NINH BINH PROVINCIAL PEOPLE'S COMMITTEE
NINH BINH PROVINCE'S DEPARTMENT OF
AGRICULTURE AND RURAL DEVELOPMENT

CONSTRUCTION OF KIM DAI LOCK COMPLEX FOR SALTWATER PREVENTION, FRESHWATER RETAINING AND RESPONSE TO CLIMATE CHANGE AND SEA LEVEL RISE FOR 6 DISTRICTS/CITIES OF SOUTHERN NINH BINH AREA, NINH BINH PROVINCE

FEASIBILITY STUDY REPORT

CONTENTS

I PROJECT INTRODUCTION

PROJECT NAME: Construction of Kim Dai Lock Complex for Saltwater Prevention, Freshwater Retaining and Response to Climate Change and Sea Level Rise for 6 districts/cities of Southern Ninh Binh Area, Ninh Binh Province

DONOR: Agence Française de Développement (AFD)

EXECUTIVE AGENCY: Ninh Binh PPC

CLIENT: Ninh Binh Province's DOARD

CONSTRUCTION LOCATION: At Kim Dai Estuary of Kim Son District

IMPLEMENTATION PERIOD: From 2015 to 2018

II PROJECT OBJECTIVES

Project's general objectives

- Contributing to response to climate change and sea level rise, flood tide, flood and drought which has been becoming increasingly serious in Vietnam and particularly, in the project area which consists of 6 districts/towns of Ninh Binh Province.
- Helping ensure the province's steady economic development, especially agricultural development.
- Helping enhance management capacity of the local goverental agencies.
- Helping ensure life, property, asset and crop safety for the project area's affected people.
- Helping improve environmental sanitation, reduce risks of flood, drought-caused diseases, improve health and living conditions for the residents.

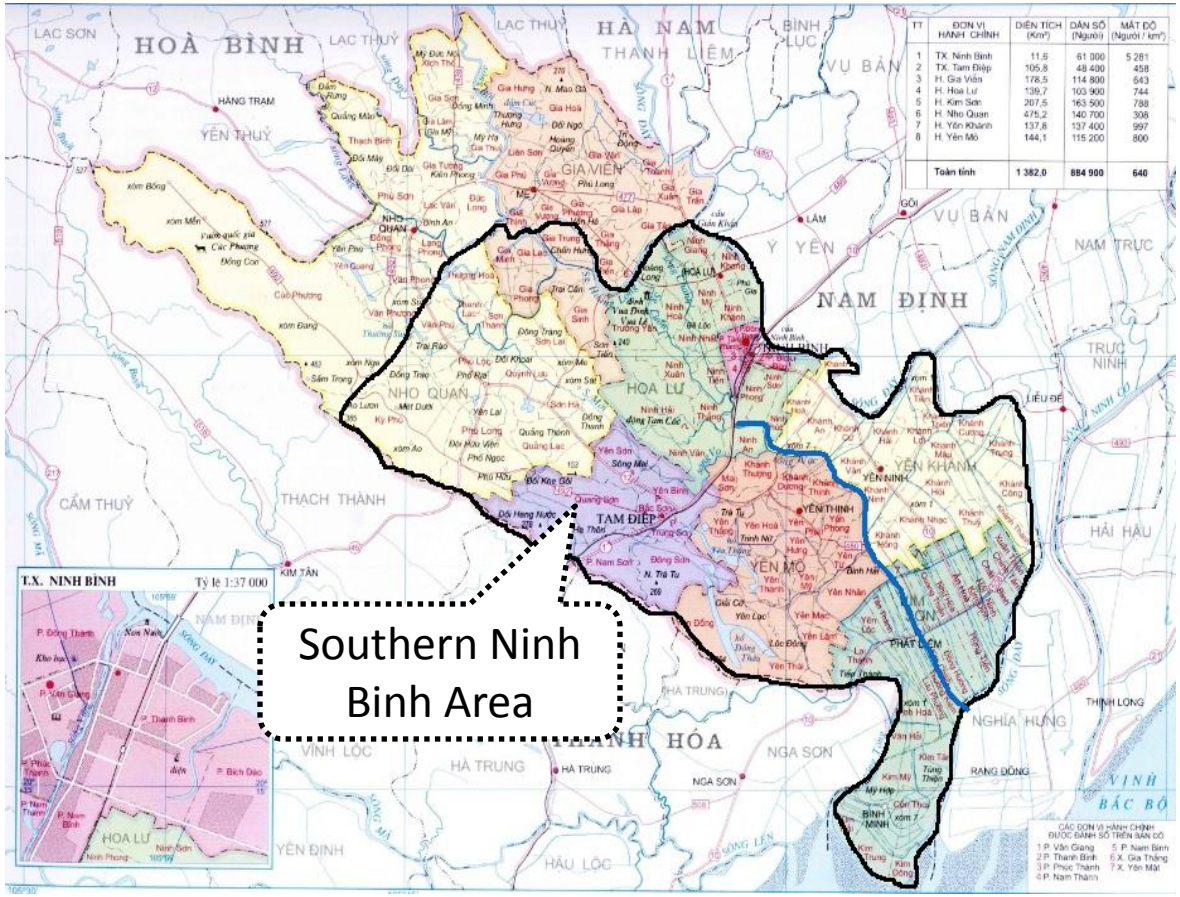
II PROJECT OBJECTIVES

- **Project's specific objectives**
- Helping prevent saltwater from deeply intruding into Vac River and other saltwater intrusion activities.
- Helping store freshwater for agricultural production, aquacultural production and domestic water supply.
- Helping improve and regulate water supply for the Southern Ninh Binh area in order to ensure safety for agricultural/aquacultural production and improve the living conditions of more than 200,000 HHs (nearly 830,000 residents), especially sanitation conditions.
- Helping prevent flood water coming reversely from Day River to Vac River and prevent tidal rise, helping reduce flood risks.
- Helping improve operational efficiency of the existing lock complexes of the province (Van Lock, Xanh Lock, Cau Hoi Lock).
- Facilitating development of waterways transport.
- Helping raise awareness of the residents about climate change and combined water resources management demands.

III PROJECT SCOPE

The project is implemented in Sothern Ninh Binh area:

- 6 districts/cities: Hoa Lu, Yen Mo, Yen Khanh, Kim Son districts, Ninh Binh and Tam Diep cities and 10 communes of Nho Quan District and 4 communes of Gia Vien District
- Total natural area: 98,593ha
- Population: 775,433 people
- Cultivation area: about 41,059ha.

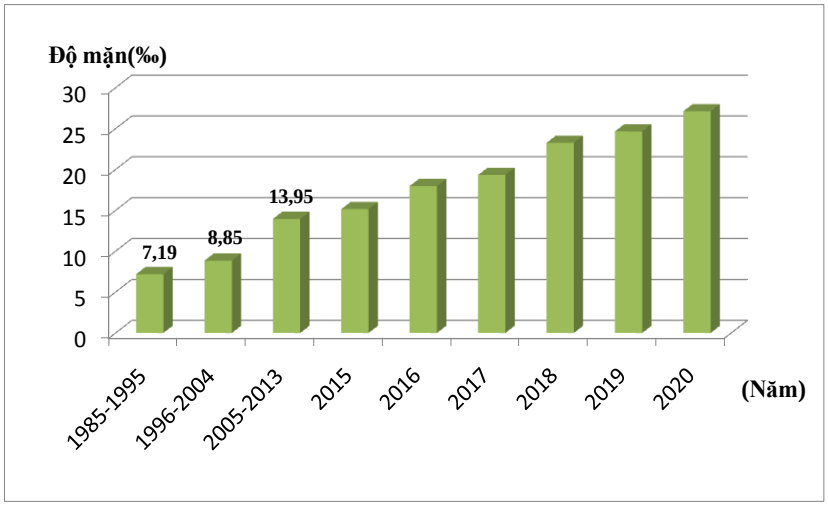


Project scope

IV CURRENT CONDITIONS AND INVESTMENT NECESSITY

I. SALTWATER INTRUSION REALITY

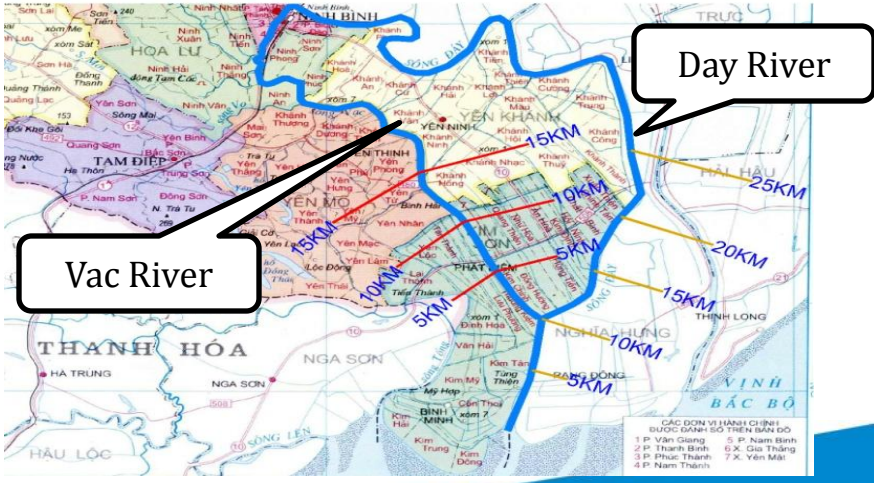
- The entire left-, right-of-Vac River areas are in shortage of irrigation water because of high salinity.
- Saltwater intrusion is about 20 ÷ 25km deep on Day River and about 10 ÷ 15km on Vac River.
- Average salinity of 2013 – 2014 winter-spring crop is 10 - 15‰, possibly 24‰ at some locations, making rice productivity decrease by 20%.
- Current total area under saltwater intrusion of Yen Khanh District is 2,410ha, Kim Son District – 6,458ha, Yen Mo District – 2,459ha.



Variation of average salinity at Vac River

Measuring salinity in the river Table Vac

#	Measurement time	Salinity (‰)	
		Co Quang Culvert – Vac River	Tien Hoang Culvert – Day River
1	Jan – 2000	2	2,5
2	Jan –2001	2,5	2
3	Jan – 2002	2	2
4	Jan – 2003	3	2,5
5	Jan – 2004	4	3
6	Jan – 2005	8	9

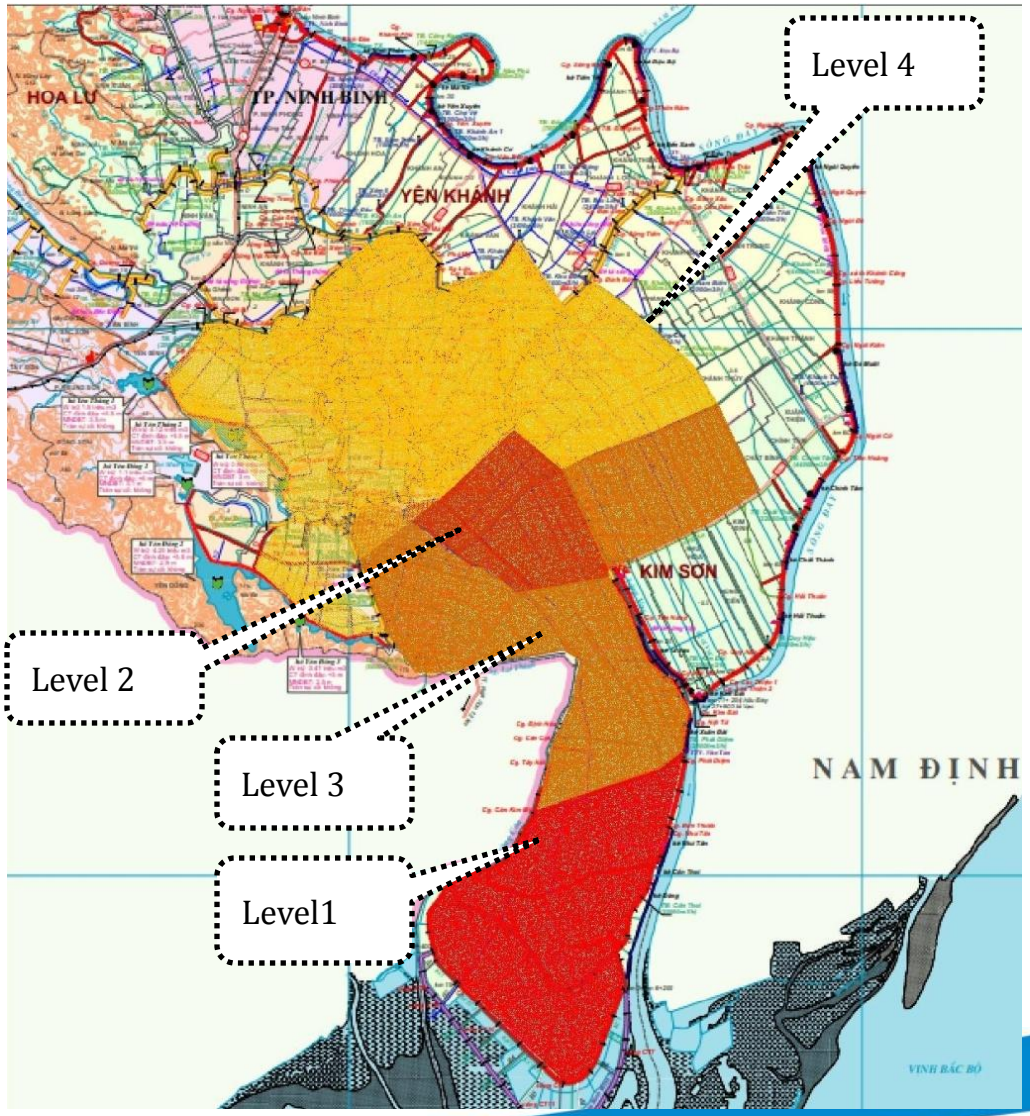


Current saltwater intrusion area

IV CURRENT CONDITIONS AND INVESTMENT NECESSITY

Standard salinity of salt-dissolved solution types			
Freshwater	Brackish water	Saltwater	Brine
< 1 (‰)	1 – 10 (‰)	>10 (‰)	> 50 (‰)

- Level 1: Salinity is 5(‰) - 10(‰), just possible for aquaculture, impossible for cultivation
- Level 2: Salinity is 2(‰) - 5(‰), possible for cultivation, yet of much lower productivity
- Level 3: Salinity is 1(‰) - 2(‰), having great impacts in winter – spring crop time
- Level 4: Salinity is 0.5(‰)- 1(‰), affecting the supply of clean water for human and cattle

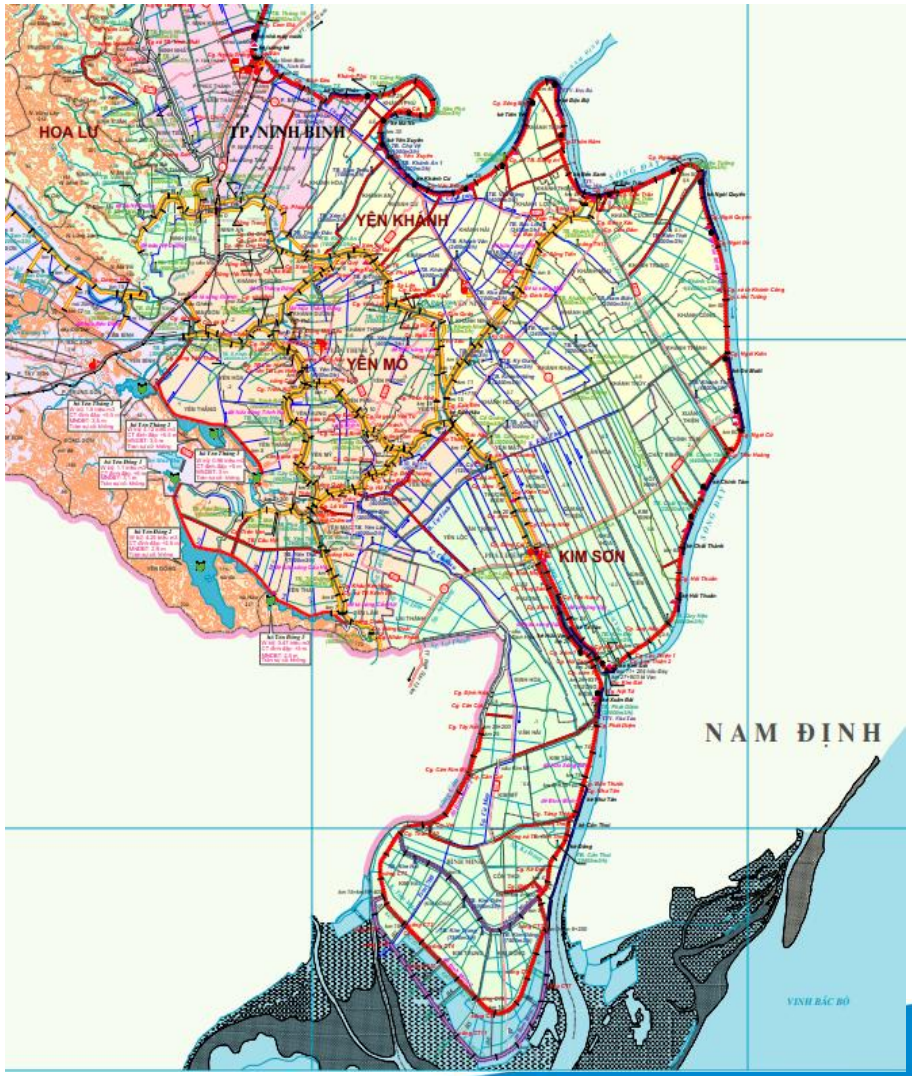


Current saltwater intrusion levels

IV CURRENT CONDITIONS AND INVESTMENT NECESSITY

II. CURRENT WATER SUPPLY CONDITIONS

- The area has totally 9,849ha of un-irrigated cultivation land, 6,001ha of perennial crops in Tam Diep Town currently in shortage of irrigation water;
- The entire area has been under gravity irrigation, taking advantage of tidal rise to bring water to irrigation area; Because of decreased water amount in dry season and field walls of elevation above +0.9m, water-taking is almost impossible;
- The coastal areas currently do not have irrigation water and must use 15 pumps of 1,000m3/h for freshwater supply;
- 60% of the HHs are affected by shortage of domestic freshwater.



The project area's current irrigation/drainage system

IV EXISTING CONDITIONS AND PROJECT NECESSITY

No.	Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Year
1	Tam Diep City	0.69	17.05	5.26	9.53	7.69	11.61	5.48	3.37	2.58	2.36	2.17	2.92	70.70
2	Gia Vien District	0.22	5.42	1.67	3.03	2.45	3.69	1.74	1.07	0.82	0.75	0.69	0.93	22.50
3	Hoa Lu District	0.67	16.42	5.07	9.18	7.41	11.19	5.28	3.24	2.48	2.27	2.09	2.81	68.11
4	Kim Son District	1.05	43.34	23.28	33.12	35.42	36.30	14.45	10.83	15.37	4.00	6.61	6.35	230.13
5	Nho Quan District	0.66	16.28	5.02	9.10	7.35	11.09	5.23	3.21	2.46	2.25	2.07	2.78	67.51
6	Yen Khanh District	0.68	28.03	15.06	21.41	22.91	23.47	9.35	7.00	9.94	2.59	4.28	4.10	148.81
7	Ninh Binh City	0.44	10.85	3.35	6.07	4.90	7.39	3.49	2.14	1.64	1.50	1.38	1.86	45.01
8	Yen Mo District	0.94	23.04	7.11	12.88	10.40	15.69	7.40	4.55	3.48	3.19	2.94	3.94	95.56
9	Total	5.36	160.44	65.82	104.31	98.52	120.43	52.42	35.42	38.77	18.91	22.24	25.68	748.32

No.	Tên	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Year
1	Tam Diep City	1.22	19.96	6.94	11.72	9.58	13.97	6.47	4.06	3.17	3.71	4.11	5.25	90.16
2	Gia Vien District	0.39	6.35	2.21	3.73	3.05	4.45	2.06	1.29	1.01	1.18	1.31	1.67	28.69
3	Hoa Lu District	1.18	19.23	6.69	11.29	9.23	13.46	6.23	3.91	3.05	3.57	3.96	5.06	86.87
4	Kim Son District	3.97	54.05	32.00	50.45	52.46	48.94	19.21	15.15	20.25	10.12	13.68	13.19	333.46
5	Nho Quan District	1.17	19.06	6.63	11.19	9.15	13.34	6.18	3.88	3.02	3.54	3.93	5.01	86.09
6	Yen Khanh District	2.56	34.95	20.69	32.62	33.92	31.64	12.42	9.79	13.10	6.55	8.85	8.53	215.63
7	Ninh Binh City	0.78	12.71	4.42	7.46	6.10	8.90	4.12	2.58	2.02	2.36	2.62	3.34	57.40
8	Yen Mo District	1.65	26.98	9.38	15.84	12.95	18.89	8.74	5.49	4.28	5.01	5.56	7.10	121.87
9	Total	12.92	193.31	88.95	144.28	136.45	153.59	65.42	46.15	49.89	36.04	44.01	49.16	1020.17

IV EXISTING CONDITIONS AND PROJECT NECESSITY

Qcoming and Qrequired values "before the project" of Southern Ninh Binh area

No.	Name		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Year
1	Tam Diep City	Qcoming	0.35	8.52	2.63	4.76	3.85	5.81	2.74	1.68	1.29	1.18	1.09	1.46	35.35
		Qrequired	0.69	17.05	5.26	9.53	7.69	11.61	5.48	3.37	2.58	2.36	2.17	2.92	70.70
		Difference	-0.35	-8.52	-2.63	-4.76	-3.85	-5.81	-2.74	-1.68	-1.29	-1.18	-1.09	-1.46	-35.35
2	Gia Vien District	Qcoming	0.13	3.69	1.14	2.06	1.66	2.51	1.19	0.73	0.56	0.51	0.47	0.63	15.30
		Qrequired	0.22	5.42	1.67	3.03	2.45	3.69	1.74	1.07	0.82	0.75	0.69	0.93	22.50
		Difference	-0.09	-1.74	-0.54	-0.97	-0.78	-1.18	-0.56	-0.34	-0.26	-0.24	-0.22	-0.30	-7.22
3	Hoa Lu District	Qcoming	0.43	10.51	3.24	5.87	4.74	7.16	3.38	2.08	1.59	1.45	1.34	1.80	43.59
		Qrequired	0.67	16.42	5.07	9.18	7.41	11.19	5.28	3.24	2.48	2.27	2.09	2.81	68.11
		Difference	-0.24	-5.91	-1.82	-3.30	-2.67	-4.03	-1.90	-1.17	-0.89	-0.82	-0.75	-1.01	-24.52
4	Kim Son District	Qcoming	0.63	26.01	13.97	19.87	21.25	21.78	8.67	6.50	9.22	2.40	3.97	3.81	138.08
		Qrequired	1.05	43.34	23.28	33.12	35.42	36.30	14.45	10.83	15.37	4.00	6.61	6.35	230.13
		Difference	-0.42	-17.34	-9.31	-13.25	-14.17	-14.52	-5.78	-4.33	-6.15	-1.60	-2.65	-2.54	-92.05
5	Nho Quan District	Qcoming	0.43	10.58	3.26	5.91	4.77	7.21	3.40	2.09	1.60	1.46	1.35	1.81	43.88
		Qrequired	0.66	16.28	5.02	9.10	7.35	11.09	5.23	3.21	2.46	2.25	2.07	2.78	67.51
		Difference	-0.23	-5.70	-1.76	-3.18	-2.57	-3.88	-1.83	-1.13	-0.86	-0.79	-0.73	-0.97	-23.63
6	Yen Khanh District	Qcoming	0.41	16.82	9.03	12.85	13.74	14.08	5.61	4.20	5.96	1.55	2.57	2.46	89.29
		Qrequired	0.68	28.03	15.06	21.41	22.91	23.47	9.35	7.00	9.94	2.59	4.28	4.10	148.81
		Difference	-0.27	-11.21	-6.02	-8.57	-9.16	-9.39	-3.74	-2.80	-3.98	-1.04	-1.71	-1.64	-59.52
7	Ninh Binh City	Qcoming	0.33	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
		Qrequired	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
		Difference	-0.11	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.84
8	Yen Mo District	Qcoming	0.52	12.67	3.91	7.08	5.72	8.63	4.07	2.50	1.92	1.75	1.61	2.17	52.56
		Qrequired	0.94	23.04	7.11	12.88	10.40	15.69	7.40	4.55	3.48	3.19	2.94	3.94	95.56
		Difference	-0.42	-10.37	-3.20	-5.80	-4.68	-7.06	-3.33	-2.05	-1.57	-1.43	-1.32	-1.77	-43.00
9	Total	Qcoming	3.23	89.18	37.57	58.79	56.12	67.55	29.43	20.15	22.51	10.69	12.77	14.51	418.42
		Qrequired	5.36	150.03	62.91	98.69	94.07	113.48	49.38	33.72	37.57	17.85	21.30	24.27	703.76
		Difference	-2.02	-60.79	-25.28	-39.83	-37.88	-45.86	-19.88	-13.50	-15.00	-7.10	-8.46	-9.69	-286.13

→ **This statistical table shows that the coming flows of the project area are currently much lower than required ones..**

IV EXISTING CONDITIONS AND PROJECT NECESSITY

Water balancing calculation

- According to calculation results of "Red River – Thai Binh's Water Sources Combined Utilization Planning" Project, total water demand in 6 months of dry season by 2020 of the entire Red River's downstream area is about 18.95 – 21.72 billion m^3.
- Total water amount by the time there's participation of reservoirs by 2010 is about 23.73 - 24.73 billion m^3, by 2020 is about 32.32 – 33.51 billion m^3.
- So, it is possible to ensure sufficient water source for the entire Red River Delta in the future. - Calculation results also show that if we only take into account water amount of Hoang Long's and Day rivers' basins, then the study area is always in shortage of water.
- However, the study area is supplemented with water from Red River via Dao River. Moreover, tidal rise causes water level rise on Day and Hoang Long rivers. So supply water is always sufficient.

Dry season's average flow rates on Day River observed at some locations of the project area:

+ Gian Khau:	Up/down flow rate: 100m^3/s.	
+ Ninh Binh:	Down flow rate:	Q_{max} = 140 ÷ 150 m^3/s
	Up flow rate:	Q_{max} = 220 ÷ 240 m^3/s
+ Doc Bo:	Down flow rate:	Q_{max} = 600 ÷ 650 m^3/s
	Up flow rate:	Q_{max} = 550 ÷ 600 m^3/s

→ **Water of the main rivers shall always well meet Southern Ninh Binh area's demands. Therefore, Kim Dai Lock Complex shall help free Southern Ninh Binh area from shortage of domestic and production water.**

IV EXISTING CONDITIONS AND PROJECT NECESSITY

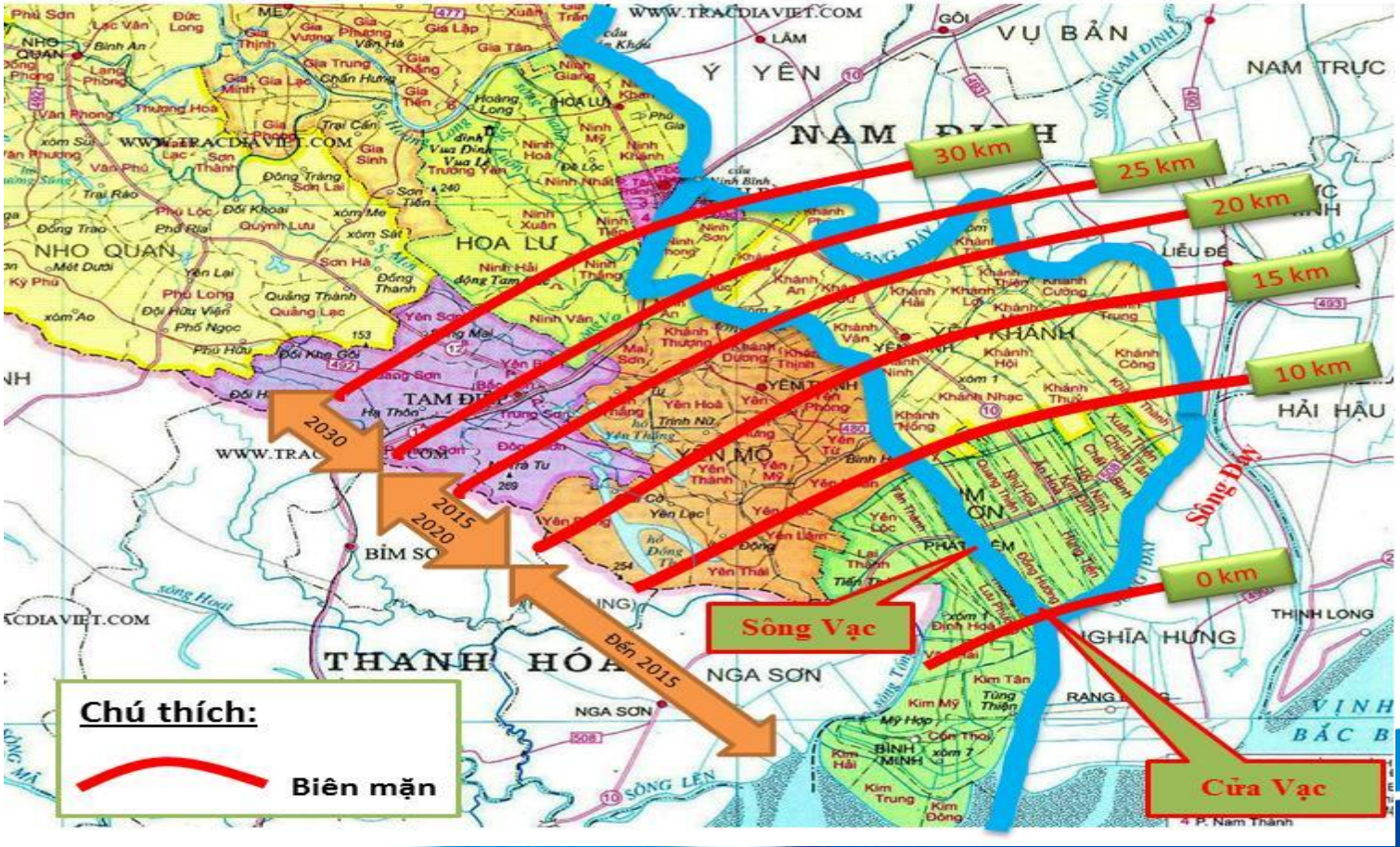
Qcoming and Qrequired values "when there's the project" of Southern Ninh Binh area

No.	Name		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Year
1	Tam Diep City	Qcoming	0.66	16.20	5.00	9.05	7.31	11.03	5.20	3.20	2.45	2.24	2.06	2.77	67.16
		Qrequired	0.69	17.05	5.26	9.53	7.69	11.61	5.48	3.37	2.58	2.36	2.17	2.92	70.70
		Difference	-0.03	-0.85	-0.26	-0.48	-0.38	-0.58	-0.27	-0.17	-0.13	-0.12	-0.11	-0.15	-3.53
2	Gia Vien District	Qcoming	0.22	5.32	1.64	2.97	2.40	3.62	1.71	1.05	0.80	0.74	0.68	0.91	22.05
		Qrequired	0.22	5.42	1.67	3.03	2.45	3.69	1.74	1.07	0.82	0.75	0.69	0.93	22.50
		Difference	0.00	-0.11	-0.03	-0.06	-0.05	-0.07	-0.03	-0.02	-0.02	-0.02	-0.01	-0.02	-0.45
3	Hoa Lu District	Qcoming	0.66	16.26	5.02	9.09	7.34	11.07	5.22	3.21	2.46	2.25	2.07	2.78	67.43
		Qrequired	0.67	16.42	5.07	9.18	7.41	11.19	5.28	3.24	2.48	2.27	2.09	2.81	68.11
		Difference	-0.01	-0.16	-0.05	-0.09	-0.07	-0.11	-0.05	-0.03	-0.02	-0.02	-0.02	-0.03	-0.68
4	Kim Son District	Qcoming	1.02	42.04	22.59	32.12	34.36	35.21	14.02	10.50	14.91	3.88	6.42	6.16	223.23
		Qrequired	1.05	43.34	23.28	33.12	35.42	36.30	14.45	10.83	15.37	4.00	6.61	6.35	230.13
		Difference	-0.03	-1.30	-0.70	-0.99	-1.06	-1.09	-0.43	-0.32	-0.46	-0.12	-0.20	-0.19	-6.90
5	Nho Quan District	Qcoming	0.65	15.95	4.92	8.92	7.20	10.86	5.13	3.15	2.41	2.21	2.03	2.73	66.16
		Qrequired	0.66	16.28	5.02	9.10	7.35	11.09	5.23	3.21	2.46	2.25	2.07	2.78	67.51
		Difference	-0.01	-0.33	-0.10	-0.18	-0.15	-0.22	-0.10	-0.06	-0.05	-0.05	-0.04	-0.06	-1.35
6	Yen Khanh District	Qcoming	0.67	27.47	14.75	20.99	22.45	23.00	9.16	6.86	9.74	2.54	4.19	4.02	145.83
		Qrequired	0.68	28.03	15.06	21.41	22.91	23.47	9.35	7.00	9.94	2.59	4.28	4.10	148.81
		Difference	-0.01	-0.56	-0.30	-0.43	-0.46	-0.47	-0.19	-0.14	-0.20	-0.05	-0.09	-0.08	-2.98
7	Ninh Binh City	Qcoming	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
		Qrequired	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
		Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Yen Mo District	Qcoming	0.92	22.58	6.97	12.62	10.19	15.38	7.26	4.46	3.41	3.12	2.88	3.86	93.65
		Qrequired	0.94	23.04	7.11	12.88	10.40	15.69	7.40	4.55	3.48	3.19	2.94	3.94	95.56
		Difference	-0.02	-0.46	-0.14	-0.26	-0.21	-0.31	-0.15	-0.09	-0.07	-0.06	-0.06	-0.08	-1.91
9	Total	Qcoming	5.24	146.26	61.32	96.20	91.68	110.62	48.14	32.88	36.62	17.41	20.77	23.67	685.95
		Qrequired	5.36	150.03	62.91	98.69	94.07	113.48	49.38	33.72	37.57	17.85	21.30	24.27	703.76
		Difference	-0.12	-3.77	-1.59	-2.49	-2.38	-2.86	-1.23	-0.84	-0.95	-0.44	-0.53	-0.60	-17.81

III. PROJECT's NECESSITY

1. The project area's climate change scenario

- According to the climate change scenario, saltwater shall have intruded 25 – 30km deep into Vac River by 2030 and caused serious impacts



IV CURRENT CONDITIONS AND INVESTMENT NECESSITY

- Temperature-wise climate change scenario

Nho Quan Station temperature rise under B2 scenario

Currently, Nam Ninh Binh area are also affected by the process of global warming, the average temperature rise over previous year about 1 0 C under climate change scenarios, the temperature of the project area changes after

Scenario		2020	2030	2040	2050	2060	2070	2080	2090	2100
B2	XII-II	0.5	0.7	1.0	1.3	1.6	1.8	2.1	2.3	2.5
	III-V	0.5	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.7
	VI-VIII	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.8	2.0
	IX-XI	0.5	0.7	0.9	1.2	1.5	1.7	2.0	2.2	2.3
	Year	0.5	0.7	1.0	1.2	1.5	1.8	2.0	2.2	2.4

Ninh Binh Station temperature rise under B2 scenario

Scenario		2020	2030	2040	2050	2060	2070	2080	2090	2100
B2	XII-II	0.5	0.8	1.1	1.4	1.7	1.9	2.2	2.4	2.6
	III-V	0.6	0.8	1.2	1.5	1.8	2.1	2.4	2.6	2.9
	VI-VIII	0.5	0.7	1.0	1.3	1.6	1.9	2.1	2.3	2.5
	IX-XI	0.5	0.8	1.1	1.4	1.8	2.0	2.3	2.5	2.8
	Year	0.5	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.7

Analysis of climate change scenarios for the project area shows that:

-→ If there's no counter-measures, the project area shall be under serious impacts of climate change

IV EXISTING CONDITIONS AND PROJECT NECESSITY

- Rainfall-wise climate change scenario

Ninh Binh has high annual rainfall (1750 ÷ 1850 mm), mostly for July, August and September. There are also heavy rainfalls occurring during these months.

Ninh Binh's flooding issues are also caused by the main rivers flowing through the area (Day, Hoang Long, Tong, sea storms and tide regime).

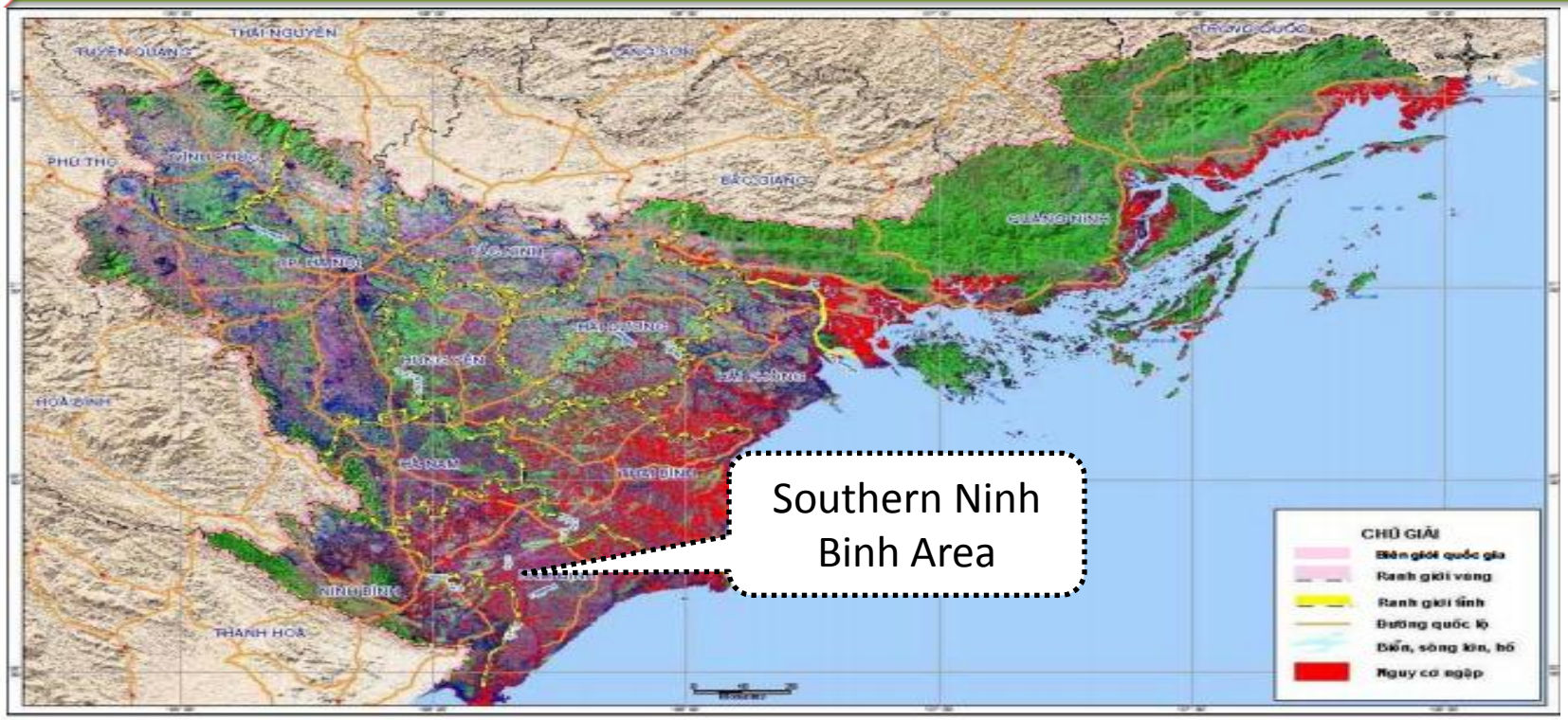
The increasingly complicated weather conditions, with dramatically rainfall decrease in dry season and increase in wet season, have been causing difficulties for irrigation/drainage work.

For development of the project, we base on the climate change scenario with rainfalls suggested by MONRE in 2012 as follows:

Time mark	Period(%)		
of 21st century	Dry season	Wet season	Year
2020	-0.20	1.40	1.10
2030	-0.30	2.00	1.70
2040	-0.40	2.90	2.40
2050	-0.60	3.70	3.00
2060	-0.70	4.50	3.70
2070	-0.80	5.30	4.30
2080	-0.90	5.90	4.90
2090	-1.00	6.50	5.40
2100	-1.10	7.10	5.80

--> The climate change scenario shows that the average rainfall increases by 5.8%, yet are remarkably different between dry season and wet season, causing serious impacts on agricultural production.

IV CURRENT CONDITIONS AND INVESTMENT NECESSITY



Hình 4.2. Bản đồ nguy cơ ngập khu vực đồng bằng sông Hồng và Quảng Ninh ứng với mực nước biển dâng 1m

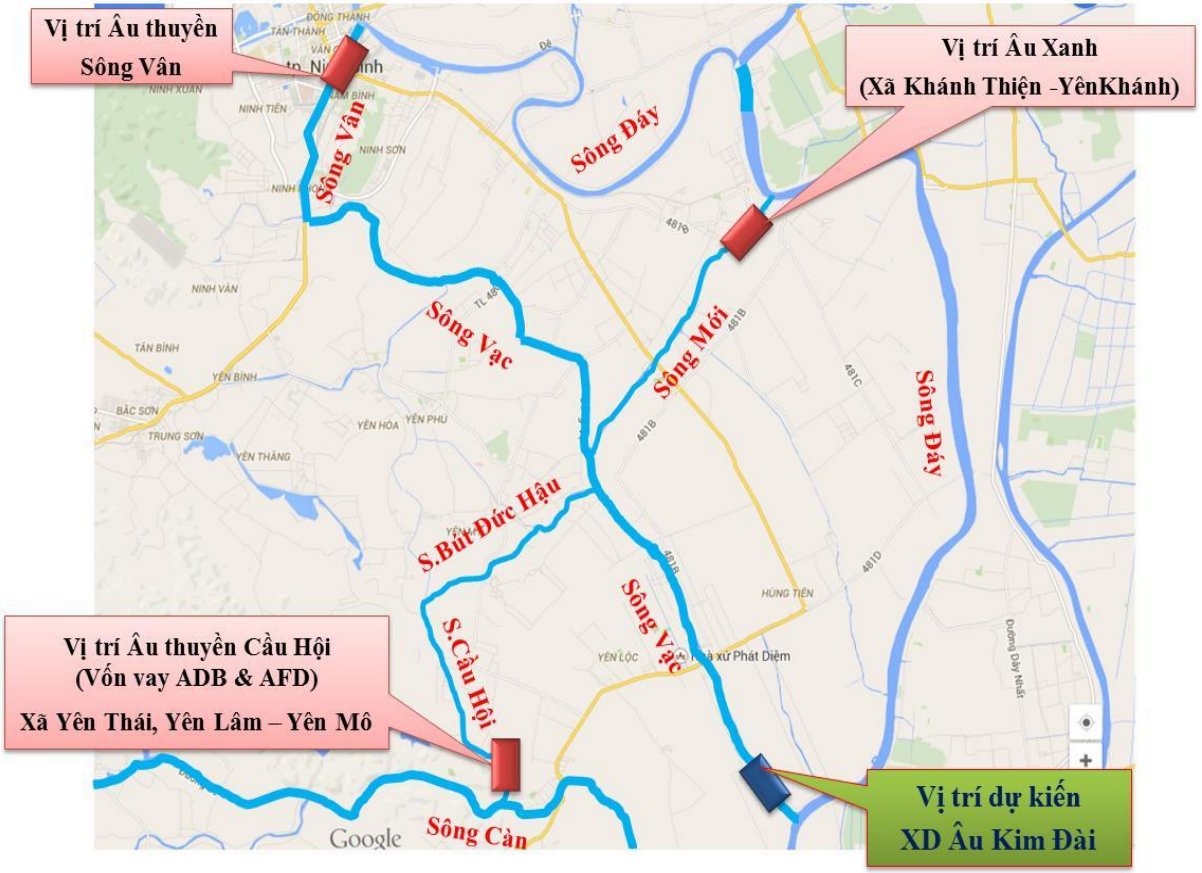
Scenario	Time marks of 21st century								
	2020	2030	2040	2050	2060	2070	2080	2090	2100
B2	8-9	12-13	17-19	23-25	30-33	37-42	45-51	52-61	60-71

-> Via scenario sea level rise by the end of 21st century sea level rise 60-71cm while large parts of Kim Son will be submerged in water.

IV CURRENT CONDITIONS AND INVESTMENT NECESSITY

2. Project's necessity

- Relationship of locks:
  - Xanh Lock, Cau Hoi Lock and Van Lock prevent flood water from outside rivers
  - Taking freshwater from Day and Can rivers to supply Southern Ninh Binh area
  - Serving waterway transport



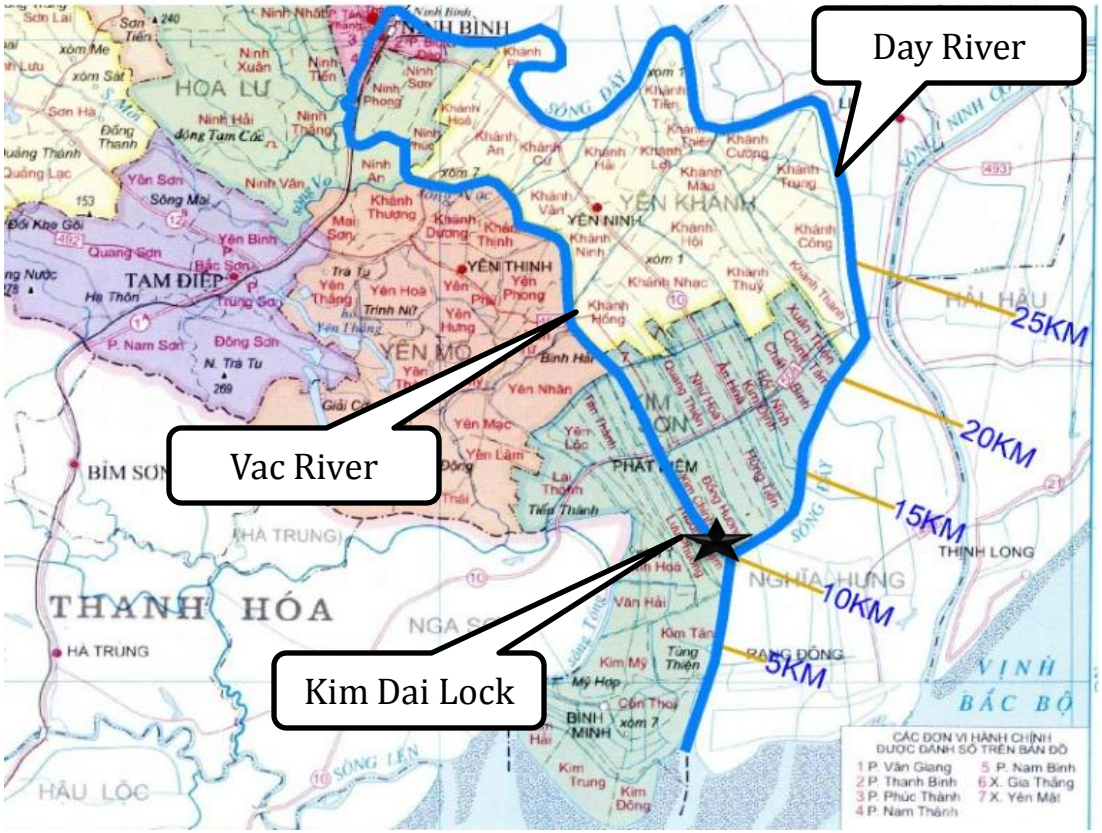
- However, the water amount taken from outside rivers can only partly supply the irrigation/drainage system of the area. The rest amount flows through Vac River and Day River to enter the sea

→ Therefore, construction of Kim Dai Lock Complex is of top priority for retaining of irrigation freshwater

IV CURRENT CONDITIONS AND INVESTMENT NECESSITY

2. Project necessity

- Saving 11,727ha of area under saltwater intrusion of Yen Mo, Yen Khanh, Kim Son districts.
- Increasing total area supplied with freshwater of Southern Ninh Binh area from 41,059ha to 47,060ha
- Combining with Van, Cau Hoi and Xanh locks to form a completed water supply system for Southern Ninh Binh area (retaining freshwater of the field river system)
- Preventing normal flood water from Day River into Vac River



Saltwater intrusion area after the project finihses

V CONSISTENCY WITH PLANNING OF PROJECT

National planning

- Kim Dai lock project is consistent with irrigation planning and climate change resilience program of the Government:
- Climate change resilience program (Document No. 1443/TTg-QHQT dated on 19/09/2012 of the Prime Minister): construction of Kim Dai lock in Ninh Binh province is located on project list approved by the Prime Minister.

Regional planning

- Irrigation planning in Red River Delta in period 2012-2020 (according to Decision No.1554/QĐ-TTg dated on 17/10/2012 of the Prime Minister): includes 11 provinces in Red River Delta in which Ninh Binh province with area is expected to 2.1 million hectare, population: 19.8 million people

V CONSISTENCY WITH PLANNING OF PROJECT

Ninh Binh provincial planning

- Master plan for agricultural development in Ninh Binh to 2020 (according to Decision No. 459/QĐ-UBND Ninh Binh province on 25/06/2012).
- In master plan for agricultutral development of Ninh Binh province to 2020, one of solutions on irrigation for agricultural industry is to promote progress of Kim Dai lock to be able to meet production requirements and living standards and socio-economic development of the local.
- -Detailed planning for flood prevention and dykes on river line with interior dyke – Ninh Binh province (11/2009).
- - Water resource planning – Ninh Binh province (QĐ 1145/UBND of Ninh Binh province dated on 31/12/2014).

VI PROJECT DESCRIPTION

COMPONENT 1:

KIM DAI HEADWORK CONSTRUCTION

I.1 KIM DAI LOCK COMPLEX CONSTRUCTION LOCATION SELECTION
I.2 HYDRAULIC MODELING
I.3 TECHNICAL SOLUTIONS
I.4 CONSTRUCTION TECHNOLOGY SELECTION
I.5 MAIN EQUIPMENT

COMPONENT 2:

TECHNICAL ASSISTANCE AND CAPACITY CONSULTANCY

I. 1 KIM DAI LOCK COMPLEX CONSTRUCTION LOCATION SELECTION

Location Kim Dai lock should ensure the following criteria:
Criteria 1: Advantages clearance
Criteria 2: Consistent with regional planning
Criteria 3: saltwater prevention
Criteria 4: Prevent flooding from the river Day and infield flooding
Criteria 5: Freshwater retaining
Table selection criteria are satisfied O, X is not satisfied

Slated construction location

criteria	Location 1	Location 2
Criteria 1	X	O
Criteria 2	X	O
Criteria 3	X	X
Criteria 4	X	X
Criteria 5	X	O

Location No. 1 is optimal and very compliant with planning

I. 2 HYDRAULIC MODELING

1. INPUT DATA

To build Europe Jintai, building hydraulic models calculate precipitation, flood flow, tides, water level masterpiece for the project area is essential. To calculate they must rely on the input parameters are as follows:

Existing hydraulic condition data for calculation

No.	Input data
1	10% flood water level of Kim Dai on Day River side
2	5% flood water level of Kim Dai on Day River side
3	1% flood water level of Kim Dai on Day River side
4	Lowest daily-average water level respective to frequency P=85%
5	Lowest annual-average water level respective to frequency P=95%

Work specs for calculation

Work	Calculated work dimensions
Kim Dai Culvert	8 mx 6m (-4,3 range)
Kim Dai Lock	14m (-4,3 range)
Freshwater retaining ranges	-1.5m, -1m, -0.5m

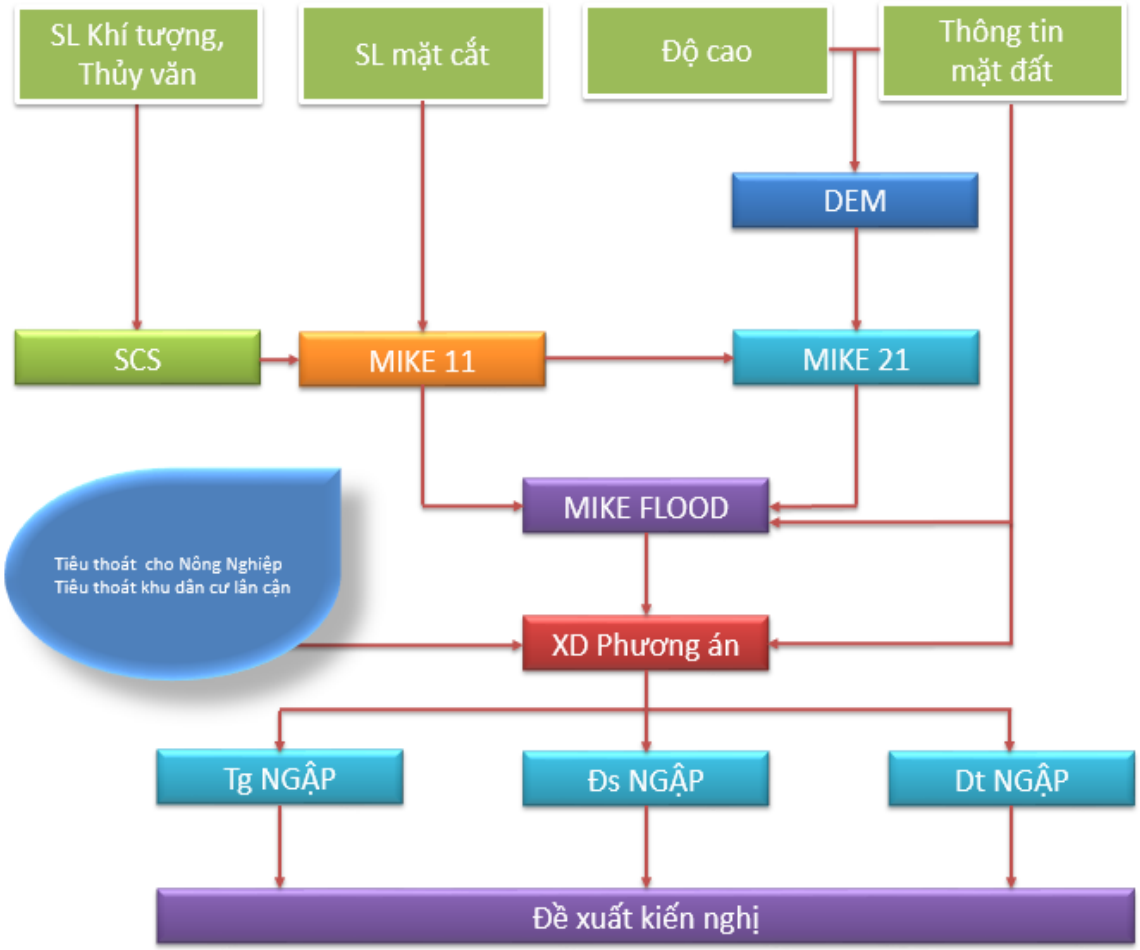
I. 2 HYDRAULIC MODELING

2. CALCULATION SOFTWARE

- MIKE FLOOD is one of the most advanced combined 1-D and 2-D calculation modeling softwares so far, used by most national and international universities, research institutes and consultant companies.

-The MIKE model set consists of many modules, each with own functions: MIKE 11 in charge of 1-D river network hydraulic calculation, with sub-modules for hydraulic calculation, sub-modules for storm-water flow calculation, sub-modules for substance propagation and sand, sludge conveying; MIKE 21 in charge of 2-D hydraulic calculation; MIKE FLOOD combines 1-D and 2-D models for calculation and development of flood maps.

--> Using MIKE FLOOD

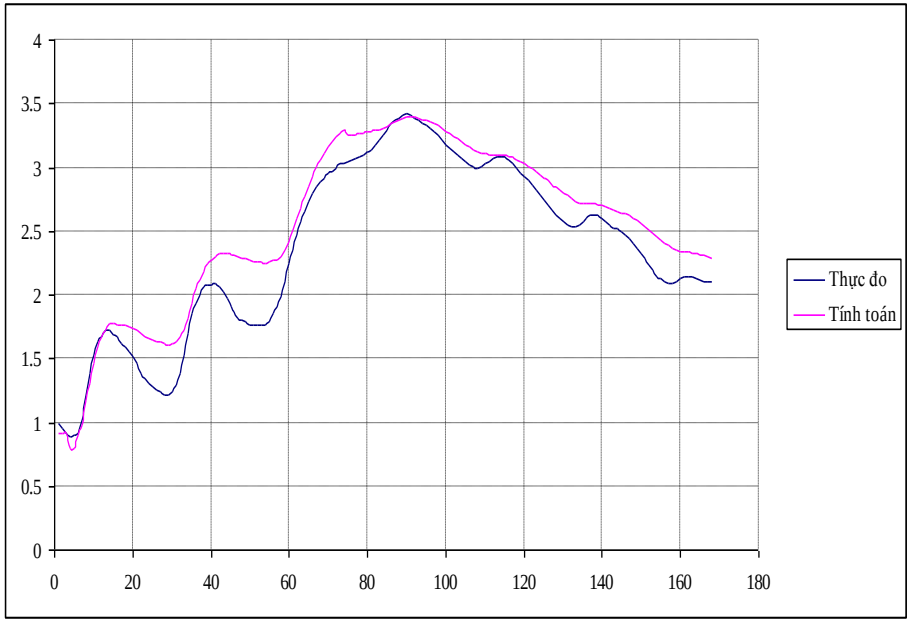


Calculation diagram

I. 2 HYDRAULIC MODELING

2.MODEL ADJUSTMENT AND TESTING

Based on the system's existing terrain documents, those about measured water levels, rainfalls during occurrence of the flood form 3rd to 9th Oct 2007:



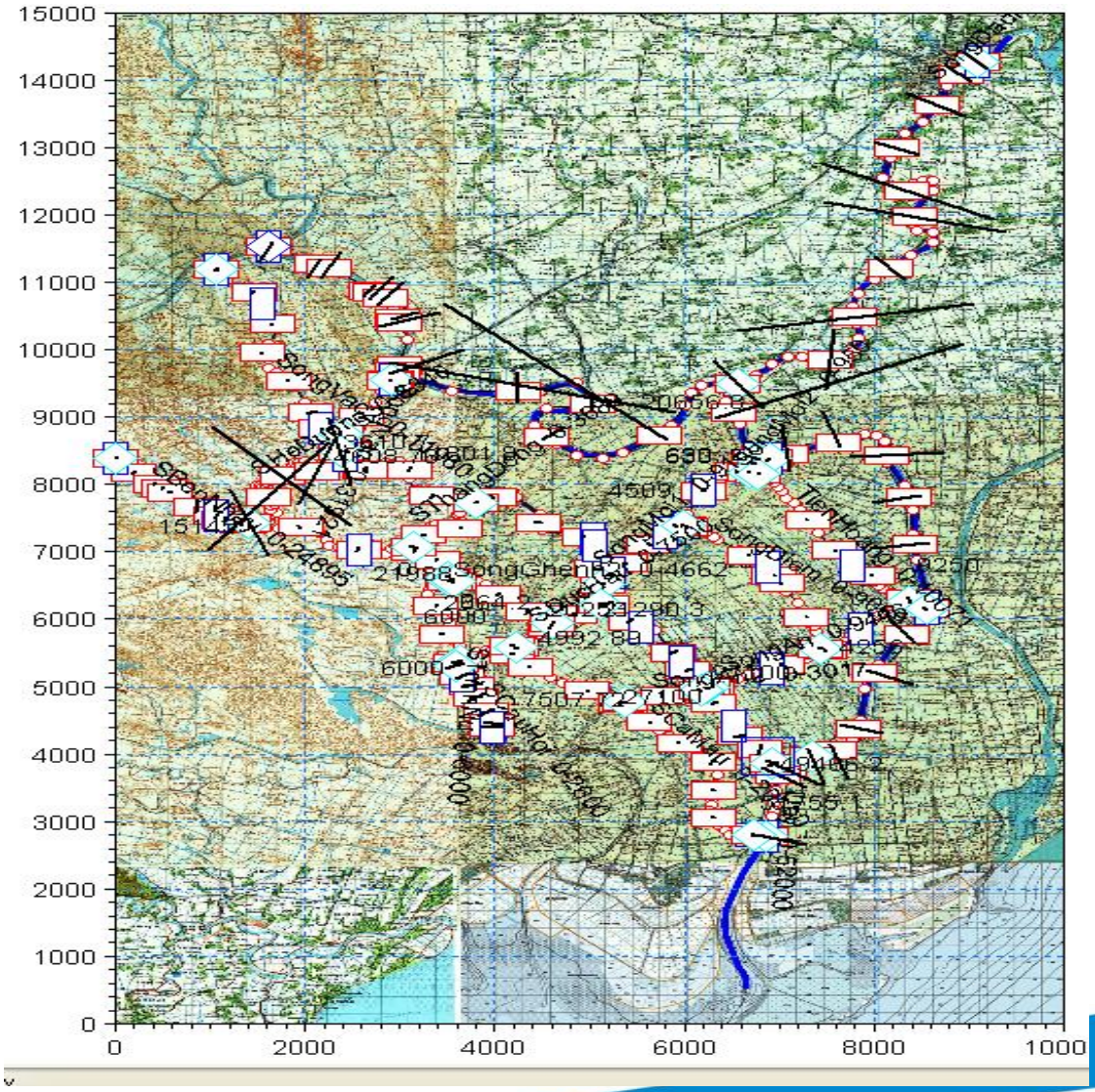
No.	Location	River	Water level (m)	
			Investigation	Calculation
1	Ninh Binh	Đáy	3,42	3,40
2	Van Lock	Nt	3,5	3,45
3	Vac Estuary	Vac	2,2	2,18

Calculation results on highest water levels along the system's rivers are relatively compliant with investigation results. Difference is within 0.02÷0.05m range. These calculation results are relatively close to practical conditions and acceptable.

I. 2 HYDRAULIC MODELING

River data table

River name	Length(m)
Vac River	31921
Vac River 2 (Chanh River)	11980
Moi River 1	9180
Moi River 2	950
An River	9446
Tien Hoang	10071
Diem River	9069
Trinh Nu River	6000
Ghenh River 2	4662
Ca Mau River	20600
Cau Hoi River	2600
Thang Dong River	3689
He Duong River	8340
Duc Hau River	7500
Ben Nhay River	24895
An River 2	3100



River system hydraulic calculation network

I. 2 HYDRAULIC MODELING

3. Calculation results

- Project area's rainfall calculation results

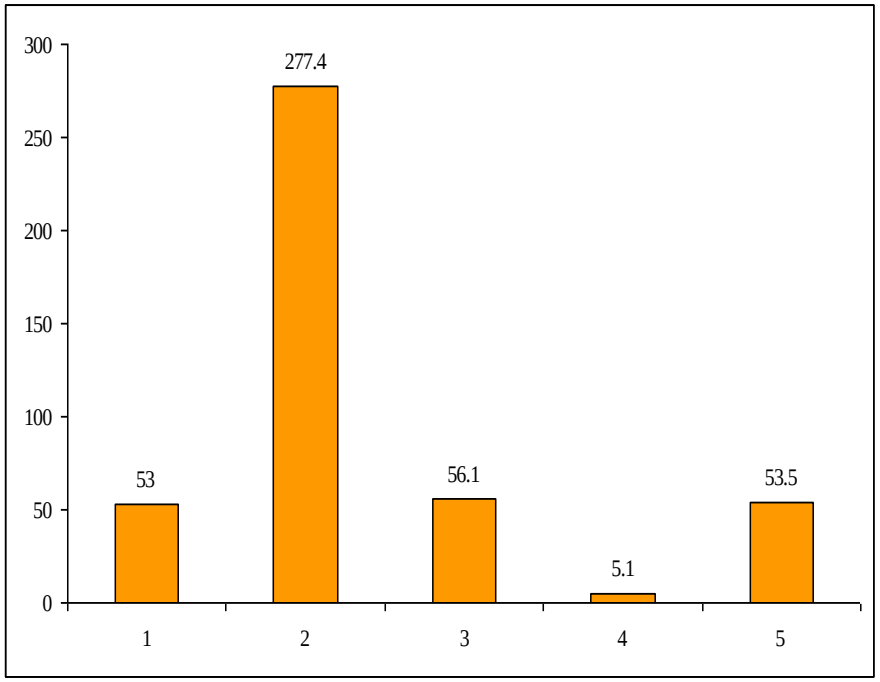
Based on the input data for determination of rainfalls within 5 days of the project area, we have the 10% design drainage rainfall table as follows:

Parameter	X_0(mm)	C_V	C_S	$X_{10\%}$(mm)
X_{1max} (mm)	173,1	0,45	1,35	277,4
X_{3max} (mm)	234,2	0,49	1,72	386,5
X_{5max} (mm)	264,4	0,52	1,82	445,1

10% design drainage rainfall table for the project area

Day	1	2	3	4	5
$X_{10\%}$ (mm)	53,0	277,4	56,1	5,1	53,5

5-day drainage rainfall pattern table (10% frequency)

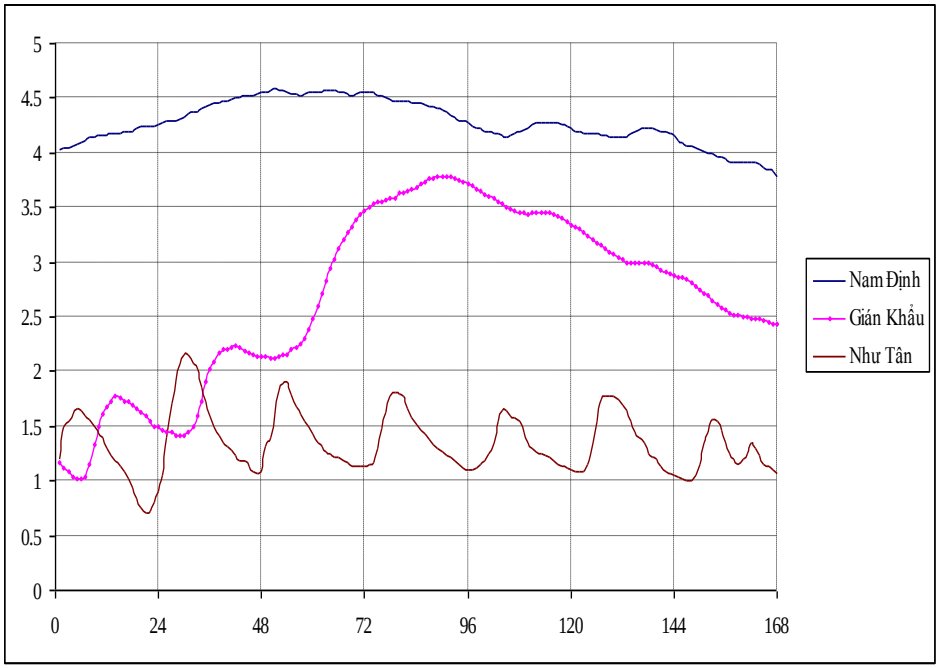


5-day highest rainfall distribution (Ninh Binh Station)

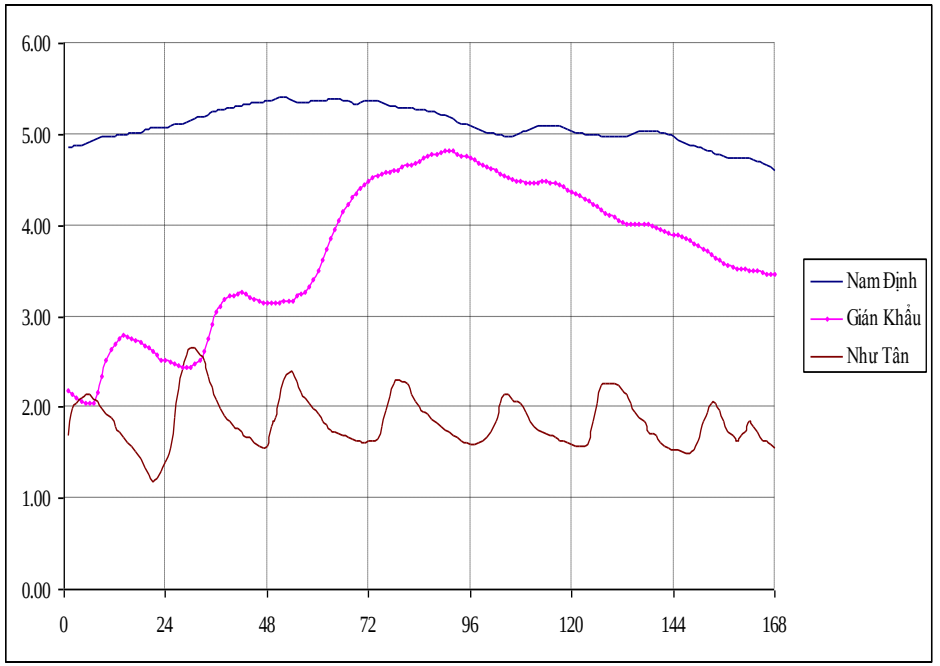
I. 2 HYDRAULIC MODELING

- Tidal water level calculation results

Based on simulation of the 2007 actual tidal water level at Nhu Tan, Nam Dinh and Gian Khau, the design tidal peak for the project is determined as follows:



Design water level process (P = 10%)



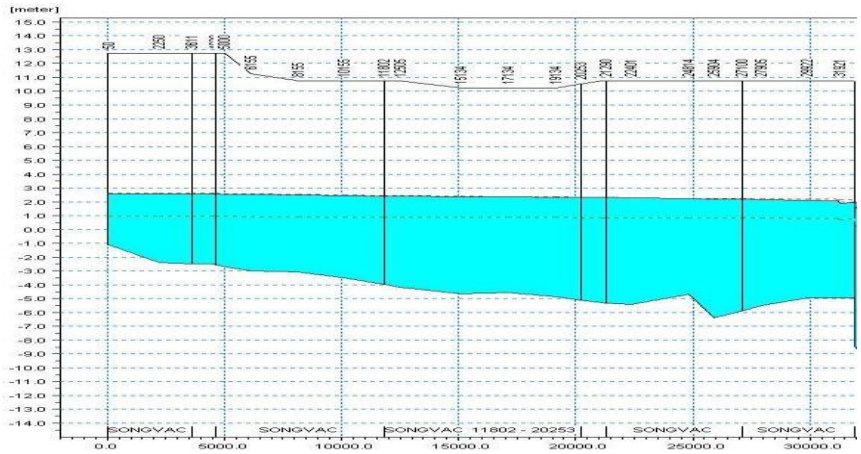
Design water level process (P = 1%)

Calculation of water levels in dry season for calculation of the freshwater retaining level for the work:

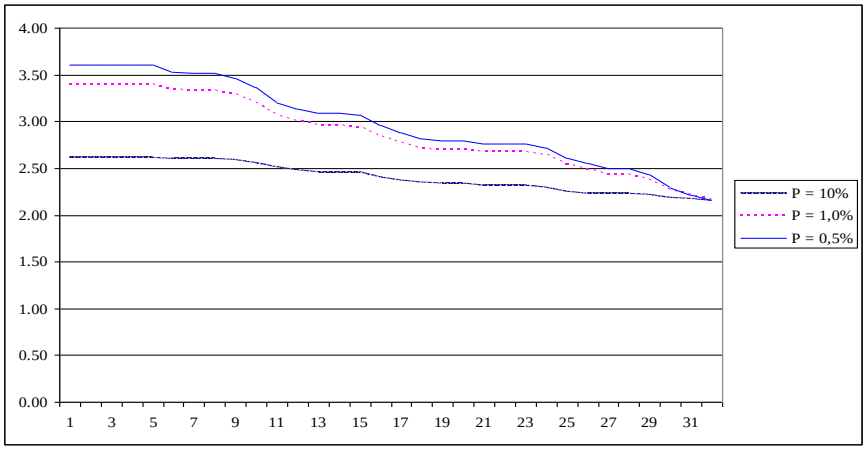
Annual-minimum water level respective to P = 95% is -0.965m

I. 2 HYDRAULIC MODELING

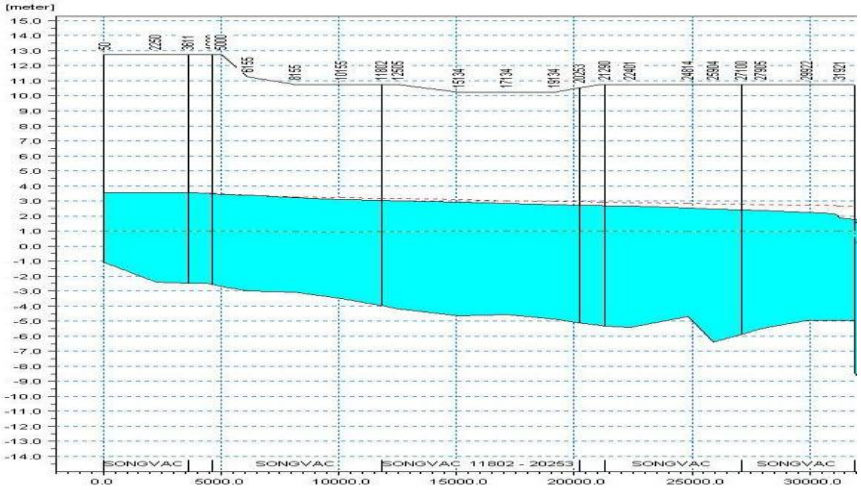
- HYDRAULIC CALCULATION RESULTS FOR FLOOD FREQUENCY OF 10%, 1%



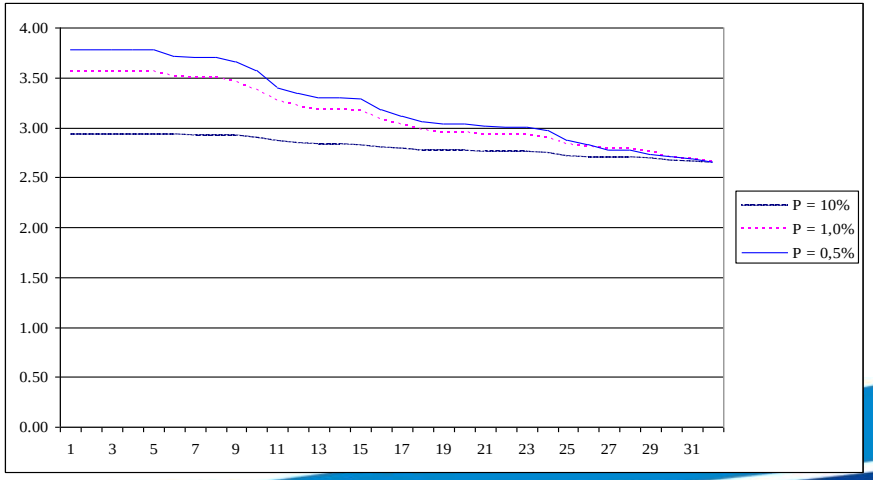
Field flood process with P=10% - River water level procress - P=10%



Highest water level along Vac River for 10% river flood cases



Field flood process with P=10% - River water level procress - P=10%



Highest water level along Vac River for 1.0% river flood cases

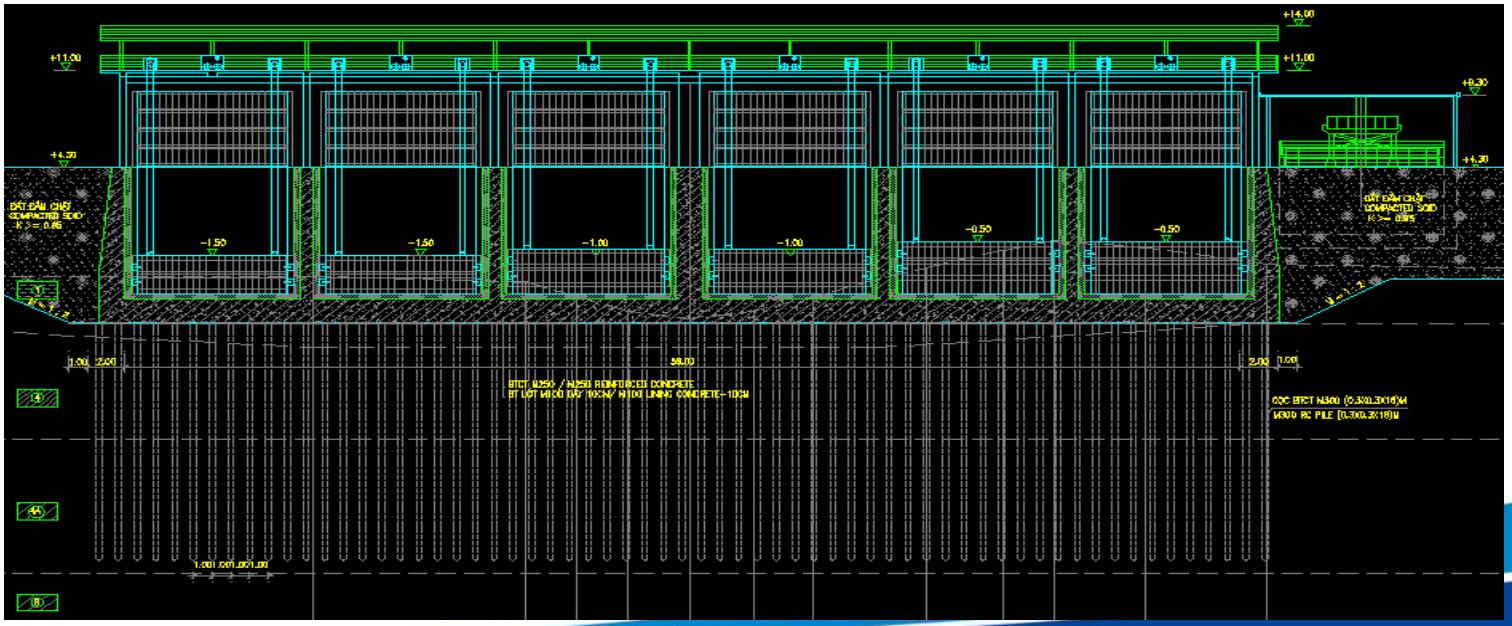
I. 2 HYDRAULIC MODELING

From the hydraulic calculation results shown in the table above:

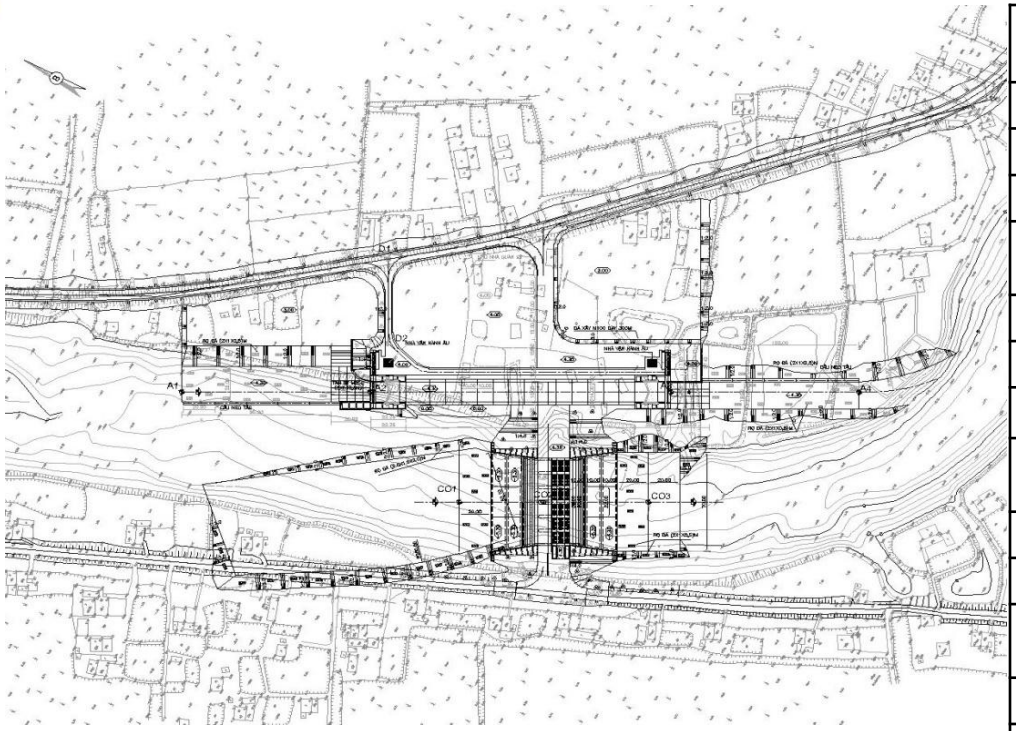
- Day River and field river flood frequency of 10%: max. water level on Vac River is 2.8m
- Day River and field river flood frequency of 1%: max. water level on Vac River is 3.6m
- Left/right-of-Vac River dyke routes currently have elevation of 4.0 - 4.2m

Kim Dai Lock Complex: The regulator and the lock have elevation of 4.3m

→ Based on the hydraulic calculation results and the area's practical data, it can be seen that Kim Dai Lock Complex shall help Southern Ninh Binh area successfully prevent flood water coming reversely from Day River



I.3 TECHNICAL SOLUTION



Kim Dai Lock Complex's plan

No.	Item	Unit	Proposed
I	**Regulator**		
1	Location		On the right of the river
2	Culvert type		Open
3	Number of culvert chambers	Chamber	6
4	Chamber width	m	8
5	Bottom elevation	m	-4.3
6	Culvert wall top elevation	m	4.3
7	Freshwater retaining elevation	m	-1.5,-1,-0.5
8	Main structure		M250 RC
II	**Lock**		
1	Location: The left side of the lock body is on river bank		
2	Lock bottom elevation	m	-4.30
3	Lock wall top elevation	m	4.30
4	Navigational clearance width	m	14
5	Lock head length	m	22.25
6	Lock body length	m	145
7	Boat, ship station length	m	100
8	Main structure		M250 RC
III	**Soil fall-in prevention embankment**		
1	Top elevation	m	4.30
2	Top width	m	5.0

I.4 CONSTRUCTION TECH OLOGY SELECTION

Kim Dai Lock Complex shall be constructed using one of two currently popular construction options:

- Traditional construction diversion technology

- Pillar dam technology

CONSTRUCTION DIVERSION

PILLAR DAM

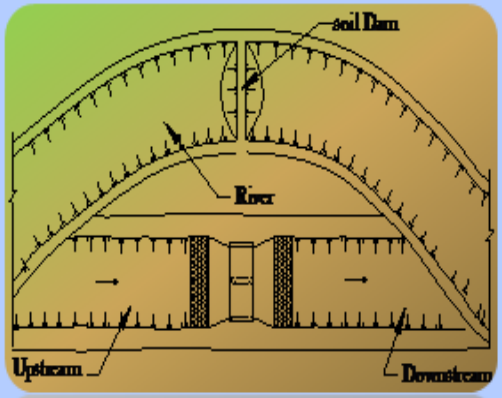
I.4 CONSTRUCTION TECHNOLOGY SELECTION

	Traditional technology	Pillar dam technology
Pros	• Already used in many similar projects • Vac River is not to wide, so this method is suitable.	• New technology, requiring small construction area • Construction is within surrounding frame
Cons	• Construction period is 3 months longer than pillar dam technology	Limited construction experience
Application	Small rivers	Large, complicated rivers

➡ For Vac River's hydro-geologic conditions and because Vac River's river-bed is not two wide, we select the traditional technology as construction method.

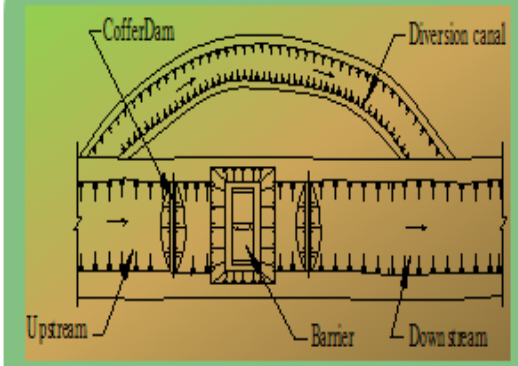
I.4 CONSTRUCTION TECHNOLOGY SELECTION

Cách 1: Xây dựng trên bãi khô



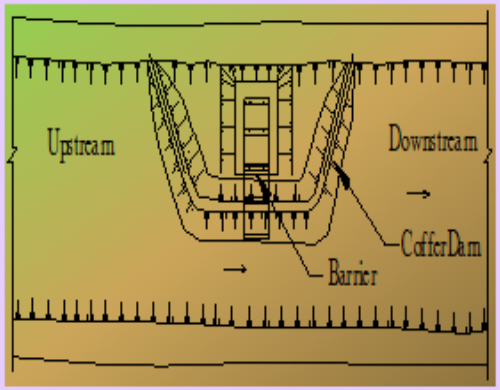
+ Đào móng thi công trên bãi
+ Dẫn dòng qua lòng sông
+ Thi công xong => Lấp sông
+ Áp dụng: đoạn sông cong

Cách 2: Xây dựng trên lòng sông chính



+ Đào kênh dẫn dòng
+ Đắp đê quai thượng hạ lưu
+ Thi công cống trong khô
+ Làm xong => Phá đê quai

Cách 3: Xây dựng trong đê quai lấn dòng



+ Đắp đê quai 1 phần sông
+ Thi công 1 hạng mục
+ Thi công nối tiếp các phần
+ Áp dụng cho sông rộng

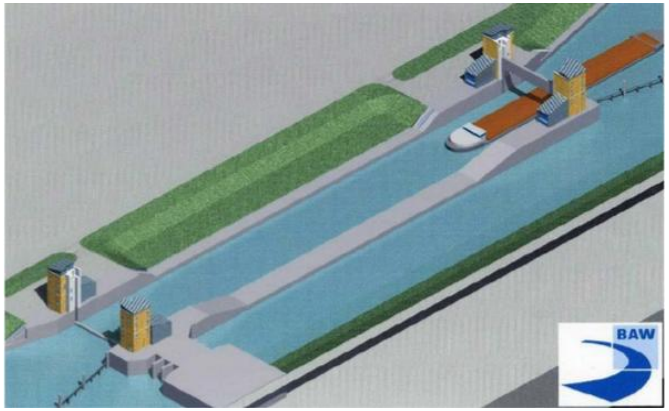
➡ Based on actual conditions, we select Option 2: Building the lock on river bank and the regulator on the main river bed

I.5 MAIN EQUIPMENT

THE LOCK'S GATES

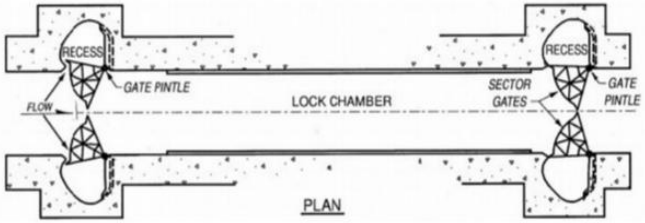
Functions of the lock's gates:

+ In dry season: The gates open, close to let the boats, ships pass through and also to help saltwater prevention, freshwater retaining.
+ In wet season: When the river water level exceeds saltwater prevention level, the gates are open freely to discharge flood water and let boats, ships pass through



TWO-LAYER FLAT GATE

MITRE GATE



RADIAL GATE

I.5 MAIN EQUIPMENT

	RADIAL GATES	2-LAYER FLAT GATES	APRIMATIC-SLIDING FLAT GATES	MITRE GATES
Pros	• Requiring low working load	• When the gates are pulled up, repairing and maintenance are very convenient • Reduce lifter's floor elevation	• Not depending on the required clearance of the lock	•Not depending on the required clearance of the lock • Simple gate structure and O&M • Light open/close forces
Cons	• Equipment and O&M are not convenient	• This option is not suitable for Kim Dai Lock's elevation	• Not suitable for Kim Dai Lock in terms of arrangement area and structure	

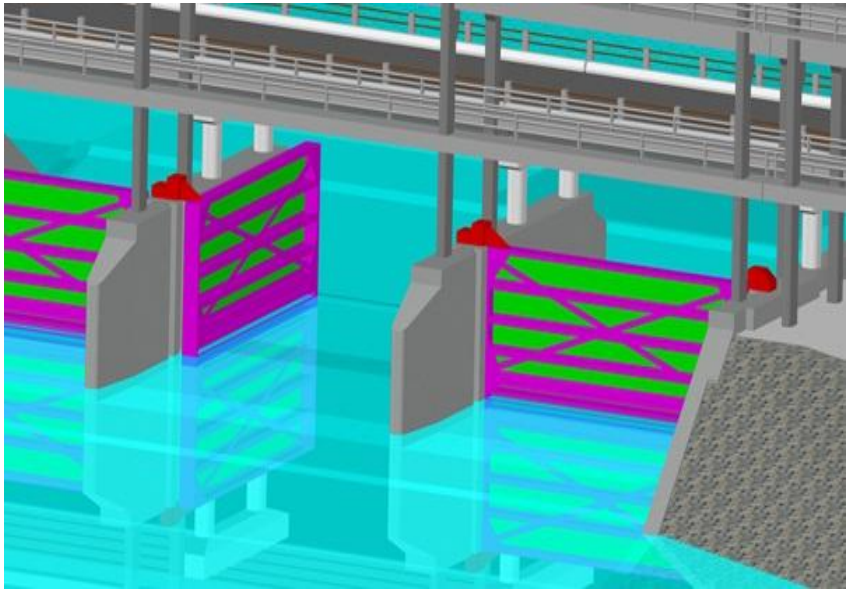
➡ The mitre gate option is optimal.

I.5 MAIN EQUIPMENT SELECTION

REGULATOR'S GATVES

Regulator's gates shall be of one of the two currently popular types:

- Flat gate
- Radial gate



FLAT GATE

RADIAL GATE

I.5 MAIN EQUIPMENT SELECTION

	RADIAL GATE	TWO-LAYER FLAT GATE
Pros	• Light open/close forces • Typically used for weir construction	• Simple, easy-to-be-made structure • Reliable, safe gates • Convenient for Kim Dai Lock Complex's retaining purpose
Cons	• Complicated manufacturing • Heavy • Requiring large arrangement space	

➡ Selection: The two-layer flat gate option is more advantageous, for is less required arrangement space, less mechanical equipment amount and operation, freshwater-retaining conveniences.

VI PROJECT'S COMPONENTS

COMPONENT 2:

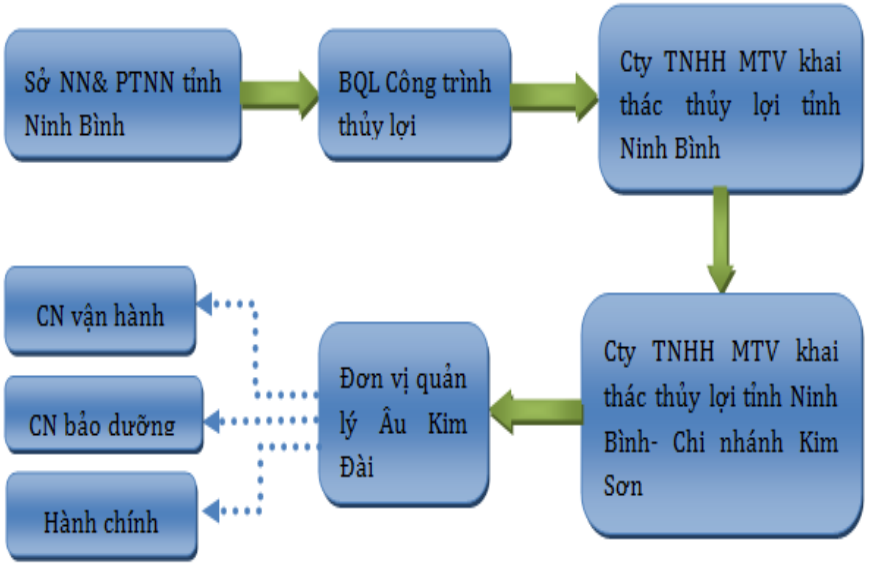
TECHNICAL ASSISTANCE AND CAPACITY BUILDING CONSULTANCY

Consisting of the following work items:
Training for the experts, workers to improve their M&O capacity;
Re-structuring, improving production efficiency.

Southern Ninh Binh Aea's irrigation/drainage system management and operation capacity building solution:

- Developing irrigation/drainage system management, exploitation and protection system;

Modernizing equipment, machinery; transferring advanced technologies for the management system.



Work management system

VI PROJECT'S COMPONENTS

➢**Restructuring, improving production efficiency**

Restructuring cultivation, breeding, aquaculture to serve the smart and comprehensive agriculture, aquaculture development of Southern Ninh Binh area.

-Shifting agricultural structure from rice cultivation to cultivation of high-value vegetable crops; Applying effective agricultural production modes: 2 rice crops, a winter crop or the rice + fish model, etc.; Applying technological advances into production processes.

-Boosting breeding of key livestock types such as pig, poultry and regionally specialized types such as goat, milk cow, beef cow, etc.; changing farming methods in the form of industrial concentration

-Shifting aquaculture form, from hollow-field to intensive and semi-intensive, focusing on high-value maritime products such as tiger shrimp, white shrimp, etc.

VII IMPACT OF PROJECT

VII.1. SOCIO-ECONOMIC SURVEY

1 Spring paddy area in 2014

- Kim Son district, Khanh Yen, Yen Mo district is an area of huge spring paddy, irrigation water supply primarily from the Vac River

2 career

- 60.7% of respondents work in agriculture

3 Current status of river/ channel/ trench

- Systems river / canal / ditch for irrigation of agricultural production is occurring salinization

4 salinization months in year

- Water salinization occurs between December to April next year. This is the time of sowing paddy winter - spring crop thus greatly affect yield.

VII IMPACT OF PROJECT

VII.1. SOCIO-ECONOMIC SURVEY

5 Impact, damage due to water salinization

- Water salinity mainly affects the productivity of crops, aquaculture and livestock. Also Restrict on food and Must change suitable crop plants

6 Forecasting sea water rise and salt intrusion

- Most households that situation happens in the mangrove future Kim Son district (154/402 households), Yen Khanh (117/402 households).

7 The positive impact of the project

- Most people believe that the project put into operation will contribute to increasing crop yields, reducing the impact of natural disasters and climate change.

8 The negative impact of the project

- The survey shows that people are concerned construction project will cause air pollution, noise during the construction

VII IMPACT OF PROJECT

VII.2. RESETTLEMENT

The work items	The number of households affected	The number of people affected			The average number of person / household
		Male	Female	Total	
Kim Chính Commune	25	55	49	104	4
Thượng Kiệm commune	10	21	19	40	4
Total	**35**	**76**	**68**	**144**	**4**

The number of households affected land acquisition

The work items	Agricultural land		land		Total	
	Households	Acreage (m^2)	Households	Acreage (m^2)	Households	Acreage (m^2)
Lock	35	47.829,9	9	2.330,2	35	50.160,1
Total	**35**	**47.829,9**	**9**	**2.330,2**	**35**	**50.160,1**

The number of households with land acquisition

VII IMPACT OF PROJECT

Job items	compensation costs (VNĐ)
I. Indemnify	
Rural land	466,040,000
Farmland	1,616,932,000
Aquatic Land	50,312,000
Public land (managing people's committees)	1,687,598,960
Land for cemeteries	335,392,000
II. Structure	
Home	3,906,545,725
Tomb	1,400,000,000
III. Supporting policies	
Support for land reclamation	3,934,196,000
Support training, job transition and job search	2,621,760,000
Supporting steady and productive life	648,000,000
IV. The cost to make restitution	**16,666,776,685**
V. Management costs (2%)	**333,335,534**
Total	**17,000,112,218**
Rounding	**17,000,000,000**

Estimated cost of land acquisition and resettlement of the project

VII IMPACT OF PROJECT

VII.3. ENVIRONMENTAL IMPACT ASSESSMENT

A. MITIGATION MEASURES DURING PREPARATION AND CONSTRUCTION

Develop a plan for site clearance and resettlement

↓

Publicity of legal texts and plan clearance and resettlement for households in the area have clearance

↓

Listed draft compensation and resettlement assistance for comments contributions of households affected and consulting, all chapters

↓

Completion and approval of compensation, support and resettlement to the competent authorities

↓

Making payments in compensation funding, support and resettlement

↓

Thời điểm bàn giao mặt bằng

VII IMPACT OF PROJECT

VII.3. ENVIRONMENTAL IMPACT ASSESSMENT

A. MITIGATION MEASURES DURING PREPARATION AND CONSTRUCTION

Moisten at construction site	• Shielding temporary dump construction materials, solid waste collection building • Spraying / watering regularly to maintain humidity daily, 2 times / day in areas near residential areas, sheds, the road transport, ...
Apply TCVN 6438-2001	• The vehicle used for the project must ensure TCVN6438-2001 emission standards to curb air pollution
Regulations reduce dust with trucks of construction material	• Arranging transportation vehicles properly tonnage, no overload • The transport vehicles will be sealed or coated canvas with guards; car wash • In the passage through the residential area will arrange sanitation workers, loose stones, cleaning, cleaning the pavement at least 2 days / times.
Other measures	• Reasonable construction organization to reduce dust • Manage and control the activities on the site to limit air pollution

VII IMPACT OF PROJECT

VII.3. ENVIRONMENTAL IMPACT ASSESSMENT

A. MITIGATION MEASURES DURING PREPARATION AND CONSTRUCTION

Construction of solid waste, sludge dredged sediments

- Soil excavation, organic peeled for construction of road, bridge and construction of technical infrastructure along the route: utilize collected for filling in low-lying areas, embankment slopes
- Construction of solid waste remaining contract to collect and transport the unit functions in landfill disposal regulations.

domestic solid waste

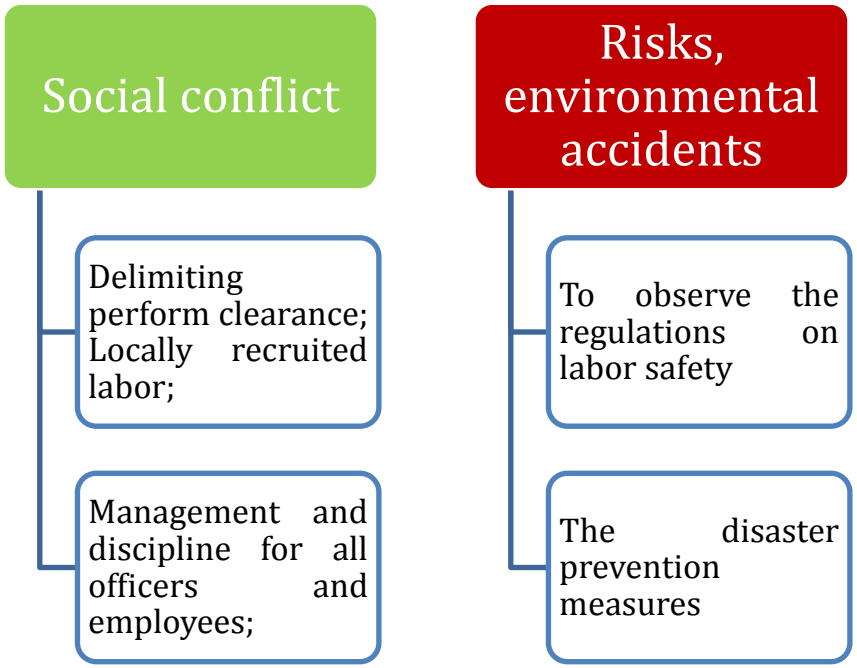
- Classification of solid waste, solid waste can be recycled as plastic cans, crates catton, paper, .. separate collection for resale to base purchasing and recycling.
- Armed with trash minimum 02 composite 150 - 240lit for each camp. Contracts for collection and processing units at local functions

hazardous solid waste

- Armed with 01 barrels / non-dedicated, 150-240lit capacity to collect and store hazardous waste, labeling, warning scooped hazardous solid waste.
- Contracts for collection and processing of hazardous waste with other functional units.

VII.3. ENVIRONMENTAL IMPACT ASSESSMENT

B. MITIGATION MEASURES OTHER IMPACTS



VIII PRELIMINARY COST ESTIMATE AND FINANCIAL EFFICIENCY

1. TOTAL INVESTMENT

Calculation unit: Million VND

#	COST ITEM	COST		
		BEFORE-TAX	VAT	AFTER-TAX
I	**Direct cost**	**412,000**	**39,500**	
1	Construction	276,500	27,650	304,150
2	Equipment	39,500	3,950	43,450
3	Power system	79,000	7,900	86,900
4	Site clearance and resettlement	17,000		17,000
II	**Indirect cost**	**39,405**	**3,771**	43,176
1	Consultancy	16,827	1,683	18,510
2	Investment preparation	7,900	790	8,690
3	Project management	4,740	474	5,214
4	Technical assistance, capacity building	7,963	796	8,760
5	Fees and other costs	1,975	28	2,003
III	**Contigencies (10%)**	44,344	4,434	48,779
VI	**Total investment**	**495,750**	**47,705**	**543,455**

VIII PRELIMINARY COST ESTIMATE AND FINANCIAL EFFICIENCY

2. FINANCIAL MECHANISM

No.	COST ITEM	Percentage	Amount (million dong)	Amount (EUR)
1	ODA fund	83.36%	453,009.70	18,875,320.83
2	ODA fund non-refundable aid	1.47%	7,963.50	331,812.50
3	Counterpart fund	15.18%	82,481.47	3,436,727.92
	Total investment amount	100%	543,455	22,643,861.25

ODA fund: Used for the project's direct costs

Counterpart fund: Used for project-related costs, including site clearance and resettlement costs, project management cost, investment preparation costs, taxes, fees and other types of costs.

Recommendations: Government to provide Ninh Binh PPC with a support of 70% of total counterpart fund, from the State Budget, with objectives as stated in Decision No. 60/2010/QD-TTg dated 30 September 2010 of Prime Minister.

VIII PRELIMINARY COST ESTIMATE AND FINANCIAL EFFICIENCY

2. FINANCIAL ANALYSIS

- Financial analyses are based on: Project's life cycle of 50 years, Project's revenue as per Circular No. 41/2013/TT-BTC dated 11 Apr 2013 of Ministry of Finance and calculations of minimum cost amount for operation of the completed irrigation/drainage system. The Project's calculated financial indices are: FIRR = 3.16% > WACC = 2.04%; FNPV = 321,977.76 triệu đồng > 0; and B/C = 1.29 > 1. These indices show that the project is financially efficient, yet efficiency is not high and payback shall be very slow.

- The Project's economic efficiency is assessed on "with the Project" and "without the Project" bases to determine benefit increases. Results of conversion from financial analysis to economic analysis (with reference to calculations of ADB experts for Vietnam) are: EIRR = 31.08% > selected discount cost of 12%; ENPV = 982,338.17 million dong > 0 and B/C = 18.4 > 1. These results show that the project brings about tremendous economic/financial benefits for Southern Ninh Binh area in particular and for Ninh Binh Province in general.

VIII PRELIMINARY COST ESTIMATE AND FINANCIAL EFFICIENCY

3. PROJECT EFFICIENCY

Calculation unit: million VND

No.	Item	Without the project	With the project	Economic benefits brought about by the project
1	Agricultural losses caused by flooding in the project area	(75,361.86)		75,361.86
2	Cultivation output increase thanks to irrigation water sufficiency	0	3008	3,008
3	Cultivation output increase thanks to "no more saltwater intrusion"	0	35,416	35,416
4	Cultivation output increase thanks to cultivation on areas previously left uncultivated due to shortage of irrigation water	0	31,839.68	31,839.68
5	Aquaculture output increase thanks to use of areas previously subject to saltwater intrusion, totally unusable	0	37,616.85	37,616.85
6	Cost for buying water from other sources	5483.75	1096.75	4,387
Tổng cộng lợi ích kinh tế khi có dự án				**187,629.39**

IX TIẾN ĐỘ THỰC HIỆN DỰ ÁN VÀ CÔNG VIỆC ĐÃ THỰC HIỆN CỬA TƯ VẤN

1. Project implementation progress

No.	Implementation item	Completion time
1	Preparation of Detailed Outline – by national consultants	Jul 2015
2	AFD selecting project implementation TA Consultant	Oct 2015
3	AFD organizing inception seminar	Nov 2015
4	AFD organizing interim seminar (first-time)	Jan 2016
5	AFD organizing interim seminar (second-time); PPC submitting Detailed Project Outline to Government for approval.	Feb 2016
6	AFD organizing final seminar	March 2016
7	Prime Minister approving PDO	Apr 2016
8	PPC approving the project	May 2016
9	Government approving Resettlement Policy Framework	Aug 2016
10	State Bank signing Loan Agreement with AFD (becoming effective after 3 months)	Sep 2016
11	Designing, construction bidding	Nov 2016
12	Construction implementation of all components	Dec 2016 – the end of 2018

2. CONSULTANT'S IMPLEMENTED TASKS

A) Collecting data and working with relevant agencies

- Input data for the project are collected from Department of Planning & Investment, Department of Construction, Department of Agriculture & Rural Development, Department of Finance, DONRE of Kim Son, Yen Khanh, etc.

B) Consultant's work implementation progress

1. Feasibility Study Report (FS): 100% completed and submitted to Client on 24 Sep 2015 and to AFD on 26 Sep 2015.
2. Hydraulic-Hydrologic Modeling Report: 100% completed.
3. Topographic-Geologic Surveying Report: 100% completed.
4. Basic Design: 100% completed.
5. Socio-Economic Report: 100% completed.
6. Resettlement Report: 100% completed.
7. Environmental Impact Assessment Report: 100% completed.

X CONCLUSION AND RECOMMENDATION

Conclusion

Southern Ninh Binh Area is key agricultural production area, and also, the economic, socio-cultural, tourism center of Ninh Binh Province. Saltwater prevention and supply of freshwater for domestic use and for agricultural production are of the area's top priorities.

Therefore, imlementation of "Construction of Kim Dai Lock Complex for Saltwater Prevention, Freshwater Retaining and Response to Sea Level Rise for 6 districts/cities of Southern Ninh Binh Area, Ninh Binh Province is very urgent and neccessary, to help stablize life and agricultural, forestry and aquacultural production.

Recommendation

For the tremendous benefits that this project can bring about for Southern Ninh Binh area in particular and for Ninh Binh Province in general, we recommend AFD to consider and soon approve this project.

THANKS FOR YOUR ATTENTION.