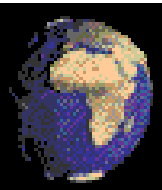


United Nations University
UNU-EHS
Institute for Environment and Human Security

WISDOM
A GERMAN - VIETNAMESE INITIATIVE

WISDOM project
Water-related Information System for the sustainable Development Of the Mekong Delta in Vietnam

WISDOM
6th PhD Scientific Seminar

REUSE OF WASTEWATER AS A CLIMATE CHANGE ADAPTATION MEASURE CASE STUDY IN CAN THO CITY

Bonn, Germany
10-14 June 2013

Dr. Trinh Thi Long
Southern Institute of Water Resources Research

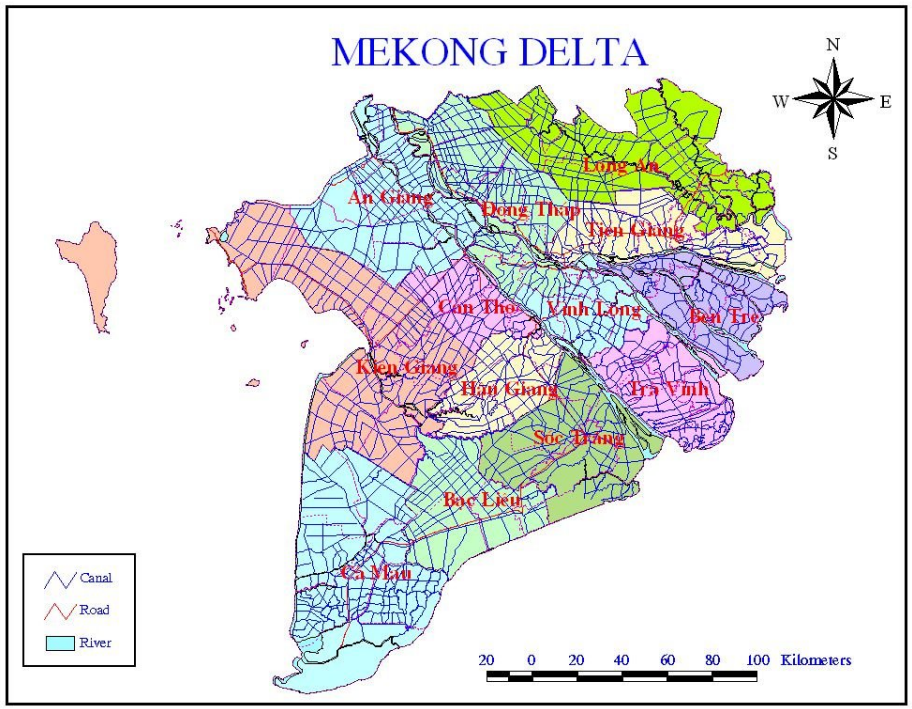
CLIMATE CHANGE

impact

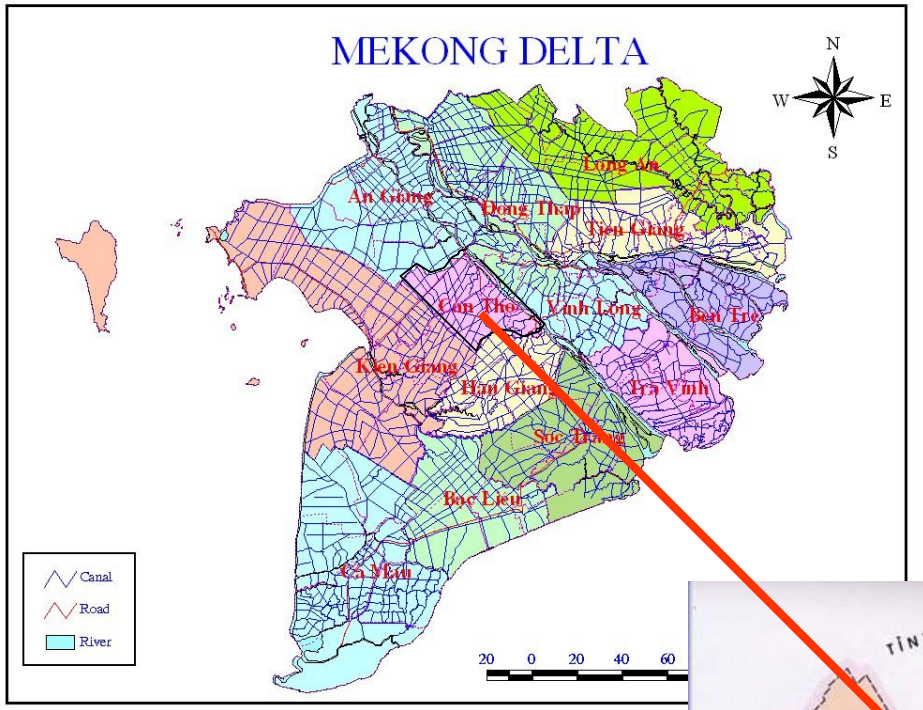
VIETNAM

impact

ranks among the top five developing countries most impacted by climate change



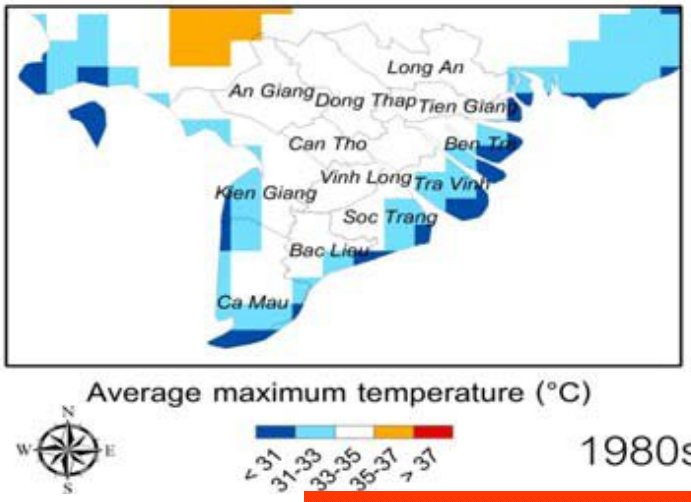
has been identified as being particularly susceptible to the impacts of extreme climate events and climate variability

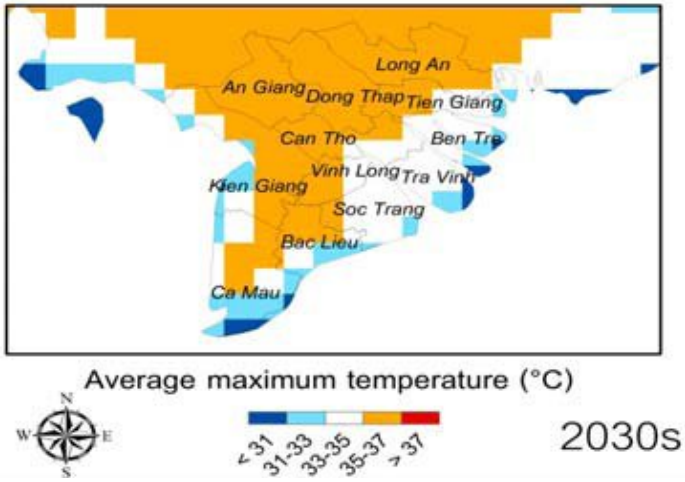

MEKONG DELTA
N
W
E
S
Long An
An Giang
Dong Thap
Tien Giang
Can Tho
Vinh Long
Ben Tre
Kien Giang
Hau Giang
Tra Vinh
Soc Trang
Bac Lieu
Ca Mau
Canal
Road
River
20 0 20 40 60


BẢN ĐỒ HÀNH CHÍNH
TP CẦN THƠ - TRỰC THUỘC TRUNG ƯƠNG
TỈNH AN GIANG
TỈNH ĐỒNG THÁP
TỈNH VĨNH LONG
TỈNH KIÊN GIANG
TỈNH HẬU GIANG
HUYỆN THỐT NỐT
HUYỆN VĨNH THẠNH
HUYỆN CỜ ĐỎ
QUẬN Ô MÔN
QUẬN BÌNH THỦY
QUẬN NINH KIỀU
HUYỆN PHONG ĐIỀN
QUẬN CÁI RĂNG
B
CHÚ THÍCH
Trụ sở UBND Phường, Thị trấn
Trụ sở UBND Tỉnh, Huyện thị
Sông, kênh, rạch
Đường giao thông (liên huyện, xã, ấp, hẻm)
Ranh giới Tỉnh
Ranh giới Huyện, Thị
Ranh giới Xã, Phường, Thị trấn
Quốc lộ, Hương lộ, Liên tỉnh lộ

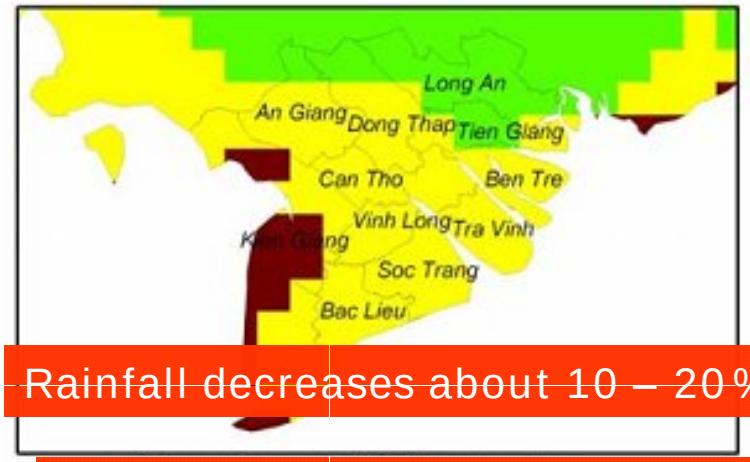
METHODOLOGY

- **Identification of the water resources** in Can Tho City **-** quantification and system level mapping;
- **Baseline water quality determinations** in the river/canal system (rainy and dry season).
- **Investigations and surveys of pollution sources** in the city and the availability/stability of centralized secondary wastewater treatment plants in the region;
- **Analyzing water and nutrient requirements of paddy rice** crops and the **demand that treated wastewater can meet**: land use and crop patttern, water and nutrient requirement of paddy rice, potential of wastewater reuse for both quantity and quality.
- **City planning of water supply and wastewater treatment** (based on Decisions, Development plans, Standards …).
- **Meetings and interviews with local authorities and farmers** to obtain insights on “local knowledge”: meetings and interviews with local authorities at the City, District and Village levels conducted in October 2010 and March 2011.

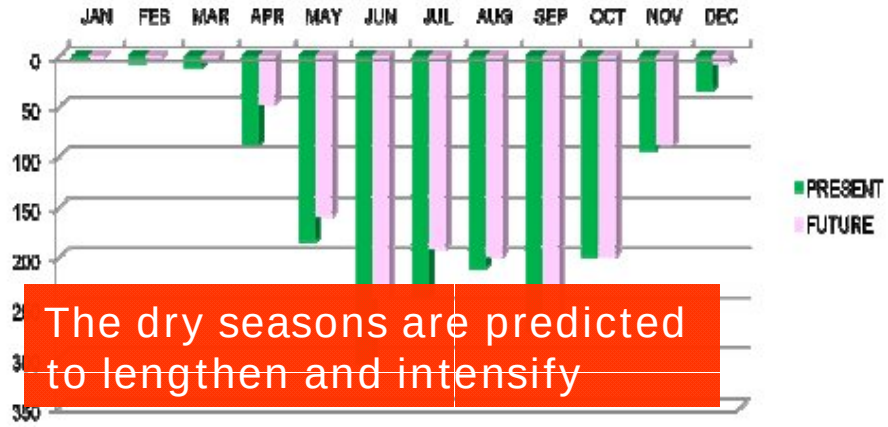




Temperature increases from 33 – 35 °C to 35 – 37 °C



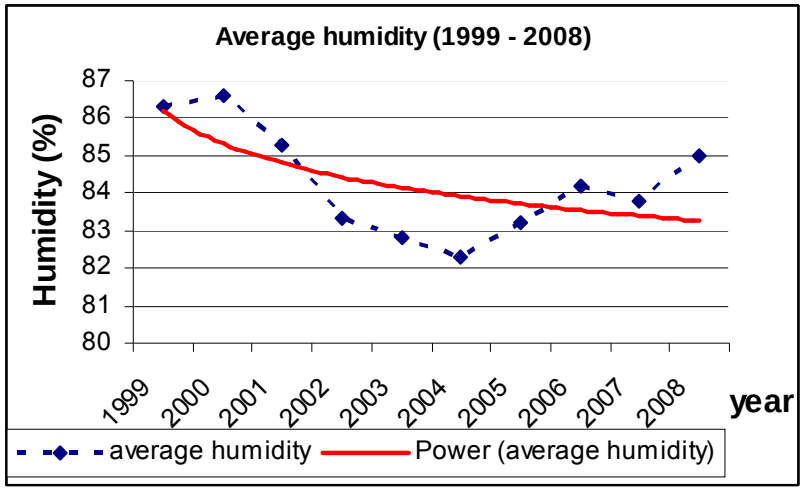
Rainfall decreases about 10 – 20%



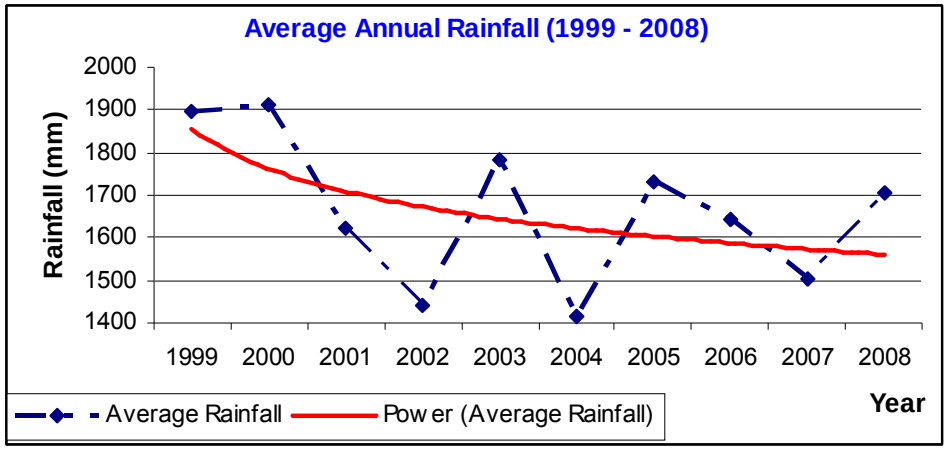
The dry seasons are predicted to lengthen and intensify

Total annual rainfall in An Giang, Can Tho and Soc Trang will decrease about 20%, and rainy season will start 2 weeks later.

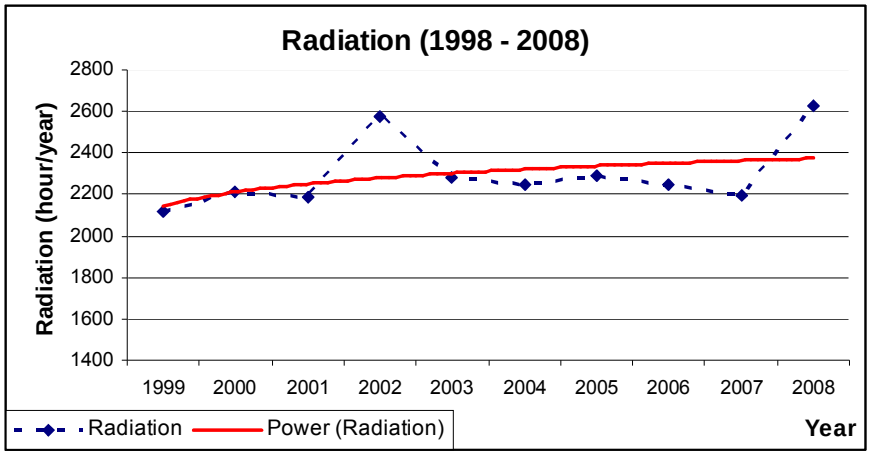
With the use of Global Circulation Models (GCMs) combined with the downscaling regional climate model PRECIS and series of data from 1980 – 2000, University Chulalongkorn - Thailand and Climate Change Research Institute – Can Tho University (Vietnam) have done the forecasting for the year 2030-2040 that many areas in the Mekong Delta will get serious impacts due to climate change



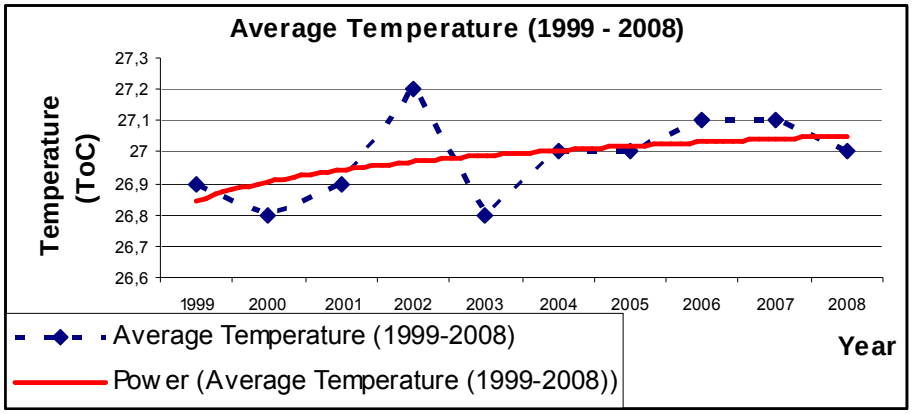
humidity has a trend of decreasing 5 %



Rainfall decreasing 200mm/year



air-temperature increasing 0.2 ^{0}C

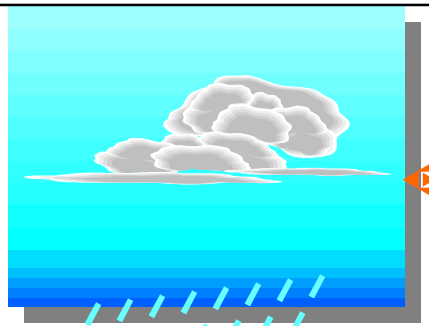


sun radiation increasing 200 hours/year

From 2000 to 2007 in Hau river at Tan Chau, water level is decreased 0.8m, meanwhile the max water level in Can Tho is increased 0.3m with decreasing

facilitate salinity to intrude deeply into the land

In the dry season of the year 2006, 2007 and 2008 water discharge of Hau river was only 800 m3/s instate of 1250 m3/s in about 30 years ago (DONRE, 2009)

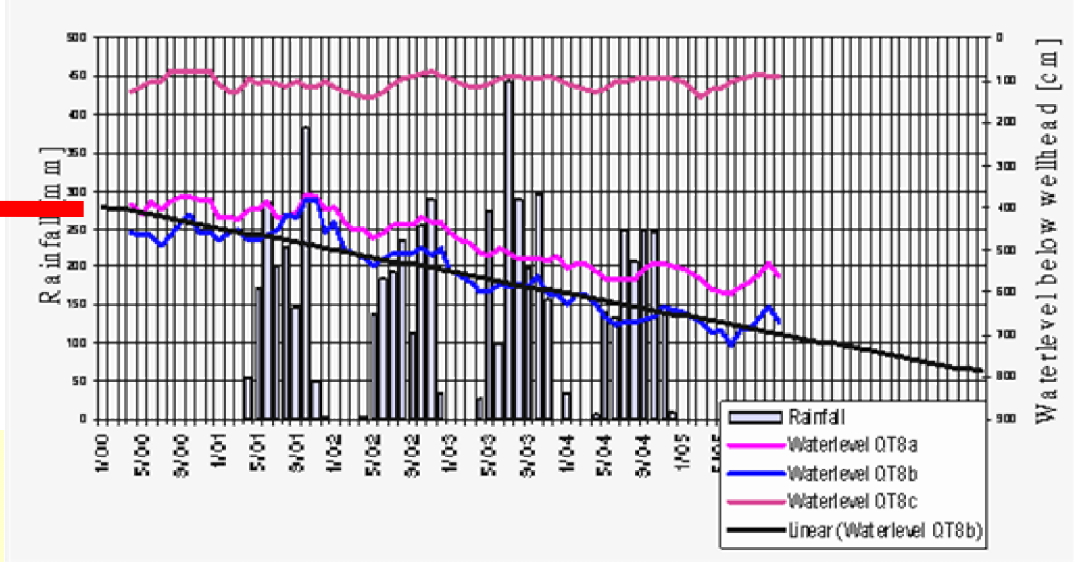


Rain water with total average calculation for 10 year (1999 – 2008) is about 2.3 billion m3/year. If making use of this source, it's nearly enough for domestic use in 3 months in the dry season.
However, it's not possible to havest 100% of the rainwater.

WATER RESOURCES

SURFACE WATER

?



Depression of groundwater level in Tra Noc Industrial zone

Over-extraction, saltwater intrusion, and pollution

Designed capacity: 163,558 m3/day
Actual extraction: 101,061 m3/day

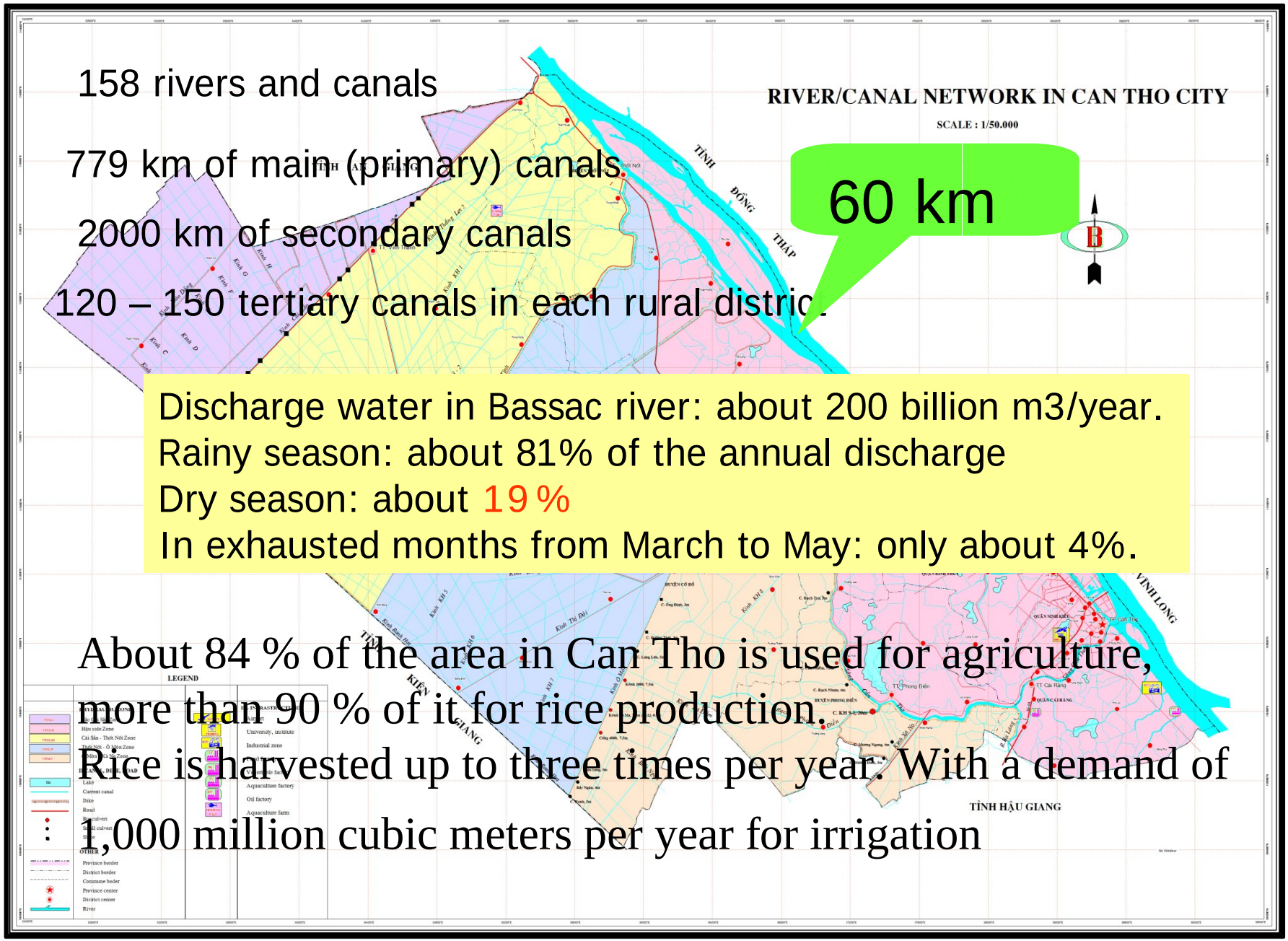
Well 5 m3/day: 32,000; 50 m3/day: 400; 500 – 1000 m3/day: 30; 200 GWP in 2010

158 rivers and canals

779 km of main (primary) canals

2000 km of secondary canals

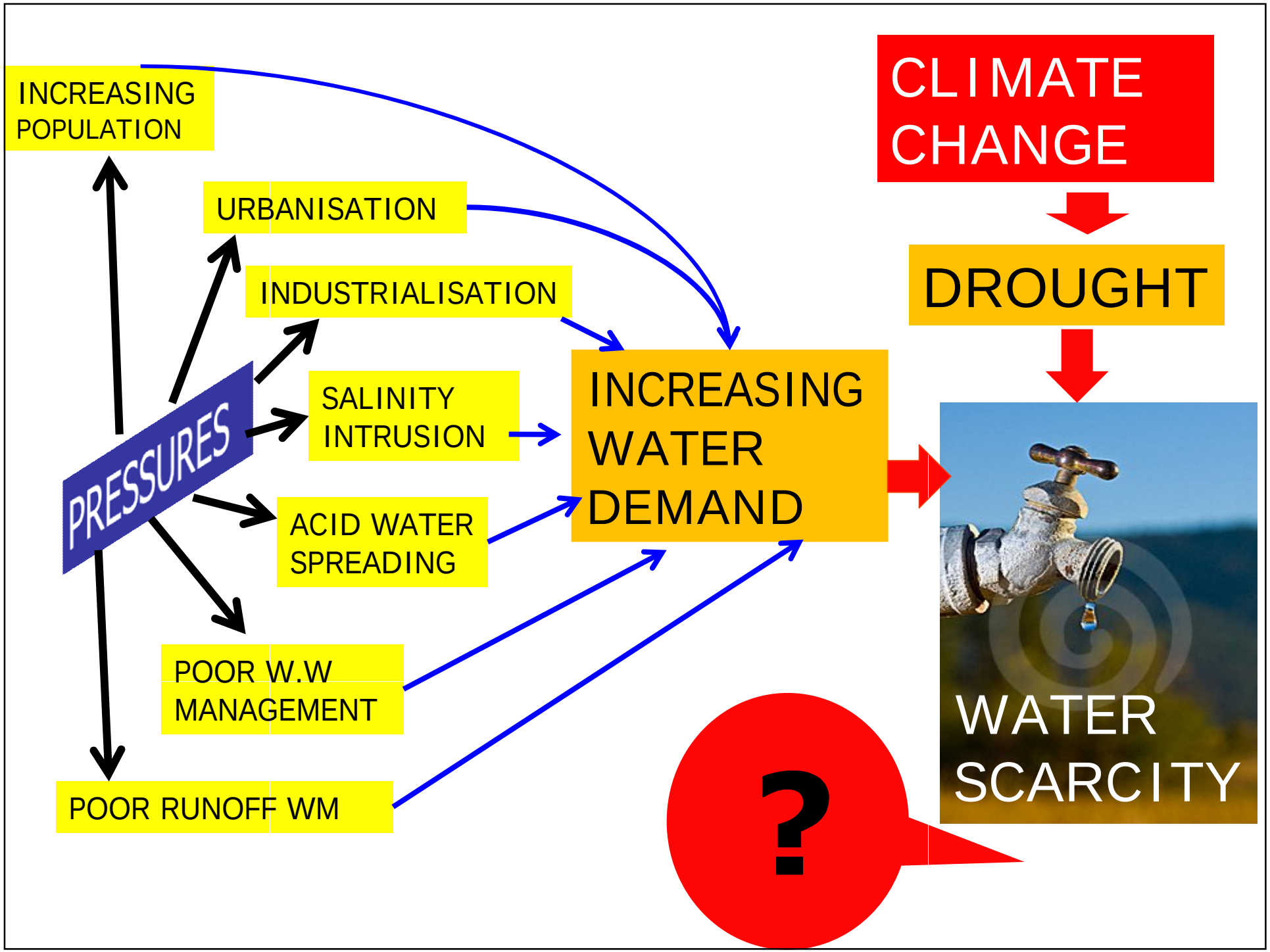
120 – 150 tertiary canals in each rural district

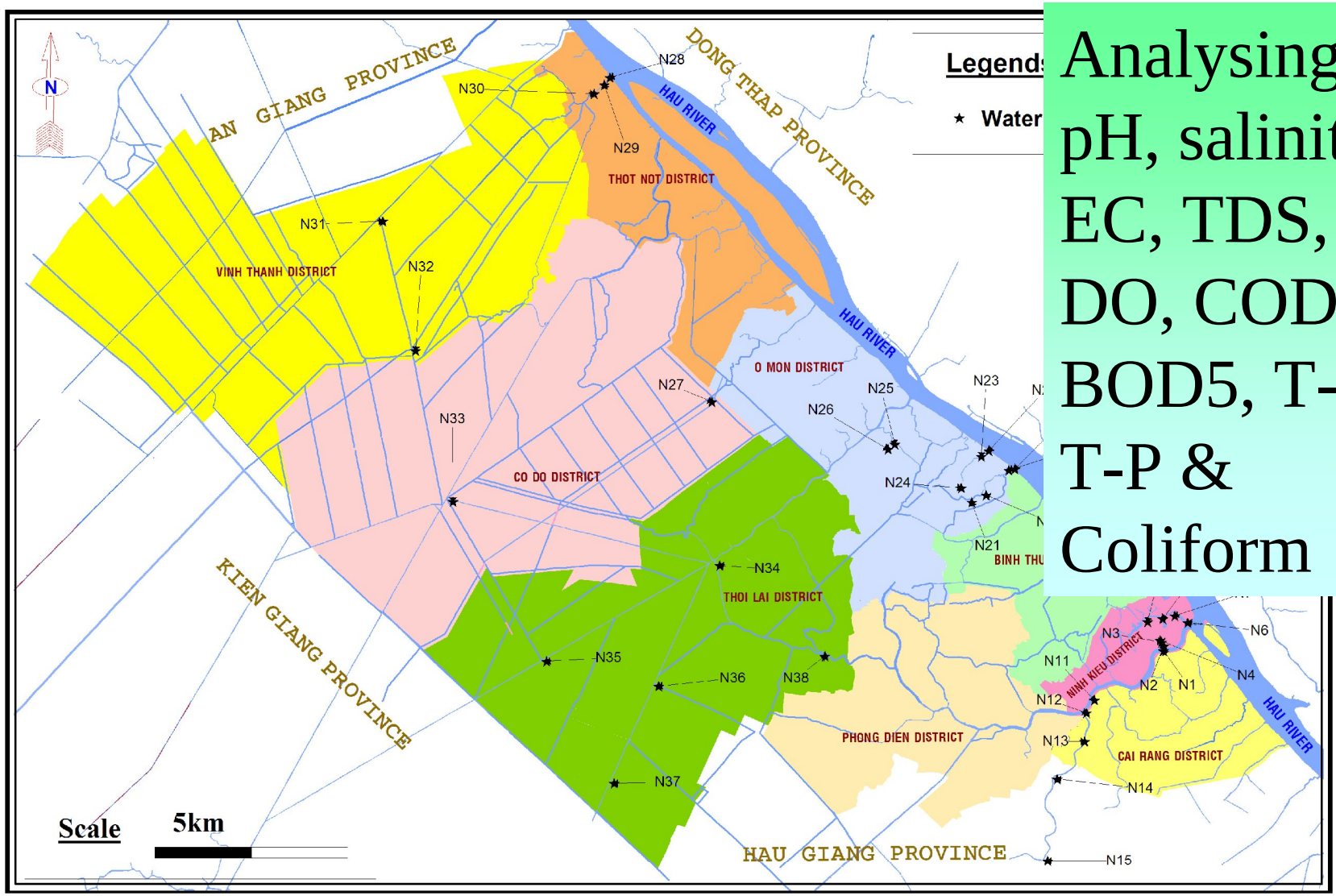


Discharge water in Bassac river: about 200 billion m3/year.
Rainy season: about 81% of the annual discharge
Dry season: about 19 %
In exhausted months from March to May: only about 4%.

About 84 % of the area in Can Tho is used for agriculture, more than 90 % of it for rice production.

Rice is harvested up to three times per year. With a demand of 1,000 million cubic meters per year for irrigation


INCREASING POPULATION
URBANISATION
INDUSTRIALISATION
SALINITY INTRUSION
ACID WATER SPREADING
POOR W.W MANAGEMENT
POOR RUNOFF WM
PRESSURES
INCREASING WATER DEMAND
CLIMATE CHANGE
DROUGHT
WATER SCARCITY
?



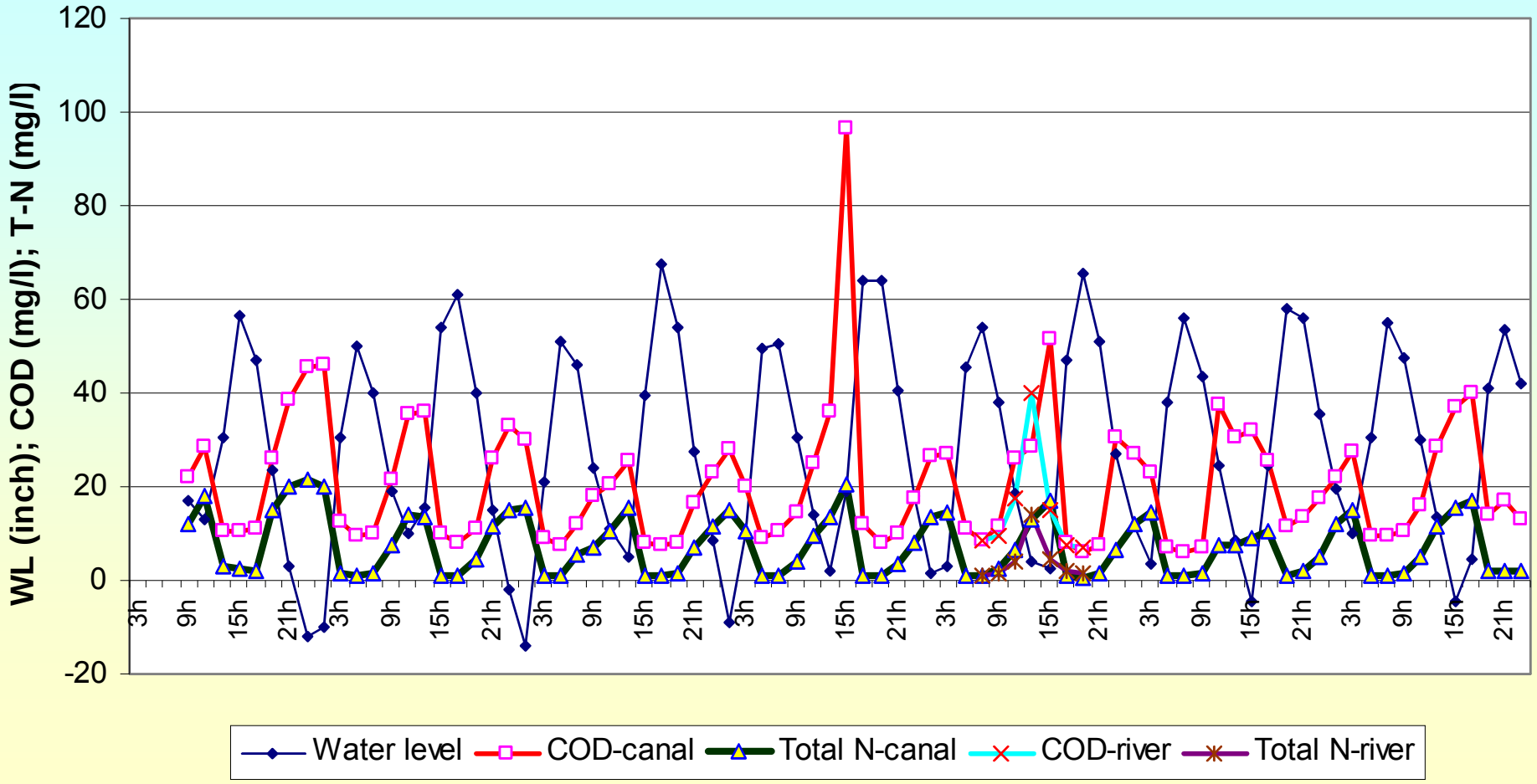
Analysing: pH, salinity, EC, TDS, DO, COD, BOD5, T-N, T-P & Coliform

Figure 2: Location of water quality sampling stations

One week of daily monitoring 24-31/3/2011

Water level
COD, T-N & TP

Variation of COD and TN in Tham Tuong canal water

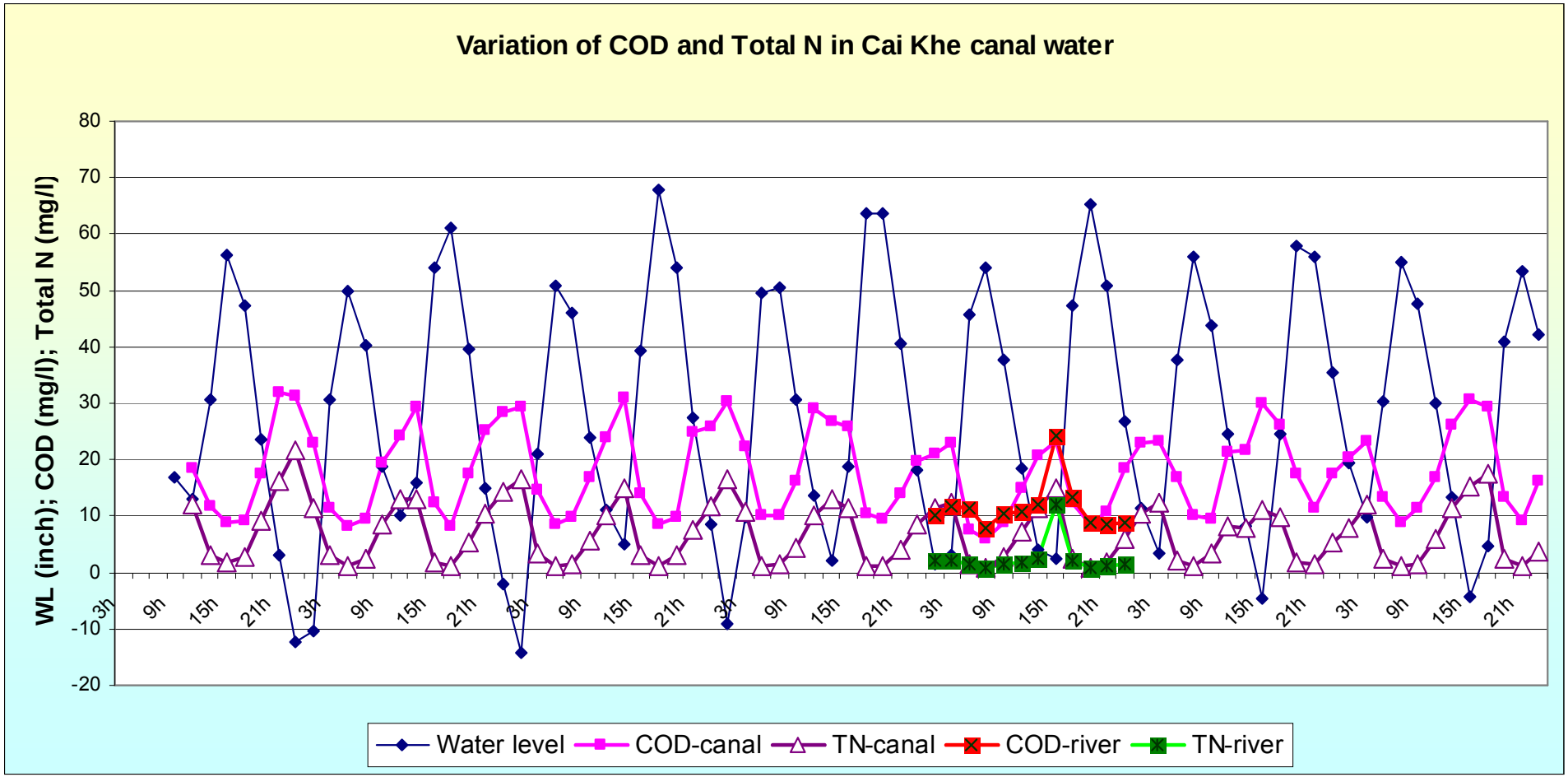


QCVN A1 = 10 mg/l

A2 = 15 mg/l

B1 = 30 mg/l

MRC value TN = 1.7 mg/l

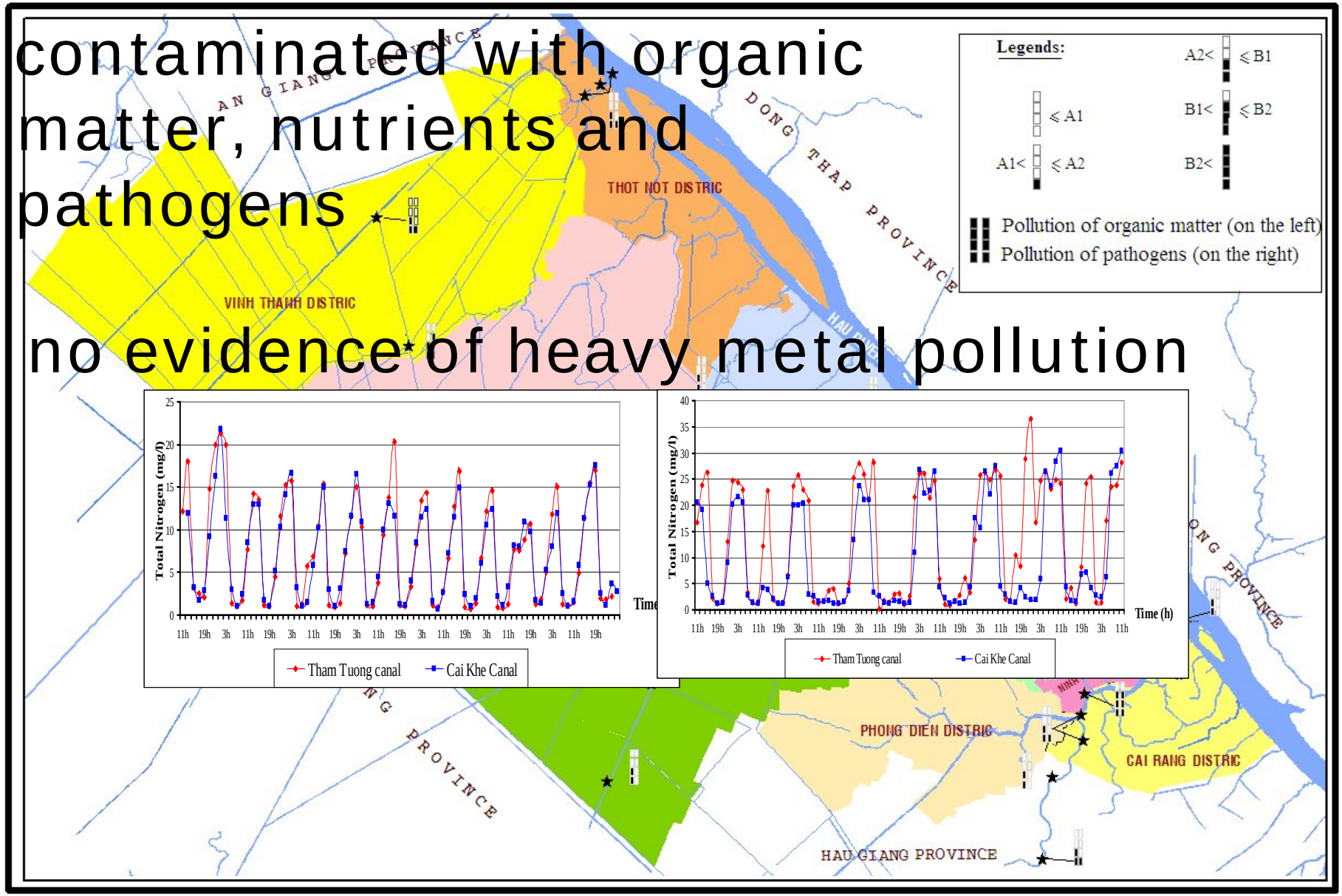


QCVN A1 = 10 mg/l
A2 = 15 mg/l
B1 = 30 mg/l

MRC value TN = 1.7 mg/l

contaminated with organic matter, nutrients and pathogens

no evidence of heavy metal pollution



A1: for domestic water supply

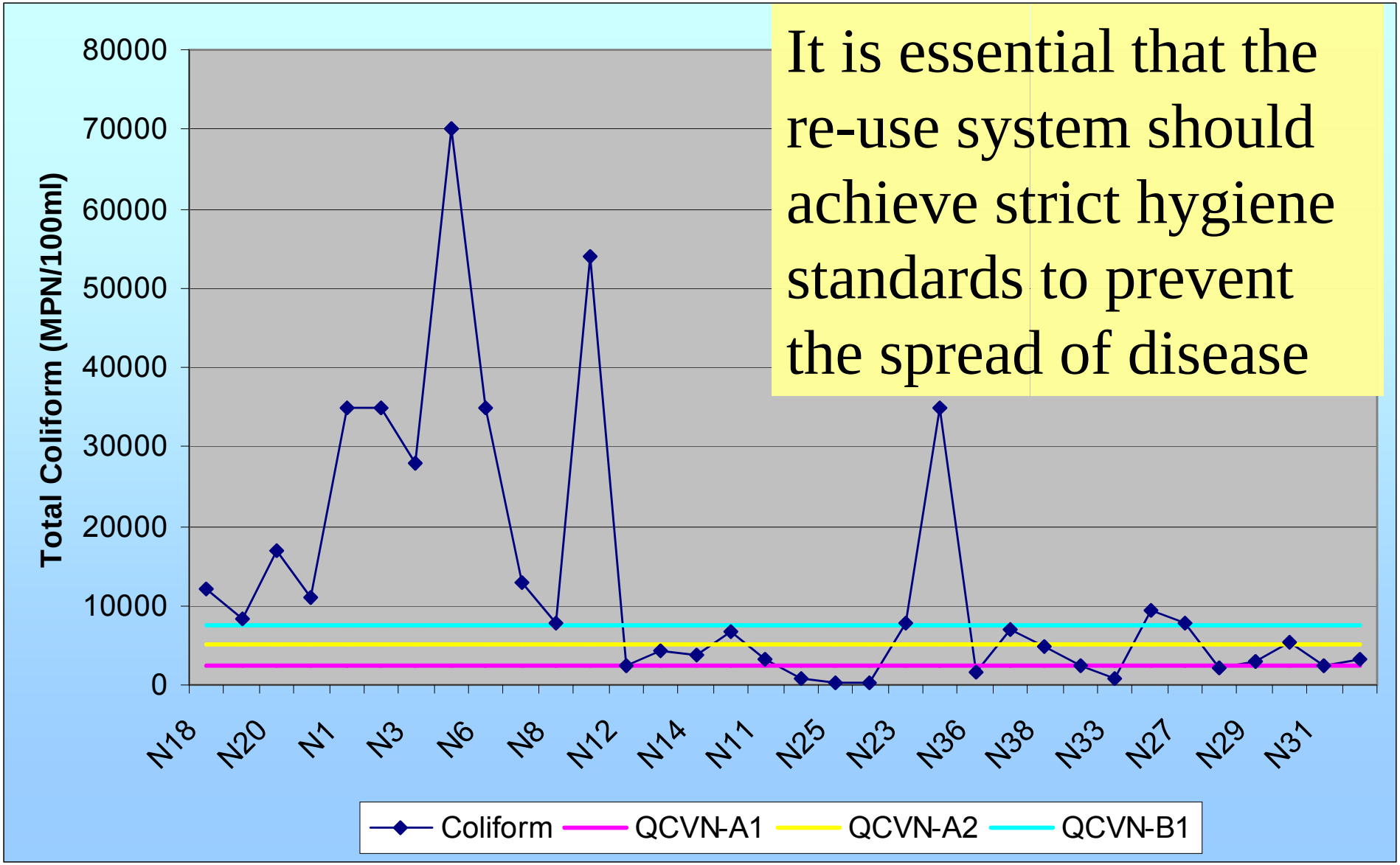
A2: for domestic water supply with treatment

B1: for irrigation

B2: Navigation and other purposes required low quality

BUT

Pathogenic organisms

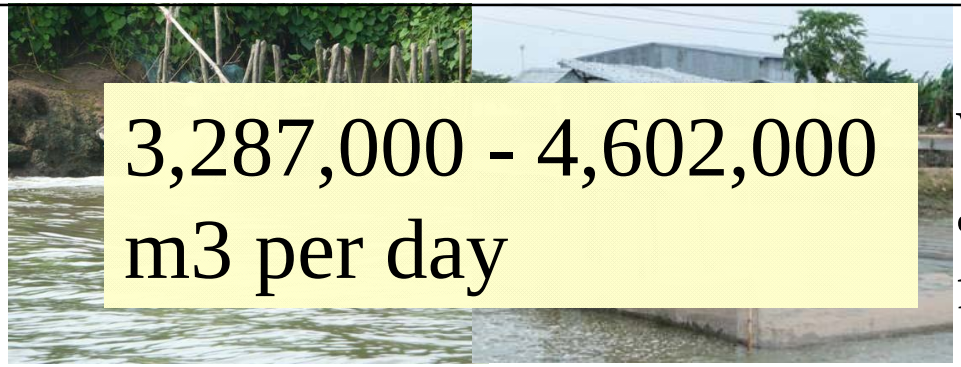


It is essential that the re-use system should achieve strict hygiene standards to prevent the spread of disease

Guidelines for Water Reuse

Type of Reuse	Treatment Required	Reclaimed Water Quality	Recommended Monitoring	Setback Distances
AGRICULTURAL	Secondary Disinfection	pH = 6-9	pH weekly	300 ft from potable water supply wells
Food crops commercially processed		BOD ≤ 30 mg/l	BOD weekly	
		SS = 30 mg/l	SS daily	
Orchards and Vinerds		FC ≤ 200/100 ml	FC daily	100 ft from areas accessible to public
		Cl2 residual = 1 mg/l min.	Cl2 residual continuous	
		BOD ≤ 30 mg/l	BOD weekly	
		SS ≤ 30 mg/l	SS daily	
		FC ≤ 200/100 ml	FC daily	100 ft from areas accessible to the public
		Cl2 residual = 1 mg/l min.	Cl2 residual continuous	
AGRICULTURAL	Secondary Filtration Disinfection	pH = 6-9	pH weekly	50 ft from potable water supply wells
Food crops commercially processed		BOD ≤ 30 mg/l	BOD weekly	
		Turbidity ≤ 1 NTU	Turbidity daily	
		FC = 0/100 ml	FC daily	
		Cl2 residual = 1 mg/l min.	Cl2 residual continuous	

Source: USEPA, *Process Design Manual: Guidelines for Water Reuse*, Cincinnati, Ohio, 1992



3,287,000 - 4,602,000 m3 per day

Wastewater from aquaculture – fish ponds

86,000m3/day

Domestic wastewater

Sources of WW

197,000m3/day

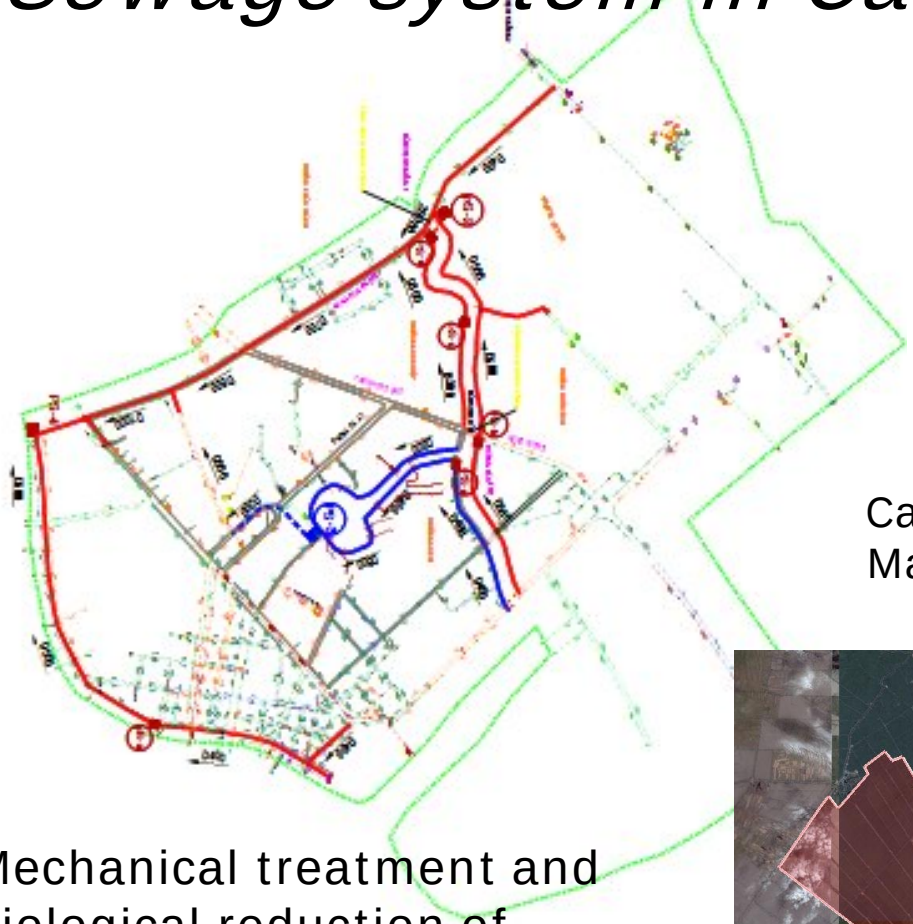
Wastewater from aquatic product processing industries

only one of those sources can make water quality in river/canal system of Can Tho city exceeds the permissible limitation of the current National Standard QCVN 08: 2008/BTNMT.

Meanwhile, Can Tho has all those 3 sources.

This is the reason that concentration of COD in surface water is increasing every year even with high flow of Hau river and pollution water if wash out to the sea everyday.

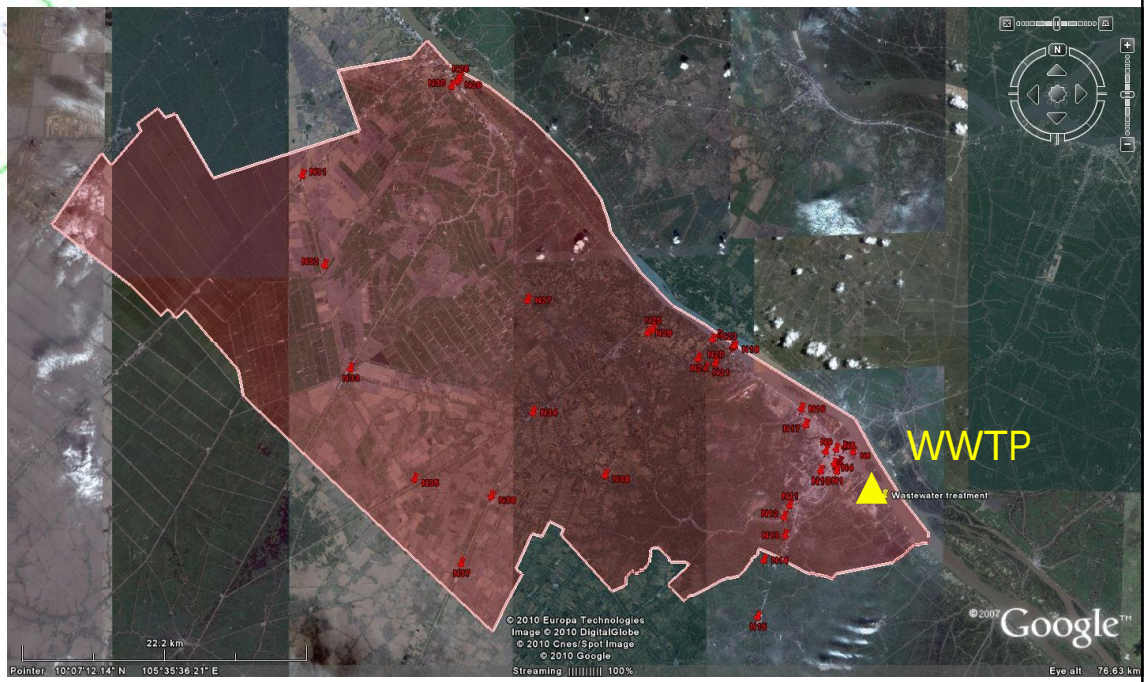
Sewage system in Can Tho city



WWTP

Total amount of 18,7million Euros
Vietnam approximately 52%
KfW and 48%

Capacity 22,550m3/d,
Maximum hydraulic flow of 0,726 m3/sec



Mechanical treatment and biological reduction of BOD and COD
TCVN – B LEVEL

TCVN 5945 – 2005

BOD: 50 mg/l
COC: 80 mg/l

Planned wastewater treatment capacity for Can Tho City

Number of domestic wastewater treatment plants		Total capacity Q (m^3 day^{-1})		Number of industrial wastewater treatment plants		Total capacity Q (m^3 day^{-1})	
2015	2020	2015	2020	2015	2020	2015	2020
4	4	60,000	86,000	8	10	64,600	197,600

Source: Decision No. 2066/QD-TTg January 12, 2010

Land use in Can Tho City to 2020, in hectares

Year		**2005**	**2010**	**2015**	**2020**
Natural land		140,096	140,096	140,096	140,096
I. Agriculture land		115,676	108,494	104,459	97,009
1	Rice crop land	92,793	89,308	70,189	58,299
2	Other crop land	21,559	17,404	32,430	36,810
3	Aquaculture land	10,97	1,550	1,600	1,650
4	Forestry land	227	232	240	250
II. Non-agriculture land		17,069	24,611	28,800	36,250
1	Dedicated land*	11,109	16,536	19,990	25,550
2	Domestic land**	5,960	8,075	8,810	10,700
II. Free space land, river/canals					
1	Free space land	321	154	0	0
2	River/canals	7,030	6,837	6,837	6,837

Source: Government Resolution No 12/2007/NQ-CP

Characteristics of the effluent of WWTP for residential areas

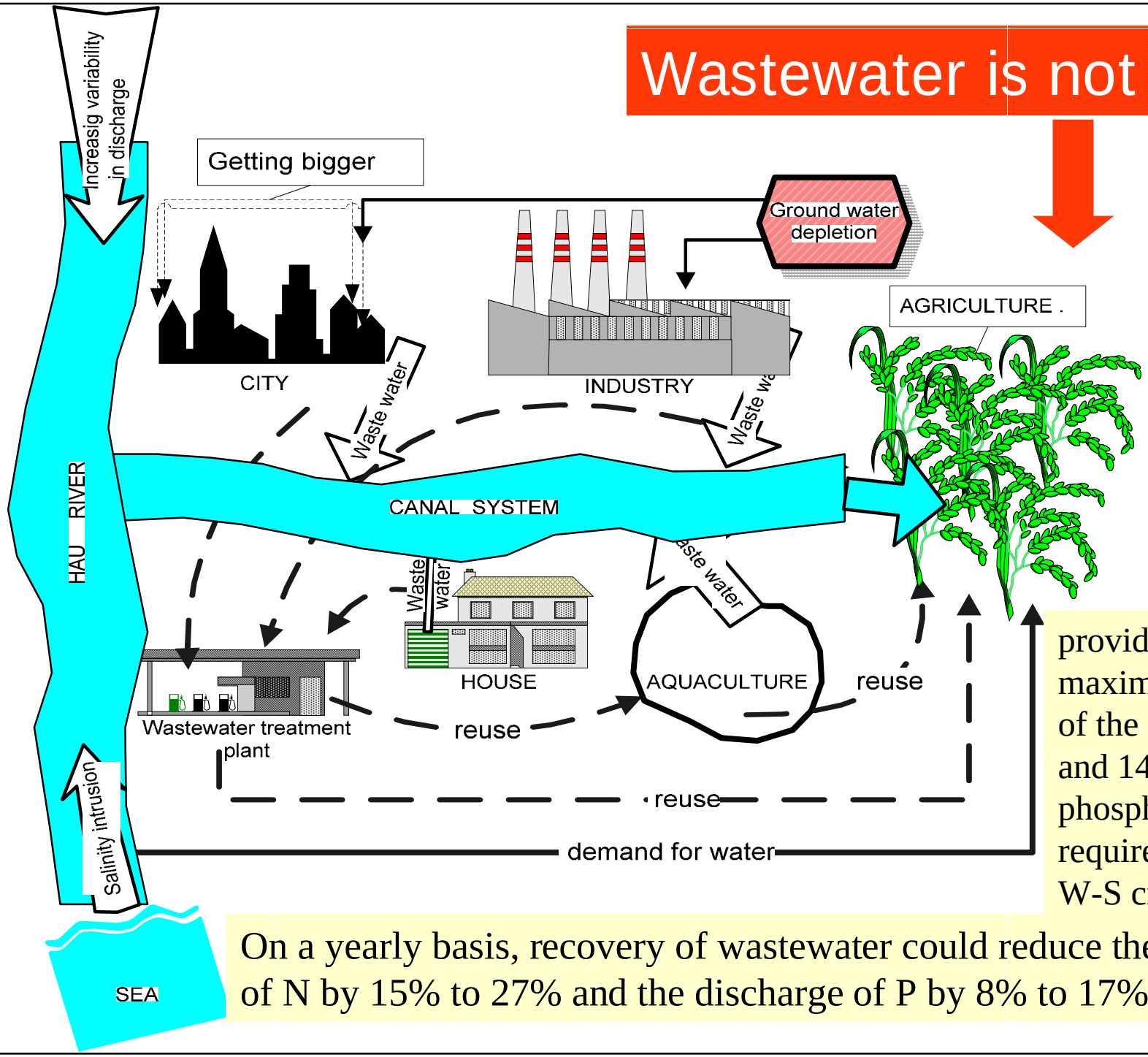
No	Parameter	Unit	WWTP of Trung Son residential area		WWTP of Tan Qui Dong residential area	
			Influent	Effluent	Influent	Effluent
1	pH		5 - 9	7.86	5 - 9	6.8 - 8.0
3	COD	mg L^{-1}	120 - 200	11	58 - 267	13 - 36.5
4	SS	mg L^{-1}	200 - 250	8	34 - 161	1-4
5	T-N	mg L^{-1}	60	14.0	41- 98	10 - 31.4
6	T-P	mg L^{-1}	-	1.42	0.6 - 3.22	0.08 - 0.9

Components and characteristics of wastewater from catfish processing in Tra Noc industrial zone in Can Tho City

Parameter	Unit	Factory 1		Factory 2	
		Influent	Effluent	Influent	Effluent
COD	mg L^{-1}	1,580	81	2,120	76
T-N	mg L^{-1}	118	64	122	60.7
T-P	mg L^{-1}	28.4	17.1	46.9	30.4

Source: Tra Noc Industrial Zone

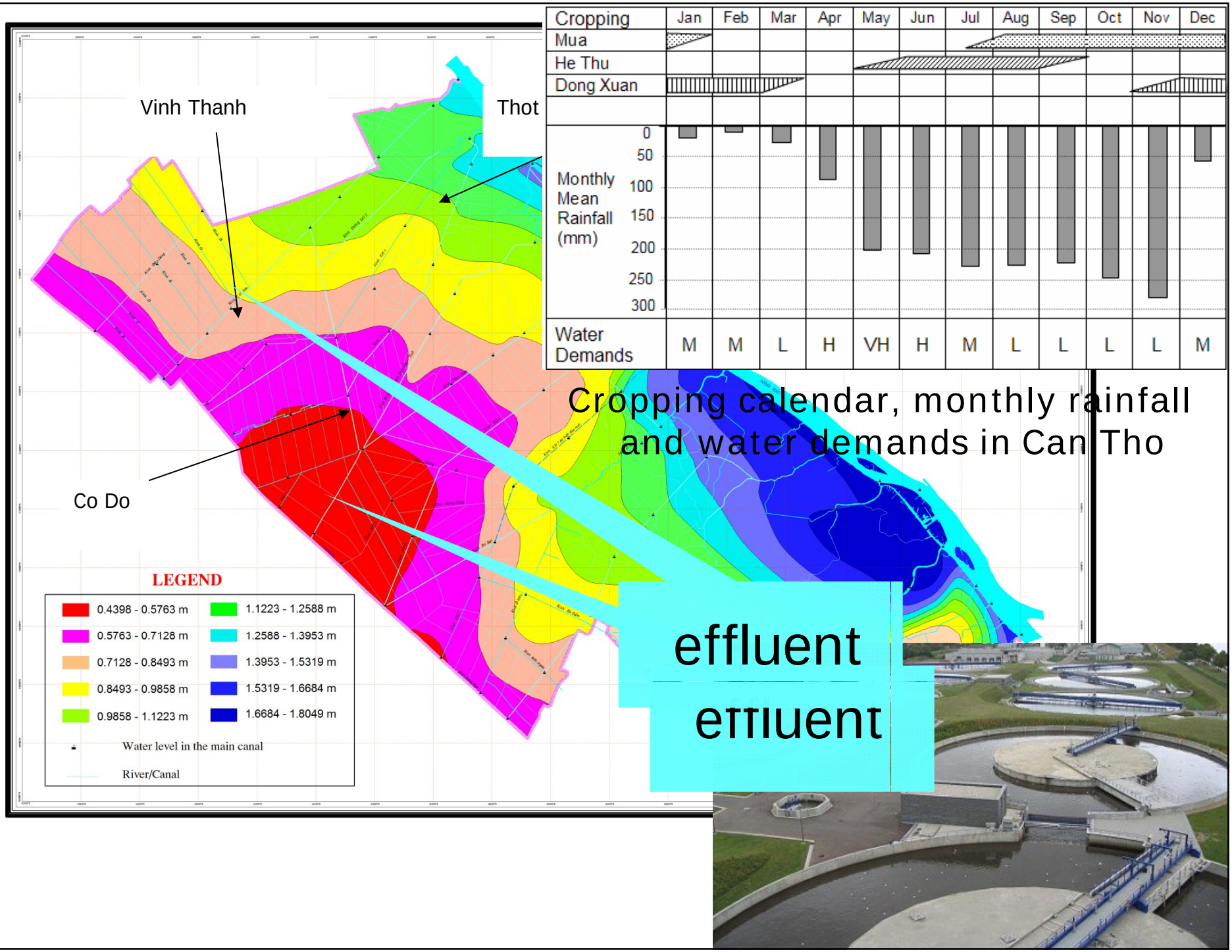
Wastewater is not a waste



irrigate at least to 22,719 ha of paddy rice (16% of the rice-cultivated area in the city) at 3 crops per year.

providing a maximum of 22% of the nitrogen (N) and 14% of the phosphorus (P) requirement for the W-S crop

On a yearly basis, recovery of wastewater could reduce the discharge of N by 15% to 27% and the discharge of P by 8% to 17%.

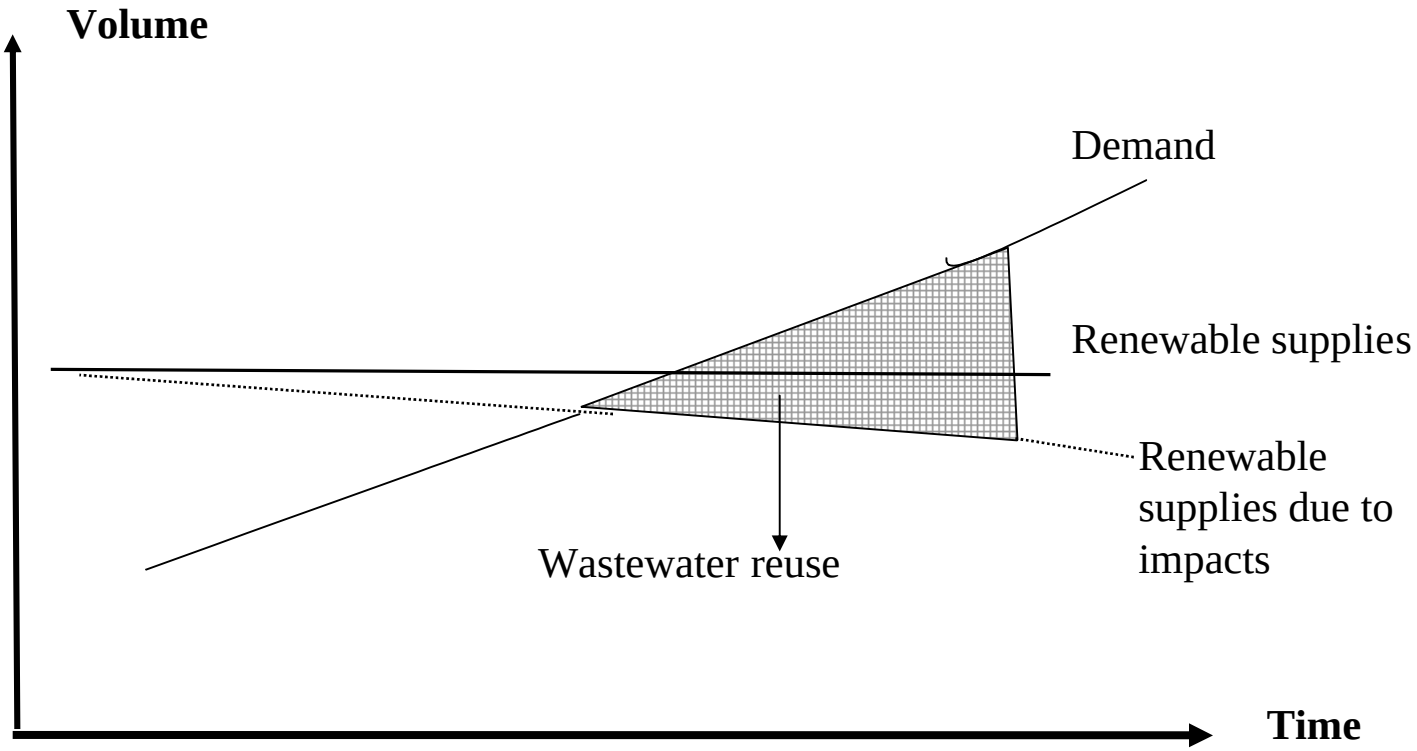


Cropping	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mua												
He Thu												
Dong Xuan												
Monthly Mean Rainfall (mm)	0 / 50 / 100 / 150 / 200 / 250 / 300											
Water Demands	M	M	L	H	VH	H	M	L	L	L	L	M

Cropping calendar, monthly rainfall and water demands in Can Tho

effluent

effluent



Water availability and demand in Can Tho City in the dry season and the potential of wastewater reuse to overcome the water deficit

Advantages of reuse of wastewater in agriculture

- Conserves water (by recycling and groundwater recharge);
- Is a low-cost method for sanitary disposal of municipal wastewater;
- Reduces pollution of rivers and other surface water;
- Conserves nutrients, thereby reducing the need for artificial fertilizer;
- Increases crop yields; and
- Provides a reliable water supply to farmers
- Reduce the need for expensive tertiary treatment
- Environmental benefits

ENVIRONMENTAL BENEFITS

Options/strategies	
Option 1: Reuse of effluent from centralized wastewater treatment plants (WWTPs) with capacity of 283,000 m^3/day.	
Option 2: Reuse of effluent from centralized and decentralized WWTPs with a total estimated capacity of 500,000 m^3/day.	
Option 3: Extensive reuse of aquaculture wastewater for rice irrigation, especially wastewater from catfish farming	
Option 4: reuse wastewater from domestic, industry and aqu	
Option 4a: Combined option 1 and option 3	
Option 4b: Combined option 2 and option 3	

- The strategy 3 is the most promising option for WW management and reuse because it saves up to 25% irrigated water, 22% N, and 20% P fertilizer per crop season.
- improved sanitation in the City with the value of the EB up to 355,068,493 €/crop

(*Long et al., 2012*)

CONCLUSION

- *In Can Tho city as well as other provinces in the Mekong Delta, wastewater is not a waste. It can be reuse for agriculture, such as rice irrigation.*
- *Wastewater reuse in agriculture is an adaptation measure of water scarcity due to climate change and sea level rise with salinity intrusion.*
- *The % of demand satisfied by wastewater in term of quantity and quality is possible indicators for the assessment of water management and wastewater reuse.*