

## IMPACTS OF SEA LEVEL RISE SCENARIOS ON FLOOD WATER LEVELS IN DONG THAP MUOI REGION, MEKONG RIVER DELTA

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**Abstract:** Dong Thap Muoi region is a lowerest part of Mekong Delta in Vietnam, flood is annual occurred during wet season, and its impact causes a large inundation area in this region every year. Moreover, in context of sea level rise impacts lead to flood water levels and flood inundation time is more increase, the flood drainage is also more difficult. These problems are to influence on water resources, environment, ecosystems, socio-economic activities of people, and especially impacted directly to agricultural production. Therefore, purpose of study is to assess the change flood water levels and flood inundation time in Dong Thap Muoi region under impact of sea level rising of 20cm and 50cm scenarios. The results of study could be useful to forecast of water level floods change and inundation time, which can help the manager to proposal of flood control solutions in order to mitigate the flood damage and to exploit the flood benefits as well as satisfy immediate and long-term requirements in flood management in Dong Thap Muoi region.

**Keywords:** Flood inundation, sea level rise, tide, scenarios, Dong Thap Muoi region.

### 1. INTRODUCTION

Dong Thap Muoi region is a large area in the northern part of Mekong Delta, is flooded annually when the water level in the main channels rises above the river, canal banks. Flooding has serious negative impacts on production and livelihood of the people. Therefore, over the last 20 years, the Government of Vietnam has put more investments in programs in Mekong river Delta in general and Dong Thap Muoi in particular such as: Flood control programs have built 13.347 km of resident clusters for 314.133 households, 19.930km of flood control ring dykes completely protecting 6.026 of field cells of 3-crop paddy fields and 17,760km of flood control ring dykes protecting 4,513 2-crop paddy fields; salinity control programs and land improvement programs; many policies to support people living in flooded areas were promptly issued. To solve the urgent needs of inundation by flood and handle challenges of climate change, the Government of Vietnam has approved many planning projects such as Mekong Delta Master Planning in the context of climate change and sea level rise by 2020 and vision towards 2050 (the Government of

Vietnam, 2012). Mekong Delta Master Plan with technical support from Dutch specialists (DGMIEP, 2013). The Irrigation Planning for flood prevention in CanTho city, Vinh Long and Ca Mau provinces has been approved, with a total protected area of 66.800ha, divided into 39 compartments, protected by 500km of dikes and serviced by 47 drainage pumping stations (Mard, 2013), Irrigation plan for Dong Thap Muoi region includes of Long An, Dong Thap and Tien Giang provinces which also have been approved to solve the inundation by flood. Recent, there were many researches considering for impacts assessment of climate change on rice productivity in Dong Thap Muoi region (Thanh et al., 2012), or flood control alternatives (Quan, 2006), Adaptation to climate change in the countries of the Lower Mekong Basin (Mekong River Commission, 2009), Flood Damage Assessment in the Mekong River Delta, Vietnam (Ngoc, 2003). However, in context of sea level rise impacts lead to flood water levels and flood inundation time is more increase, the flood drainage is also more difficult. Therefore, objective of study is to investigate and assess the change flood water levels and flood inundation time in Dong Thap Muoi region under impact of sea level rising scenarios, which is not only to provide information of water level floods change and inundation time but also to help

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managers to proposal of flood control solutions in order to mitigate the flood damage and to exploit the flood benefits as well as satisfy immediate and long-term requirements in flood management in region.

## 2. STUDY AREA

The Dong Thap Muoi region is a part of Viet Nam Mekong Delt, it includes of Long An, Dong Thap and Tien Giang provinces with area of 697.000 ha as shown in figer 2.1.

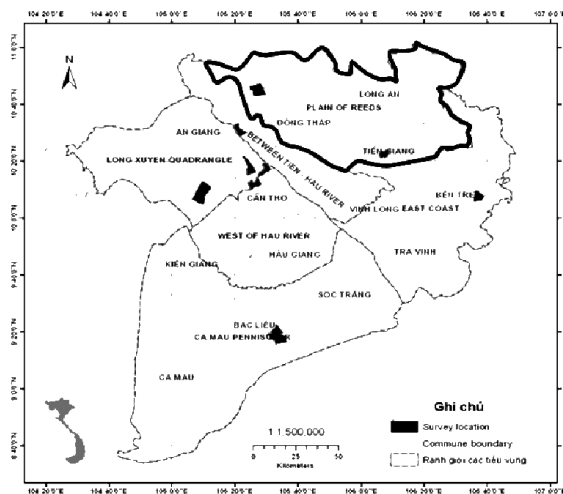


Figure 2.1. Location of study area

This region is characterized by dense canals and flooded every year in the wet season.

## 3. MATERIALS AND METHODS

In this study, the Mike 11 model was used to simulate floods water level on rivers systems and canal network in Dong Thap Muoi region under scenarios. And the all available hydrological data in the study area are collected and shown in the table 3.1 below and location of all station is described in figure 3.1-3.2 below.

Table 3.1. The data collection of stations in study area

No.	Observed data	Station	River location
1	Water level	Tan Chau	Tien River
2	Water level	Cho Moi	Tien River
3	Water level	Cao Lanh	Tien River
4	Water level	My Thuan	Tien River
5	Water level	My Tho	Tien River
6	Water level	Moc Hoa	West Vam Co
7	Water level	Kien Binh	Lagrange
8	Water level	Hung Thanh	Dong Tien

9	Rainfall	Vinh Hung	West Vam Co
10	Rainfall	Tan An	West Vam Co
11	Discharge	Kratie	MeKong
12	Discharge	Bien Ho	Tolesap
13	Discharge	East Vam Co	East Vam Co
14	Discharge	West Vam Co	West Vam Co
15	Tidal	Vam Kenh	Tien river
16	Tidal	Binh Dai	Ham Luong
17	Tidal	Ben Trai	Co Chien

Particular, the hydraulic calculation scenarios, and river networks for hydraulic calculation by Mike 11 model as given figures below. These main scenarios are mentioned below for review and comparison such as: (i) The under corresponding with scenarios of sea level rise (SLR) as 20 cm and 50cm.

- DTM01: With the current state in 2011 (terrain in 2011 + upstream data of boundaries condition + sea tidal data boundaries condition of 2000 + No sea level rise)

- DTM02: With the current state in 2011 and sea level rise of 20cm scenario (terrain in 2011 + upstream data of boundaries condition + tidal data boundaries condition of 2000 + sea level rise of 20cm)

- DTM03: With the current state in 2011 and sea level rise of 20cm scenario (terrain in 2011 + upstream data of boundaries condition + tidal data boundaries condition of 2000 + sea level rise of 50cm)

The illustrate river systems of hydraulic calculated by Mike 11 model as shown below.

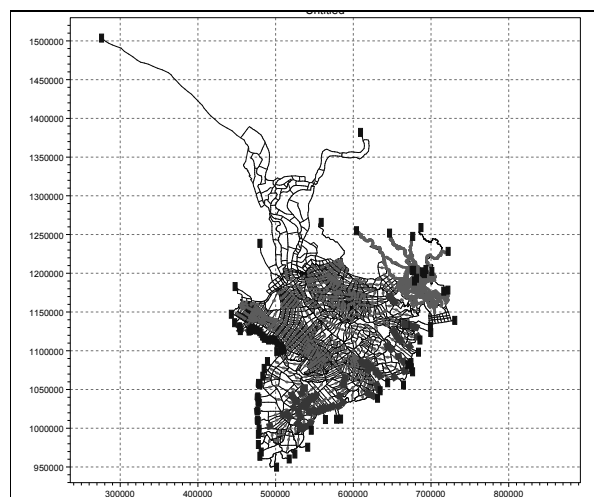


Figure 3.1. The illustrate river systems of hydraulic calculated by Mike 11 model

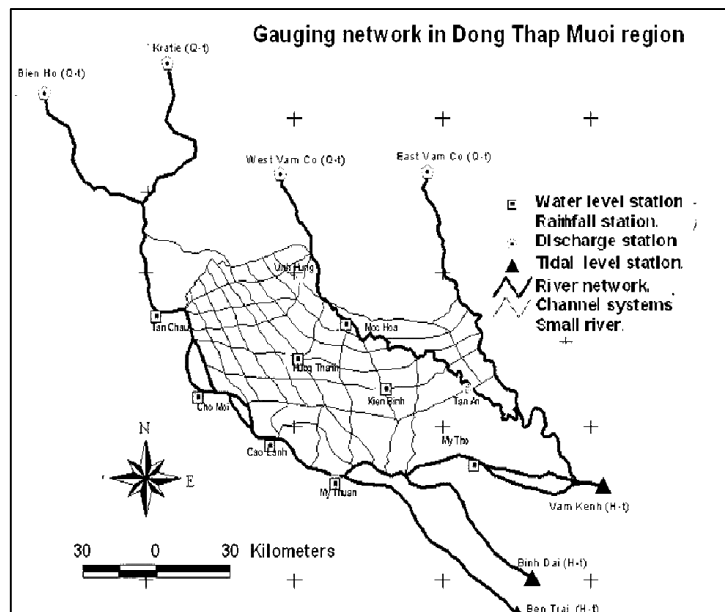


Figure 3.2. The station locations on rivers and fields of study area

#### 4. RESULTS AND DISCUSSIONS

##### 4.1 Results model calibrated and validated

Compared results between observed and simulated for calibrated of flood 2000 at Tan

Chau and My Thuan stations as shown in figures 4.1-4.2 and validated of flood 2011 at Tan Chau and My Thuan station. as given in figures of 4.3-4.4:

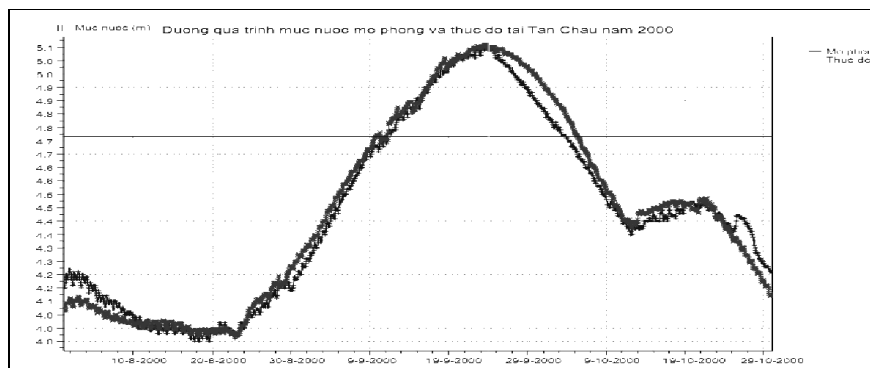


Figure 4.1. Water level for Observed and Simulated at Tan Chau in flood 2000

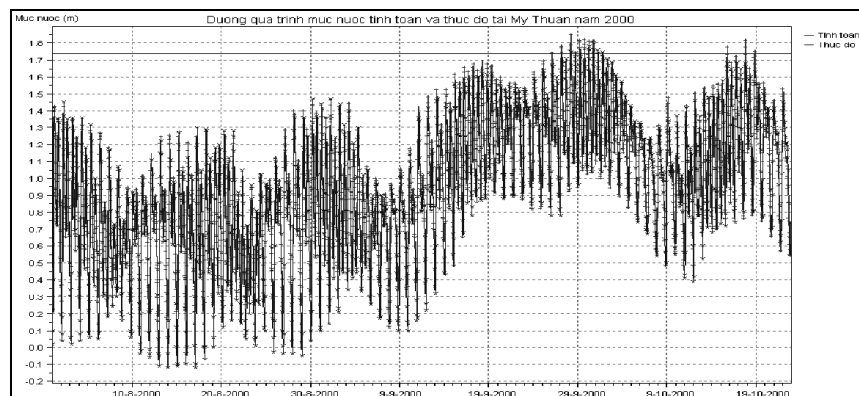


Figure 4.2. Water level for Observed and Simulated at My Thuan in flood 2000

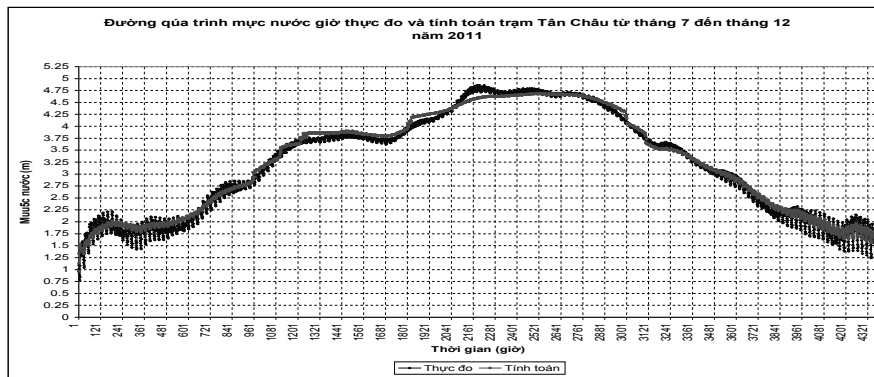


Figure 4.3. Water level for Observed and Simulated at Tan Chau in flood 2011

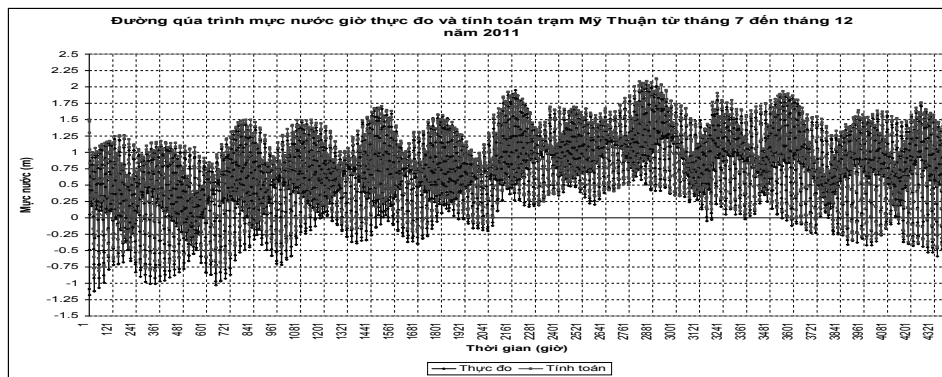


Figure 4.4. Water level for Observed and Simulated at My Thuan in flood 2011

Based on the results of calibration and verification showed that: Water level of simulated match with observed of both vibration amplitude of tide and the absolute value. The difference between the actual measured data and simulated results from about 3-5 cm. the results can show that the database to simulate the hydraulic factors in the study of acceptable reliability. Hydraulic model Mike11HD compatible with Dong Thap Muoi region, and given the simulation results of stability and reliability, proper description of the dynamics of the flow in the region. Therefore, these results are trusted enough models to apply simulation of hydraulic elements on the network the river, channels and forecast of the influence under scenarios of sea level rise.

#### 4.2 Results on water levels flood under sea level rise scenarios

The results of max water level along in the river at some locations during flood time from 08, Nov to 10, Dec 2011 according to the sea level rise (SLR) 20cm (DTM02) scenario and 50cm scenario (DTM03) which is compared the

scenario DTM01 (without SLR). (i) The results showed that under of sea level rise of 20cm scenario is the max water level more increase on Tien river, specific the water level increase of 15cm at My Thuan (near sea), and 8cm at Hong Ngu (upstream near Tan Chau station). The flood water levels on the Tan Thanh-Lo Gach river is 2cm while flood water levels at field locations in Dong Thap Muoi region is increase 3cm at Hung Thanh, 9cm at Kien Binh.

(ii) Under sea level rise of 50cm scenario is the water level more increase on Tien river, specific the water level increase of 38cm at My Thuan (near sea), at increased 50cm in the estuaries (sea), and 10cm at Hong Ngu (upstream near Tan Chau station). The flood water levels on the Tan Thanh-Lo Gach river through is 10cm while flood water levels at field locations in Dong Thap Muoi region is increase 10cm at Hung Thanh, 15cm at Kien Binh, and 15cm at Dong Tien; increase 10cm at Vam Nao, Highest water level in the field increase 13cm in My An, and 16cm in My Phuoc Tay. The sults shown in figures 4.5 - 4.6 below.

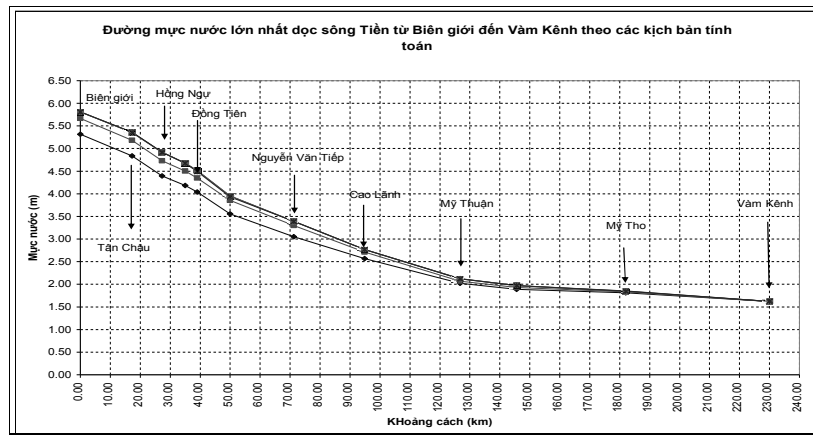


Figure 4.5. Max water level along Tien river from border to the sea in the calculation scenarios as no SLR, SLR20cm, and SLR50cm

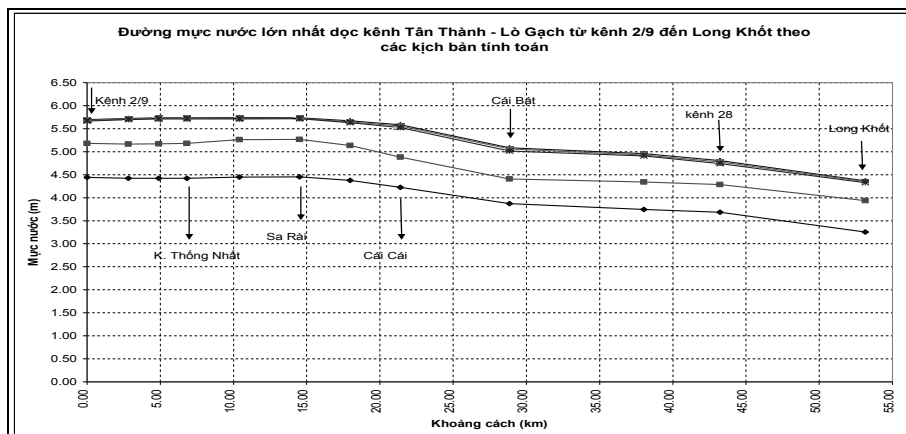


Figure 4.6. Max water level along Tan Thanh – Lo Gach canal from 2/9 canal to Long Khot canal under scenarios as no SLR, SLR20cm, and SLR50cm

### 4.3 Calculation results about flooding time

The results of the flooded/inundated time showed that flood inundation time with sea level rise increased longer than without sea level rise, particular inundation time at the end of Hong

Ngu river is increase of 3 days and at Kien Binh station is increase of 7days with sea level rise 50cm scenario compared without sea level rise for drainage time in Dong Thap Muoi region as shown in figures 4.7 - 4.8 below.

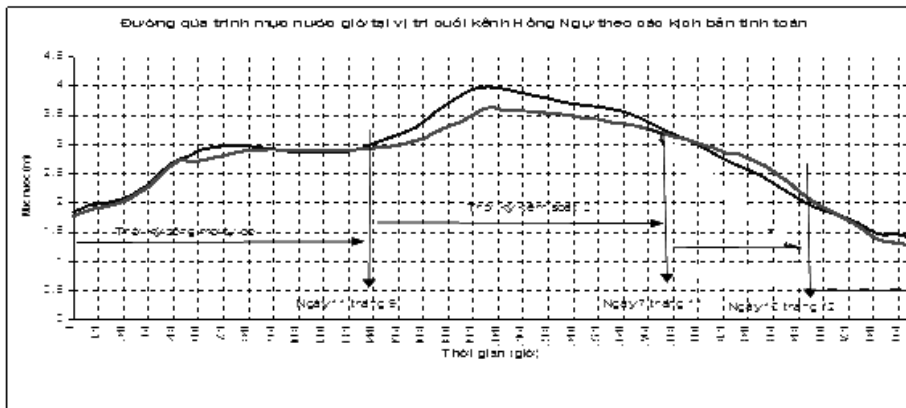


Figure 4.7. Hourly water level at the end of Hong Ngu canal under SLR 20cm scenario

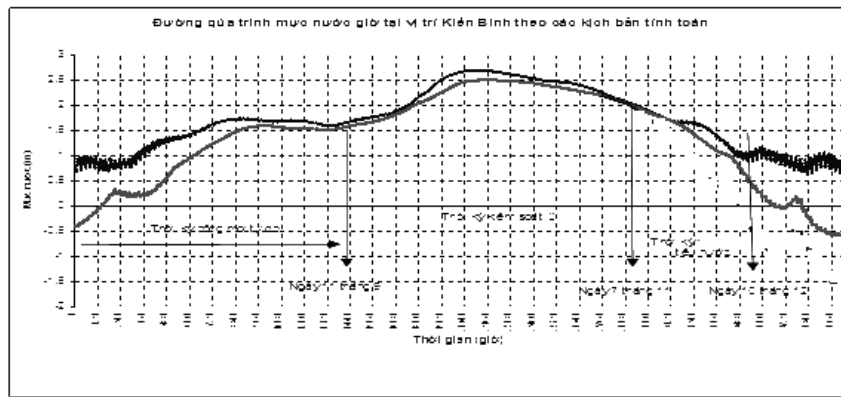


Figure 4.8. Hourly water level at the end of Kien Binh location under SLR 50cm scenario

## V. CONCLUSIONS

In the context of challenges from the upstream, from the sea level rise, The results of this study showed that under compared to scenarios as DTM02 and DTM03 with DTM01: the max water level increase in the beginning of rivers as Tien river, Hong Ngu river and Tan Thanh-LoGach river, water level gradually increase in upstream and significantly increase in downstream, in particularly as (i) under of sea level rise of 20cm scenario is increase of 14cm at My Thuan (near sea), and 5cm at Hong Ngu (upstream near Tan Chau station). The flood water levels on the Tan Thanh-Lo Gach river is 2cm while flood water levels at field locations in Dong Thap Muoi region is increase 3cm at Hung Thanh, 9cm at Kien Binh. (ii) Under sea level rise of 50cm scenario is increase of 38cm

at My Thuan (near sea), and 10cm at Hong Ngu (upstream near Tan Chau station). The flood water levels on the Tan Thanh-Lo Gach river through is 10cm while flood water levels at field locations in Dong Thap Muoi region is increase 10cm at Hung Thanh, 15cm at Kien Binh. (iii) In inundation time as with DTM02 and DTM03 scenarios, the flooded/inundated time longer than the scenario DB01 from 3 to 7 days at Hong Ngu and Kien Binh locations respectively if the sluices are operated in the same time for water flood drainage. The results of study could be useful to provide information of water level floods change and inundation time to proposal of flood control solutions in order to mitigate the flood damage and to exploit the flood benefits as well as satisfy immediate and long-term requirements in flood management in region.

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#### **Tóm tắt:**

### **TÁC ĐỘNG CỦA NƯỚC BIỂN DÂNG ĐẾN MỰC NƯỚC LŨ TRONG VÙNG ĐỒNG THÁP MƯỜI, ĐỒNG BẰNG SÔNG CỬU LONG**

Vùng Đồng Tháp Mười là một phần trũng thấp của đồng bằng Cửu Long, nơi đây lũ lụt xảy ra hàng năm trong mùa mưa lũ, tác động của lũ đã gây ra tình trạng ngập lụt trên diện tích lớn trong khu vực. Hơn nữa, trong bối cảnh tác động của mực nước biển dâng dẫn đến mực nước lũ và thời gian ngập lụt cũng ngày càng tăng thêm, việc tiêu thoát nước lũ đảm cũng ngày càng khó khăn. Những tác động này đã ảnh hưởng đến việc quản lý tài nguyên nước, môi trường, hệ sinh thái, và các hoạt động kinh tế xã hội trong vùng, và đặc biệt là ảnh hưởng đã tác động trực tiếp đến sản xuất nông nghiệp của người dân nơi đây. Do đó, mục đích chính của nghiên cứu là đánh giá biến đổi mực nước lũ và thời gian ngập lụt dưới tác động của mực nước biển dâng ứng với các kịch bản 20cm và 50cm. Kết quả của nghiên cứu đã cung cấp và dự báo biến đổi mực nước lũ và thời gian ngập lụt trong bối cảnh nước biển dâng, để từ đó giúp các nhà quản lý đưa ra giải pháp kiểm soát lũ nhằm giảm thiểu thiệt hại do lũ lụt gây ra, đồng thời để khai thác các lợi ích của lũ cũng như đáp ứng yêu cầu trong quản lý và kiểm soát lũ hiện tại và lâu dài trong tương lai cho vùng Đồng Tháp Mười.

**Các từ khóa:** Ngập lũ, nước biển dâng, triều, kịch bản, vùng Đồng Tháp Mười.

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