

↓

TSS (Total soluble salt) IN SOIL INCREASES

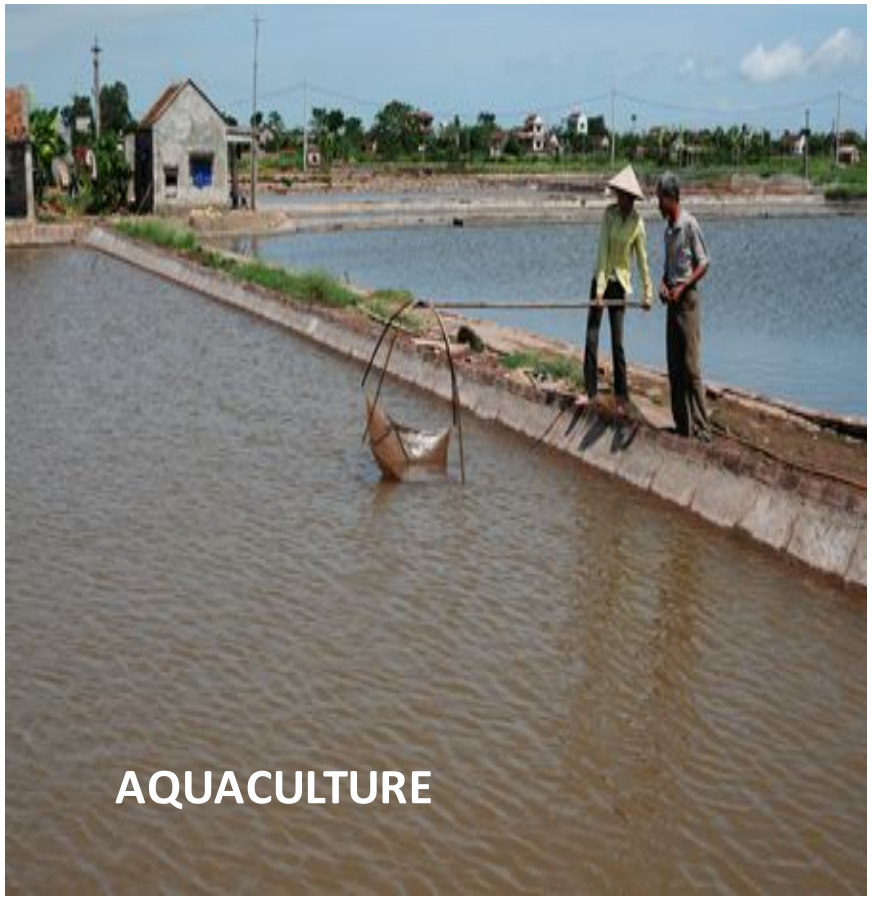
↓

STRONGER SECONDARY SOIL SALINIZATION

SEA-LEVEL RISE IMPACT ON THE SECONDARY SOIL SALINIZATION

b) Aquaculture

Sea-level rise → more popular



Increase the secondary soil salinization in Tien Hai District

SALINIZATION PROCESS	FACTORS CAUSING SALTY	IMPACTS (under Sea-level rise)
Primary salinization	Sea water overflowing	No impacts
	Percolation/ transmission from the outer to the inner of the dyke system	Negligible
	Groundwater	Maybe ? (need a particular research)
Secondary salinization	**Irrigation water**	**Stronger salinization**
	Aquaculture	Increasing salinization

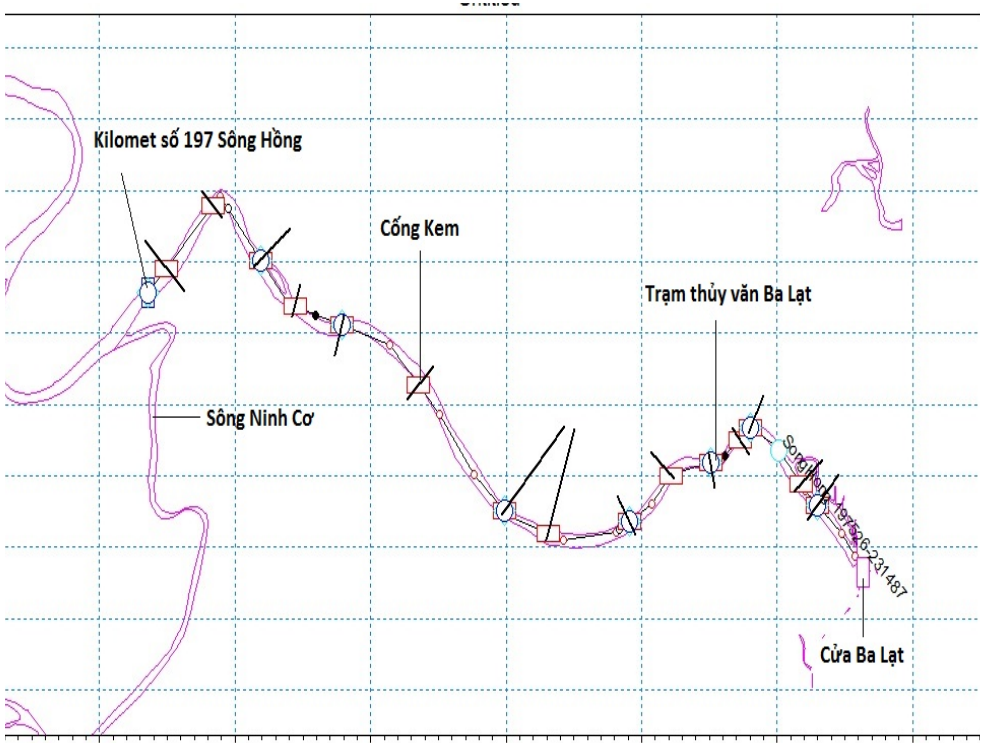
RESULT 1: Sea-level rise impact assessment on the soil salinization process of agricultural land in Tien Hai district, Thai Binh

2. Forecasting the salinity trend of Tien Hai rice-cultivated land up to 2100

Mike 11 application to predict the irrigation water salinity

- 2006 -2007: modification & verification
- B2 scenario of MONRE 2009 – lower border
- Simulation period: February – March – April

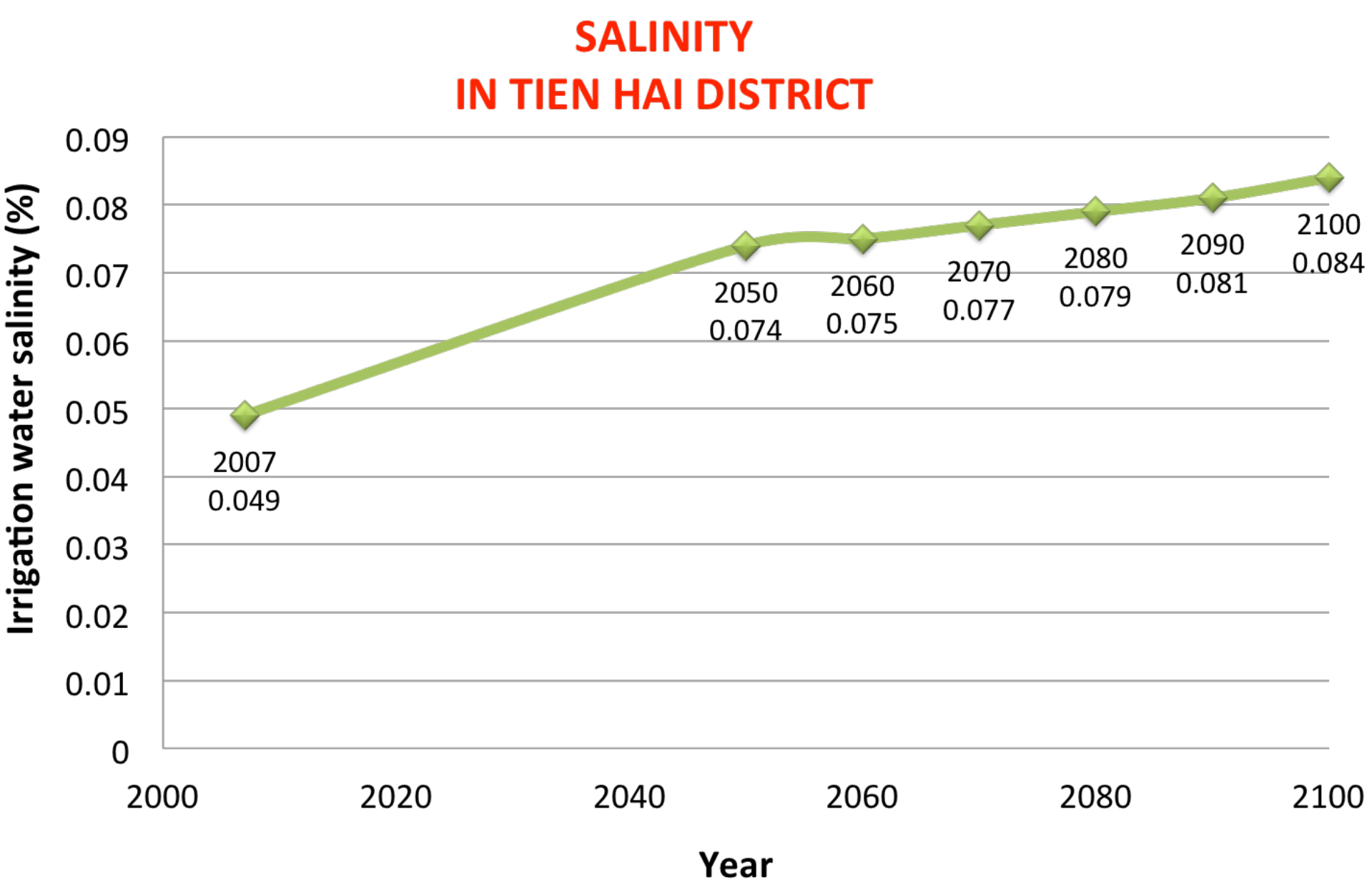
Input data	
Hydrological data	Terrain data
• Higher border: Inflow – Salinity at the 197km	•Hydrological map of the Red river downstream
• Lower border: Water level – Salinity at Ba Lat estuary	•Cross sections of the Red river
• Water level – Salinity at adjustable and verified stations	



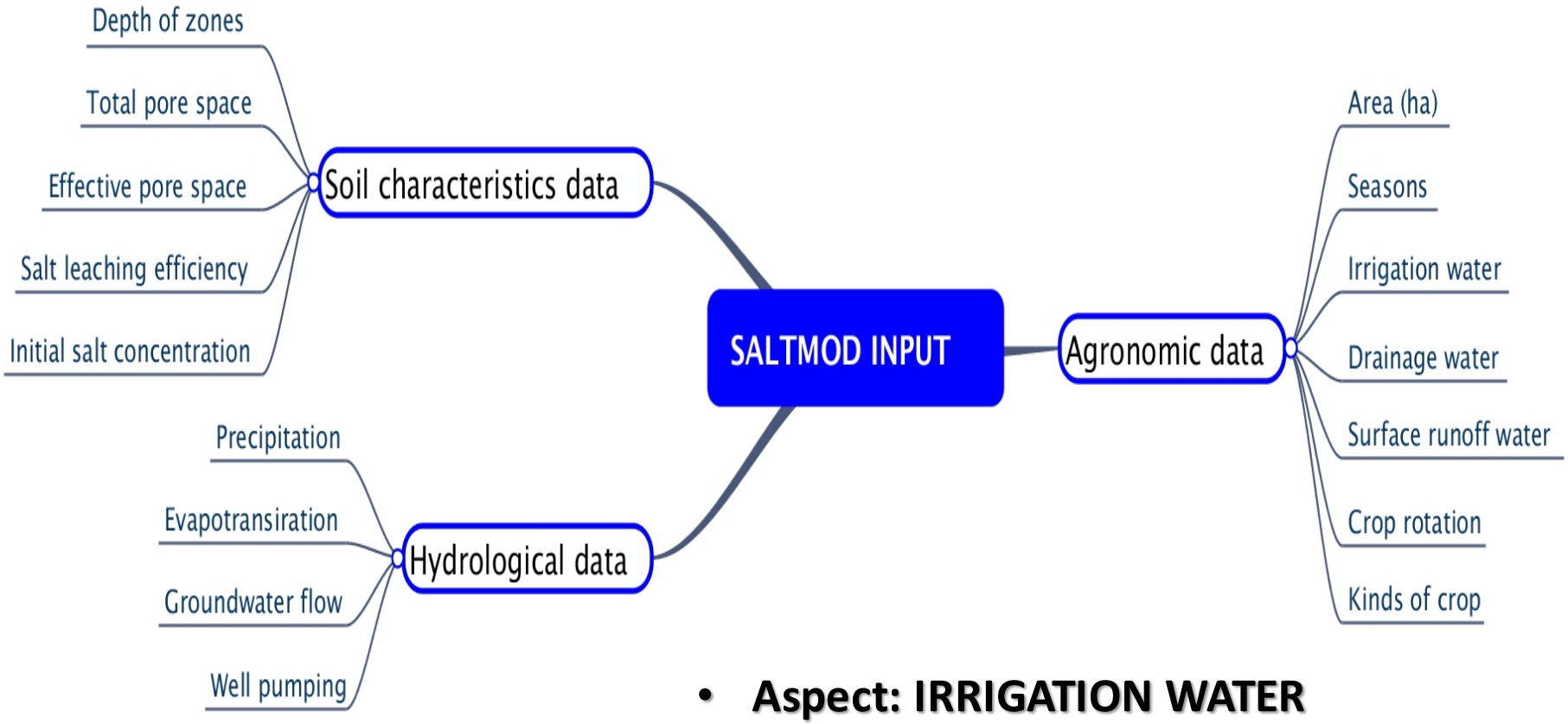
River network

DATA GROUP	INDEX		VALUE
SOIL CHARACTERISTICS DATA	Storage efficiency of water in the root zone		0.6
	Thickness of	Root zone	0.2 (m)
		Transition zone	0.37 (m)
		Aquifer	5 (m)
	Total porosity of	Root zone	0.5
		Transition zone	0.48
		Aquifer	0.47
	Effective porosity	Root zone	0.15
		Transition zone	0.07
		Aquifer	0.05
	Salt leaching efficiency	Root zone	0.12
		Transition zone	0.1
		Aquifer	0.05
	Initial salt concentration (when saturated)	Root zone	0.33 %
		Transition zone	0.36%
		Aquifer	0.35%
	Initial depth of the water table		0.35 (m)
	Critical depth of the water table for capillary rise		2 (m)

DATA GROUP	INDEX		VALUE
HYDROLOGICAL DATA	Percolation loss from irrigation canal system		0
	Amount of irrigation water	Dry seasons	0.6 (m/season)
		Rainy seasons	0.45 (m/season)
	Incoming groundwater flow through the aquifer		8.693 l/s -km²
	Surface runoff		0 (m/season)
	Surface drainage	Dry seasons	B2 scenario,2009
		Rainy seasons	
	Precipitation	Dry seasons	
		Rainy seasons	
	Evapo-transpiration	Dry seasons	
		Rainy seasons	
	Salt concentration	Groundwater	0.35%
		Rainwater	0.002 %
AGRONOMIC DATA	Area		8100 ha
	Number of seasons		2 seasons
	Duration of seasons in months	Dry seasons	2,3,4,5
		Rainy seasons	7,8,9,10

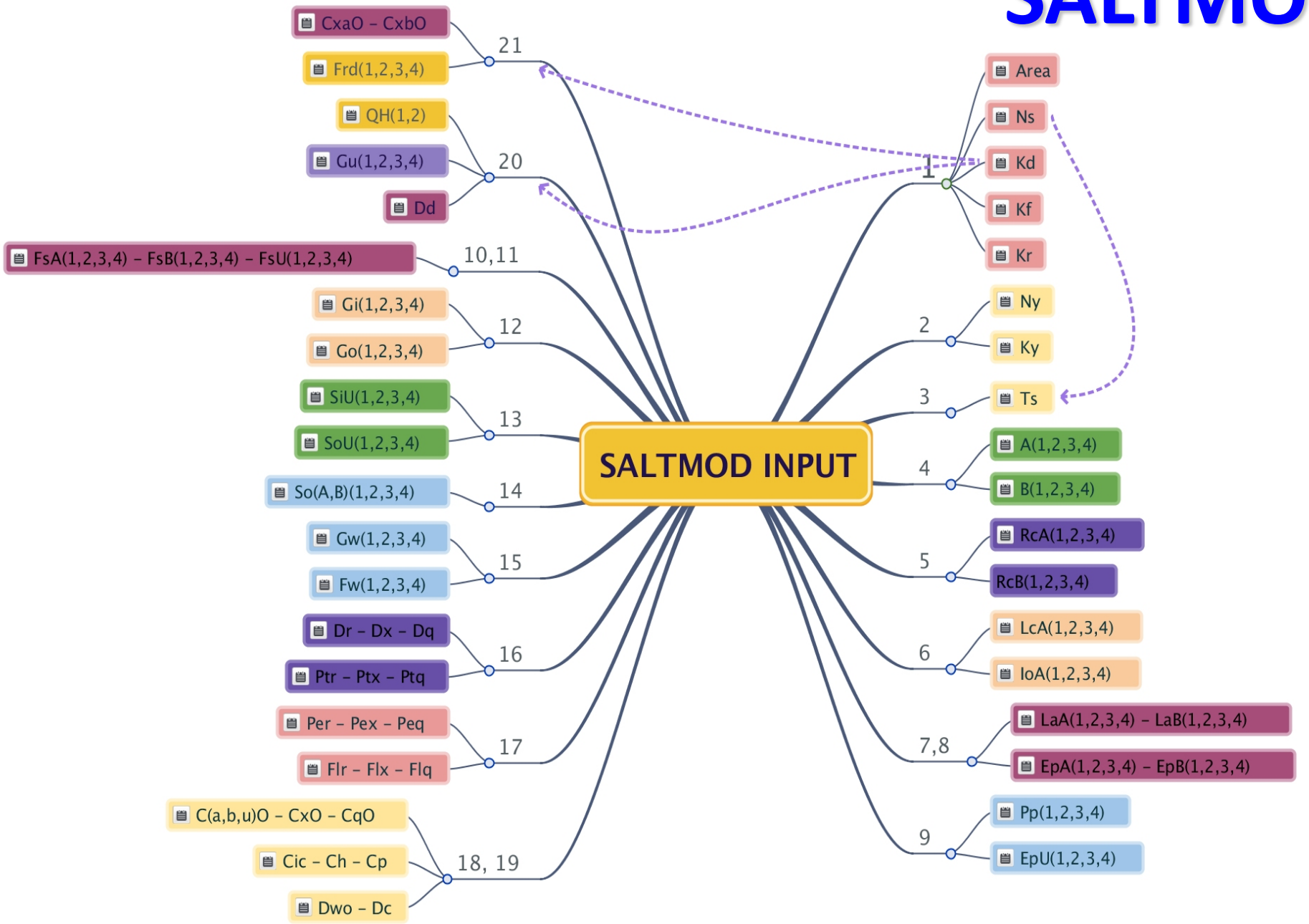

GRAPH PREDICTION OF THE IRRIGATION WATER SALINITY
IN TIEN HAI DISTRICT
Irrigation water salinity (%)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
2000
2020
2040
2060
2080
2100
Year
2007
0.049
2050
0.074
2060
0.075
2070
0.077
2080
0.079
2090
0.081
2100
0.084

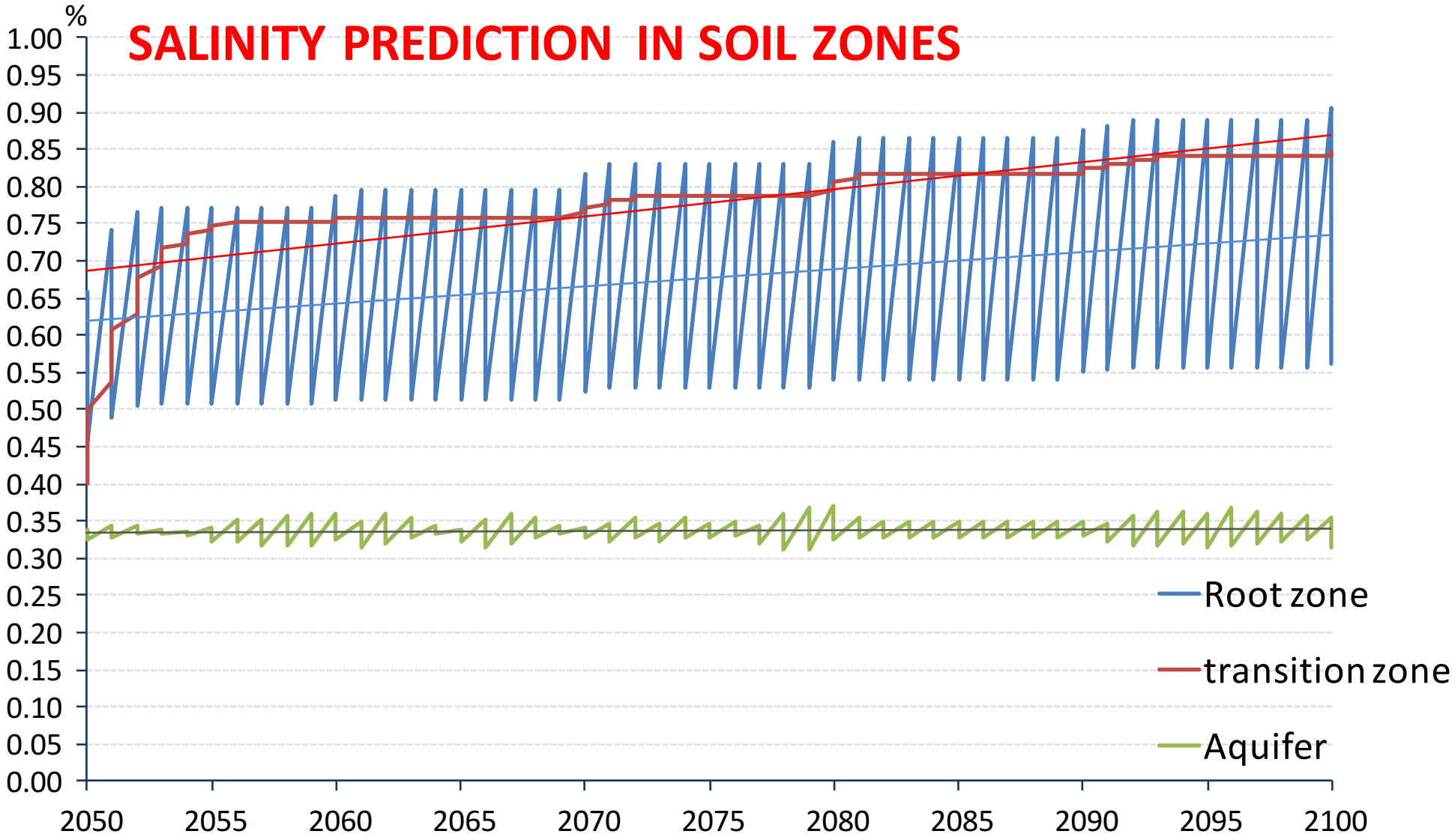
SALTMOD application for the prediction of rice-cultivated land's salinity trend



- **Aspect: IRRIGATION WATER**
- Principles: Water balance and Salt balance
- Seasonal Input data

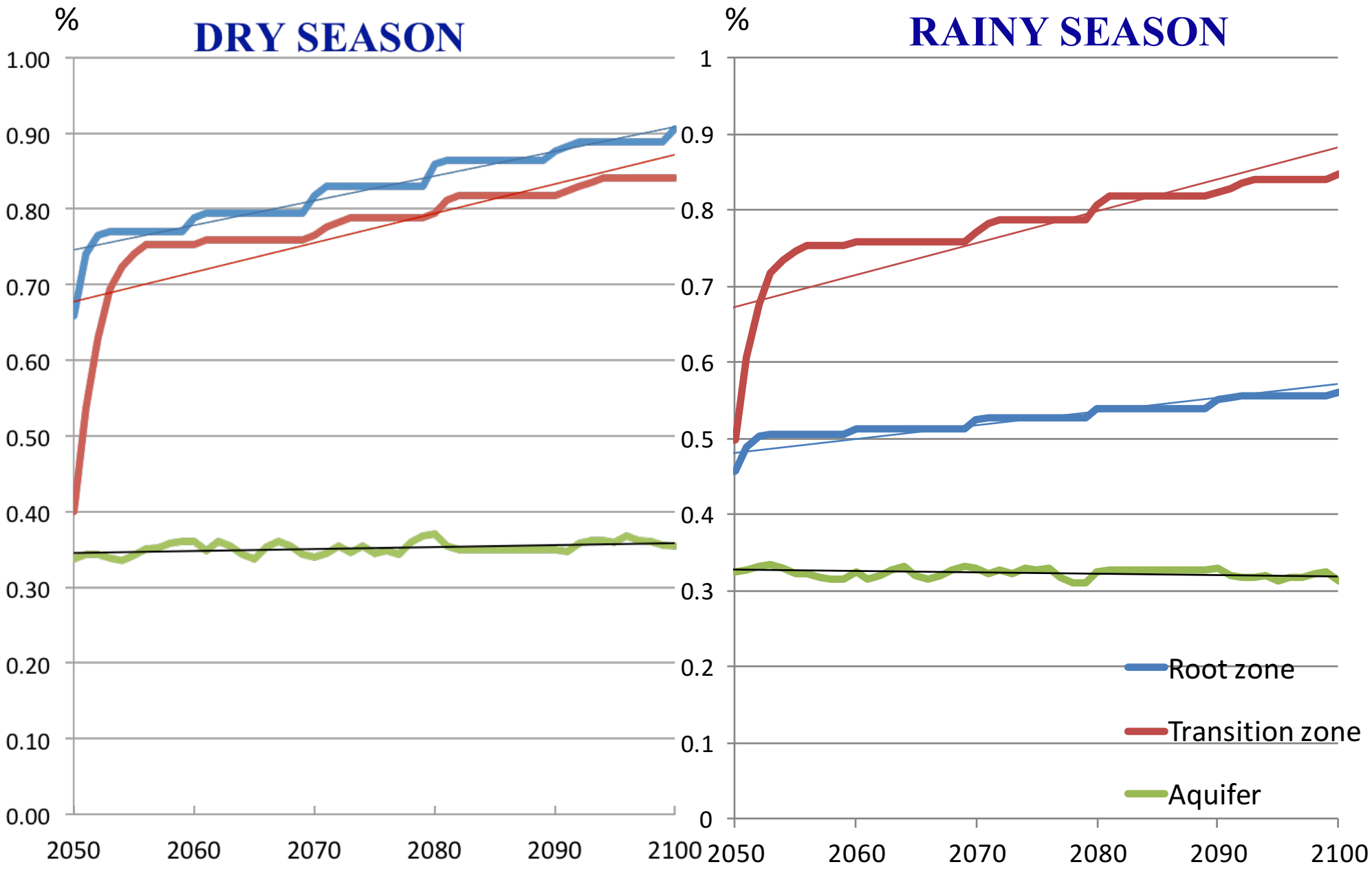
SALTMOD


SALTMOD INPUT
21
CxaO – CxbO
Frd(1,2,3,4)
20
QH(1,2)
Gu(1,2,3,4)
Dd
10,11
FsA(1,2,3,4) – FsB(1,2,3,4) – FsU(1,2,3,4)
12
Gi(1,2,3,4)
Go(1,2,3,4)
13
SiU(1,2,3,4)
SoU(1,2,3,4)
14
So(A,B)(1,2,3,4)
15
Gw(1,2,3,4)
Fw(1,2,3,4)
16
Dr – Dx – Dq
Ptr – Ptx – Ptq
17
Per – Pex – Peq
Flr – Flx – Flq
18, 19
C(a,b,u)O – CxO – CqO
Cic – Ch – Cp
Dwo – Dc
1
Area
Ns
Kd
Kf
Kr
2
Ny
Ky
3
Ts
4
A(1,2,3,4)
B(1,2,3,4)
5
RcA(1,2,3,4)
RcB(1,2,3,4)
6
LcA(1,2,3,4)
IoA(1,2,3,4)
7,8
LaA(1,2,3,4) – LaB(1,2,3,4)
EpA(1,2,3,4) – EpB(1,2,3,4)
9
Pp(1,2,3,4)
EpU(1,2,3,4)



RESULT 2: General trend of the soil salinity is a considerable increase in the period 2007-2100 time.

SOIL SALINITY TREND



CLIMATE CHANGE AND SEA-LEVEL RISE IMPACTS ON THE SOIL SALINITY OF THE RICE-CULTIVATED LAND IN TIEN HAI DISTRICT, THAI BINH PROVINCE

DRY SEASON

- **Root zone salinity**:
  0.33% (2007) to 0.91% (2100)
- **Transition zone salinity:**
  0.36% (2007) to 0.84% (2100)
- **Aquifer salinity**: nearly stable

  2 reasons:

  _Primarily governed by the groundwater salinity 0.35%

  _Salt leaching efficiencies (Fl)

  Flr (root zone) = 0.12%

  Flx (transition zone) = 0.1%

  → Almost the soluble salts in the irrigation water are captured in the 2 above zones.

RAINY SEASON

- **Desalinization time**
- **Root zone salinity:**

  _Slightly decrease after each rainy season

  _General trend: the increasing salinity (0.23%) due to the small value of Flr.
- **Transition zone salinity**:

  _Slight increase after each rainy season. **Possible reason**: the removal salt from the root zone is accumulated there

  Flx = 0.1%
- **Aquifer salinity**: slightly decrease from 0.35% to 0.31%.

CONCLUSION

1. Saltmod output: Salinity trend for the long term prediction
   => entirely appropriate for the research's objective
2. Under sea-level rise impacts, the soil salinization process will become stronger.
3. From 2007 to 2100, due to the sea-level rise impact on the irrigation water, soil salinity increases remarkably especially in dry seasons:
   . Root zone: 0.33% - 0.91%
   . Transition zone: 0.36 – 0.84%
   . Aquifer: (stable around) 0.35%

RECOMMENDATION

1. Improvement of the irrigation work system, the expand of the irrigation water supply culverts located on the upstream in order to prevent the impacts of sea-water intrusion.
2. Attaching importance to the expand of the seed-rice transformation into kinds which are able to suffer the salinity in the district.

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THANK YOU FOR YOUR LISTENING

Đường biểu diễn xâm nhập mặn sông Hồng năm 2100

Sai số thu được từ mô hình tính theo chỉ tiêu Nash-S cho mô đun thủy lực:

$$S = 1 - \left[\frac{\sum_{i=1}^{n}(P_i - O_i)^2}{\sum_{i=1}^{n}(|O - \bar{O}|)^2}\right]$$

S>0.4 phương án dự báo đạt

Trong đó: *P_i: giá trị dự báo*

O_i: giá trị thực đo

$\bar{O}$: trung bình thực đo

n: số giá trị trong lần dự báo.

S (%)	Đánh giá chất lượng dự báo
< 40	Kém
40 – 70	Trung bình
70 – 85	Khá
85 - 100	Tốt

Và dựa theo chỉ tiêu IOA cho mô đun xâm nhập mặn.

$$IOA = 1 - \left[\frac{\sum_{i=1}^{n} (O_i - P_i)^2}{\sum_{i=1}^{n} (|P_i - \overline{O}| + |O_i - \overline{O}|)^2} \right]$$

IOA>0.5 phương án dự báo đạt

IOA (%)	Đánh giá chất lượng dự báo
< 50	Kém
50 – 70	Trung bình
70 – 85	Khá
85 - 100	Tốt

Trong đó: P_i: *giá trị dự báo;* O_i: *giá trị thực đo*

$\overline{O}$: *trung bình thực đo;* *n: số giá trị trong lần dự báo*

Bảng : Sai số giữa kết quả của mô hình và thực đo

	SAI SỐ	ĐÁNH GIÁ
Hiệu chỉnh mô đun HD	84,5%	Khá
Kiểm định mô đun HD	90,6%	Tốt
Hiệu chỉnh mô đun AD	62,4%	Trung bình
Kiểm định mô đun AD	59,7%	Trung bình