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TEKNIK KEAIRAN

STRATEGY PLANNING : SHORE PROTECTION WORK FOR SANUR BEACH

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ABSTRAK

Pengembangan pekerjaan perlindungan pantai untuk pantai Sanur memerlukan strategi perencanaan dengan demikian keseimbangan perlindungan pantai dan lingkungan dapat terjaga. Strategi Perencanaan mengandung langkah langkah penyelidikan awal, pengumpulan data, dialog dan negosisasi serta draf gambar yang dibutuhkan dalam ketidakmampuan pemerintah untuk menjawab isue. Strategi Perencanaan merupakan langkah dasar dalam proses Integrated Coastal Zone Management (ICZM) yang berfungsi sebagai dasar untuk berkomonikasi dengan masyarakat dan menjadi dasar persetujuan antara stakeholder. Dengan Strategi Perencanaan, pekerjaan perlindungan pantai Sanur dapat di selesaikan dengan perlindungan kombinasi antara groin dan beach nourisment.

***Kata kunci** : Strategi Perencanaan, perlindungan pantai*

INTRODUCTION.

Background

Bali Island with its exotic culture and scenic beauty of beaches and mountains is most popular with international tourists. Bali has beach length ± 430 km and around 18% are coral beach with white sand. However about 64.5 km of the beach length or 15% have been eroded because of the human activity and natural factor. It is giving impact to the environment, also existing infrastructures surrounding it.

The tourist industry is centred a round the southern coral beaches of Sanur, Nusa Dua and Kuta which are occupied 6% of the total coastline of Bali. For protecting the own land and beach which are threatening, it is important to do such preservation/conservation efforts especially for the beach area because tourism contribute to the national income.

For the people of Bali, beaches are functioned as religious, recreational, fishery and living places. Considering to the function and value of the beach in Bali is very important and also as a very potential asset, so the eroded process that still happened need to be concerned and a seriously efforts have

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to carried out by Government and society.

Based on Feasibility Study carried out by the Bali Regional Office of Ministry of Public Work, some areas are categorized experienced serious erosion and become to the priority conservation such as Kuta, Sanur, Nusa Dua and Tanah Lot, shown in Figure 1.

To overcome this situation in 1997-2004, the Government of Republic Indonesia with a Foreign Loan from Japan Banking for International Cooperation (JBIC) under the Urgent Bali Beach Conservation Project carried out the project with major shoreline construction for the whole area in Bali (Tanah Lot, Candi Dasa, Kuta, Sanur and Nusa Dua).

To develop shore protection work for Sanur Beach need Strategy Planning. Strategy Plan is the key whole integrated planning and management process. Strategy Plan involved all the preliminary investigation, data collection, dialogue, negotiation and draft writing that is necessary to enable the government to define the issue (John R Clark,1996). Some strategy plan will be integrated became Master plan and improved ICZM. It is most important assist government to develop guideline for ICZM.

Objectives

The objectives of this paper is to apply a strategy planning for develop Sanur Beach.

Figure 1. Bali Island

STRATEGY PLAN.

According to Clark, 1996 Strategy Planning and Master Planning, there are two important stage of ICZM. Strategy Planning is the process that explores option and develops an optimum strategy for management program. This is the stage where needs and solution are examined and recommendations advanced. This is not detailed planning stage for the management program; that comes in the Master Plan creation phase.

A strategy plan is an excellent mean to assure the balance between coastal defence and environment. It provides an overview of the realistic goals, steps to reach these goals, the planning time and the resources needed. In this way a strategy plant is also an essential element in obtaining finance and all legal permit, which are necessary for implementation (Geense, 2005).

Another important function of a strategic plan is that it lays the foundation for communication to the public and it is the basis for an agreement between the parties involved. All relevant interested parties should support the strategy. We should not forget that a favourable judgement of the plan and agreement between the various interested parties would prevent infringement on existing operations and future developments.

According to the limit time and data collection, the study only addresses about a strategy planning for shore protection work only not addressing social economic aspect, finance and legal permit.

Addressing shore protection work for Sanur beach, there are following steps of strategic plan can be distinguished:

1. Overview of current situation
2. Setting goals and objectives.
3. Problem Analysis
4. Data Collection
5. Alternative Analysis
6. Design Consideration
7. Implementation
8. Monitoring

Sanur Beach: Overview of current situation.

Bali beach Conservation Project at Sanur Beach is implemented along the beach of approx 6-7 km between Grand Bali Beach and Serangan Area. Before, the beach and the hotel are naturally protected from erosion by nearly continuous parallel ridge of coral lying just offshore. In the more-less 500 m space between the coral ridge and the beach, there is very shallow tidal lagoon, which is rich in sea life and which dampens the force of waves coming over the reef top.

Present condition, there are many coastal protection structure like groin and seawall have been made along the coast by the owner of the properties to protect their own area, which finally led to an unnatural beach and degraded the coastal and recreational amenity value and the natural character has been severely degraded. All of the structures can be seen on the Figure 2 below. Only beach in from of Bali Beach Hyatt Hotel (almost 1 km) are still preserved without any coastal protection. This is shown the effectiveness of natural offshore reefs to absorb and attenuate the wave energy before reaching the beachfront.

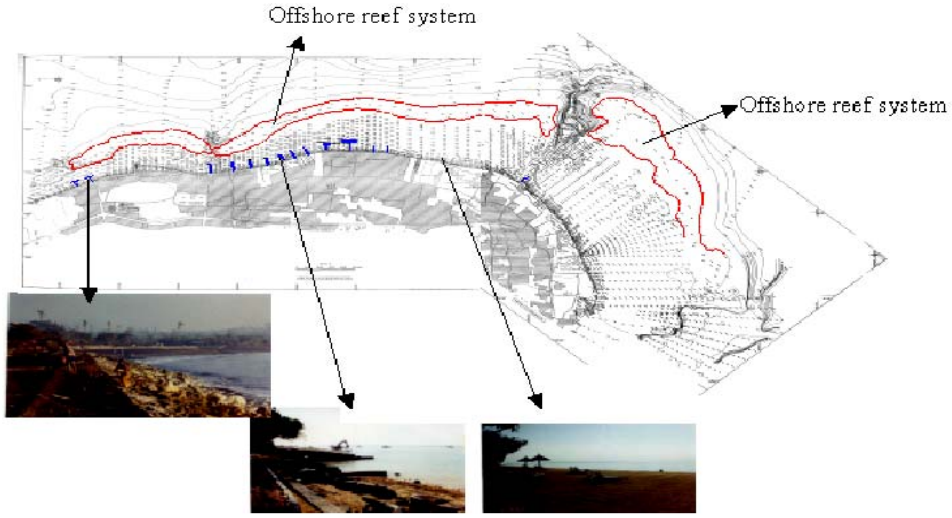

Figure 2. Sanur Beach

More than 30 m of shoreline retreat has occurred since 1983 due to the destruction of the coral reefs by mining, beach sand extraction and man made channel cut through the reef and pollution.

Setting Goal and Objectives.

The second step of strategic planning is plan the required situation. In this stage communication with decision maker and stakeholder is essential. Several alternatives should be developed and feasibility studies should be carried out in order to assess the economic, technical and environmental feasibility of the various alternatives.

According to function of the beach, shore protection work for Sanur Beach need to fulfils the following requirements:

- Protect the beach and reduce erosion
- Provide a wide beach and a safe swimming area
- Maintain good aesthetic effect
- Religious activity for Hindu people

After desire the required situation, some alternative can be making base on feasibility studies and existing investigated reports.

Problem Analysis.

The first step before star to design, determine the problem analysis from the existing condition is most important. After understood the problem well, some possible solution can be discuss on alternative.

Possible causes of erosion in Sanur Beach are:

- Coral mining
- Natural influence
- The construction of the groins, which is carried out partially without coordination and technical consideration and not executed comprehensively.
- Pollution

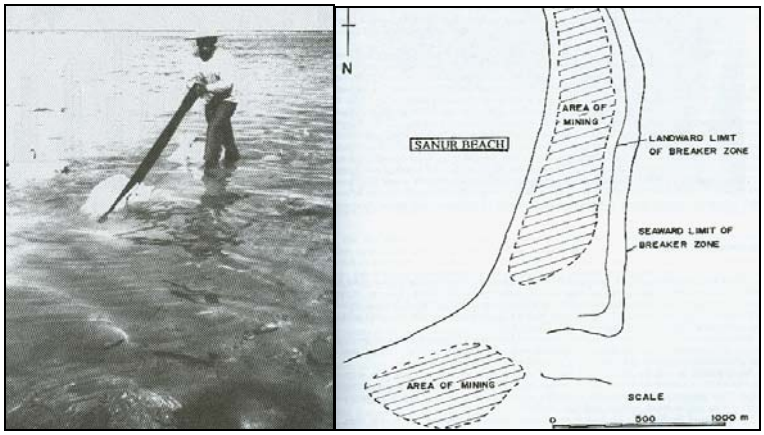

Figure 3. Mining activity location

Shoreline retreat has occurred due to the destruction of the coral reefs by mining, beach sand extraction and man made channel cut through the reef. They are many fishermen broken the coral reef to make canal. This is made the effectiveness of natural offshore reefs reduce to absorb and attenuate the wave energy before reaching the beachfront.

When the coral was removed, stronger wave came through the lagoon, presumably eroding the beachfront and making certain parts of the beach unsuitable for tourist use. Beside that, lowering of the lagoon give effect to an increased beach slope caused some slump of beach sand into the lagoon.

The immediate reaction of many tourist hotel owner was protected their own area without coordinate. The owner of the properties has made coastal protection structures like groin and seawall/riprap along the coast. This is caused new and difference problem, like total loss of adjacent and down current beach at some site. Which finally led to an unnatural beach and degraded the coastal and recreational amenity value and the natural character has been severely degraded.

Mostly lateral current moves sand, which is related to water entering the lagoon over the reef top and exiting at two-reef gap. Beach sand is composed mostly of foram from the reef. Probably the major ecological threat to the coral reef ecosystem of Sanur is actually the poor quality water issuing from Benoa Port just to the South West and sewage being discharge in Benoa from Nusa Dua settlement and the International airport. It seem that coral ecosystem could already be near a pollution threshold. High concentration of organic matter are discharge from Benoa Harbour with CODs of 20 ppm reaching some of the reef area and the amount of dissolved phosphate exceeding ecological limit (1 mg/l) in some place. Increasing sewage or increasing amount of fertilizer runoff from paddies could stimulate alga attack of the coral reef. When this happened the algae overgrow the reef killing the coral. Then the coral are worn down by bioerosion (drilling, grazing and burrowing animal) and

chemical dissolution and the coral reef begin to disappear.

Data Collection.

The available wave data for Sanur area is from the Global Wave Statistics for Area 78 with result table below.
The storm selection needs to be determining designing the beach profile. Evaluation of potential storm damage requires selection of a set of storms representative of future event that may impact the project area. The amount of the return period ranging from 5 or less to the 1000 years, has to be determined depending on the economical judgement and the risk according to the value of the project area.

Features of the bathymetry of the region are dominated by the coral reef system. There is not enough data contour along beach to the top of the reef. During low tide all the coral reef is exposed up to more less 500 m offshore and during the high tide most waves break at the offshore reef.

Table 1. Production of exceedance using 'Global Wave Statistics

Height (m)	Percentage of Total				Total (%)	Cum (%)
	NE	E	SE	S		
7-8				0.03	0.030	0.030
6-7		0.04	0.09	0.20	0.330	0.360
5-6	0.01	0.09	0.26	0.68	1.040	1.400
4-5	0.05	0.32	0.73	1.94	3.040	4.440
3-4	0.16	1.00	2.00	4.48	7.640	12.080
2-3	0.55	2.73	4.71	7.98	15.970	28.050
1-2	1.55	5.32	8.04	9.22	24.130	52.180
0-1	1.88	4.03	5.59	3.69	15.190	67.370
Total	4.2	13.53	21.42	28.22		32.630

OTHER DIRECTION

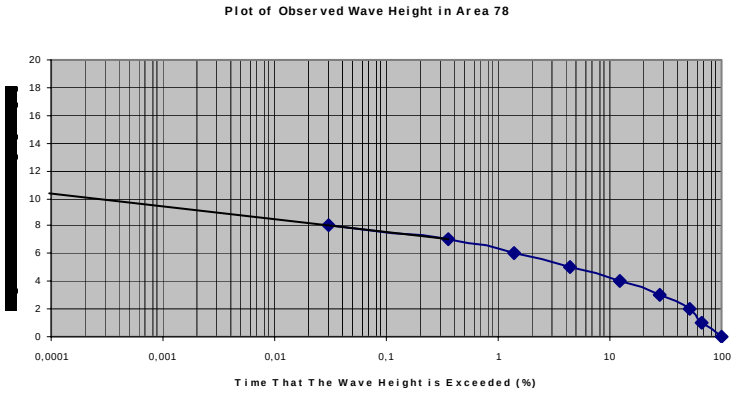

Figure 4. Wave High Exceeded

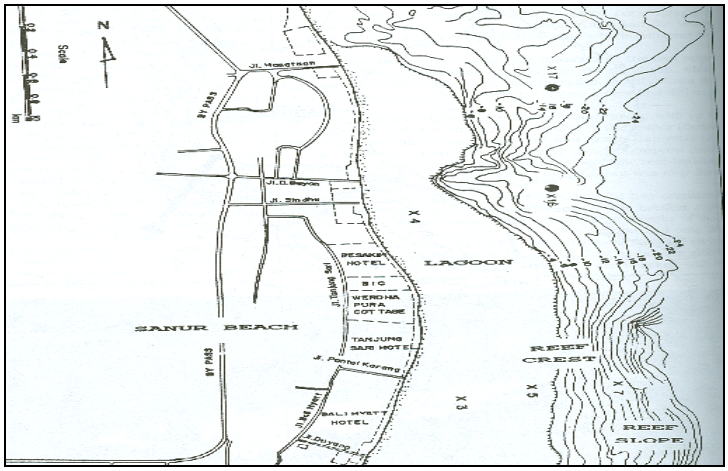

Figure 5. Part of Sanur Beach Bathymetry

Beach material of Sanur beach is composed of fairly coarse sand, light brown coloured on the southern part and black on the northern part of the beach. The possible main origin of the sediment is coral, limestone and volcanic product, which is mainly supplied by northern rivers. The median grain size D_{50} is varies from about 0.2 mm - 1.5 mm.

Beach sand is composed mostly of forams from the reef. Mostly lateral current moves sand, which is related to water entering the lagoon over the reef top and existing at two-reef gap. High current speed (0.4-0.5 m/sec) would be required to lift sand particle of 1 mm or large.

To analyse coastline, we should be analyse sediment transport because erosion or accretion of coastline depends on the gradient of sediment transport. Littoral transport is classified as cross-shore and long shore transport. These are resulted from the interaction of wind, wave, current, tide, sediment and other phenomena in the littoral zone. The motion of sediment particle typically has both an onshore – offshore and a long shore component.

To estimate sediment transports a numerical model CRESS can be used. CRESS 424 Sediment transport acc to CERC with climatic input chooses to use. With input wave characteristic to the software total sediment transport can be counting. Before calculate sediment transport wave characteristic from each direction should be determine.

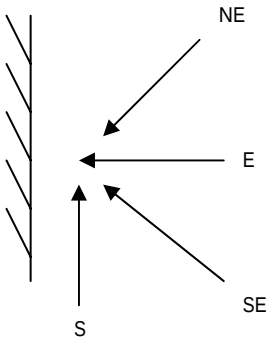

Figure 6. Original coastal orientation angle

Table 2. Sediment transport rate calculation.

α	Total sediment transport (m^3/year)
0	9.231.091
5	9.630.900
10	9.753.230
15	9.602.223
30	7.303.519
90	- 298.387

I

n Sanur beach during high water, waves will eroded the beach and transport the sand to the deeper water and during low water waves cannot transport sand toward the cost because coral reef. From the mid-1960s to 1980 total coral mining about 975.000 m^3, this would result in an average lowering of the lagoon of about 0.31 m. So the cross-shore transport can be estimate (Clark, 1996).

Alternative Analysis.

Generally, there are several measures that can be considered to address the existing erosion problem. In this case is not possible to use the zero option (do-nothing) because the existing condition already damaged seriously. So according the beach required, possible alternatives will be investigated.

The merit and demerit of hard solution (Seawall, Groin, Offshore Breakwater) and Soft solution (Beach Nourishment) can be studied both from the technical and economic point of view. The selection of suitable type depends on a number of parameter like: goal and objective the project, environment impact, cost of the project, availability of material, construction. All parameter can be analysis on Multi Criteria Analysis.

To determine the solution among many possible alternatives Multi Criteria Analysis (MCA) method can be used. This method will calculate some parameter related to the project. Every parameter has different weight. The important factor will have a higher weight value. The weight values depend on the purpose of development in that area. The parameter in MCA will give indications as an advantage or a disadvantage to the alternative. The value range of the mark is set up between –5 and 5.

Table 3. Multi Criteria Analysis

	Weight Factor	Groins		Offshore Breakwater		Sea Wall / Revetment		Beach Nourishment		Groin and Beach Nourishment	
		Mark	Total	Mark	Total	Mark	Total	Mark	Total	Mark	Total
Environment	4	-2	-8	-3	-12	-1	-4	-2	-8	-2	-8
Goal & objective	5	2	10	3	15	-5	-25	3	15	5	25
Cost	3	-1	-3	-3	-9	1	3	-2	-6	-3	-9
Availably material	1	3	3	3	3	3	3	3	3	3	3
Construction	2	-1	-2	-2	-4	3	6	1	2	-2	-4
Total		0		-7		-17		6		7	
Rank		3		4		5		2		1	

Since the required of the project and the best rank, hence groin field with beach nourishment is finally recommended.

Design Consideration

According the setting goal and objective, beach nourishment proposed for this project to increase beach area for recreation and religious activity. It is important to note that nourishment material is sacrificial in nature and required periodical maintenance. Such phenomena shall be part of the design concept. Related to beach nourishment that needs to be considered with Borrow Area and Placement of Fill Material.

According to Shore Protection Manual, 1984, the basic principle to design of groin is:

- Groin can be used to interrupt long shore transport
- The beach adjustment near groin will depend on the magnitude and direction of the long shore transport.
- The groin-induced accumulation of long shore drift on the fore shore will modify the beach profile, then try to re-establish its natural shape.
- Water pushed by wave into a groin compartment will sometimes return offshore in the form of rip current along the side of groin.
- The percentage of long shore transport, which bypasses a groin, will depend on groin dimension, water level and wave climate.
- The long shore drift that is collected in the up drift fillet is prevented from reaching the down drift area, where the sand balance is upset.

There are many type of groin I, L and T. In this Project one of the groin type T proposed to protect beach nourishment shown on figure 4. Coral reef on offshore is not functional well so to reduce wave energy to the shore and keep sand nourishment groin type T proposed.

Figure 7. Combination Groin and Beach Nourishment.

Implementation

Process in the construction stage or implementation is the realization of the required situation. Monitoring and control of the environment impact during construction should be an integrated part of the program of supervision. After the groin and the scheme for nourishment are designed, site preparation can be start. Before nourishment, groin filed construction should be over.

The method for beach nourishment is starts from dredging a material in the borrow area. The dredging activities can be using a trailing suction hopper dredger (TSHD) or cutter suction hopper dredger (CSD) depending on the distance of the borrow area to the project area and the climate condition. The sand delivery to the site will be by barge and pumping using the connection pipeline from the vessel to the shore. A bulldozer then will be used to spread out the pumped sand.

Monitoring.

When the project is complicated, the work is not end at this stage. As mention before a periodic maintains program for re-nourishment need to be done, periodic inspection, routine monitoring and evaluating as well as improvement and alteration need to be done from time to time to ensure a positive outcome and to determine a success of a nourishment project.

CONCLUSION

Strategy Plan is a good guideline to define the issue by government because its involved all the preliminary investigation, data collection, dialogues, negotiation and draft paper. Development used Strategy Plan to assure the balancing between coastal defense and environment.

Since only using groins system to solve the erosion of the coastal line, the erosion in the down drift of the groin system is unavoidable. It is necessary to take other engineering measures to offset the consequence. Beach nourishment scheme with the groin construction is good alternative to be considered. One time, nourishment is sufficient with groin construction. It will be a feasible solution to create a stable beach within very short period.

RECOMMENDATION

This is quite difficult to make clear to politicians and to the public. They usually think that after nourishment the wide beach will stay in position. Everyone is very happy with the beautiful wide beach, but after the first stormy weather a large part of the new beach will disappear under water (in fact the artificial profile is adapted to a more natural one). The public does not see this sand under the water and so in their perception the nourishment is fail.

Another managerial problem with artificial beach nourishment is that the work has to be done at more-or-less regular intervals. So after several years re-nourishment have to be done again. The interval is not constant as it depends on the number of storms during that interval. That is no surprise for the technical managers of the coast, but the funding politicians prefer a solution "for ever". This requires certain flexibility in the budgeting system, which is very often not possible in public finance.

REFERENCE

1. Anonym, 2004, Bali Beach Conservation Project, Paper, Public Work Department.
2. Clark, 1996, Coastal Zone Management Handbook, Miami, USA.
3. Geense, 2005, Management of Coastal Zones in Balance with Nature, Unesco-IHE, Delft.
4. Graaff. J.V, 2000, Coastal Sediment Transport, Unesco-IHE, Delft.
5. Group work Task, 2004, Conceptual designs for Improvement of the L. Burullos Beach, Egypt, Unesco-IHE, Delft.
6. Group work Task, 2004, Feasibility Study of Coastal Defence Works for Northern Egypt, Unesco-IHE, Delft.
7. Hassan.R, 2005, Coastline Management, Unesco-IHE, Delft.
8. Pujianiki, NN, 2005, Shore Protection Work for Sanur Beach, Individual Study, Unesco-IHE, Delft.
9. Verhagen H.J. Ir, 1997, Introduction of Coastal Eng, Unesco-IHE, Delft.
10. Velden R.T.J.M. Ir, 1997, Coastal Engineering, Unesco-IHE, Delft.