MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

# Impacts of Climate change on water resources in Cuu Long Delta

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# THE CONTENT

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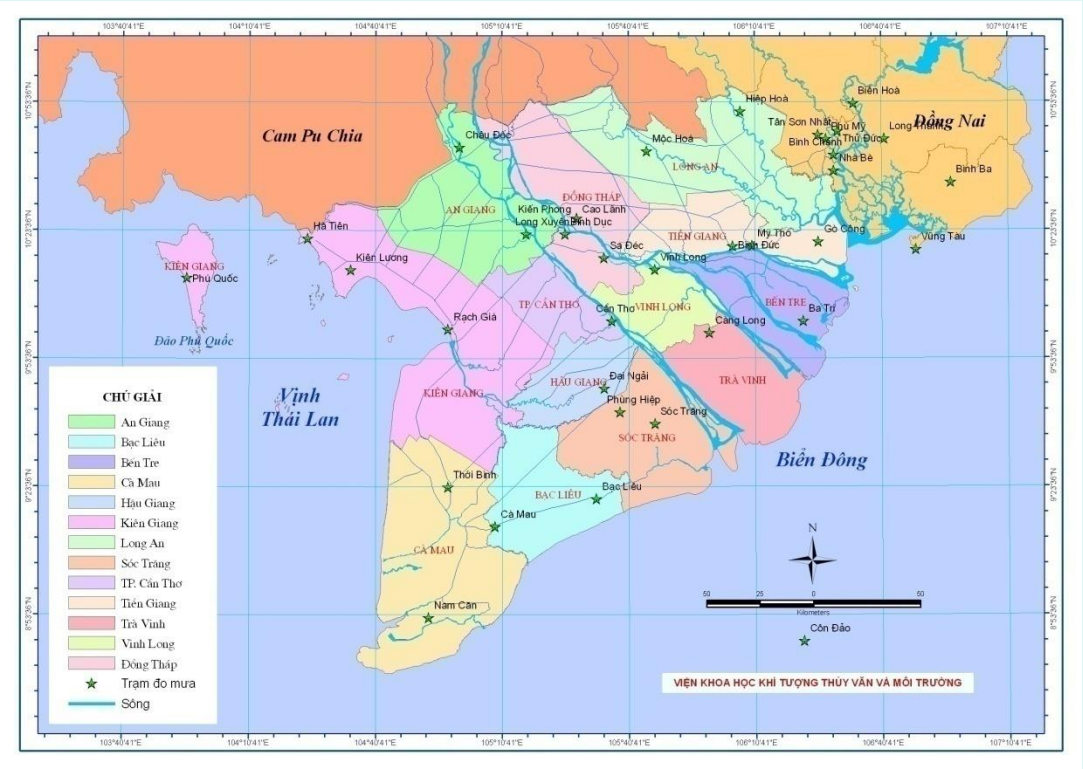
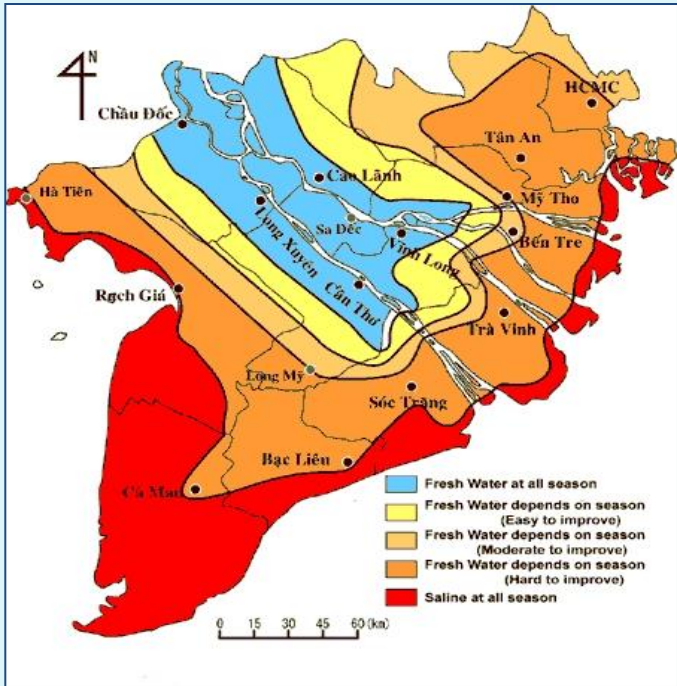
2. To assess the impacts of climate change on inundation in Cuu Long delta
3. To assess the impacts of climate change on intrusion in Cuu Long delta
4. Result and Conclusion

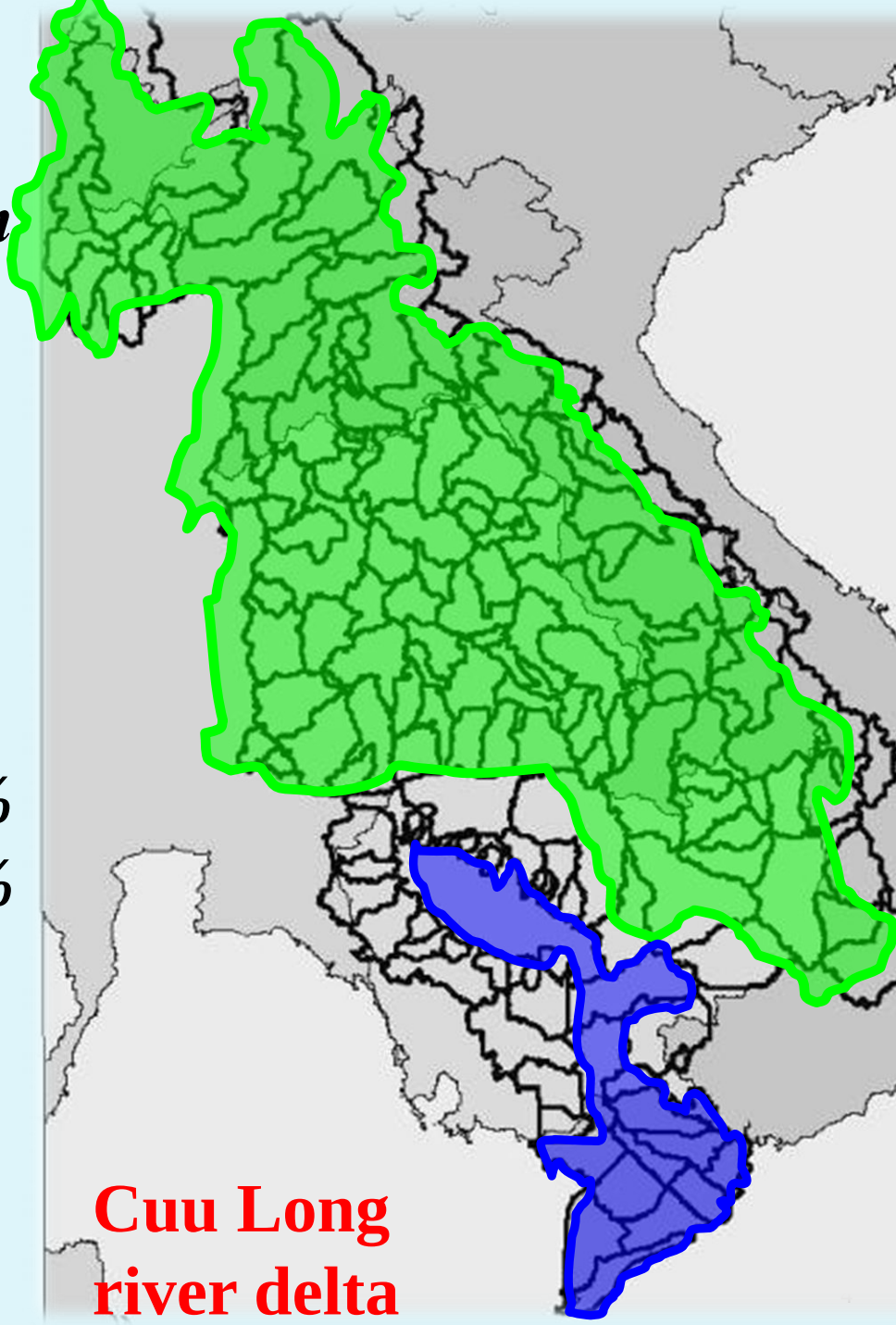
# Introduction

- **Vietnam is one of the most vulnerable countries under CC context and Cuu Long Delta is assessed as the area that will suffer most severely by CC because of flatness of the low-lying terrain .**
- ***Cuu Long Delta is a fertile delta with comprehensive river and canal system having great potential for the development in agriculture, industry, fisheries and ecotourism;***



- ***It's territory covers 13 provinces with the total natural area of 3.96 million hectares*** **, acounting for 79% of the total deltaic area and 5% of the area of Mekong river basin** ***and population is about 18 million people***
- ***Contributing more than 50% of food productivity and 65% of fish productivity;***

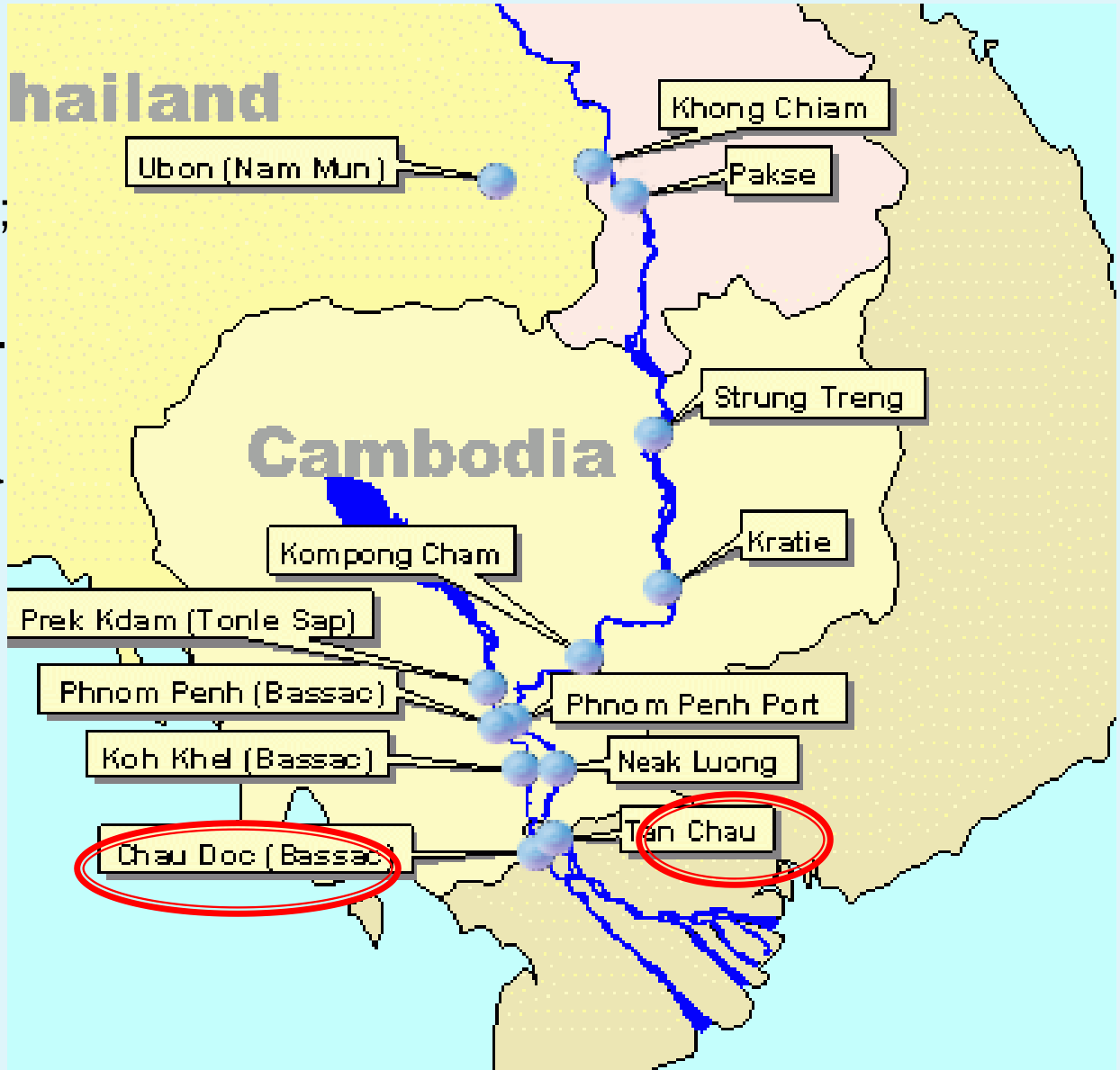


# Background

- Flow into Cuu Long Delta comes from two major sources:
  - internal flow: from rainfall in floodplains;
  - external inflow: by flow from upper Mekong (considered by Kratie station) and flow from Tonle Sap lake (considered by Prek Dam station);

# Background

- flows flows into Vietnam territory through:
  - Bassac River( Hau River): at Chau Doc;
  - Mekong River (Tien River): at Tan Chau.
- Study on flooding in Cuu Long Delta is a comprehensive task considering both inflow from upstream and sea level



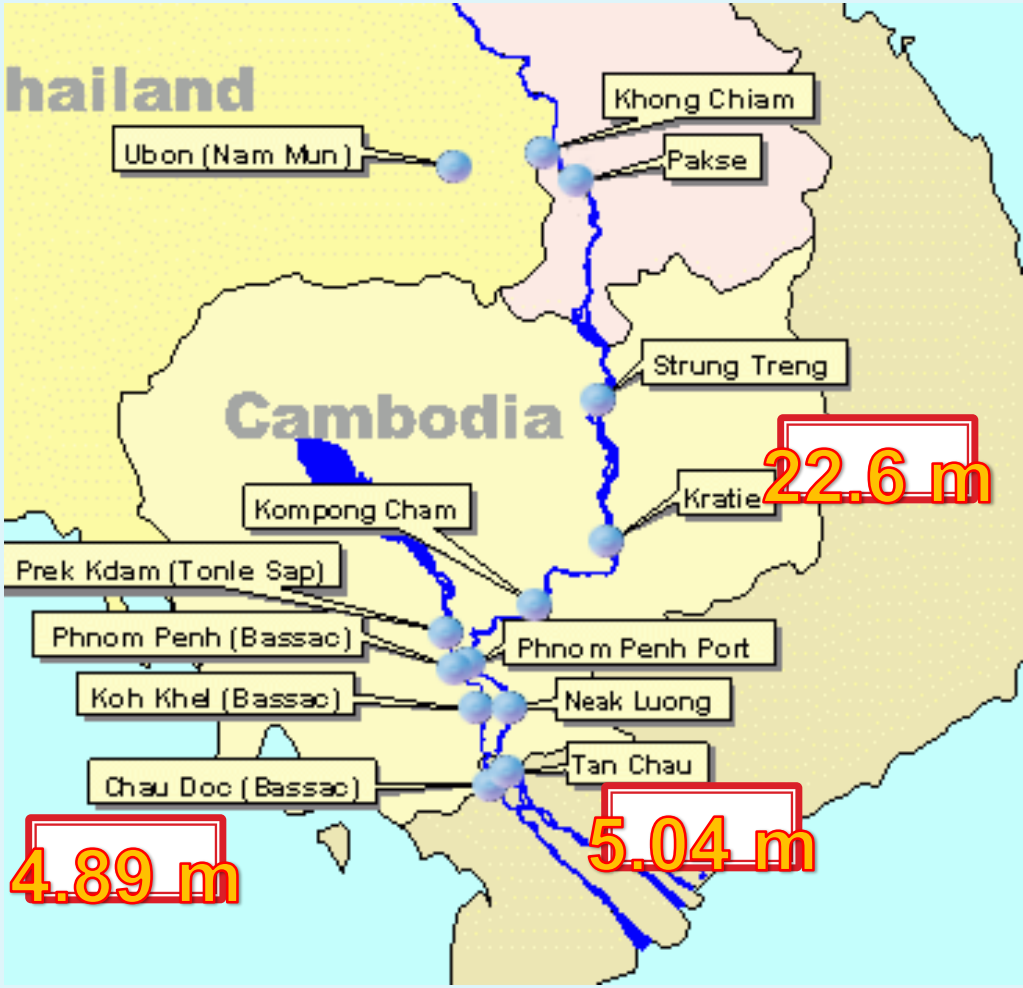
# Background

- baseline period (before 2011), on Mekong River there are many big floods occurred such as in 1961, 1966, 1978, 1984, 1991, 1994, 1996, 2000, 2001, 2002 and 2011. Whereas, floods in 2000, 2002 and 2011 have impacted strongly on inundation in Mekong Delta.

| Year | Kratie | | Tan Chau | | Chau Doc | |
|---|---|---|---|---|---|---|
| | H (m) | Q (m3/s) | H (m) | Q (m3/s) | H (m) | Q (m3/s) |
| 1996 | 23.02 | 59035 | 4.86 | 23600 | 4.54 | 8150 |
| 2000 | 22.60 | 56273 | 5.04 | 26000 | 4.89 | 7680 |
| 2001 | 22.89 | 58180 | 4.77 | 23800 | 4.47 | 7120 |
| 2002 | 22.49 | 55554 | 4.81 | 24400 | 4.42 | 6860 |
| 2011 | 22.88 | 53252 | 4.78 | 25100 | 4.24 | 8210 |

# Background

- Flood in 2000: a two-peak flood occurred hardly in Cuu Long Delta;
- First peak flood occurred earlier 1 month as usual;
- Second peak flood: in late September with extreme water level;

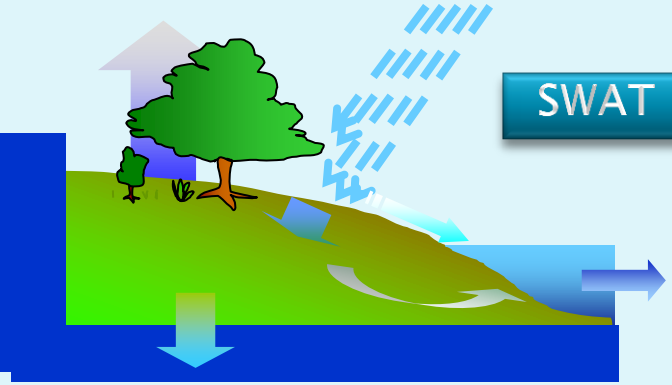


# Background

- Considering flood event in 2000 as typical simulation for baseline period:
- Simulation scenarios are developed by combining extreme flood events (observed or estimated at Kratie station) and sea level rise scenarios:

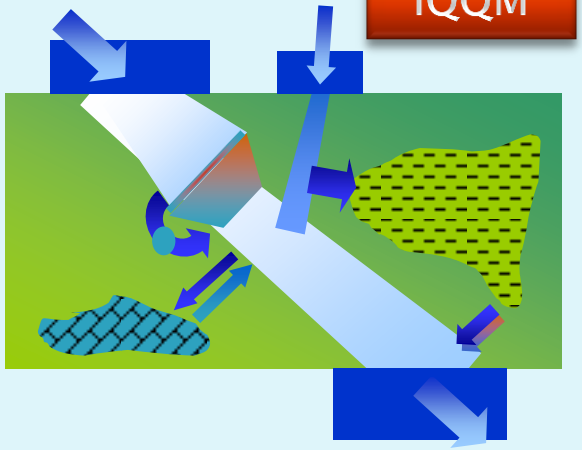
| Scenario | Period | Year of flood event | Climate change Scenario | Sea level rise |
|---|---|---|---|---|
| Baseline | – | 2000 | – | – |
| F1 | 2011 – 2020 | 2020 | A2 | 9 cm |
| F2 | 2021 – 2030 | 2028 | A2 | 15 cm |
| F3 | 2031 – 2040 | 2035 | A2 | 20 cm |
| F4 | 2041 – 2050 | 2047 | A2 | 30 cm |
| F5 | 2011 – 2020 | 2016 | B2 | 9 cm |
| F6 | 2021 – 2030 | 2028 | B2 | 15 cm |
| F7 | 2031 – 2040 | 2032 | B2 | 20 cm |
| F8 | 2041 – 2050 | 2047 | B2 | 26 cm |

# Modelling



SWAT

IQQM



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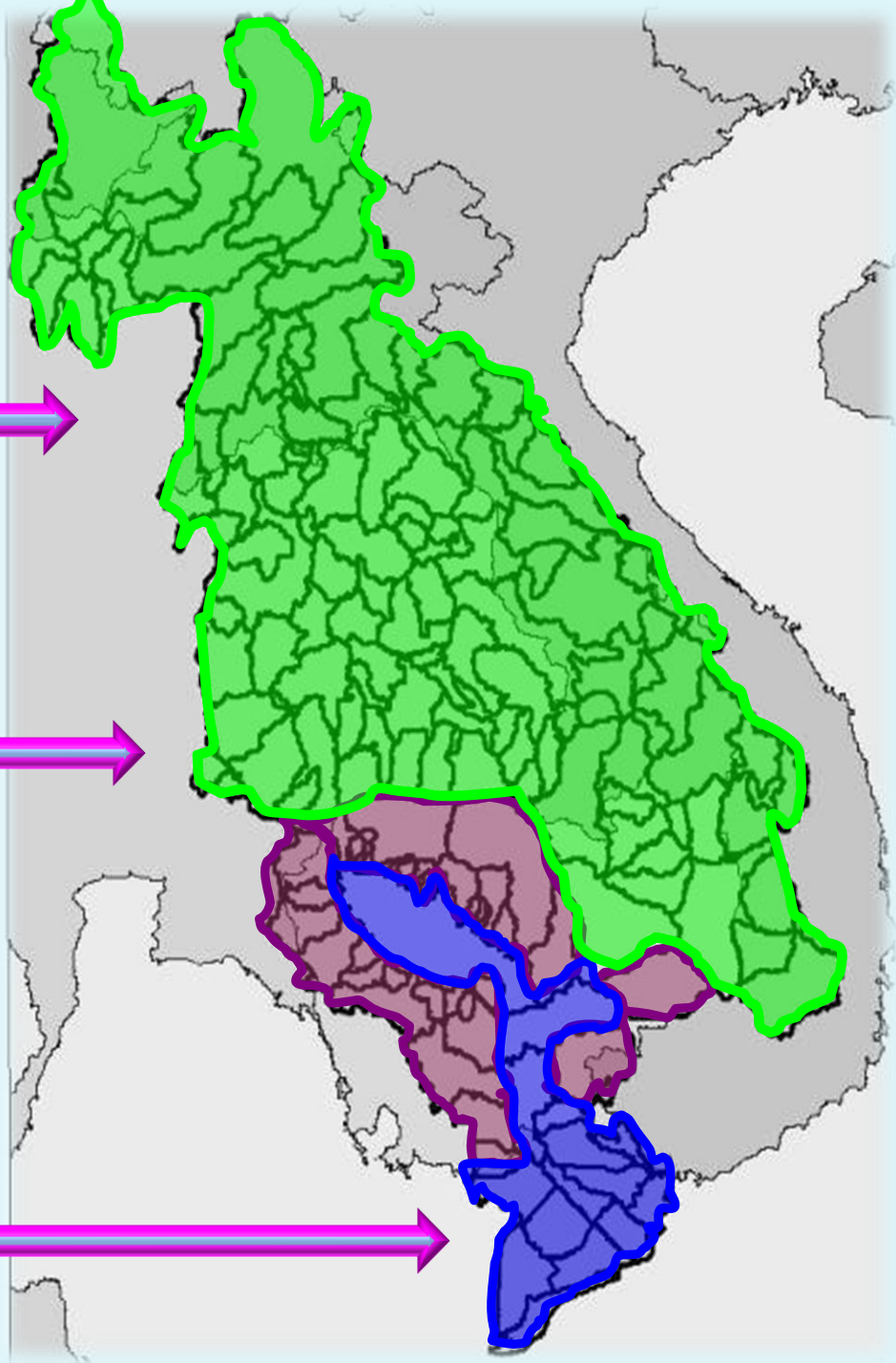
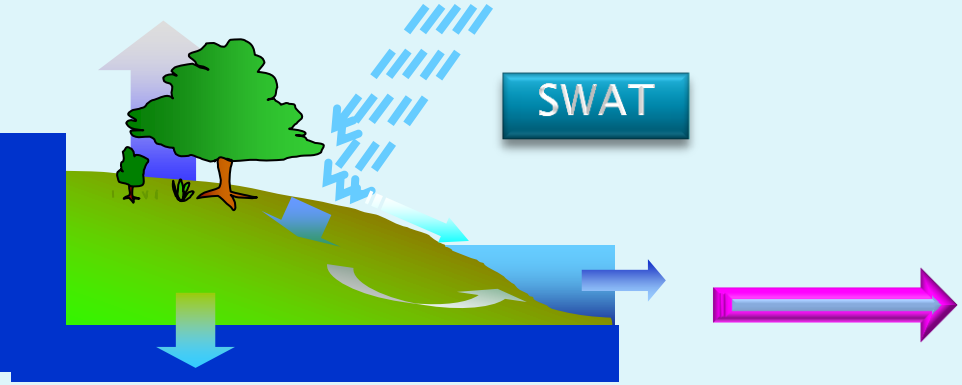
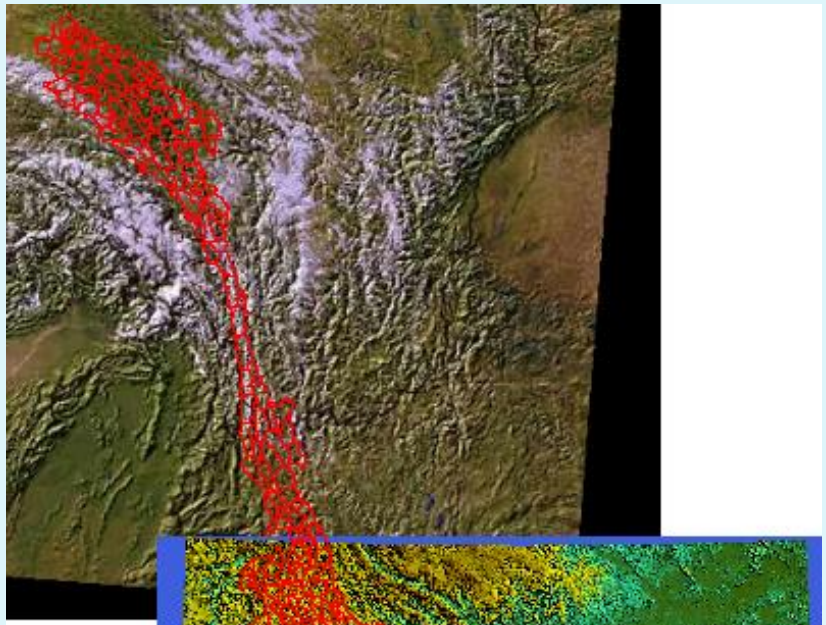


# Modelling

SWAT





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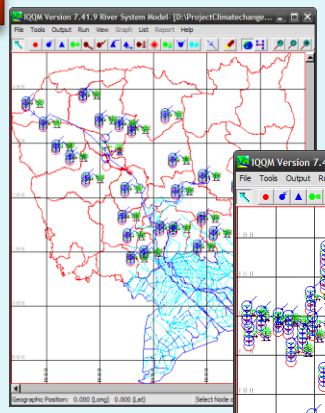


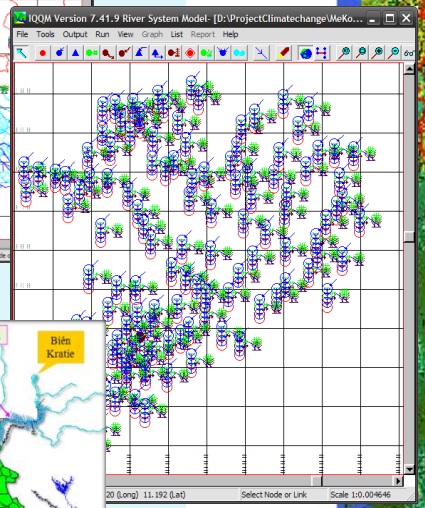


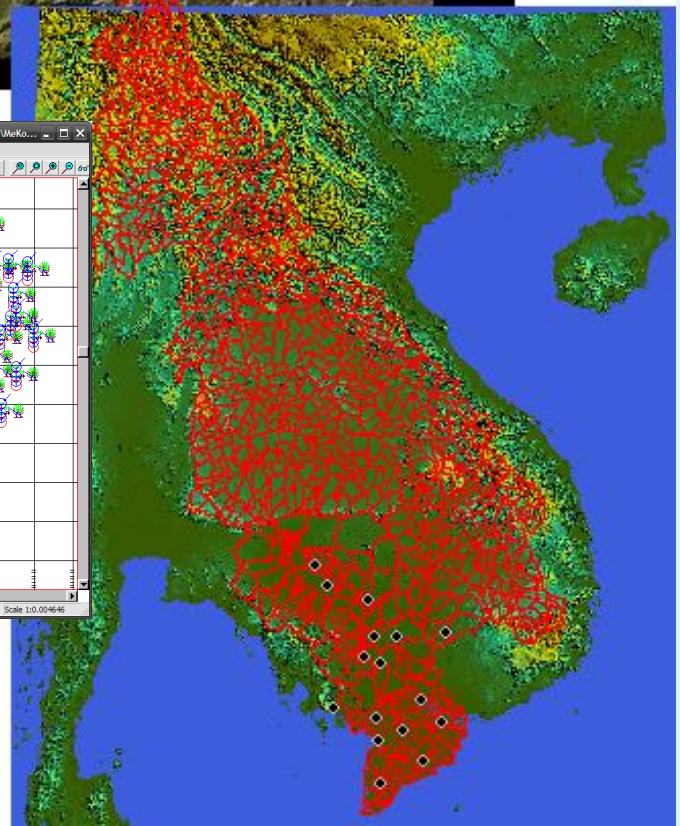

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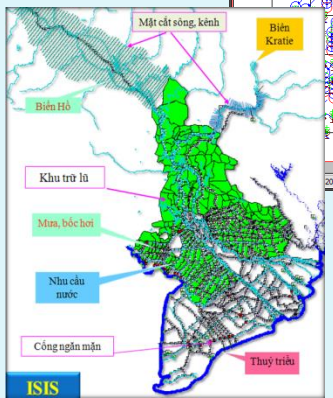
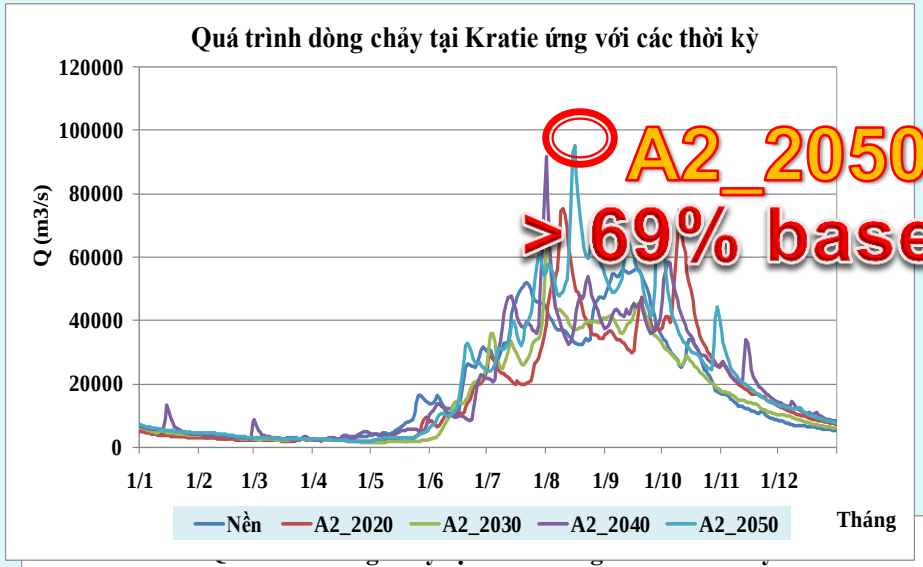
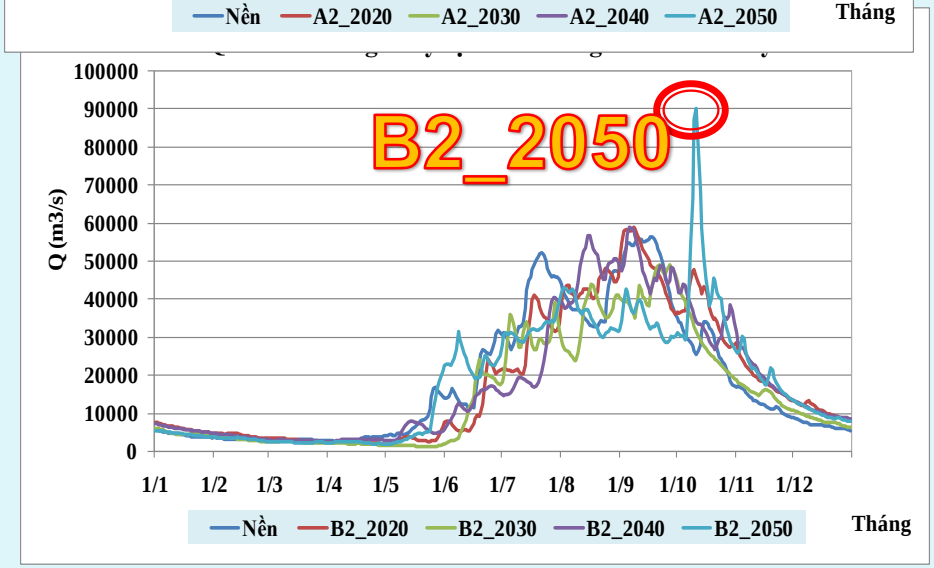


# Upstream boundary

- F3, F4, F7, F8 scenarios: Maximum daily discharge at Kratie in future is higher than in baseline (both H & Q);
- F1, F2, F5, F6: flood peak is higher while total volume fluctuate (see table)



# Upstream boundary

## *Flow patterns in periods of A2 scenario at Kratie*

| Pattern / Period | Baseline | A2_2020 | A2_2030 | A2_2040 | A2_2050 |
|---|---|---|---|---|---|
| Daily max. flow ($m^3/s$) | 56273 | 75305 | 66975 | 91795 | 95292 |
| 1 month max. volume ($10^6$ $m^3$) | 132.2 | 131.4 | 114.6 | 123.9 | 166.8 |
| 3 months max. volume ($10^6$ $m^3$) | 343.4 | 342.2 | 300.4 | 334.3 | 407.5 |
| 6 months max. volume ($10^6$ $m^3$) | 498.8 | 487.0 | 438.6 | 524.7 | 602.6 |

## *Flow patterns in periods of B2 scenario Kratie*

| Pattern / Period | Baseline | B2_2020 | B2_2030 | B2_2040 | B2_2050 |
|---|---|---|---|---|---|
| Daily max. flow ($m^3/s$) | 56273 | 58822 | 49023 | 59077 | 90117 |
| 1 month max. volume ($10^6$ $m^3$) | 132.2 | 128.6 | 111.0 | 127.2 | 118.3 |
| 3 months max. volume ($10^6$ $m^3$) | 343.4 | 342.6 | 283.6 | 347.5 | 302.9 |
| 6 months max. volume ($10^6$ $m^3$) | 498.8 | 498.3 | 432.4 | 493.9 | 500.8 |

# Downstream boundary

- Downstream boundaries at estuaries corresponding to CC scenarios are estimated from CC and SLR scenarios proposed by MONRE in 2012.
- Based on SLR scenarios for Vietnam coastal line, the study estimated sea level fluctuations for estuaries of Cuu Long Delta;
- Rainfall process in 2000 is assumed as rainfall scenario for simulation in Cuu Long delta.
- This precipitation and flood scenarios are input into ISIS model to simulate hydraulic regime in Cuu Long Delta. ISIS model is inherited from MRC and IHMEN.
- Assessed the impact on the Cuu Long flows at Chau Doc and Tan Chau station (in Tien River and Hau River) that is corresponding station to selected scenarios.

# Impact of climate change on flow into Cuu Long Delta

The research  assessed the impact of CC on flow into Cuu Long Delta (water balance and flow rate distribution) at two gauging stations are Chau Doc and Tan Chau in Tien River and Hau river, corresponding to selected scenarios.

# At Tan Chau

**+ Average dry season flow decreases in both scenarios A2, B2 compared with baseline scenario (the largest decrease is about 33% in 2030 period, the smallest decrease about 11% in the A2 scenarios. In B2 Scenario, the largest decrease is 25% in 2030 period, smallest decrease is about 5%);**

**+ The minimum average flow of one month tends to increase in the 2040 period (an increase of 12% in the A2 scenario, 10% in the B2 scenario), while the other periods tend to decrease (In Scenarios A2, the largest decrease of 33% in the 2030 period, the smallest is about 15%. In the B2 scenario and the largest decrease of 43% in the 2030 period, the smallest is about 11%);**

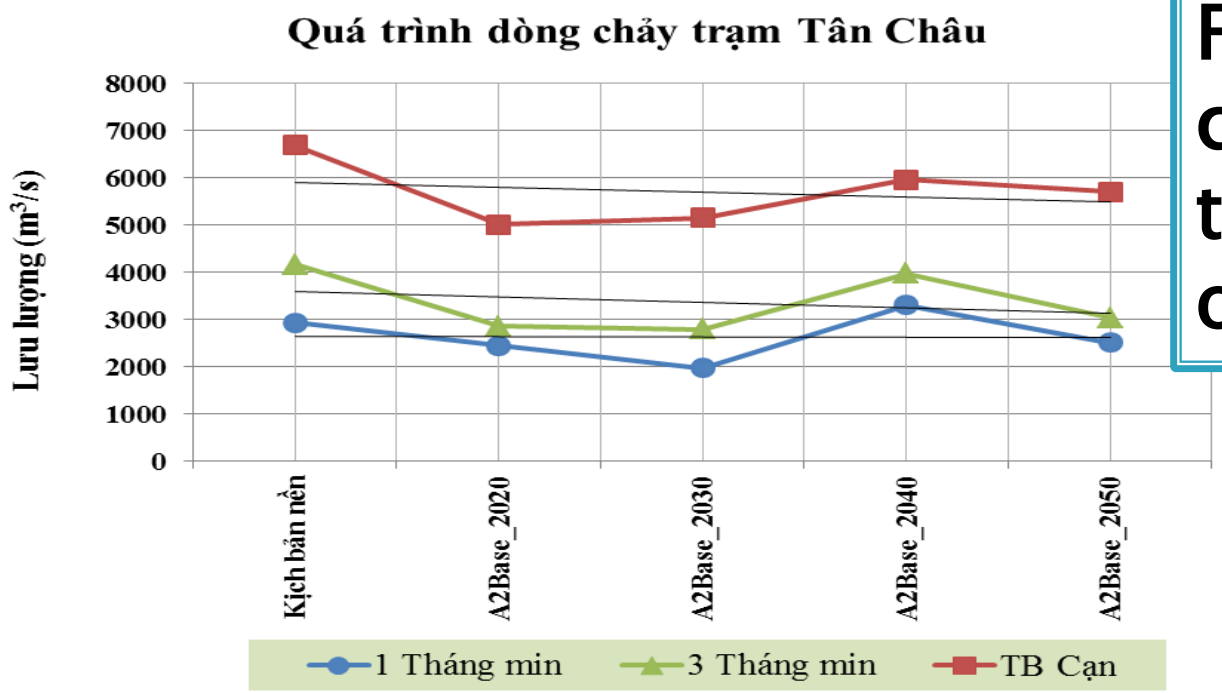
**+ Three month minimum flow tends to decrease at both A2 and B2 scenarios (in A2 scenario, the largest decrease of 33% during 2030 , the smallest about 5 % during 2040. In B2 scenarioThe largest decrease of 37% in period in 2030 , the smallest about 6 % during 2040);**

**+ One month maximum flow: in A2 Scenario, the flow increases 2% in the middle of century, however, there is a downward trend in other periods until 2040 (maximum decrease is 6 %). In B2 scenario flow decreases in all of periods ( the largest decrease is 5 % );**

**+ Flood flow : in A2 , B2 flow decreases during 2030 (down 5% ) and increases in other periods (an increase of 8 % in A2 scenarios and 2% in B2 scenario);**

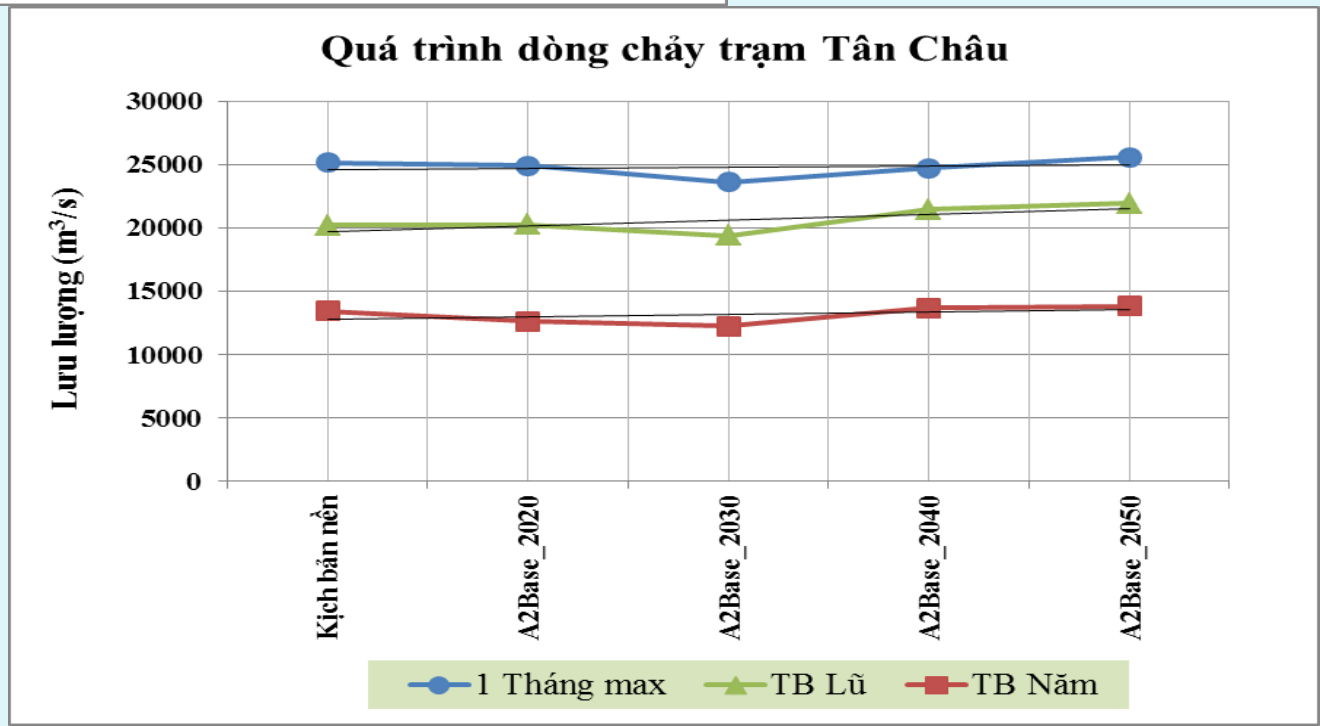
**+ Annually flow decreases in the B2 scenario ( largest decrease of about 10 % ). In the A2 scenario , the annual flow tends to increase in the period 2040-2050 ( the largest increase 3 % ) and decreases in other periods ( the largest decrease about 9 % ) .**

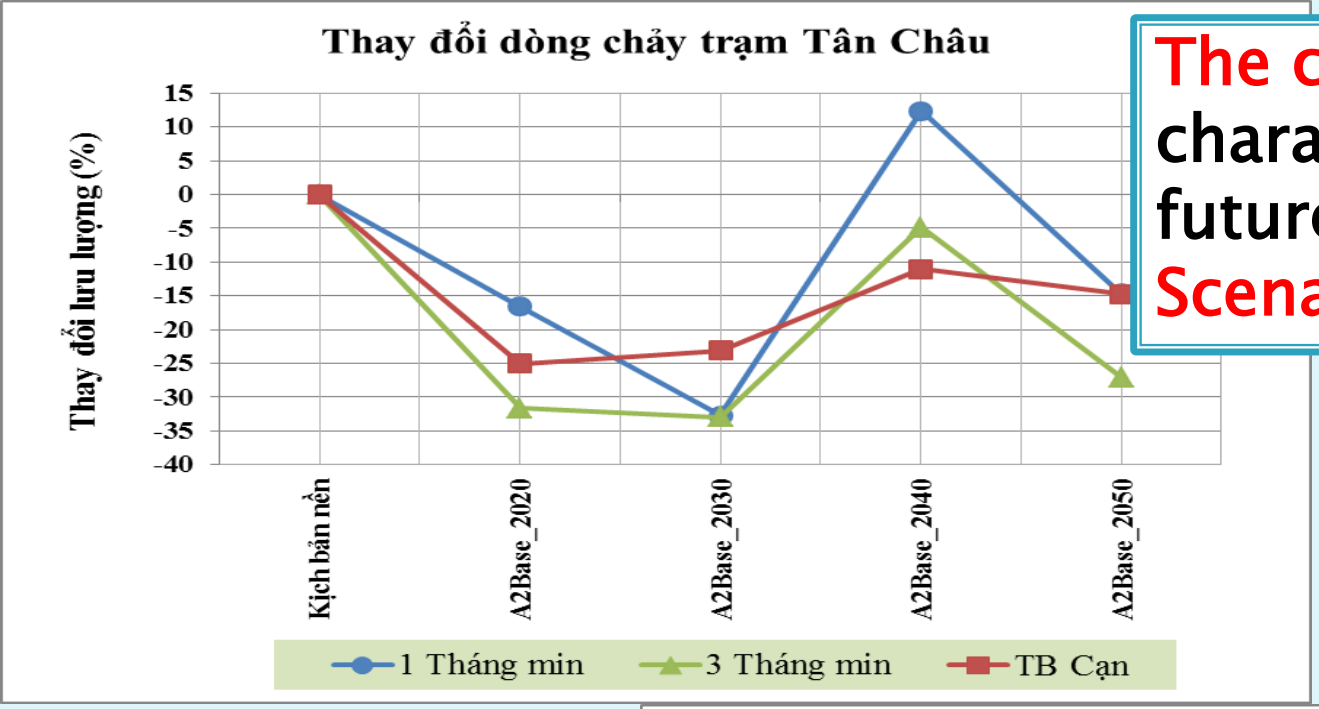
# Flow characteristics in the future based on A2 Scenario




- 1 month minimum flow;
- 3 month minimum flow;
- Average flow of dry season

- 1 month maximum flow;
- Average flow of flood season;
- Annual flow;

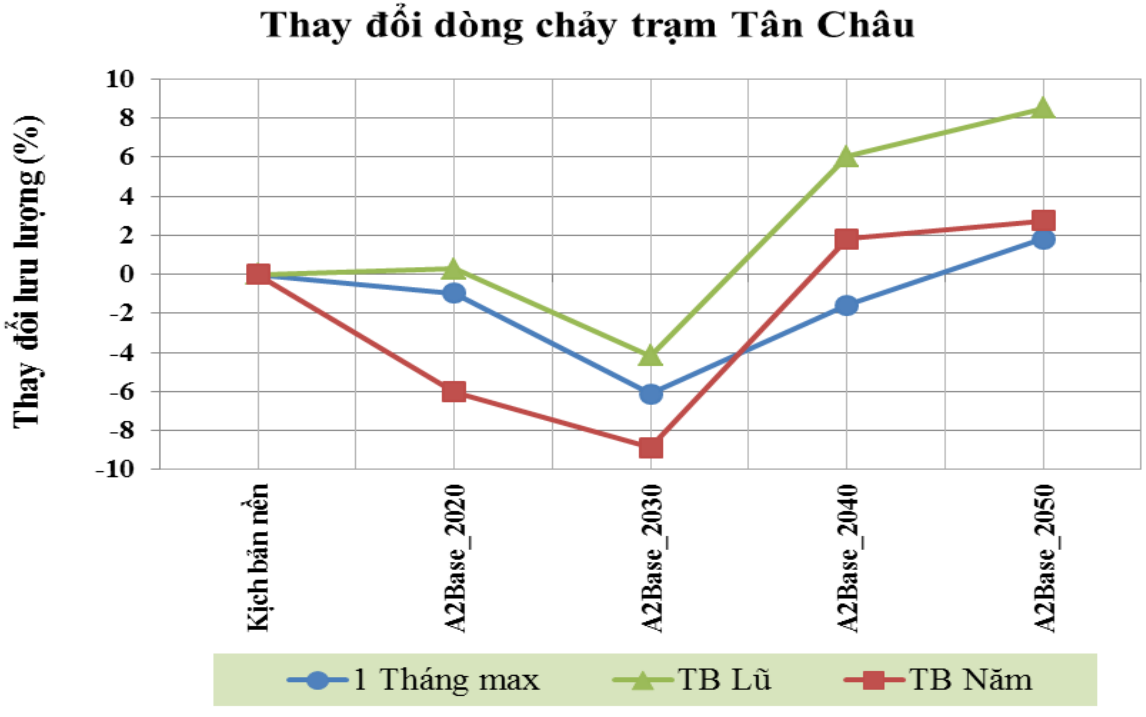




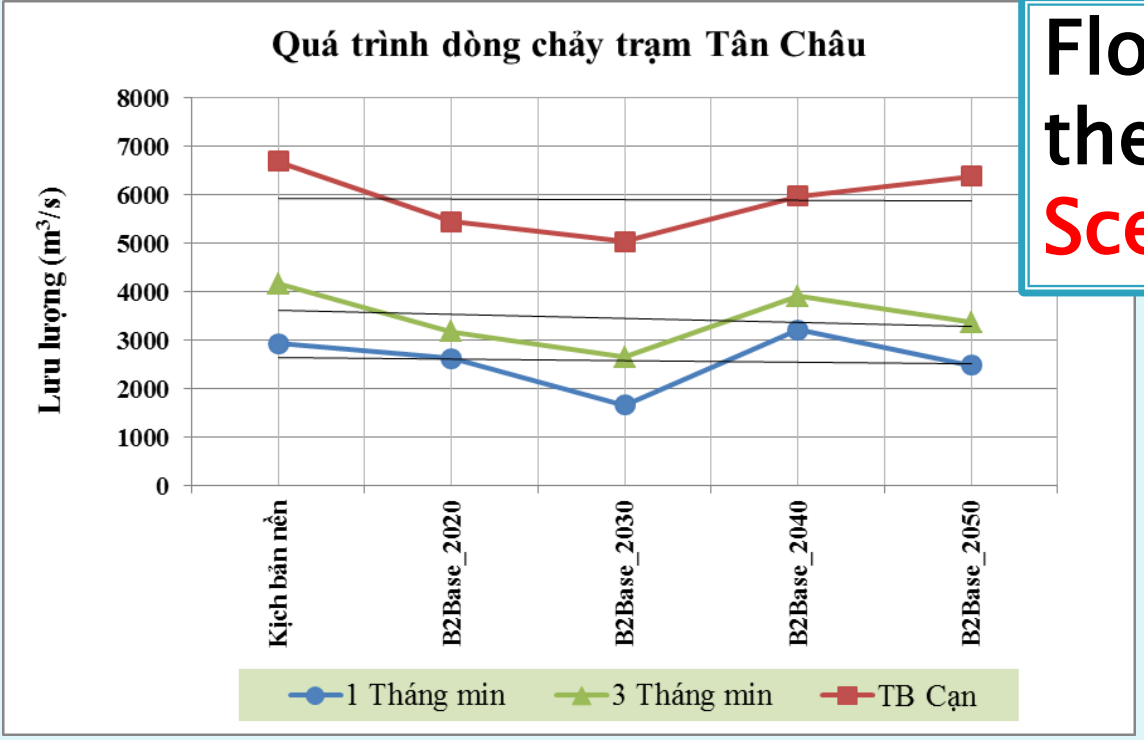

# The changes of Flow characteristics in the future based on A2 Scenario

- 1 month minimum flow;
- 3 month minimum flow;
- Average flow of dry season

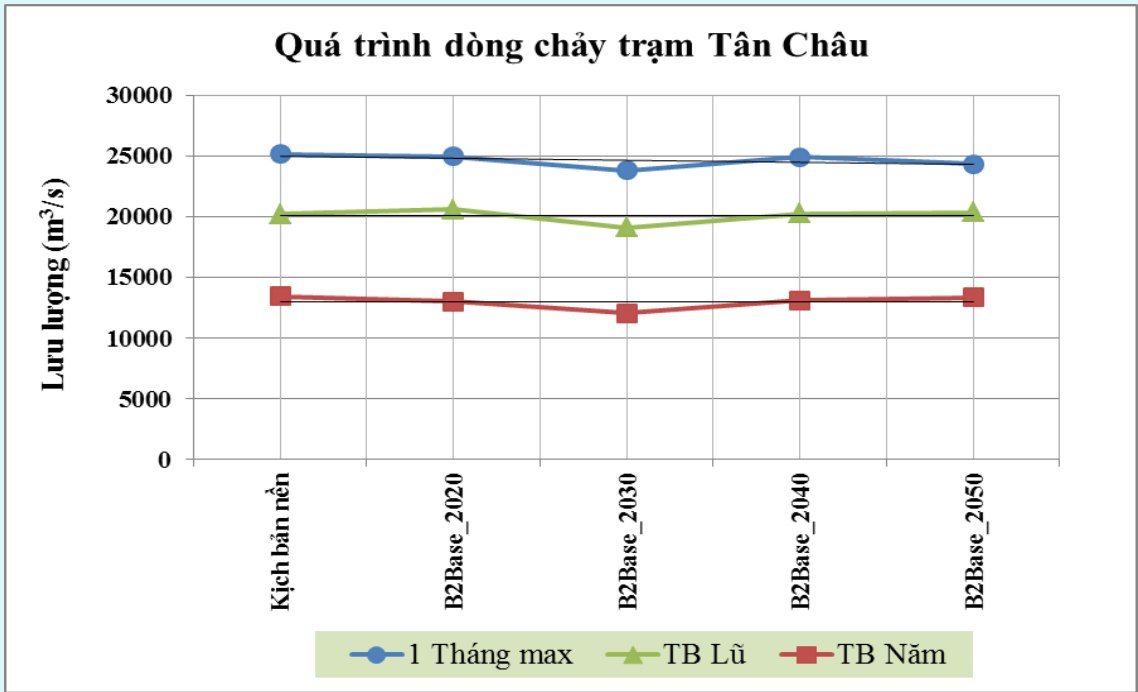
- 1 month maximum flow;
- Average flow of flood season;
- Annual flow;



# Flow characteristics in the future based on B2 Scenario

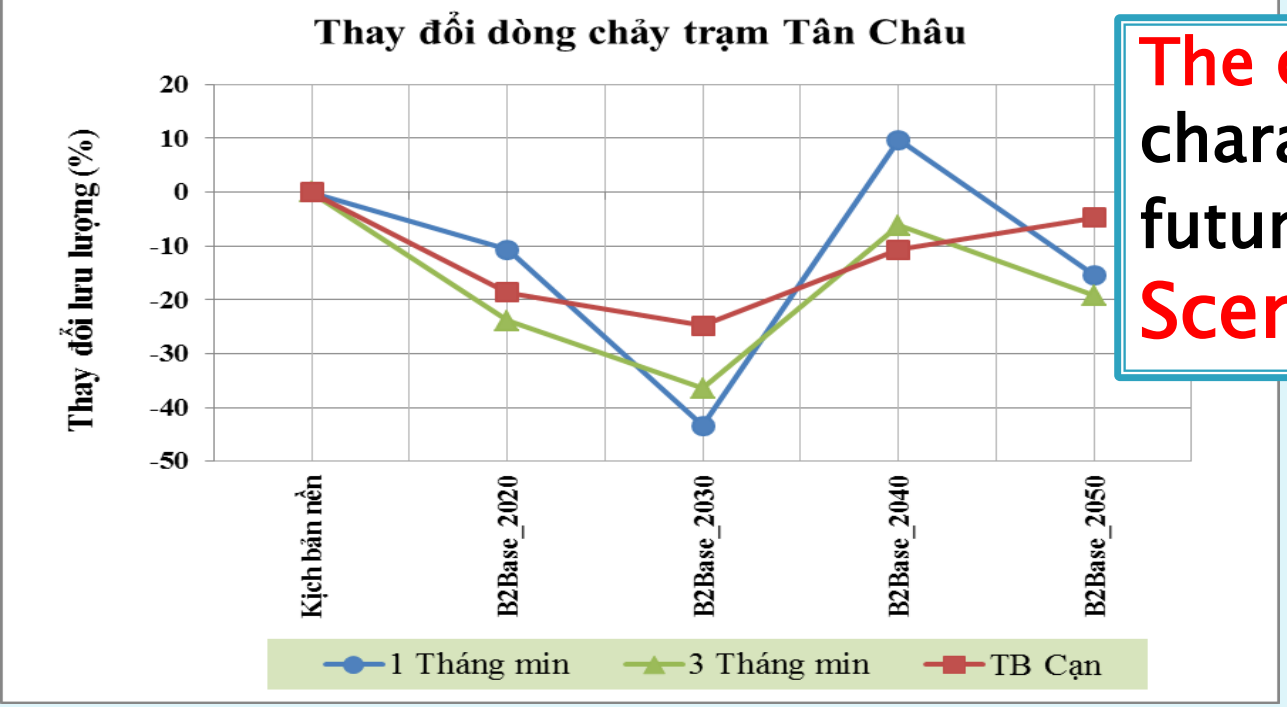



- 1 month minimum flow;
- 3 month minimum flow;
- Average flow of dry season

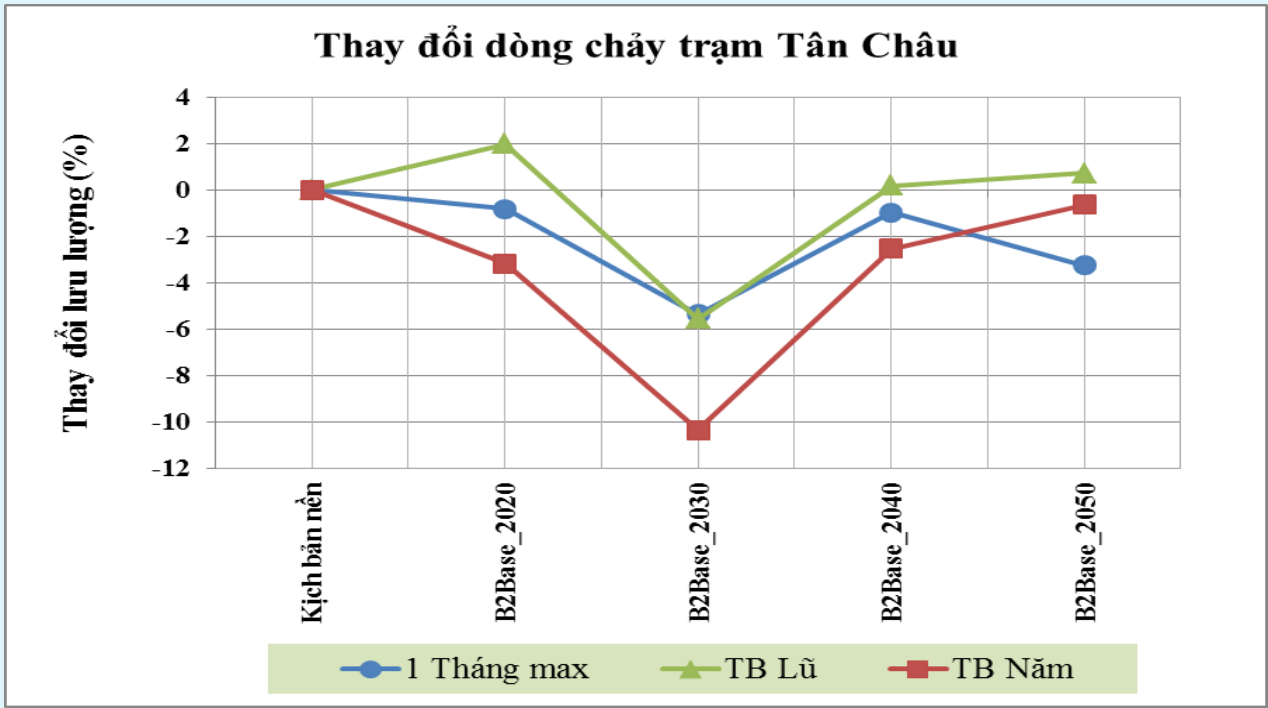



- 1 month maximum flow;
- Average flow of flood season;
- Mean annual flow;

# The changes of Flow characteristics in the future based on B2 Scenario




- 1 month minimum flow;
- 3 month minimum flow;
- Average flow of dry season




- 1 month maximum flow;
- Average flow of flood season;
- Mean annual flow;

# At Chau Doc

**+ Average dry season flow decreases in A2 scenarios compared with the baseline; the largest decrease is about 33% in 2020, the smallest decrease about 6%). In B2 Scenario, the flow increases 6% in 2050 but decreases in other periods**

**+ The minimum average flow of one month tends to increase in the period 2040-2049 (an increase of 12% in the A2 scenario, 14% in the B2 scenario), while the other periods the flow tends to decrease (In Scenarios A2, the largest decrease of 28% in the 2030 period, the smallest is 4%. In the B2 scenario, the largest decrease of 40% in the 2030 period, the smallest is 9%).**

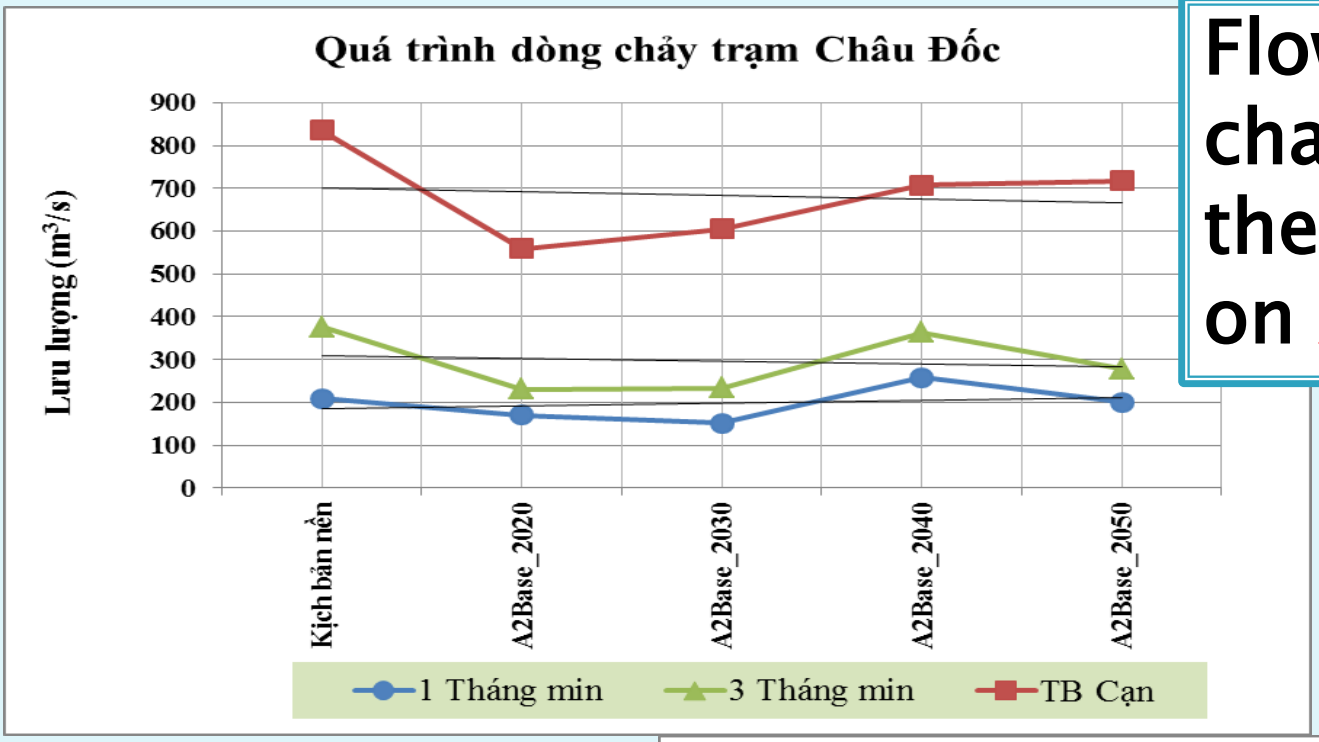
**+ Three month minimum flow tends to decrease at both A2 and B2 scenarios (In A2 scenario, the largest decrease of 39% during 2030 , the smallest about 4 % during 2040. In B2 scenario, the largest decrease of 41% in period in 2030 , the smallest about 9 % during 2040);**

**+ One month maximum flow: in A2 Scenario, the flow increases 2% in 2040 period and decreases 13% in 2050. In B2 scenario flow increases in 2020 and 2040 periods (with maximum of 3%) but decreases in 2030 and 2050 periods ( with maximum decrease of 7%);**

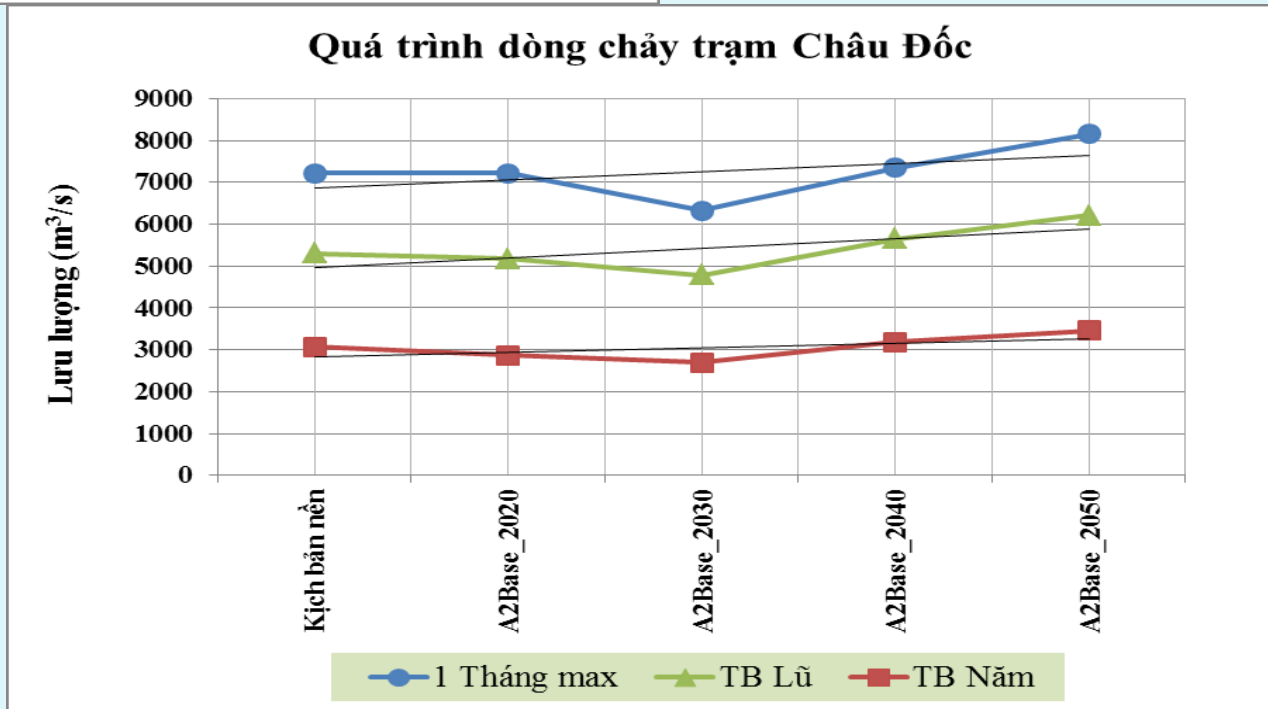
**+ Flood flow: decreases in B2 scenarios ( maximum of 14%). In A2 scenario, flow increases in 2040-2050 (17%) but decrease in other periods (largest decrease of 10%);**

**Annually flow decreases in the B2 scenario ( largest decrease of about 14 % ). In the A2 scenario , the annual flow tends to increase in the period 2040-2050 ( the largest increase 13 % ) and decreases in other periods ( the largest decrease about 12 % ) .**

# Flow characteristics in the future based on A2 Scenario

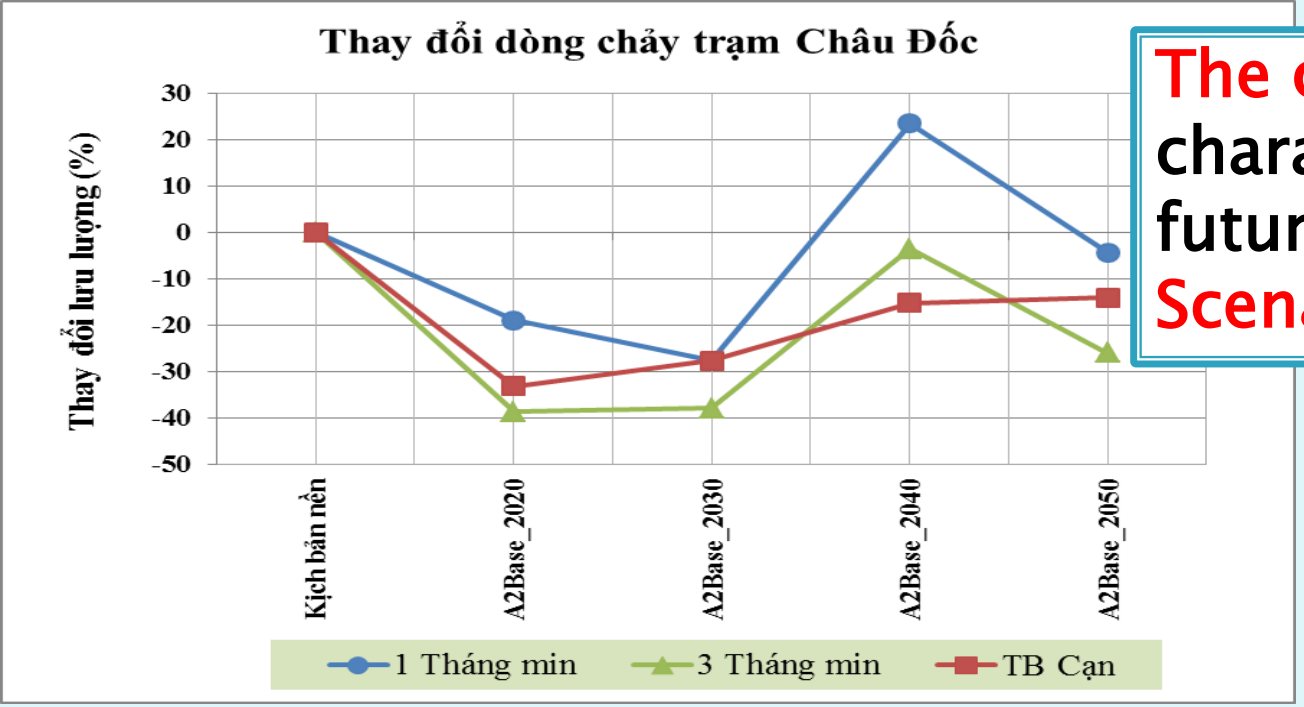



- 1 month minimum flow;
- 3 month minimum flow;
- Average flow of dry season

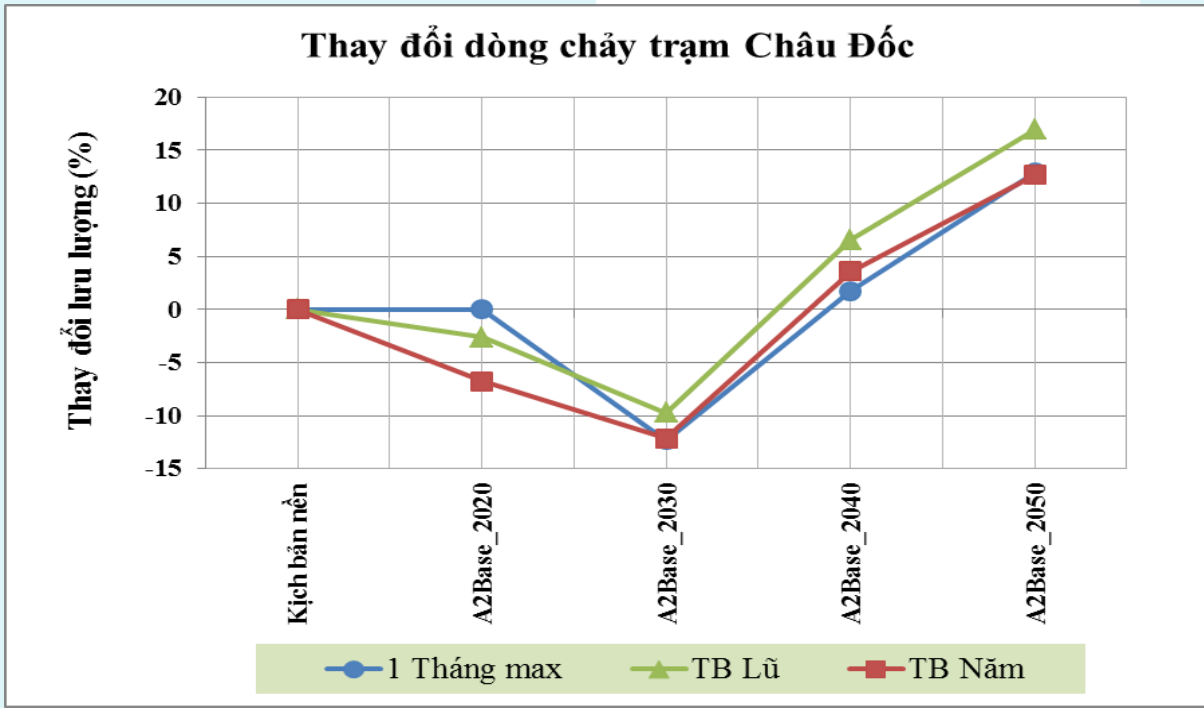



- 1 month maximum flow;
- Average flow of flood season;
- Annual flow;

# The changes of Flow characteristics in the future based on A2 Scenario

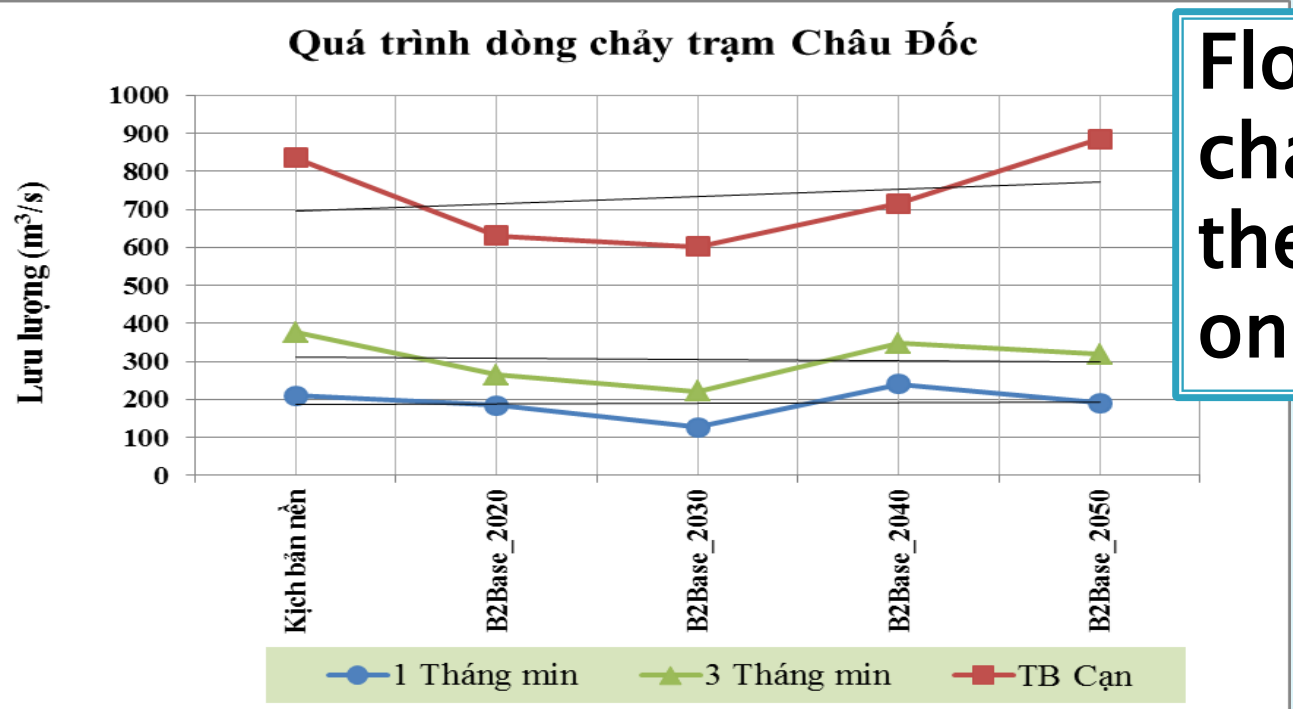



- 1 month minimum flow;
- 3 month minimum flow;
- Average flow of dry season




- 1 month maximum flow;
- Average flow of flood season;
- Annual flow;

# Flow characteristics in the future based on B2 Scenario




- 1 month minimum flow;
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- 1 month maximum flow;
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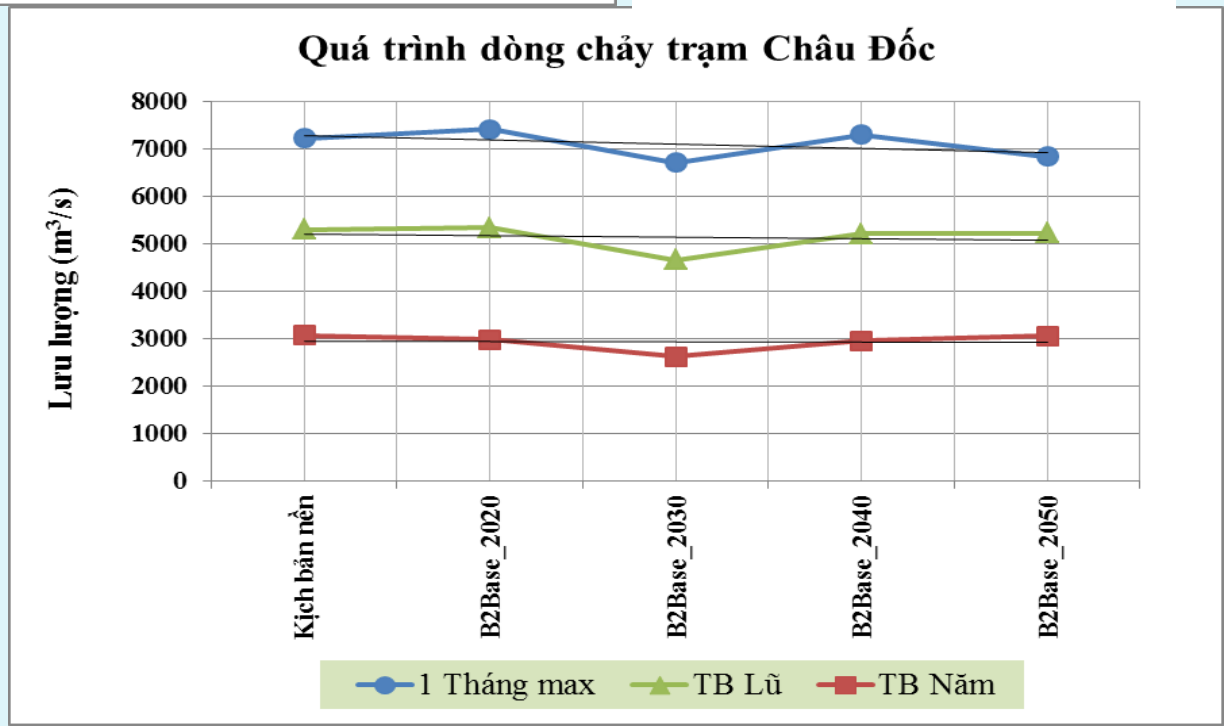


# Impact of climate change to inundation and salinity intrusion in Cuu Long river delta

## Basic research

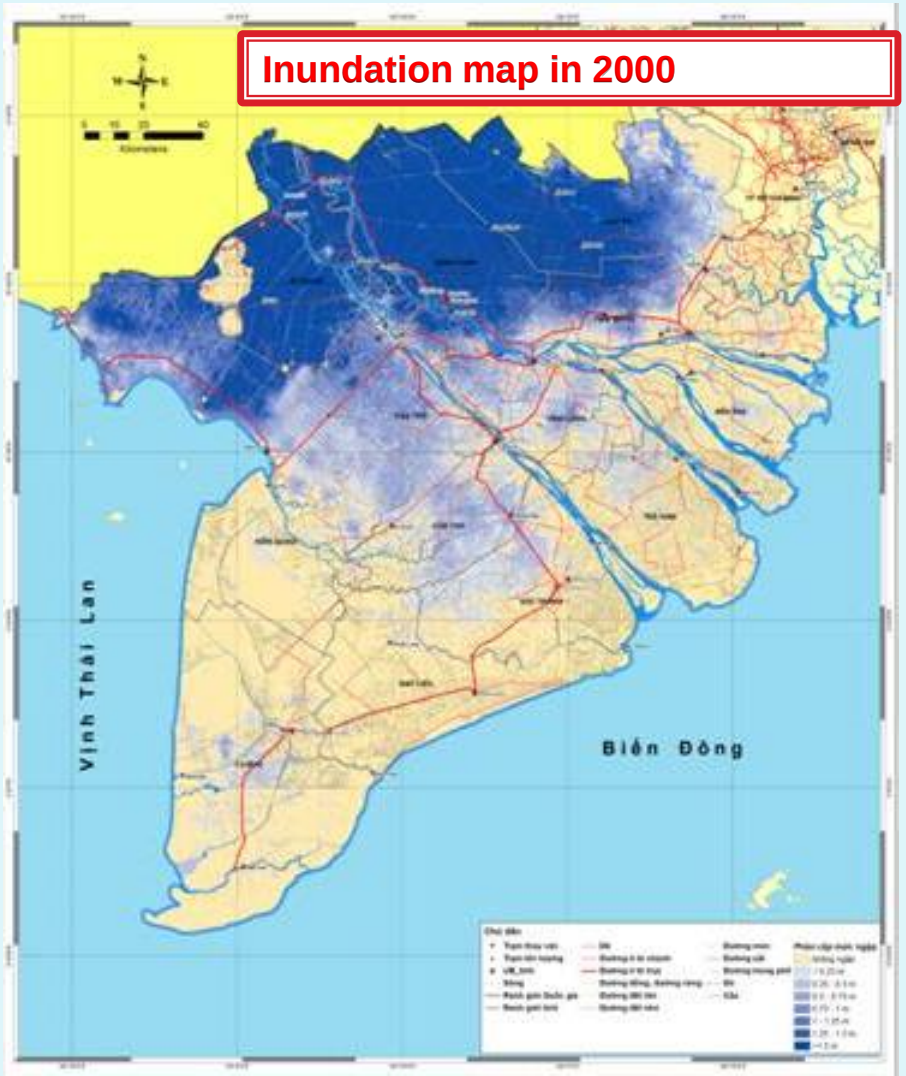
**+ Research of impact of climate change on inundation and salinity intrusion base on the researching results of Mekong river commissions of have used hydro-dynamic modeling ISIS for calculating, verification, calibration for mekong delta;**

**+ To access the impact of climate change on inundation and salinity intrusion of mekong river basin, need to consideration, evaluate about the water from upstream, rising sea level also amount of rainfall, the need of water in the internal delta basin under the impact of climate change;**

**+ In the research, the rising sea level correspondent with salty degree at outlet river was mentioned. HYMEN have calculated and integrated into input to ISIS model for calculating of inundation and salinity intrusion**

# 2. Impact of climate change on inundation in Cuu Long Delta

- In Cuu Long Delta, flooded area is about 1.9 million ha in flood season lasting 3-5 months and damages dramatically living and socio-economy.



# Impact of climate change on inundation in Cuu Long Delta

- Inundation affects seriously production and human living in Cuu Long Delta. This study assesses impact of climate change on agricultural land (2 crops and 3 crops) and residential land

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Land type** | **Total** | **≥ 0,25m** | **≥ 0,5m** | **≥ 0.75** | **≥ 1m** | **≥1.25** | **≥ 1.5m** |
| **3 crops land** | 501628 | 354862 | 266607 | 208757 | 155677 | 123970 | 104024 |
| **2 crops land** | 858616 | 755293 | 691580 | 632300 | 581959 | 526593 | 448534 |
| **Residential land** | 288877 | 214189 | 172466 | 144619 | 121614 | 104913 | 89006 |

# Calculating basic

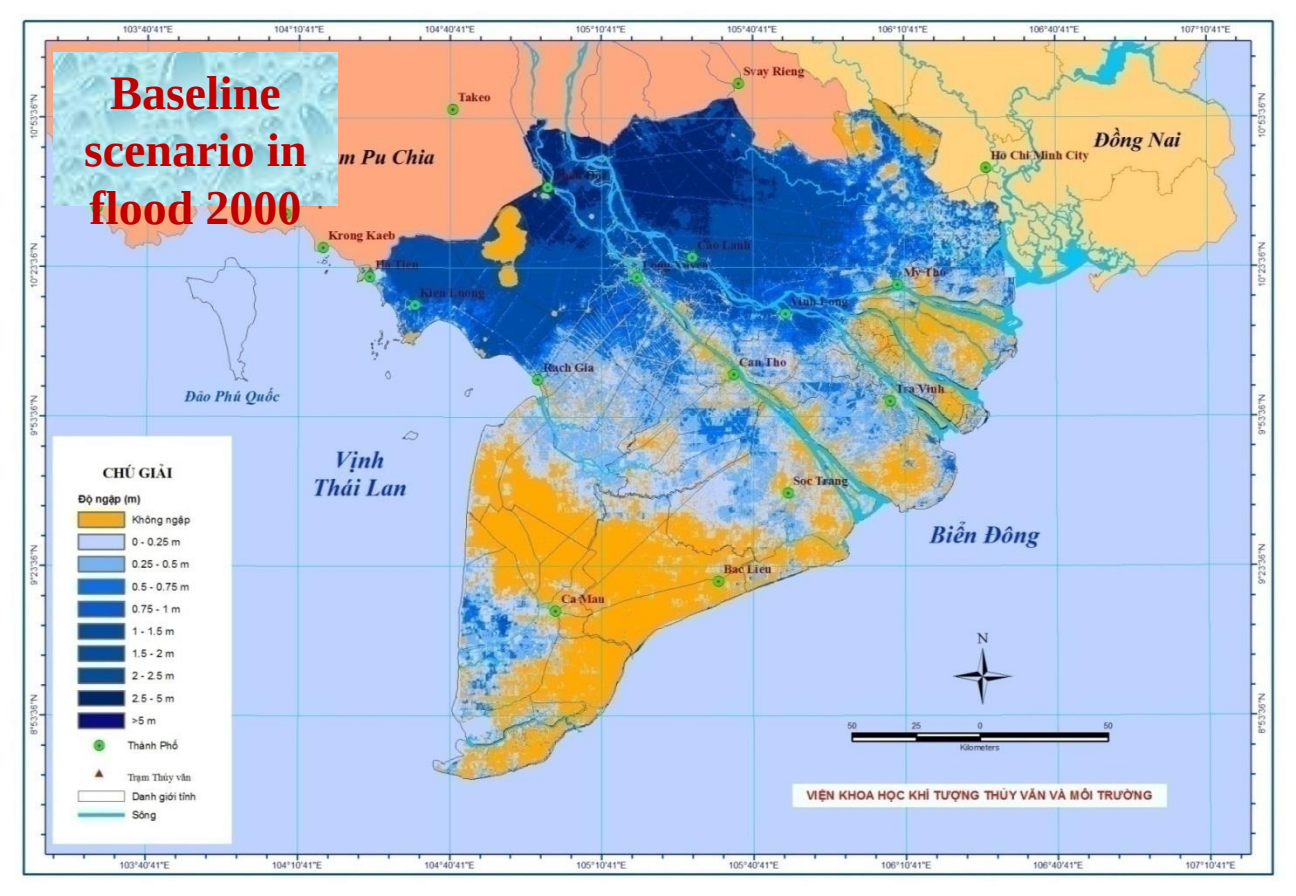
**+ Used A2, B2 scenarios; the flood of years: 2019, 2021, 2039, 2047 correspondence of period of 2010-2019; 2020-2039; 2040-2049 selected to calculate;**

**+ Combination of the selected flood correspondent rising sea level (rising sea level 15, 23, 30 cm) in each selected period was integarated to ISIS model for simulating hydraulic regime in the entire system;**

**+ The inudation map was built basing on hydraulic calculating results and topological map by MONRE mesure, built in 2009, with solution 5 x 5m.**

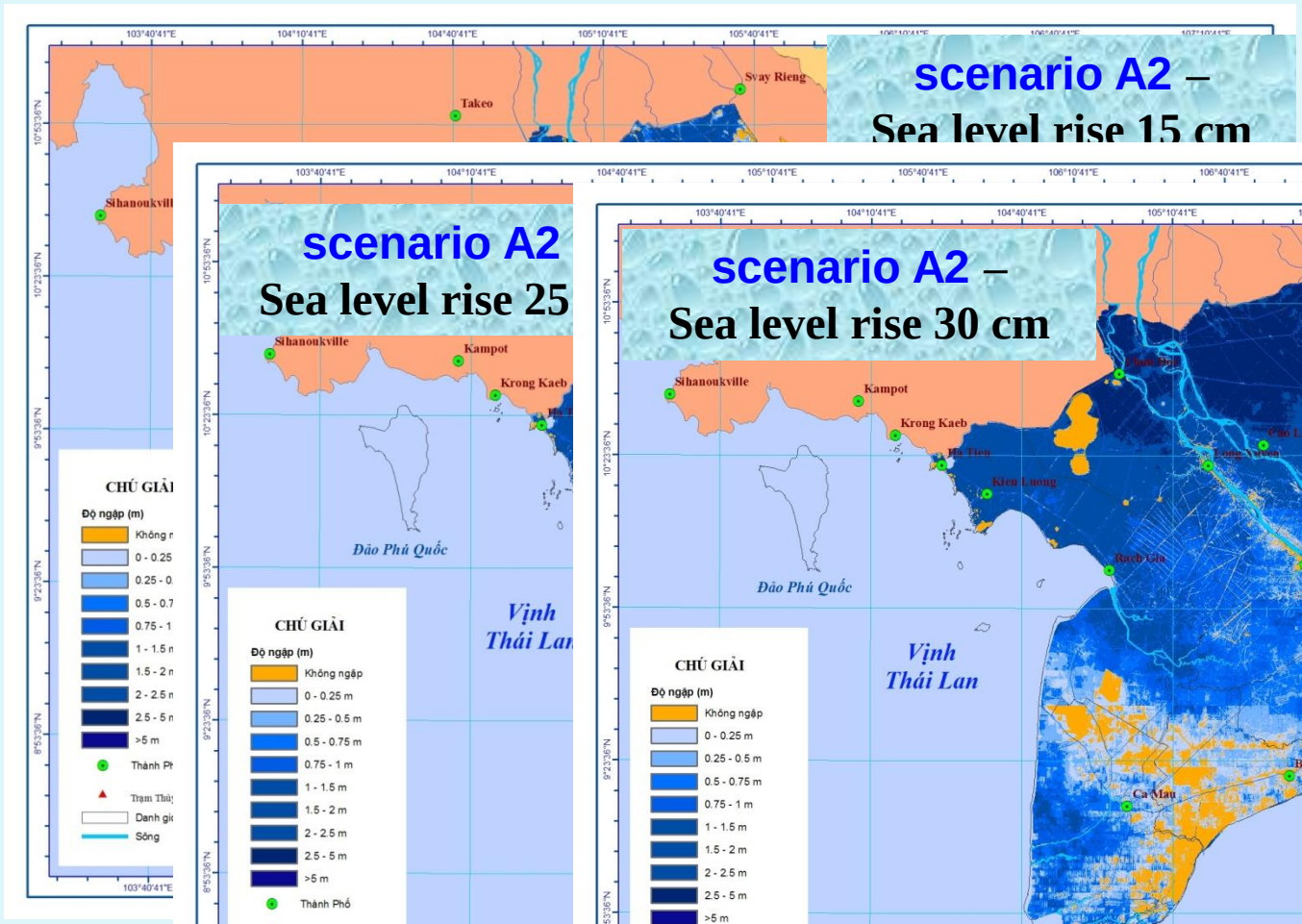
# Inundation in Cuu Long river delta

# scenario A2 - with flood 2000



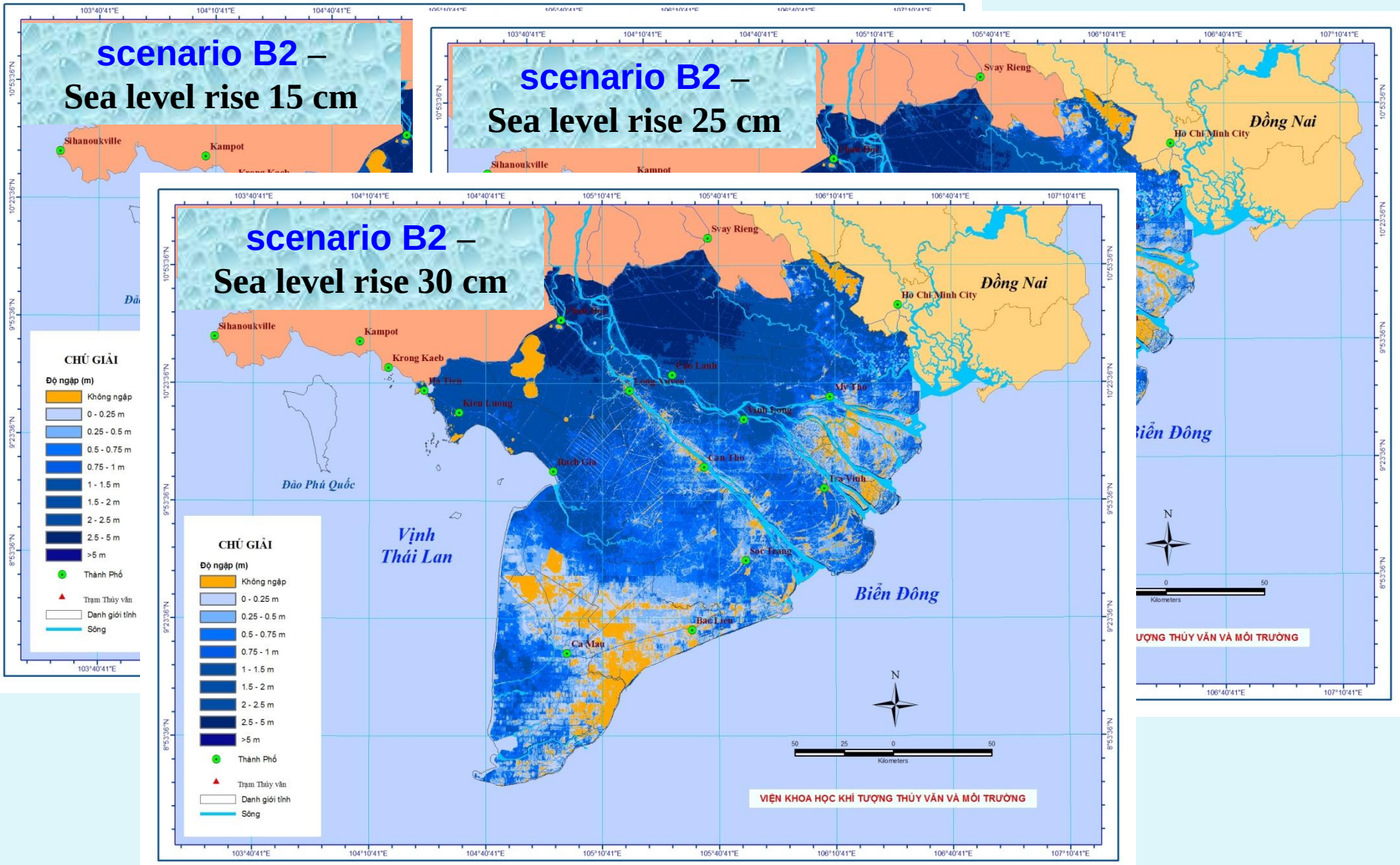
# Inundation in Cuu Long river delta

# scenario A2 - with flood 2000



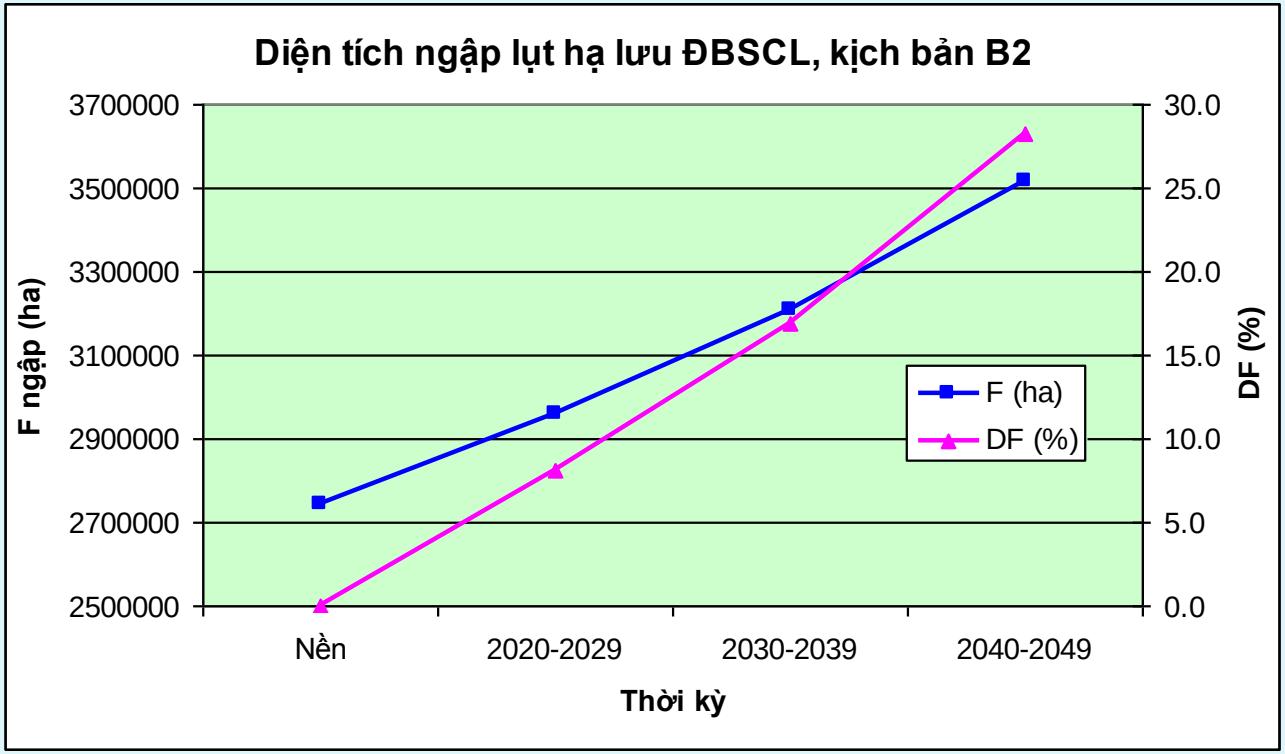
# Inundation in Cuu Long river delta

# scenario B2 - with flood 2000



# Inundation in Cuu Long river delta

| Kịch bản | Thời kỳ | Năm lũ điển hình | Tổng | |
|---|---|---|---|---|
| | | | F ngập (ha) | Thay đổi so với lũ 2000 (%) |
| Nền | Nền | 2000 | 2740919 | 0.0 |
| B2 | 2020-2029 | 2020 | 2961673 | 8.1 |
| | 2030-2039 | 2032 | 3205585 | 17.0 |
| | 2040-2049 | 2046 | 3513749 | 28.2 |
| A2 | 2020-2029 | 2021 | 3011868 | 9.9 |
| | 2030-2039 | 2039 | 3219407 | 17.5 |
| | 2040-2049 | 2047 | 3514403 | 28.2 |



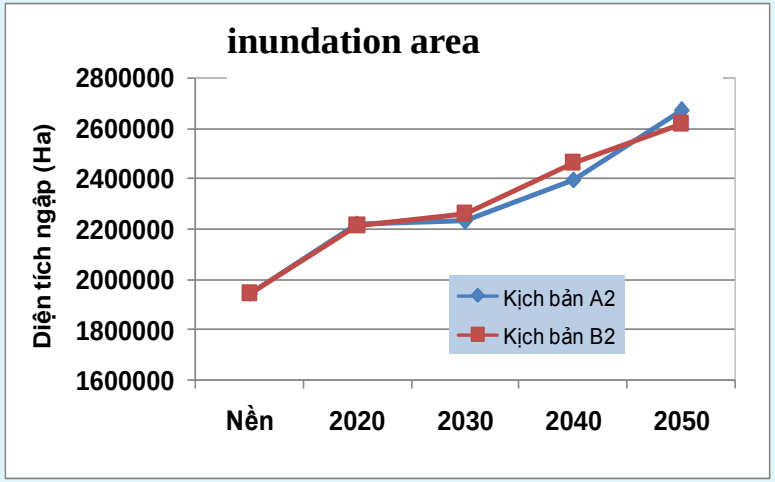
# Impact of CC on inundation in Cuu Long Delta

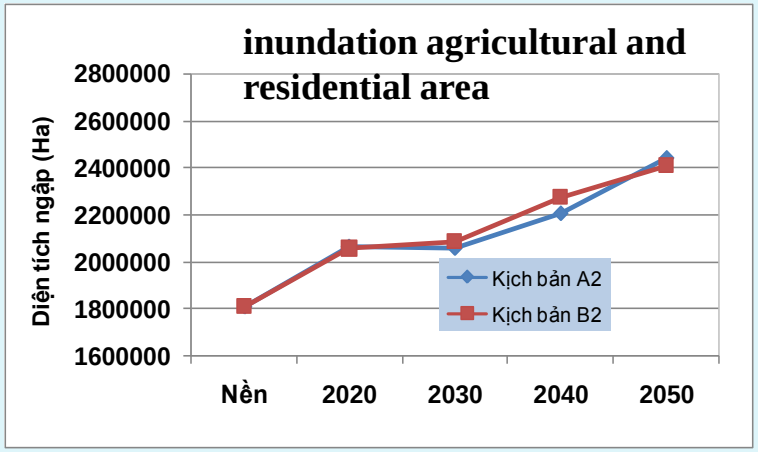
- Inundation affects seriously production and human living in Cuu Long Delta. This study assesses impact of climate change on agricultural land (2 crops and 3 crops) and residential land

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Land type** | **Total** | **≥ 0,25m** | **≥ 0,5m** | **≥ 0.75** | **≥ 1m** | **≥1.25** | **≥ 1.5m** |
| **3 crops land** | 501628 | 354862 | 266607 | 208757 | 155677 | 123970 | 104024 |
| **2 crops land** | 858616 | 755293 | 691580 | 632300 | 581959 | 526593 | 448534 |
| **Residential land** | 288877 | 214189 | 172466 | 144619 | 121614 | 104913 | 89006 |

# Impact of climate change on inundation in Cuu Long Delta

- In F1, F2, F5 and F6 scenarios **(sea level rise 9-15 cm)**, total flooded area increase about 0.3 million ha (15%) compared to baseline (approximately 1.8 million ha);
- In F3, F4, F7 and F8 scenarios **(sea level rise 20-30 cm)**, total flooded area increase about 0.4-0.6 million ha (22-35%) compared to baseline

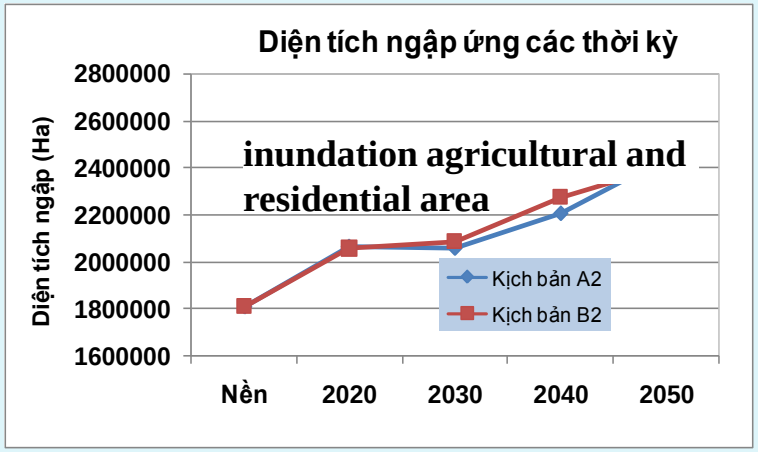


# Impact of climate change on inundation in Cuu Long Delta

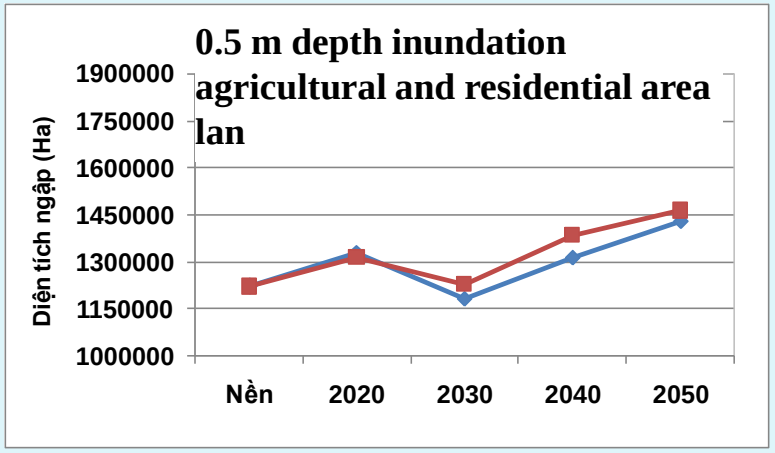
**Sea level rise 9 -15 cm:** Flooded area with the depth higher 0.5 m is 1.2 – 1.3 million ha more 2-9% than baseline.

- The area for 1.0 m depth is near 1.0 million ha and greater 6-8% than baseline scenario;




**Sea level rise 20 -30 cm:** Flooded area with the depth higher 0.5 m is 1.3 – 1.5 million ha more 14-20% than baseline.

- The area for 1.0 m depth is around 1.0 million ha and greater 8-13% than baseline scenario



# Impact of climate change on innudation in Cuu Long Delta

## F1 Scenarios: CC scenario A2 - 2020 - SLR 9 cm

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 581086 | 421660 | 303002 | 231072 | 176033 | 134370 | 111938 |
| 2 crops land | 952564 | 795716 | 730126 | 668485 | 611420 | 559043 | 488582 |
| Residential land | 338705 | 245438 | 191365 | 157400 | 132590 | 112366 | 96670 |
| | rate changes (%) | | | | | | |
| 3 crops land | 15.8 | 18.8 | 13.7 | 10.7 | 13.1 | 8.4 | 7.6 |
| 2 crops land | 10.9 | 5.4 | 5.6 | 5.7 | 5.1 | 6.2 | 8.9 |
| Residential land | 17.2 | 14.6 | 11.0 | 8.8 | 9.0 | 7.1 | 8.6 |

## F2 Scenarios: CC scenario A2 - 2028 - SLR 15 cm

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 572869 | 398121 | 266382 | 189621 | 135950 | 107734 | 88529 |
| 2 crops land | 966920 | 772757 | 668007 | 586413 | 515688 | 434329 | 354832 |
| Residential land | 338433 | 231428 | 167393 | 130985 | 106753 | 88198 | 70670 |
| | rate changes (%) | | | | | | |
| 3 crops land | 14.2 | 12.2 | -0.1 | -9.2 | -12.7 | -13.1 | -14.9 |
| 2 crops land | 12.6 | 2.3 | -3.4 | -7.3 | -11.4 | -17.5 | -20.9 |
| Residential land | 17.2 | 8.0 | -2.9 | -9.4 | -12.2 | -15.9 | -20.6 |

# Impact of climate change on inundation in Cuu Long Delta

## F5 Scenarios: CC scenario B2 - 2016 - SLR 9 cm

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 578907 | 418609 | 298693 | 227427 | 172774 | 132253 | 109084 |
| 2 crops land | 949746 | 792852 | 726215 | 661430 | 604521 | 556298 | 484545 |
| Residential land | 336859 | 243243 | 188938 | 154949 | 130241 | 110710 | 94840 |
| | rate changes (%) | | | | | | |
| 3 crops land | 15.4 | 18.0 | 12.0 | 8.9 | 11.0 | 6.7 | 4.9 |
| 2 crops land | 10.6 | 5.0 | 5.0 | 4.6 | 3.9 | 5.6 | 8.0 |
| Residential land | 16.6 | 13.6 | 9.6 | 7.1 | 7.1 | 5.5 | 6.6 |

## F6 Scenarios: CC scenario B2 - 2028 - SLR 15 cm

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 580497 | 409712 | 276875 | 197945 | 142043 | 112147 | 92756 |
| 2 crops land | 976944 | 787193 | 689261 | 609066 | 544906 | 468664 | 385119 |
| Residential land | 343850 | 238499 | 174786 | 137102 | 112363 | 94711 | 77056 |
| | rate changes (%) | | | | | | |
| 3 crops land | 15.7 | 15.5 | 3.9 | -5.2 | -8.8 | -9.5 | -10.8 |
| 2 crops land | 13.8 | 4.2 | -0.3 | -3.7 | -6.4 | -11.0 | -14.1 |
| Residential land | 19.0 | 11.3 | 1.3 | -5.2 | -7.6 | -9.7 | -13.4 |

# Impact of climate change on inundation in Cuu Long Delta

## F3 Scenarios: CC scenario A2 - 2035 - SLR 20 cm

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 610613 | 448576 | 304251 | 226350 | 167603 | 127719 | 105478 |
| 2 crops land | 1025501 | 816503 | 716202 | 644813 | 591333 | 528486 | 442150 |
| Residential land | 369088 | 259750 | 190507 | 153593 | 128421 | 107523 | 88359 |
| | rate changes (%) | | | | | | |
| 3 crops land | 21.7 | 26.4 | 14.1 | 8.4 | 7.7 | 3.0 | 1.4 |
| 2 crops land | 19.4 | 8.1 | 3.6 | 2.0 | 1.6 | 0.4 | -1.4 |
| Residential land | 27.8 | 21.3 | 10.5 | 6.2 | 5.6 | 2.5 | -0.7 |

## F4 Scenarios: CC scenario A2 - 2047 - SLR 30 cm

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 661245 | 530182 | 355597 | 247873 | 176583 | 129254 | 103308 |
| 2 crops land | 1132830 | 895084 | 750301 | 659285 | 587235 | 519622 | 433172 |
| Residential land | 415308 | 303444 | 212108 | 160913 | 128048 | 105787 | 86322 |
| | rate changes (%) | | | | | | |
| 3 crops land | 31.8 | 49.4 | 33.4 | 18.7 | 13.4 | 4.3 | -0.7 |
| 2 crops land | 31.9 | 18.5 | 8.5 | 4.3 | 0.9 | -1.3 | -3.4 |
| Residential land | 43.8 | 41.7 | 23.0 | 11.3 | 5.3 | 0.8 | -3.0 |

# Impact of climate change on inundation in Cuu Long Delta

## F7 Scenarios: CC scenario B2 - 2043 - SLR 20 cm

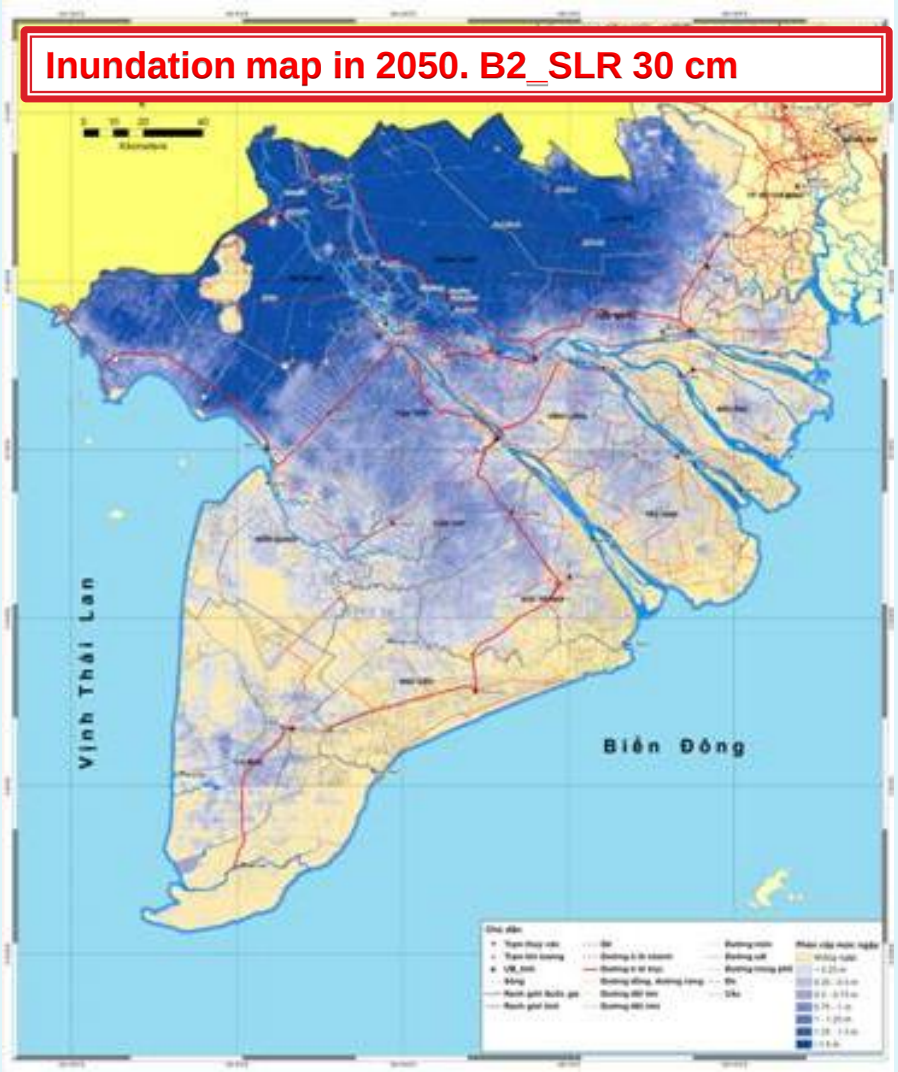
| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 627309 | 481940 | 330563 | 241440 | 179506 | 134714 | 110637 |
| 2 crops land | 1049132 | 839209 | 743233 | 670190 | 607118 | 555369 | 482502 |
| Residential land | 380755 | 274982 | 202408 | 161199 | 132869 | 111901 | 95344 |
| | rate changes (%) | | | | | | |
| 3 crops land | 25.1 | 35.8 | 24.0 | 15.7 | 15.3 | 8.7 | 6.4 |
| 2 crops land | 22.2 | 11.1 | 7.5 | 6.0 | 4.3 | 5.5 | 7.6 |
| Residential land | 31.8 | 28.4 | 17.4 | 11.5 | 9.3 | 6.7 | 7.1 |

## F8 Scenarios: CC scenario B2 - 2047 - SLR 30cm

| | Flooded area corresponding to depths (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| Land type | < 0.25m | ≥ 0.25m | ≥ 0.5m | ≥ 0.75 | ≥ 1m | ≥1.25 | ≥ 1.5m |
| 3 crops land | 655971 | 526102 | 361724 | 262247 | 194103 | 143863 | 114757 |
| 2 crops land | 1112487 | 882474 | 762465 | 689518 | 621887 | 556762 | 480815 |
| Residential land | 407983 | 299775 | 217110 | 170627 | 139349 | 115767 | 96848 |
| | rate changes (%) | | | | | | |
| 3 crops land | 30.8 | 48.3 | 35.7 | 25.6 | 24.7 | 16.0 | 10.3 |
| 2 crops land | 29.6 | 16.8 | 10.2 | 9.0 | 6.9 | 5.7 | 7.2 |
| Residential land | 41.2 | 40.0 | 25.9 | 18.0 | 14.6 | 10.3 | 8.8 |

# Impact of climate change on inundation in Cuu Long Delta

- In sea level rise 30 cm scenario, extreme floods in mid 21st century inundates about 2.7 million ha (greater 25-37% than baseline) occupying 60-67% total area of Cuu Long Delta;
- Area with flooded depth higher than 0.5 m is 1.6 million ha (40% area of Cuu Long Delta) and higher than 1.0 m is 1.9 million ha (26% area of Cuu Long Delta)



# 3. Impacts on salinity intrusion

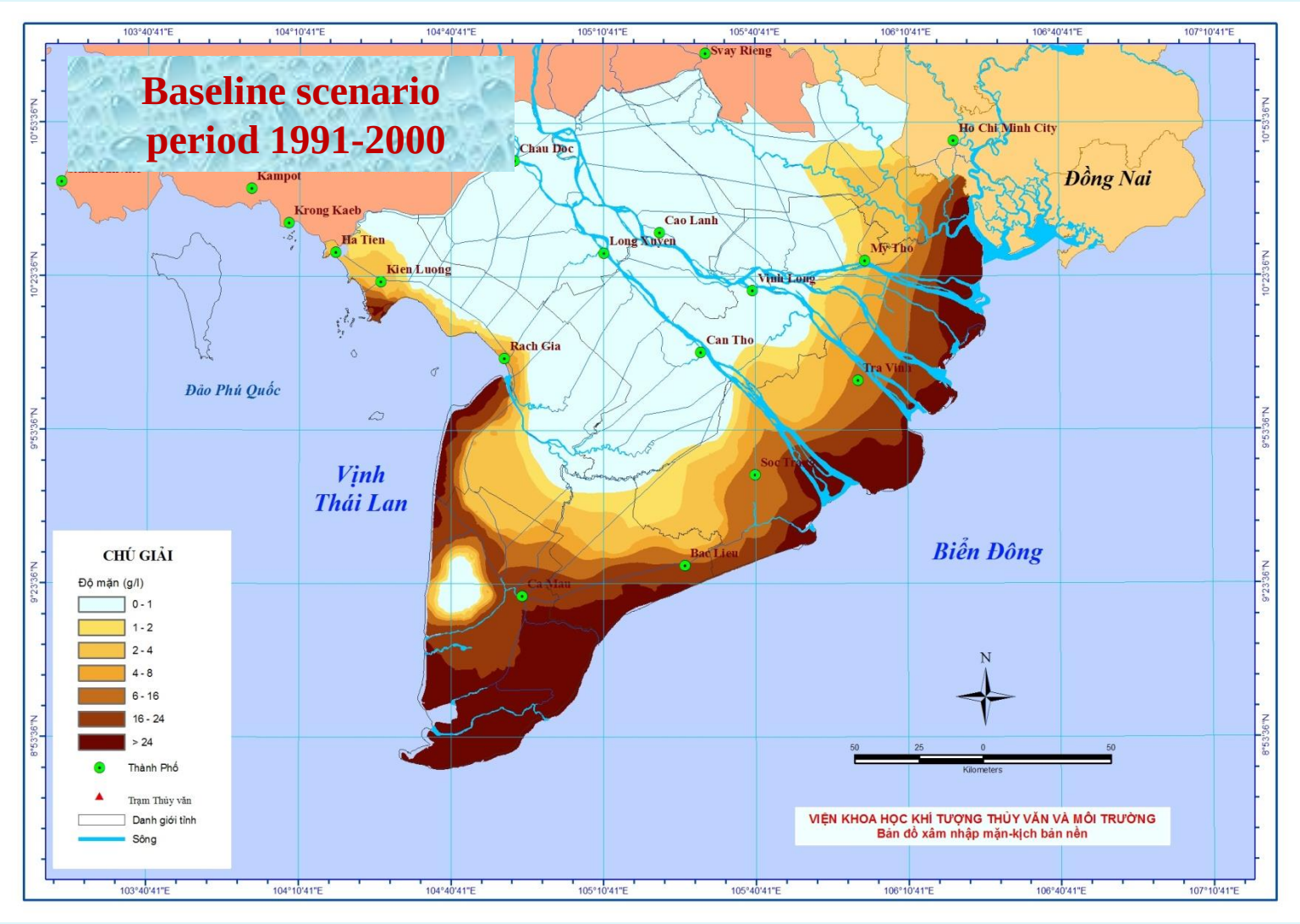
# Calculating basic

**+ In the project, the intrusion events are calculated in each 10-year period, the base period is 1991-2000; the future periods are 2010-2019; 2020-2039; 2040-2049.**

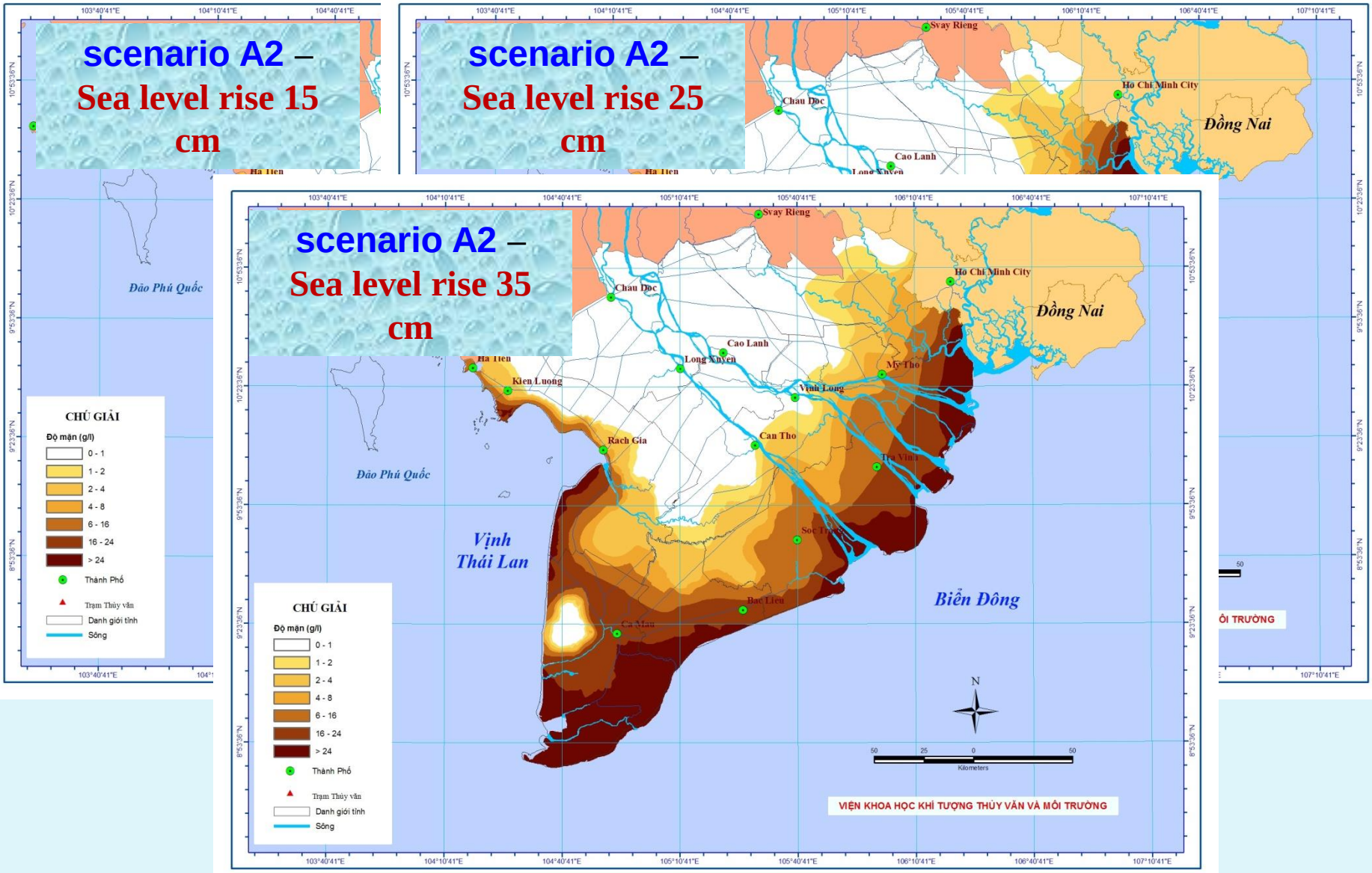
**+ Combination of average daily flow with the SLR and salinity respectively 15, 23, 30 cm will be editing the input to simulate the process of salinity intrusion on the entire system**

**+ Combination of selected flow with the SLR in each period was integrated to ISIS hydro-dynamic model to simulate the hydraulic regime of entire system.**

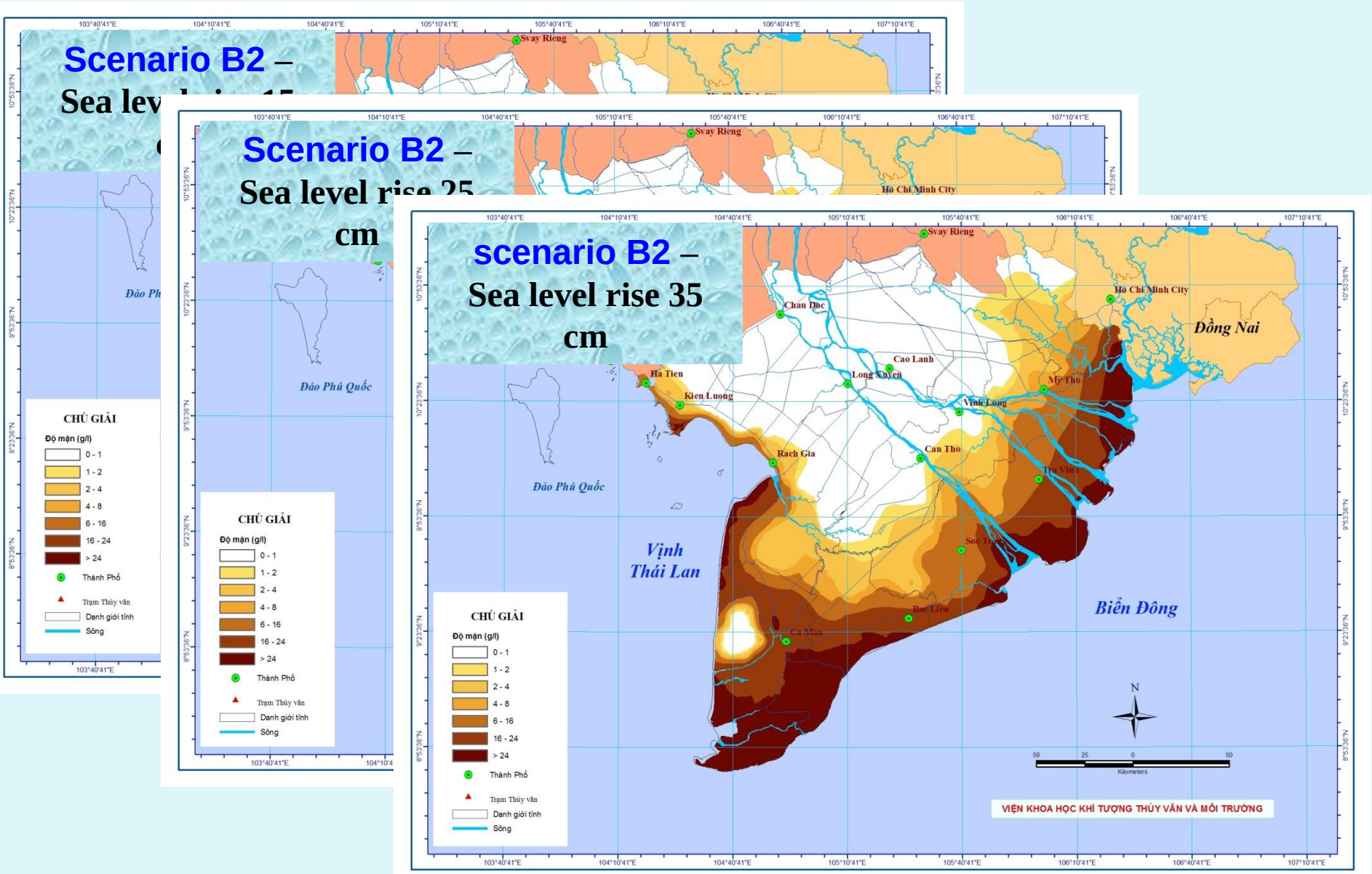
# The calculated results of salinity intrusion of Cuu long river delta



# Result of salinity intrusion of Cuu long river delta, Scenario A2



# Result of salinity intrusion of Cuu long river delta, Scenario B2



# The status of used soil of Cuu Long river delta

| Kịch bản | Thời kỳ | Diện tích đất bị ảnh hưởng ứng với danh giới độ mặn 1 phần nghìn (ha) | | |
|---|---|---|---|---|
| | | Đất ở và đất công nghiệp | Thủy sản | Đất nông nghiệp |
| Nền | 1991-2000 | 3004 | 2875 | 10030 |
| A2 | 2020-2029 | 3196 | 2905 | 10900 |
| | 2030-2039 | 3399 | 2909 | 11780 |
| | 2040-2049 | 3744 | 2909 | 13210 |
| B2 | 2020-2029 | 3129 | 2900 | 10600 |
| | 2030-2039 | 3267 | 2908 | 11240 |
| | 2040-2049 | 3595 | 2909 | 12540 |

| Kịch bản | Thời kỳ | Diện tích đất bị ảnh hưởng ứng với danh giới độ mặn 4 phần nghìn (ha) | | |
|---|---|---|---|---|
| | | Đất ở và đất công nghiệp | Thủy sản | Đất nông nghiệp |
| Nền | 1991-2000 | 2076 | 2394 | 5690 |
| A2 | 2020-2029 | 2246 | 2426 | 6506 |
| | 2030-2039 | 2438 | 2512 | 7413 |
| | 2040-2049 | 2706 | 2644 | 8744 |
| B2 | 2020-2029 | 2196 | 2411 | 6232 |
| | 2030-2039 | 2307 | 2451 | 6844 |
| | 2040-2049 | 2641 | 2585 | 8379 |

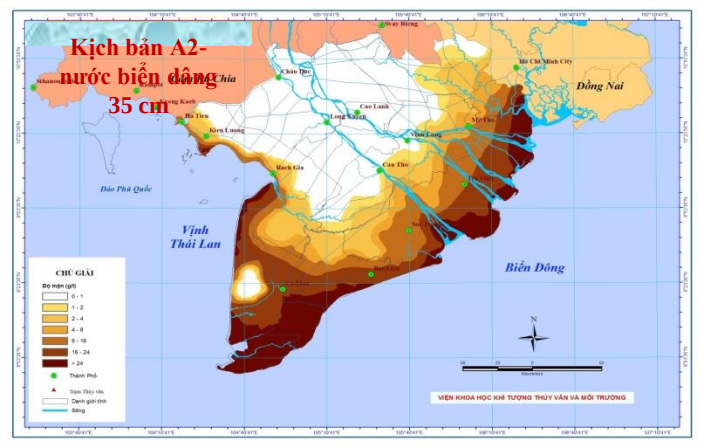
# The planning of used soil of Cuu Long river delta

| Kịch bản | Thời kỳ | Diện tích đất bị ảnh hưởng ứng với danh giới độ mặn 1 phần nghìn (ha) | | | | |
|---|---|---|---|---|---|---|
| | | Đất ở và đất công nghiệp | Thủy sản | Đất nông nghiệp kết hợp với Thủy sản | Đất nông nghiệp | Các đất khác |
| Nền | 1991-2000 | 3123 | 6929 | 1814 | 7593 | 1221 |
| A2 | 2020-2029 | 3322 | 6969 | 2075 | 8258 | 1316 |
| | 2030-2039 | 3526 | 6970 | 2380 | 8895 | 1459 |
| | 2040-2049 | 3877 | 6975 | 2937 | 9872 | 1580 |
| B2 | 2020-2029 | 3253 | 6963 | 1993 | 8011 | 1310 |
| | 2030-2039 | 3392 | 6970 | 2182 | 8499 | 1389 |
| | 2040-2049 | 3726 | 6970 | 2663 | 9398 | 1506 |

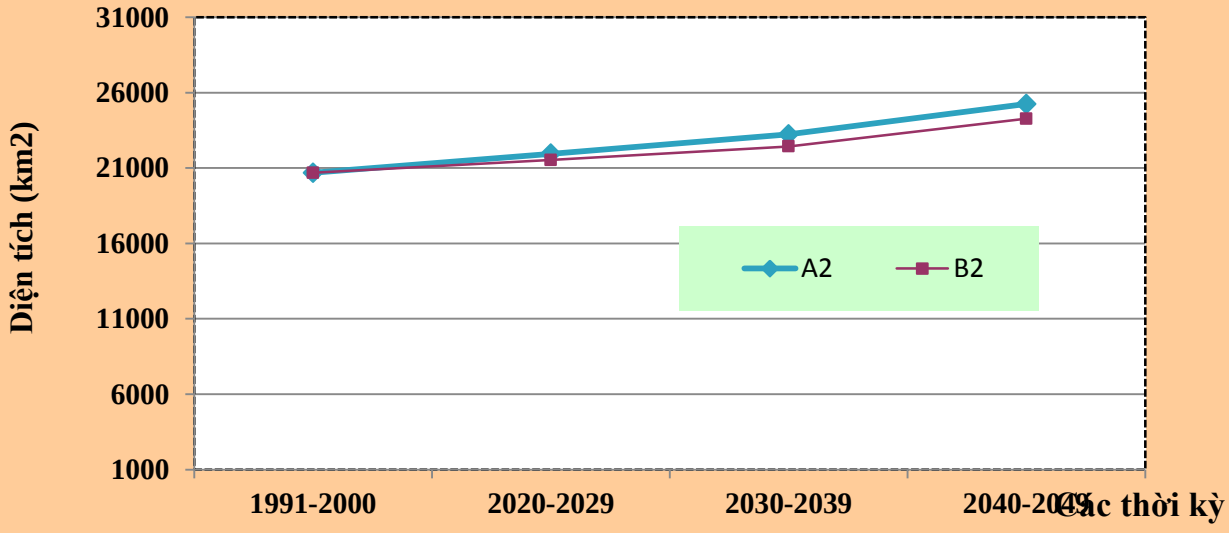
| Kịch bản | Thời kỳ | Diện tích đất bị ảnh hưởng ứng với danh giới độ mặn 4 phần nghìn (ha) | | | | |
|---|---|---|---|---|---|---|
| | | Đất ở và đất công nghiệp | Thủy sản | Đất nông nghiệp kết hợp với Thủy sản | Đất nông nghiệp | Các đất khác |
| Nền | 1991-2000 | 2159 | 5790 | 889.4 | 4433 | 848.6 |
| A2 | 2020-2029 | 2339 | 5993 | 968.5 | 5097 | 883.5 |
| | 2030-2039 | 2547 | 6192 | 1106 | 5763 | 444 |
| | 2040-2049 | 2823 | 6406 | 1378 | 6659 | 1246 |
| B2 | 2020-2029 | 2284 | 5938 | 939.8 | 4874 | 856.2 |
| | 2030-2039 | 2410 | 6042 | 1012 | 5350 | 929 |
| | 2040-2049 | 2759 | 6352 | 1280 | 6402 | 1160 |

- The max area of used soil is affected by salinity intrusion 1 ‰ to 2,5 million ha (25.241 km$^2$) equal 64% of natural area

| Loại đất | Diện tích đất bị ảnh hưởng ứng với danh giới độ mặn 1 phần nghìn (km$^2$) | |
|---|---|---|
| Kịch bản /Thời kỳ | A2 | B2 |
| 1991-2000 | 20680 | 20680 |
| 2020-2029 | 21940 | 21530 |
| 2030-2039 | 23230 | 22432 |
| 2040-2049 | 25241 | 24263 |

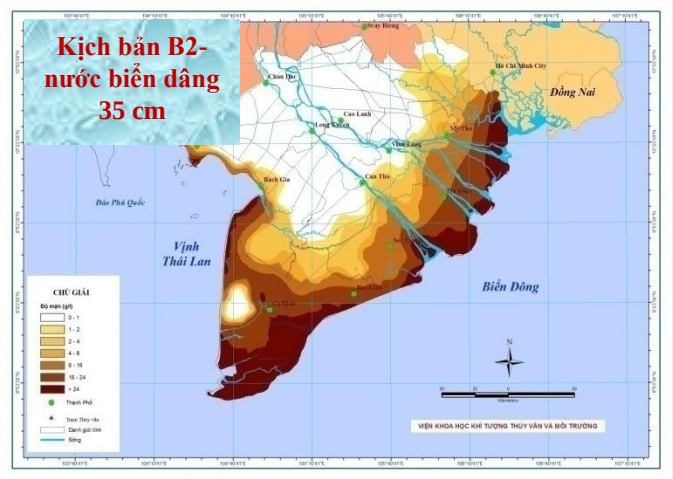


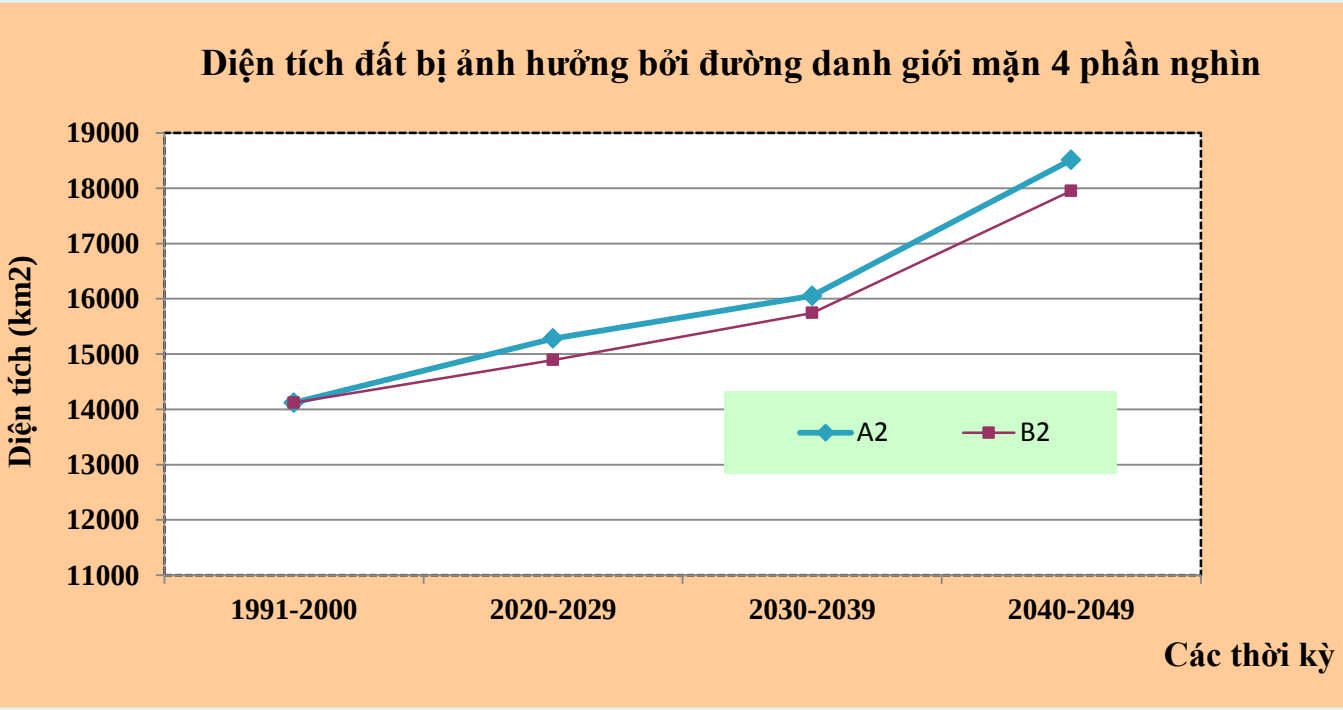

Diện tích đất bị ảnh hưởng bởi đường danh giới mặn 1 phần nghìn



- **The max area of used soil is affected by salinity intrusion 4‰ to 1,85 milion ha (1.8512 km$^2$) equal 47% of natural area**

| Loại đất | Diện tích đất bị ảnh hưởng ứng với danh giới độ mặn 4 phần nghìn (km$^2$) | |
|---|---|---|
| Kịch bản /Thời kỳ | A2 | B2 |
| 1991-2000 | 14120 | 14120 |
| 2020-2029 | 15281 | 14892 |
| 2030-2039 | 16052 | 15743 |
| 2040-2049 | 18512 | 17953 |



# 4. Results and Conclusion

- **Climate change impact strongly to water resources of Cuu Long river delta (The maximal monthly flow increases progressively. The trend of flooding is more and more increasing in Cuu Long Delta.**

- **By 2050, the maximal flooded area which is more than 0.5 m depth will be up to 68.3% of the entire area of Cuu Long Delta, and this will increase by nearly 30% of the natural area compared with the flood situation in 2000.**

- **Flood season will come earlier and also reduce later with longer duration that's why it is much more difficult to drain water and arrange crops.**

- **The average flow in dry season tends to increase gradually. Combination of the low flows and SLR makes salinity level increase that appears more and more severe in Cuu Long Delta.**

❖ **Climate change and sea level rising strongly affected inundation and salinity intrusion of Cuu Long river delta.**

❖ **The calculated results is primitive basic for proposed adaptation measure**

- ***Planning aspect***
- ***Construction of sea dyke***
- ***Study measures for salinity prevention***
- ***Study the change of crop patterns and livestock***
- ***Use of fresh water storage measures***
- ***Environmental protection***
- ***International cooperation***


Thank you very much for
your attention