

## MARINE AND COASTAL RESOURCES AND THE ECONOMIC VALUES OF TOGEAN ISLANDS, CENTRAL SULAWESI

(Sumber Daya Kelautan dan Pesisir dan Nilai Ekonomi  
Kepulauan Togeian Sulawesi Tengah)

By/Oleh :

Yatin Suwarno<sup>1</sup> dan Irmadi Nahib<sup>2</sup>

<sup>1</sup>Peneliti Madya Bidang Penginderaan Jauh

<sup>2</sup>Peneliti Madya Bidang Sistem Informasi Geografi

Jl Raya Jakarta Bogor KM 46 Cibinong 16911

Email : [yatinsuwarno@yahoo.com](mailto:yatinsuwarno@yahoo.com) dan [irmnahib@yahoo.com](mailto:irmnahib@yahoo.com)

### ABSTRAK

Lokasi penelitian adalah Kepulauan Togeian, yang terletak di tengah Teluk Tomini, Provinsi Sulawesi Tengah- Indonesia. Tujuan dari penelitian adalah: untuk mengetahui potensi sekarang, tren degradasi, dan nilai-nilai ekonomi dari sumberdaya laut dan pesisir di Kepulauan Togeian. Metode untuk inventarisasi sumber daya digunakan remote sensing dan teknologi sistem informasi geografis. Penilaian ekonomi sumber daya dengan menggunakan metode biaya perjalanan, efek pada metode produksi, dan keuntungan metode transfer. Hasil dari penelitian ini adalah terutama bagi ekosistem terumbu karang dan ekosistem mangrove. Luas wilayah ekosistem terumbu karang di Kepulauan Togeian 36,834.12 Ha, dapat diklasifikasikan sebagai terumbu karang 30,116.71 Ha (81%), rumput laut adalah 1,343.24 Ha (4%), dan pasir adalah 5,374.17 (15%). Selama sepuluh tahun (1997-2007), terumbu karang penurunan 91,07 Ha, tetapi rumput laut dan pasir meningkat 25,46 Ha dan 65,61 Ha. Jenis-jenis terumbu karang tipologi selesai: renda karang, karang penghalang, jalan karang, dan atol. Nilai ekonomi ekosistem terumbu karang sebagai ekowisata didasarkan pada metode biaya perjalanan sebesar Rp. 16,649,062.000 / tahun (US \$ 1,664,906.2 / tahun) dan produksi ikan karang efek didasarkan pada produksi adalah Rp. 68.417.000 / tahun (US \$ 6,841.7 / tahun). Luas wilayah ekosistem mangrove di Kepulauan Togeian 11,932.81 Ha, dikelompokkan menjadi 4 (empat) kelas: daerah kepadatan rendah adalah 2,979.52 Ha (24,97%), kawasan kepadatan sedang 1,504.95 Ha (12,61%), daerah kepadatan tinggi adalah 4,046.74 (33,91%), dan non hutan adalah 3,228.65 Ha (27,06%). Selama sepuluh tahun (1997-2007), kepadatan rendah bakau penurunan 1.485.836 Ha; non penurunan hutan 2.651.855 Ha. Jika tidak, moderat mangrove mangrove kerapatan dan kepadatan tinggi meningkat 3.244.543 Ha dan 1.005.475 Ha. Salah satu ekosistem mangrove nilai pakai langsung potensi mangrove adalah kepiting (*Scilla serrata*), total keuntungan adalah Rp. 3465600000 / tahun (US \$ 346.560 / tahun). Nilai pakai tidak langsung didasarkan pada biaya penggantian untuk penyangga pantai (break air) adalah Rp. 467.723.000.000 / tahun (US \$ 46.772.300 / tahun).

### ABSTRACT

The location of the research is Togeian Islands, located in the middle of Tomini Bay, Province of Central Sulawesi – Indonesia. The objectives of the research are: to know the present potential, the degradation trend, and the economic values of marine and coastal resources at Togeian Islands. The methods for resources inventory used remote sensing and geographic information system technologies. Resources economic valuation by using

travel cost method, effect on production method, and benefit transfer method. The results of this research are especially for coral reef and mangrove ecosystems. The total area of coral reef ecosystem at Togean Islands is 36,834.12 Ha, can be classified as 30,116.71 Ha (81%) of coral reef, 1,343.24 Ha (4%) of sea grass, and 5,374.17 (15%) of sand. Within ten years (1997-2007), coral reef has decreased 91.07 Ha, but sea grass and sand have increased 25.46 Ha and 65.61 Ha. The kinds of coral reef typologies completed: fringing reef, barrier reef, path reef, and atoll. Economic values of coral reef ecosystem as ecotourism based on travel cost method was Rp. 1,664,062,000/year (US \$ 1,664,906.2/year) and coral fish production based effect on production was Rp. 68,417,000/year (US \$ 6,841.7/year). The total area of mangrove ecosystem at Togean Islands was 11,932.81 Ha, and were classified into 4 (four) classes: low density area was 2,979.52 Ha (24.97%), moderate density area was 1,504.95 Ha (12.61%), high density area was 4,046.74 (33.91%), and non forest was 3,228.65 Ha (27.06%). Within ten years (1997-2007), low density mangrove has decreased 1,485,836 Ha; non forest has decreased 2,651,855 Ha. Otherwise, mangrove moderate density and mangrove high density have increased 3,244,543 Ha and 1,005,475 Ha. One of mangrove ecosystem direct use value is potency of mangrove crab (*Scilla serrata*), with the total benefit of Rp. 3,465,600,000/year (US \$ 346,560 /year). Indirect use value based on replacement cost for coastline buffer (break water) was Rp. 467,723,000,000/year (US \$ 46,772,300/year).

**Keywords :** Marine and Coastal, Resources, Economic Value

**Kata Kunci:** Pesisir dan Laut, Sumber Daya, Nilai Ekonomi

## I. BACKGROUND

Mangrove ecosystem spread almost throughout the coastline islands in the Togean Islands. A seagrass ecosystem in the Togean Islands relatively less when compared with the coral reef ecosystem and mangrove ecosystem. The result of spatial analysis show the broad ecosystem of the Togean island seagrass in the year 2007 is 189.69 hectares, while the coral reef area in 2007 is 9767.98 hectares (Zamani, 2007).

Coral reefs have an important role in the sea, other than as a protector of the coast from abrasion of currents and waves attacks, coral reef ecosystem also have ecological functions, namely as a habitat for biota, feeding ground (search for food), spawning, and nursery ground (breeding region) various types of marine organisms such as fish, crustaceans, molusca, echinodermata, polikhaeta, and other biota that lived in the vicinity.

Togean Island National Park (TINP) as defined by Decree of the Minister of Forestry, Republic of Indonesia No.418/Menhut-II/2004. The area of TINP has a

wide 362,605 ha, covering a land area of 25,832 ha and 336,773 ha water area. The land area include:  $\pm$  10,659 ha of forest protection,  $\pm$  193 ha of limited forest production,  $\pm$  11,759 ha of forest production remains, and  $\pm$  3,221 ha of converted forest production.

According to the BKSDA's and BAPPEDA's Poso data, the extensive mangrove forest Togean Islands is estimated around 4,800 ha spread in several large islands such as Talatakoh, Togean, Batudaka, and some Walea Bahi island. The existence of mangrove forest in the Togean Islands is not only to maintaining the integrity of the coastline but also to bolster up the potential of fisheries and the coral reef ecosystem as the mainstay of community life Togean. Although the area is not really large enough but mangrove forest has a very important function for Togean Island, which is the area of small islands.

## II. RESEARCH LOCATION

The location of research at Togean Islands, located in the middle of Tomini



Bay with coordinates S of  $0^{\circ}08'21''$  -  $0^{\circ}45'12''$  and the E of  $121^{\circ}33'36''$  S -  $121^{\circ}34'35''$  (Figure 1). The area of Togean Islands is  $\pm 755.4 \text{ km}^2$ , consists of  $\pm 66$  small and large islands, where the island Una Una, Batudaka, Togean, Talatakoh, Waleakodi and Waleabahi. Togean archipelago consists of 4 districts, they are Una Una, Togean, Walea and Walea Besar, consists of 47 villages with a population of 36,141 peoples.

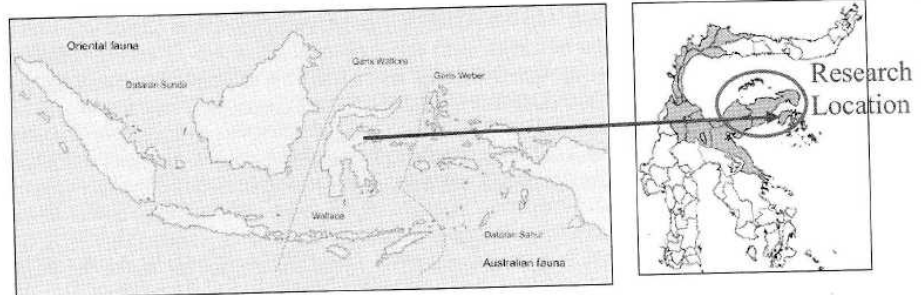


Figure 1. Research Location

#### IV. METHODS

##### 4.1. Materials and Tools

Materials were used in this research are the following:

- ALOS AVNIR 1-B imagery (recorded of 2007) and Landsat TM imagery (recorded of 1997).
- Maps of Coastal Environment on scale 50.000. The map sheets are: Una-una (2215-01), Bomba (2215-02), P. Malingi (2215 04), Togian (2115 05), and Dolong (2215-07).
- Social economic data from field in depth interview.
- Secondary data, both spatial data and textual data.

Tools are used in this research including for laboratory tools and field survey equipments are:

#### III. OBJECTIVES

The objectives of this research are:

- To know the potential and the condition of marine and coastal resources (especially of coral reef and mangrove) at Togean Islands.
- How the degradation trend of each resources for last ten years (1997 2007).
- To know the economic values both direct use values and indirect use values of each resources or ecosystems.

- Hardware: notebook, printer, plotter, and scanner.
- Software: image processing (ER-Mapper ver.7.0, ENVI ver.4.3), spatial analysis (ArcView GIS ver.3.3), and words processing (Excel 2003, MS-Word 2003).
- Field survey equipments: global positioning system, video and camera, voice recorder, questionnaire list, etc.

##### 4.2. Resources Inventory Methods

For resources inventory methods are used remote sensing and geographic information system technologies. The resources methods steps both for coral reef and mangrove as the following in Figure 2.

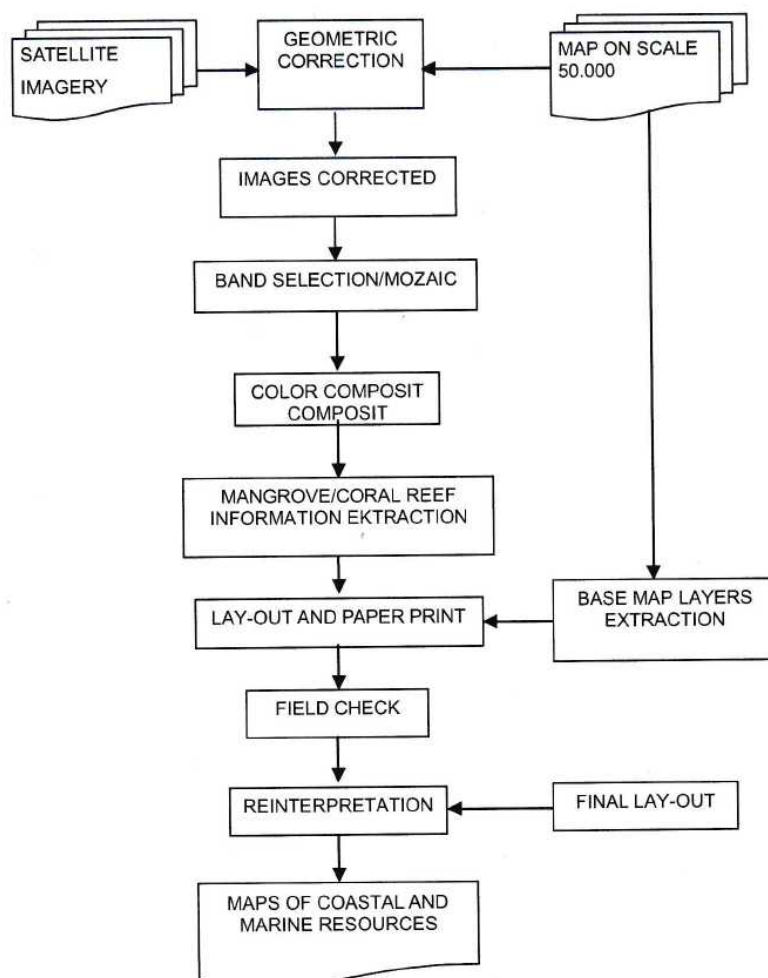


Figure 2. Scheme of resources inventory data steps

#### 4.3. Economic Valuation Methods

##### a. Travel Cost Method

Travel cost approach available for environmental service of coral reef ecosystem related with recreation activity. In this method some basic assumption will be used:

- Every visitor is grouping based on stay or her/his country, while they have same preference assumption.
  - Every visitor will give same reaction for travel cost increasing, and for entry and stay costs increasing.
- The steps of follow up some assumptions as the following:
- Random sampling selection of tourism or visitors.

- How the distant and frequency of visitors traveling to location on one year.
- Visitors classified based on distance from visitor countries to location.
- Travel cost estimation for every group and total average visitors from each country.
- Test of correlation between travel cost and total visitors.

Correlation between travel costs and total visitors is assumption that representative of recreation demand. Travel costs represent of recreation cost and total visitors represent of recreation quantity.

#### b. Effect on Production Method (Change in Productivity Method)

The principle of this method is to see how the production impact caused intervention its resources. This approach to see that the productivity and cost production will be affected by environmental quality changes, cost and production will be affect. This approach value measured is direct use value of resources extraction. Coral reef ecosystem have been some function as spawning ground, nursery ground, and feeding ground, all these as input for productivity reef fish capture.

The simple equation will be used in this production approach as bellow:

$$CP = C * P$$

Where:

CP: Commodity Price (Rp)

C : Commodity (kg)

P : Price (Rp/kg)

Analysis of each alternative to calculate of allocation benefits of coral reef ecosystem be used Cost-Benefit Analysis (CBA) or Net Present Value (NPV).

- Benefit Cost Ratio (BCR ). These equations are the following:

$$NPV = \sum_{t=1}^n \frac{(B_t - C_t)}{(1+r)^t}$$

$$BCR = \frac{\sum_{t=1}^n \frac{B_t - C_t}{(1+r)^t}}{\sum_{t=1}^n \frac{C_t - B_t}{(1+r)^t}}$$

where:

$B_t$ : Direct benefit on t time (Rp)

$C_t$ : Direct cost on t time (Rp)

t : time (year)

r : discount rate

#### c. Benefit Transfer Method

Benefit transfer is the process of taking an existing value estimate and transferring it to a new application that is different from the original one (Boyle and Bergstrom, 1992).

### V. RESULT AND DISCUSSION

#### 5.1. Coral Reef Ecosystem

##### a. Area, Distribution, and Degradation

Coral reef ecosystem of Togean Islands can be classified into 3 (three) class: coral reef, sea grass, and sand. Based on interpretation result from ALOS Imagery (2007) and ground check (2008), the total area is 36834.12 Ha (Table 1).

Distributions of each class are: coral reef area 30116.71 Ha (81%), sea grass area 1343.24 Ha (4%), and sand area 5374.17 (15%). The kinds of coral reef typologies are completed: fringing reef, barrier reef, path reef, and atoll.

To know the coral reef ecosystem degradation or coral reef ecosystem changes at Togean Islands be comparing with data from Landsat Imagery (1997). For ten years (1997



2007), coral reef was decreasing 91.07 Ha, but sea grass and sand are increasing 25.46 Ha and 65.61 Ha (Figure 3).

### c. Ecotourism Economic Value

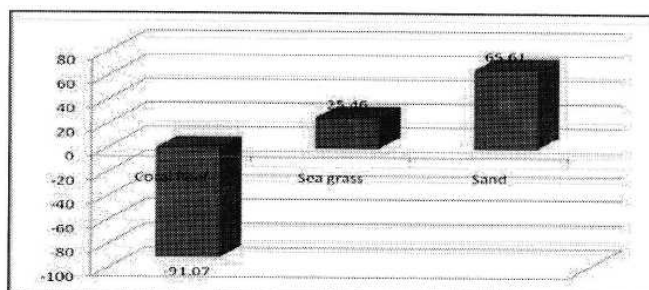
Some site or location at Togean Islands was managed by non government travel bureau for ecotourism business. The popular location is Kadidiri Island at Togean Sub District, was managed by Black Marlin Dive and Paradise Dive, also Tanjung Keramat at Walea Besar Sub District by Wallacea Dive (Figure 4).

Economical valuation of coral reef ecotourism at Kadidiri Island by using travel cost method with zone model approach. Cost component is the total of travel cost and stay cost for each visitor. Travel cost is calculated based on ticket return price from each visitors country be added travel cost from Jakarta to location. Ticket price is rate price from some travel. Stay cost include room or cottage cost (averageRp200.000/person/day) and leasing costfor diving and snorkeling tools. Visitor's data can be grouping on 8 (eight) groups or zone, and average cost component on total visitors and country can be seeing on Table 2.

**Table 1.** Distribution area of coral reef ecosystem

Ecosystem Class	1997		2007		Changes (Ha)
	(Ha)	(%)	(Ha)	(%)	
Coral Reef	30207.78	82	30116.71	81	(91.07)
Sea grass	1317.78	4	1343.24	4	25.46
Sand	5308.56	14	5374.17	15	65.61
Total	36834.12	100	36834.12	100	00.00

Source: Landsat Imagery (1997) ALOSS Imagery (2007), Field Check (2008)



**Figure 3.** Coral reef ecosystem changes (1997-2007)

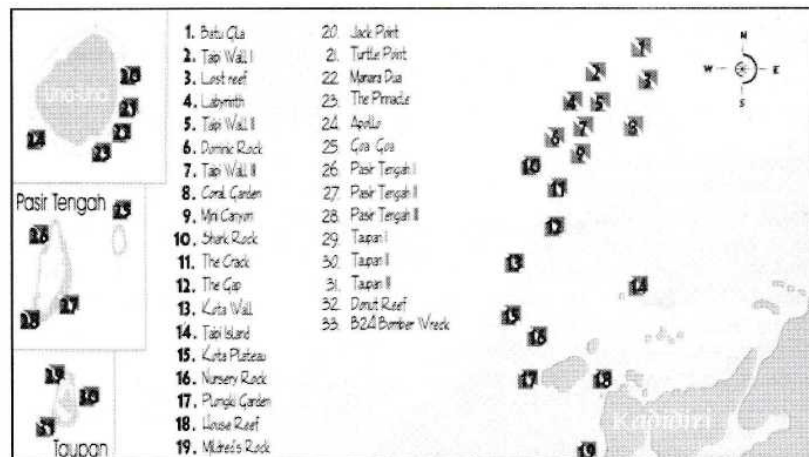


Figure 4. Populer Places for diving and Snorkeli

Table 2. Visitors and Cost Estimate at Kadidiri Island (2007)

Zone	Country	Visitor		Total Cost	
		(person)	(%)	(xRp.1.000)	US \$
1	Indonesia	6	1.54	24697	2469.7
2	Asia	1	0.26	20512	2051.2
3	Australia	2	0.51	55086	5508.6
4	Africa	3	0.77	204228	20422.8
5	South America	2	0.51	178884	17888.4
6	North America	27	6.94	1193647	119364.7
7	East Europe	37	9.51	1937879	193787.9
8	West Europe	311	79.95	13034129	1303412.9
	Total	389	100.00	16649062	1664906.2

Sources: *Paradise Dive* (2007), *Black Marlin Dive* (2007), *Field Survey* (2008)

According to the result calculation (see Table 2), the economic value of coral reef ecosystem as ecotourism at Kadidiri Island based on travel cost method is Rp. 16 649,062.000/year (US \$ 1,664,906.2/year). The three top visitors are from: West Europe (79.95%), East Europe (9.51%), and North America (6.94%). Others country visitors (except Indonesia) are not significant (less than 1%).

#### d. Coral Fish Economic Value

The main components to calculate of coral fish economic value is costs and benefits. Costs mean the total cost

from fisherman, including initial cost (ship, machine, etc.), operational cost (premium/solar, logistics, etc.), and maintenance coast (oil, coating, etc.). A component of benefit is fish production (kg/trip) and fish average local price (Rp/kg).

Coral fish fisherman at Togean Islands is unknown, so be used estimate based on total population. The total population of Tojo Una Una Regency is 31,370 (2005), where 3,532 people is fisherman, while be assumption of 67% or 2,355 people is coral fish fisherman.

Based on interview for 31 responden coral fish fisherman that

average trip is 274 trip/year, average production 7.5 kg/trip (1 937 kg/year), and average price is Rp. 20,803/kg.

Cost Benefit Analysis including Net Present Value (NPV) and Benefit Cost Ratio (BCR). The final results are: average cost is Rp. 27,249,000/year and average benefit is Rp. 68,417,000/year, so the NPV is Rp. 41,169,000/year (US \$ 4,116.9/year) and is BCR 2.31.

## 5.2. Mangrove Ecosystem

### a. Area, Distribution, and Degradation

Mangrove ecosystem of Togean Islands can be classified into 3 (three) density class (low, moderate, and high) and non forest class. Based on

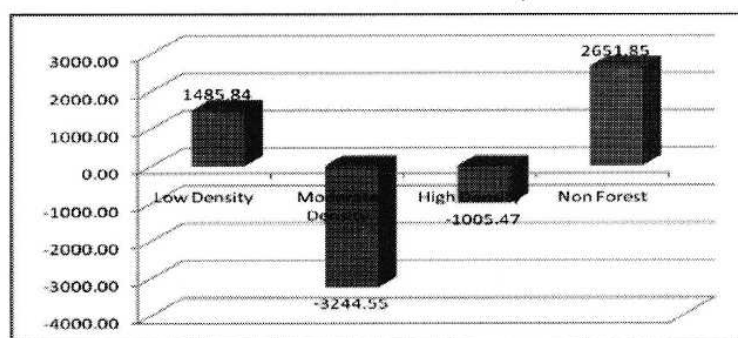
interpretation result from ALOS Imagery (2007) and ground check (2008), the total area is 11,932.81 Ha (Table 3). Distributions of each class are: low density area is 2,979.52 Ha (24.97%), moderate density area is 1504.95 Ha (12.61), high density area is 4046.74 (33.91%), and non forest class is 3228.65 Ha (27.06%).

To know the mangrove ecosystem degradation at Togean Islands be comparing with data from Landsat imagery (1997). For ten years (1997-2007), mangrove low density was decreasing 1,485,836 Ha, non forest was decreasing 2,651,855 Ha. Otherwise mangrove moderate density and high density are increasing 3,244,543 Ha and 1,005,475 Ha (see **Tabel 3** and **Figure 5**).

**Table 3.** Distribution area of mangrove ecosystem

Density Class	1997		2007		Changes(1997-2007)	
	Ha	%	Ha	%	Ha	%
Low Density	1,493.68	12.52	2,979.52	24.97	-1,485,836	-12.45
Moderate Density	4,749.49	39.80	1,504.95	12.61	3,244,543	27.19
High Density	5,052.21	42.34	4,046.74	33.91	1,005,475	8.43
Non Forest	576.79	4.83	3,228.65	27.06	-2,651,855	-22.22
Total	11,932.82	100.00	11,932.81	100.00	0.00	0.00

Sources: Landsat Imagery (1997), ALOS AVNIR-IB Imagery (2007), Field Check (2008).



**Figure 5.** Mangrove ecosystem changes (1997-2007)



#### **b. Mangrove Crab (*Scilla serrata*) Economic Value**

One of direct use value of ecosystem mangrove at Togean Islands is potential of mangrove crab (*Scilla serrata*). Some data or information is get from some respondent's interview as the following:

- Average production is 2.5 kg/day.
- Average trip is 2 trip/week or 8 trip/month or 96 trip/year.
- Local price is depend on size and quality, from Rp.25.000/kg to Rp. 50.000/kg (average price Rp. 40.000/kg).
- No cost for modal, operational and maintenance.

If the assumption that mangrove crab fisherman at Togean Islands is 361 people (1% of total population), the total benefit is Rp. 3,465,600,000/year (US \$ 346,560 /year).

#### **c. Indirect Use Value**

One of indirect benefit of mangrove ecosystem at Togean Island is indirect use value based on replacement cost such as coastline buffer (break water). This value can be estimate by replacement cost method, how many cost to make of break water.

Refer to Aprilwati (2001), estimation value of break water replacement cost (dimension of 1m x 1m x 2,5m) for 10 year is Rp. 4.153.880,00 (if inflation is 8%/year, break water cost on 2008 is 1,56 x Rp. 4.153.880 = Rp. 6.480.052).

If the mangrove buffer coastline at Togean Islands is 721,789 m, the cost of break water for 10 year is Rp. 467,723,000,000/year.

#### **VI. CONCLUSION**

- a. Total area of coral reef ecosystem at Togean Islands is 36834.12 Ha,

be classified coral reef area is 30116.71 Ha (81%), sea grass area is 1343.24 Ha (4%), and sand area is 5374.17 (15%). For ten years (1997-2007), coral reef was decreasing 91.07 Ha, but sea grass and sand are increasing 25.46 Ha and 65.61 Ha.

- b. The economic value of coral reef ecosystem as ecotourism at Kadidiri Island based on travel cost method is Rp. 16,649,062.000/year (US \$ 1,664,906.2/year). The result of Cost Benefit Analysis of coral fish: Net Present Value = Rp. 41,169,000/fisherman/year (US \$ 4,116.9/year), and Benefit Cost Ratio = 2.31.
- c. The total area of mangrove ecosystem at Togean Islands is 11,932.81 Ha, distributions of each class are: low density area is 2,979.52 Ha (24.97%), moderate density area is 1504.95 Ha (12.61), high density area is 4046.74 (33.91%), and non forest class is 3228.65 Ha (27.06%). For ten years (1997-2007), mangrove low density was decreasing 1,485,836 Ha, non forest was decreasing 2,651,855 Ha. Otherwise mangrove moderate density and high density are increasing 3,244,543 Ha and 1,005,475 Ha.
- d. The total benefit of mangrove crab (*Scilla serrata*) at Togean Islands is Rp. ,3 465,600,000/year (US \$ 346,560 /year). Indirect use value of ecosystem mangrove for buffer coastline (break water)Rpis 467,723,000,000/year (US \$ 46,772,300/year).

#### **REFERENCES:**

- Bengen, D.G. 2001. *Ecosystems and Natural Resources of Coastal and Marine*. Center for Coastal and Marine Resources Study. Bogor Agricultural University. Bogor.

Marine and Coastal Resources and the Economic Values .....(Suwarno, Y. and Nahib, I.)

Choudhury, J and Putranto, B. 1996. *Mangrove Forest Management*. Asian Development Bank and directorate General of Reforestation and Land Rehabilitation, Ministry of Forest of Republic of Indonesia.

Dahuri, R., J. Rais, S.P. Ginting dan M.J. Sitepu. 2002. *An Integrated Management of Coastal and Marine Resources*. Pradnya Paramitha. Jakarta.

Fauzi, A., et. al., 2004. *Depletion and Degradation Analysis of Coastal and Marine Resources*. Center for

Marine Resources. National Coordinating for Surveys and Mapping Agency. Cibinong.

Kusumastanto, T. 2000. *The Economical Resources and Environmental*. Coastal and Marine Resources Management Program - Bogor Agricultural University. Bogor.

Nybakken, J.W. 1988. *A Marine Biology as Ecologies Approach*. Translated by M. Eidman, D.G. Bengen, Koesoebiono, M. Hutomo dan S. Sukarjo. Gramedia. Jakarta. 410 pages.