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Determination of Embankment Minimum Elevation in Teluk Sampit Irrigation Wetland Area

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ABSTRACT: *The problem for fishpond farmers in Teluk Sampit Subdistrict that lives along the coast is the phenomenon of Tidal Flooding. The impact of tidal flooding is very detrimental to their fishpond business. Tidal flooding is the event when seawater overflows to the mainland, it can also be defined as a flooded coastal land at high tide. To cope with the effects of the flood, soil embankments are needed as water retaining. The embankment must be able to withstand leaks and be safe from landslides. So, the embankment elevation must be calculated accurately, and the embankment shape must be made in accordance with the planning design. In the harmonic analysis using the least square method, the value of amplitude (A), phase (g*), and S0, M2, S2, N2, K1, O1, M4, MS4, K2, P1 which are tidal components are obtained. The planned elevation of the main embankment is based on the highest water spring (HWS) level plus freeboard 0,5 m. From the important elevation data, it can be determined the elevation of the main embankment is +3,19 m plus freeboard 0,5 m equal to +3,69 m or simplified to be elevation of +3,70 m.*

Keywords: *Embankment Elevation, Fishpond, Wetland, Teluk Sampit*

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I. PRELIMINARY

Teluk Sampit Subdistrict is a coastal area in the Kotawaringin Timur Regency. This area has considerable natural resource potential to be developed in the fisheries sector. Being on the equator, with a steady rainy and dry season, affected by tides throughout the year, should be able to produce fishery commodities throughout the year.

Fishponds are artificial ponds that are used for aquaculture activities which are generally located in coastal areas. Fishponds cand be filled with sea water or fresh water with animals that can be cultivated in the form of fish, shrimp, or shellfish. Currently there are two types of commodities that are cultivated in community fishponds, namely Ikan Bandeng (Milkfish) and Udang Windu (Giant Tiger Shrimp or Penaeus Monodon).

Shrimp culture is an aquaculture which has a high-risk factor. Besidess the diseases and the cultivation systems, geographical factors like outdoor conditions are very vulnerable to flooding due to tides. For most of the residents and pond farmers in Teluk Sampit District who live along the coast are already familiar with the phenomenon of tidal flooding. When high rainfall makes the surface of the Mentaya River rise and sea water is in high tide, a tidal flooding can occur that can soak roads, settlements and community ponds (Jumberi, 2016). Tidal flooding certainly disturbs and disrupts the activities of the local community because these floods occur routinely in the morning and evening every season.

Some of the factors causing tidal flooding are due to the phenomenon of global climate change such as an increase in the average temperature of the earth in a few years, land subsidence while the sea levels is risings, the influence of high and low tides due to gravity, storms, and external factors such as wind, waves that occur from a distance (swell), a push of water. Tidal flooding can also occur due to the factor of high rainfall intensity, which causes the channel flow and function of the embankment is not optimal.

Technically, there are several studies that can be done to overcome the impact of the flood, including determining the elevation of the embankment until reaching the elevation above the flood. The embankment is a building around a pond made of soil, serves as a water barrier that comes from outside and protects the pond from the dangers of flooding, erosion and tide. In its planning, embankments must be designed accurately both in terms of dimensions and elevation. Construction must be made in accordance with the design so that it can be free from leaks and be safe from the danger of landslides due to the embankments weight itselft or by other factors. Therefore, in this Teluk Sampit Wetland Area case study it is necessary to know the tidal conditions at the site and identify the existing condition of the pond network to get a minimum elevation of the embankment.

II. RESEARCH METHODS

2.1 Research Sites

The research is held in Teluk Sampit Wetland Aarea, Kuin Permai Village, Teluk Sampit Subdistrict, Kotawaringin Timur Regency, Central Kalimantan Province.

Figure 1 Map of research site

2.2 Overview of Research Sites

2.2.1 Topography

Kotawaringin Timur Regency has a quite varied topography with elevation of 0 to 6 masl. The south to the central region extends from east to west. The regency is mostly lowland, while the northern part is a hilly plateau area. Common types of soil are red yellow podzolic and some others are alluvial, organosol, latosol, etc.

Table 1 Land elevation at the study site

No.	Village	Highest Land	Lowest Land	River Bed Elevation
1.	Desa Regei Lestari	4,427	3,360	2,181
2.	Desa Kuin Permai	4,478	3,333	3,011
3.	Desa Ketuyungan	3,502	2,990	2,731
4.	Desa Bedidih	3,505	2,991	2,192

2.2.1 Climate

Kotawaringin Timur Regency experiences average monthly temperatures ranging from 27^{o} C to 35^{o} C. Monthly rainfall in Sampit City in 2007 ranged from 12 mm (September) to 790 mm (April). The dry season in Sampit City range from June to October.

2.2.2 Hydrological Condition

Kotawaringin Timur Regency is flowed by one large river and five river branches. These rivers are only used as transportation infrastructure and partly for agricultural business.

Table 2 Large river that crosses Kotawaringin Timur Regency

No.	River	Long (km)	Navigable	Average Depth (m)	Average Wide (m)
1.	Mentaya	400	270	6	400
2.	Cempaga	42			
3.	Sampit	46			
4.	Tualan	48			
5.	Kuavan	18			
6.	Kalang	21			
7.	Seranau	20			

2.2.3 Demography

Total population per-subdistrict in Kotawaringin Timur Regency can be seen in this table below.

Table 3 Population per subdistrict in Kotawaringin Timur Regency

No	Subdistric	Total Population (person)
1.	Teluk Sampit	8.929
2.	Mentaya Hilir Selatan	20.803
3.	Mentaya Hilir Utara	15.774
4.	Pulau Hanaut	15.442
5.	Mentawa Baru Ketapang	76.616
6.	Baamang	51.430
7.	Seranau	9.582
8.	Kota Besi	15.011
9.	Cempaga	19.119
10.	Cempaga Hulu	22.725
11.	Parenggean	35.706
12.	Mentaya Hulu	28.554
13.	Antang Kalang	28.753
14.	Bukit Santuai	8.040
15.	Telawang	16.863
TOTAL		373.347

2.2.4 Agricultural Socio-Economic

The basic commodities owned by Kotawaringin Timur Regency are:

1) Agricultural commodities of crops consist of corn, cassava, sweet potatoes, peanuts, soybeans, and beans.
2) Agricultural commodities of fruits consist of sapodilla, banana, pineapple, salak, cempedak, guava, rambutan, durian, orange, mango, and duku.
3) Agricultural commodities of vegetables consist of onions, leaves, tomatoes, chillies, eggplant, mustard green, string beans, chayote, cucumber, spinach, kale and beans.
4) Agricultural commodities of plantation consist of rubber, copra, coffee, pepper, coconut, palm, and patchouli.
5) Animal husbandry commodities consist of cattle, buffalo, goats, sheep, pigs, chicken, and duck.
6) Fisheries commodities consist of sea fisheries, river fisheries and aquaculture fisheries.

2.3 Research Stages

2.3.1 Literature Study

Literature study is done by reading, researching and understanding all information, both in the form of written data and in the form of pictures relating to the research to be carried out. This is done in order to obtain theoretical data, theoretical basis and a variety of literature relevant to research.

2.3.2 Collecting Data and Reference

The data in this research are:

a. Primarty data were obtained from field observations of tidal fluctuations in the Kuin River in Kuin Permai village.
b. Secondary data in the form of farm map data (planning and implementation) and topographic data (planning and implementation). This data was obtained from Balai Wilayah Sungai Kalimantan II.

Tidal data used in this calculation were obtained from the tidal measurement station located close to the research location, namely in the Village of Kuin Permai, which was measured in 2014 by PT. SAICLE JASA Banjarmasin and updated with field surveys and measurement of tidal data from 12 to 26 February 2019.

Table 4 Data of tidal observations in Kuin Permai (in cm)

HOUR	FEBRUARY 2019															
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1		136	104	71	50	60	85	121	160	200	226	236	224	201	168	142
2		179	151	110	81	74	77	98	142	183	226	242	256	233	214	181
3		231	203	162	123	93	82	91	120	164	203	235	256	264	250	224
4		263	240	212	169	127	110	100	113	137	171	211	240	264	271	250
5		270	272	250	224	180	148	122	113	124	150	197	221	250	271	273
6		270	284	286	268	232	190	165	130	130	142	175	197	236	259	273
7		250	284	294	281	266	233	203	169	142	142	156	183	210	235	261
8		232	267	285	290	290	275	241	200	175	167	156	170	195	220	245
9		210	241	268	280	290	289	273	245	213	185	173	170	179	199	228
10		199	210	243	262	281	289	284	274	248	210	194	180	179	196	200
11		191	202	209	231	250	270	284	280	261	243	220	204	188	195	198
12		204	190	192	198	226	244	260	272	270	258	241	226	203	198	196
13		210	190	181	180	187	210	233	241	253	250	241	230	210	202	196
14		213	201	181	172	161	176	197	197	222	234	232	230	210	203	197
15		220	201	181	163	152	149	155	163	187	191	198	207	210	203	195
16		212	201	191	170	140	134	124	121	132	155	165	185	184	185	180
17		178	190	191	170	151	123	101	93	90	97	125	141	155	168	164
18		150	172	180	170	159	131	110	80	71	72	83	93	118	126	147
19		109	135	159	170	159	154	122	90	71	50	51	67	73	92	116
20		74	104	131	155	170	167	145	115	83	63	51	43	51	69	88
21		46	62	100	132	165	173	162	142	110	86	82	43	40	46	63
22	21	20	44	74	110	148	173	180	172	152	120	94	70	50	47	51
23	39	32	30	52	79	122	160	180	187	192	172	131	99	82	63	67
24	83	47	43	40	60	104	142	180	200	210	201	187	147	120	96	89

Figure 2 Measurement of the existing embankment elevatioin in primary channel IV

2.3.3 Data Analyze and Method

Tidal observations and measurements at the study site were carried out to find the elevation of water in the main river, main channel and drainage based on tidal fluctuations of the sea. This analysis will

simultaneously show water circulation in the fishpond network. Moreover, the highest tide level is used as a basis for determining the elevation of the fishpond embankment security plan.
Harmonic analysis calculations using the Least Square Method with the following stages:
1) Read the water level measurement data
2) Read or set the period variable for each constituent
3) Make or form a matrix A or coefficient matrix
4) Least Square process
5) Calculate the amplitude and phase 9 constituents
6) Comparing the measured water level with the calculated analysis water level

2.3.4 Result Analyze

The results of the data analysis will then be the basis for recommending the elevation of the fishpond's embankment, explaining the needs and circulation of the fishpond water, as well as the fishpond's water system.
The steps of tidal analysis in relation to the plan to determine the embankment, channel, and fishpond gate elevations are as follows:
1) Determine the Highest Water Spring (HWS) used to determine the height of the pond's main embankment
2) Determine the Mean Low Water Spring (MLWS) to plan the elevation of the secondary secondary channel / carrier channel and drainage channel / disposal channel
3) Determine the Lowest Water Spring (LWS) to determine the pond bottom / pond level elevation
4) Determine the Mean Low Water Level (MLWL) to plan the height of the water in the secondary channel / supply channel used to irrigate the pond

III. RESULT AND DISCUSSION

2.1 Tidal Component

The value of amplitude (A) and phase (g *) of tide components obtained from harmonic analysis using the Least Square Method can be seen in the following table

Table 5 Tidal constants in Kuin Permai Village

CONSTITUENT	SO	M2	S2	N2	K2	K1	O1	P1	M4	MS4
A (m)	1.72	51	8	15	4	51	25	23	0	0
g (*)	-	323	323	291	251	232	256	188	300	27

2.2 Tidal Type

Based on the Least Square Method calculation, tidal type can be determined from the ratio between the major daily tidal constants with the main double tidal constants. Teluk Sampit has a Formzahl (F) value of 1.3. Formzahl (F) value is known to be located at $0.25 < F \leq 1.50$, so it is known that the type of tides in Teluk Sampit is mixed semidiurnal dominant tidal inclines to double daily.

2.3 Important Water Level

Important elevation values that will be used as the basis for determining the height dimensions of the fishpond component for a period of 5 years (2019 to 2024) can be seen in table 6 below.

Table 6 Forecasting values of important elevations of the Teluk Sampit tides

Item	Elevation (m)	Number of Events
Highest Water Spring (HWS)/APTPT	3,19	1
Mean High Water Spring (MHWS)/APT	2,88	123
Mean High Water Level (MHWL)/APRR	2,33	3.038
Mean Sea Level (MSL)/MLR	1,72	43.800
Mean Low Water Level (MLWL)/ASRR	1,11	3.057
Mean Low Water Spring (MLWS)/ASR	0,50	123
Lowest Water Spring (LWS)/ASRPR	0,20	1

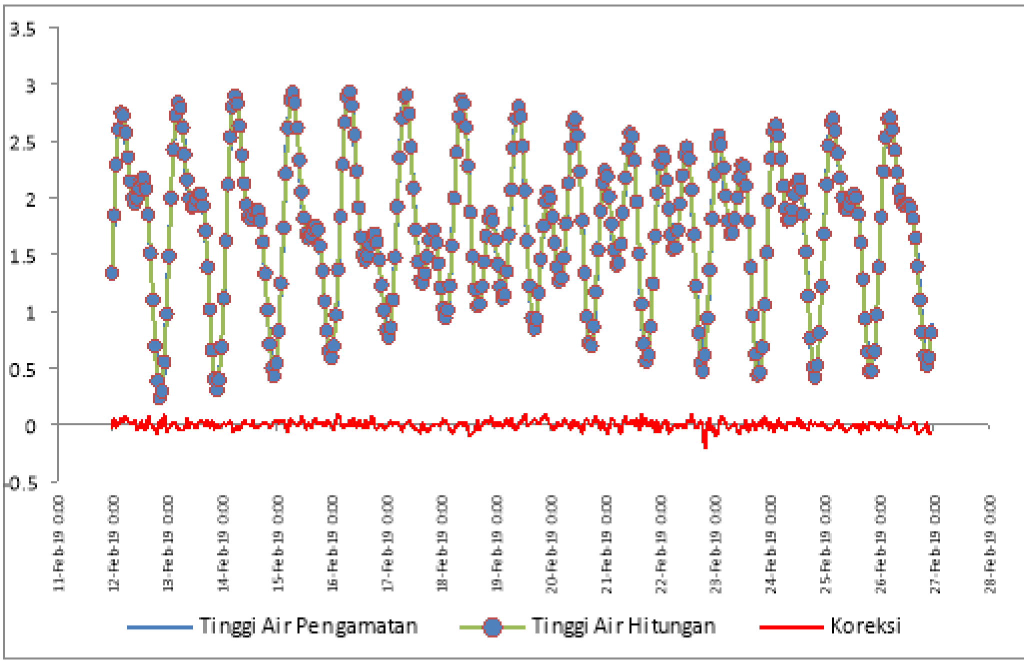

Figure 3 Tidal graph in Teluk Sampit, Kuin Permai Village

2.4 Determination of Embankment Elevation

The planned elevation of the main embankment of the fishpond is based on the Highest Water Spring (HWS) plus freeboard of 0.50 meters. From the important elevation data above, the main embankment elevation can be determined to be +3.19 m plus freeboard height of 0.5 m equal to +3.69 m or simplified to elevation +3.70 m. While the secondary embankment is determined from the elevation of HWS plus freeboard 0.3 m to +3.49 m or simplified to +3.50 m.

Table 7 Determination of the embankment elevation Teluk Sampit Wetland Area

Tidal Elevation	Elevation (m)	Freeboard (m)	Embankment Elevation
HWS	+3,19	0,50	≈ +3,70 (primer)
		0,30	≈ +3,50 (secondary)
		0,00	≈ +3,20 (tertiery)

2.5 Determination of Base Fishpond Elevation, Gate, and Channel

A good fishpond bottom surface elevation is 40 cm below the Mean High-Water Level / MHWL (Slamet Soeseno, 1988). Thus, ideally the elevation of the fishpond yard is +2.33 m - 0.40 meters = +1.93 m ≈ +**1.90** m

Fishpond water gates are on tertiary embankments which are directly related to the farm. The tertiary embankment elevation is planned 30 cm below the secondary embankment elevation. So, tertiary embankment elevation is +3.50 m - 0.30 m = +3.20 m. The height of this embankment is considered safe and in accordance with the highest tide level of +3.19 m. Thus, the upper elevation of the fishpond water gate is equal to the elevation of the tertiary embankment or equal to +3.20 m.

While the elevation below the gate is planned to be the same as the elevation of the bottom of the caren (trough at the bottom of the pond which is used to facilitate fishing and as a shelter for fish from the sun) or trench so that it will facilitate the operational drainage of the fishpond. Caren or trench elevation at the study site is made approximately 40 cm below the elevation of the fishpond. So, caren elevation is +1,90 m minus 0,40 meters equal to +1,50 m. Thus, the height of the gate is +3.20 m minus +1.50 m equal to 1.70 meters. Gate is planned to be a type of skot beam which is easy to operate and fishpond farmers are accustomed to using it.

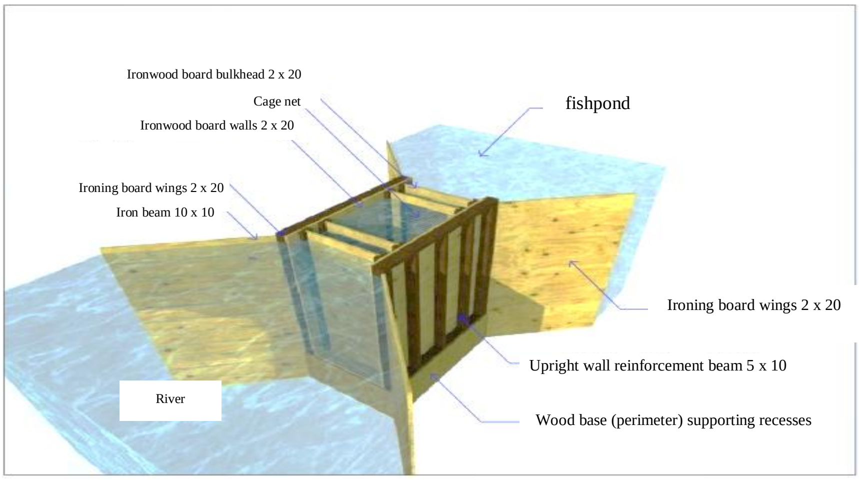

Figure 4 Typical gate at fishpond network

The bottom elevation of the secondary or tertiary channel is under the elevation under the gate around 20 cm. It is also related to circulation turnover and drainage fishpond water. While the bottom elevation of the outer or primary channel is certainly lower than the elevation of the secondary or tertiary channel.

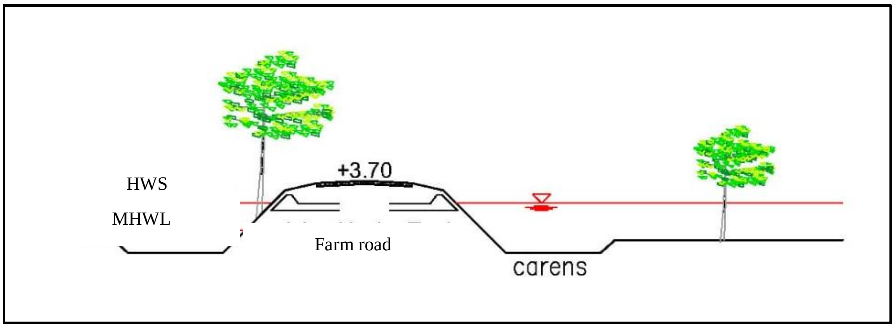

Figure 5 Typical fishpond component along with its elevation

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Based on tidal analysis, several things that can be used as a reference in determining the elevation of fishpond embankment in the Kuin Permai Village, Teluk Sampit Subdistrict are as follows:

1) Tidal type in Teluk Sampit is mixed semidiurnal dominant tidal inclines to double daily and based on the area of fishpond in Teluk Sampit Wetland Area is included in the semi technical fishpond category.
2) The results of the analysis obtained safe elevation for the embankment of the fishpond is +3,19 m plus freeboard 0,50 m equal to +3,69 m or simplified to +3,70 m. The elevation of the existing embankment on primary channel 4 is +4,536 m, which means that technically the elevation of the embankment is safe to deal with flood water.

4.2 Recommendations

Advice that can be given are:

1) Determination of the embankment elevation is absolutely carried out in accordance with the results of tidal data calculations, so that the fishpond plot is safe from the risk of water entering due to tides from sea water or due to flooding.
2) Intensive supervision from related agencies for fishpond water elevation and fishpond gate elevation by recruit water gate attendant to obtain optimal fishery products.
3) Regular coordination is needed between the district and provincial governments and the central government in terms of budgeting costs for rehabilitation and sustainable pond development.

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