Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 161 (2021) 77-89 EISSN 2392-2192

The Effect of Seasons on Green Turtle (*Chelonia mydas* (Linnaeus, 1758)) Egg Laying Activity at Pangumbahan Beach, Sukabumi, West Java, Indonesia

Fian Fathulloh[1,*], Sunarto[2], Sri Astuty[2], Ibnu Faizal[2]

[1]Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor, Sumedang 45363, West Java, Indonesia

[2]Department of Marine, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor, Sumedang 45363, West Java, Indonesia

*Email Address: fian16001@mail.unpad.ac.id

ABSTRACT

Green Turtle (*Chelonia mydas*) is one of the turtles whose populations are decreasing. Seasonal dynamics can affect the nesting habitat of Green Turtles at Pangumbahan Beach. This research aims to analyze how much influence the season has on Green Turtle nesting activity at Pangumbahan Beach, Sukabumi Regency. This research was conducted in August-September 2020 using survey and observation methods. The research results were analyzed descriptively comparatively. The primary data used are data on the width of the beach and the slope of the coast, while the secondary data used are data on wind, rainfall, currents, waves and data on the landing of the Green Turtle (*Chelonia mydas*) at Pangumbahan Beach 2015-2019. Regression analysis showed that the beach's width and slope determine the amount of Green Turtle that landed in 2016 -2019 with an R of 0.8826 and 0.7806, respectively. Wind and current variables do not correlate. Rainfall has a reasonably strong relationship with the Green Turtle landing in the Transitional Season-I with a correlation coefficient of 0.528. The waves have a reasonably strong relationship with the Green Turtle landing in the West Season with a correlation coefficient value of 0.572. While the relationship between each variable and the number of Green Turtle eggs does not show a relationship.

***Keywords*:** Season, Turtle landing, Green Turtle, *Chelonia mydas*, Pangumbahan Beach

(Received 15 August 2021; Accepted 04 September 2021; Date of Publication 05 September 2021)

1. INTRODUCTION

Turtles are included in marine reptiles whose population is currently decreasing. Turtles themselves include living things with a high migration rate and returning to the beach when laying eggs [1]. Six of the seven turtle species lays eggs on the coast of Indonesia. The dominant turtle species found was the Green Turtle (*Chelonia mydas*) [2]. All turtle species have been included in the *Red List* at the IUCN (International Union for Conservation of Nature), indicating that the turtle is an endangered animal. Turtles are also included in Appendix I CITES (*Convention on International Trade in Endangered Species of Wild Flora and Fauna),* which means that turtles are prohibited from being traded for commercial purposes [3]. The Green Turtle (*Chelonia mydas*) is the most dominant species of turtle in some turtle nesting areas in Indonesia [4]. The Green Turtle (Chelonia mydas) has existence in Indonesia since ancient times has been hunted for its meat and eggs [5].

Pangumbahan Beach is one of the beaches used as a habitat for Green Turtles (*Chelonia mydas*). It is located in Sukabumi Regency. The location of Pangumbahan Beach borders directly to the Indian Ocean makes this beach has high waves [6]. Waves are one of the marine phenomena that significantly affect marine life, especially in coastal areas [7]. Wave height can cause currents parallel to the coast and perpendicular to the coast, resulting in a deposit of coastal material until abrasion occurs [8]. One of the conditions for turtles to choose a beach as a nesting location is a coastal vegetation [9]. Vegetation in the nesting area will provide comfort for turtles when laying eggs [10]. The biophysical condition of Pangumbahan Beach, which is suitable for turtle nesting habitat, makes it a nesting place [11].

The type of turtle often found on Pangumbahan Beach is the Green Turtle (*Chelonia* mydas) [2]. However, based on green turtle nesting activity data obtained from the Pangumbahan Coastal Turtle Park, egg production and green turtle hatchlings from 2015 to 2018 decreased. Turtles are classified as sensitive and selective animals in laying eggs [12]. Many turtles are found only landing and not laying eggs [13]. Local environmental conditions, such as seasons and food availability in the sea, affect the nesting activity of Green Turtles [14]. In addition, egg-laying activity is also influenced by several factors, including tides, vegetation cover, width and slope of the beach and the type of sand [15]. In addition, the brightness level and human activity around the nesting habitat play an important role in the turtle nesting process. Not a few turtles cancel their egg-laying activities because of many disturbances [16].

Based on this background, it is necessary to research the analysis of the influence of the season on the egg-laying activity of the Green Turtle (*Chelonia mydas*) at Pangumbahan Beach Sukabumi Regency. This research is expected to assist the management of coastal areas, especially the nesting habitat of the Green Turtle (*Chelonia mydas*) on Pangumbahan Beach, Sukabumi Regency [31-34].

2. MATERIALS AND METHODS

2. 1. Research Locations

This research was conducted in August-September 2020. The observed area is the nesting habitat of the Green Turtle (*Chelonia mydas*) in the Pangumbahan Beach area, Sukabumi Regency. There are six research stations, with data on the coordinates of each station, as shown in Figure 1.

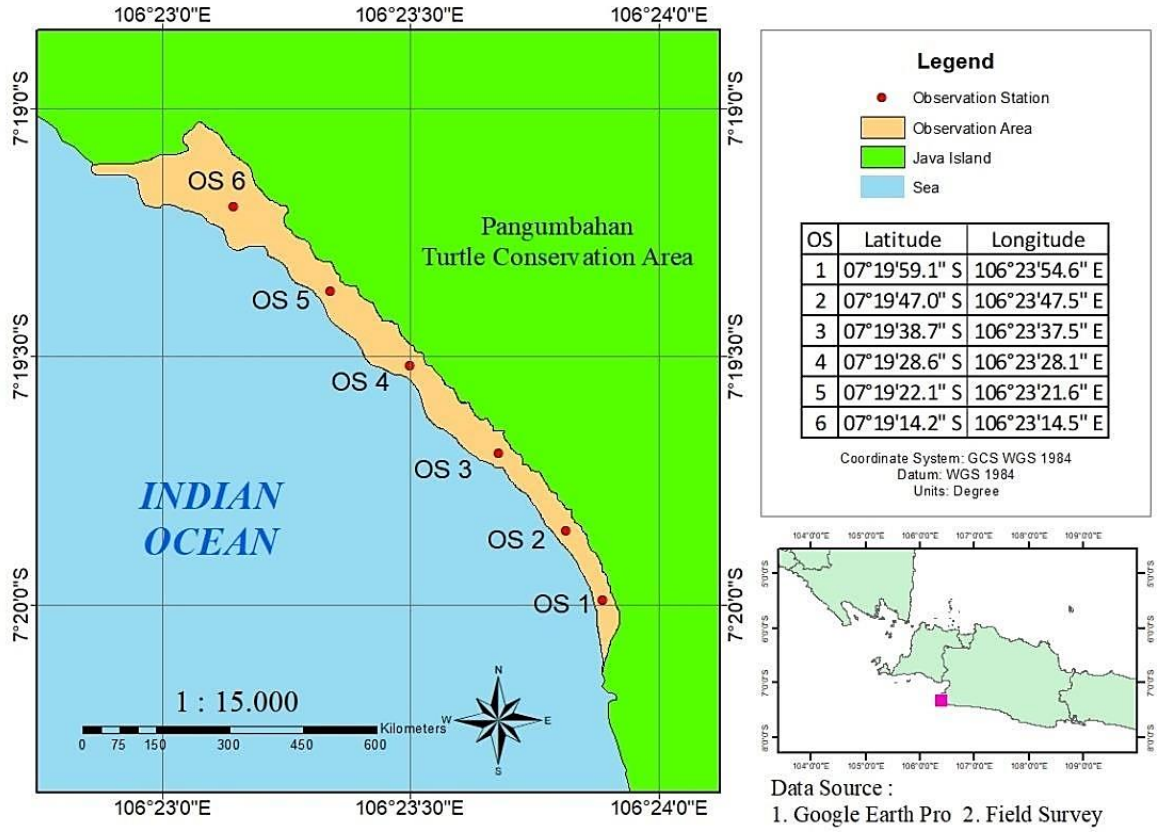

Figure 1. Map of research locations (Sukabumi Regency, West Java, Indonesia).

2. 2. Research Methods

Table 1. Research Data Set.

Data	Resolution		Source
	Spatial	Temporal	
Number of mother turtles landing and laying eggs, number of eggs and number of hatchlings	-	Monthly (2015-2019)	Pangumbahan Turtle Conservation Center 2015-2019
Wave	25 km	Season (2015-2019)	ERDDAP Ocean
Currents	1/12° (~0.08)	Season (2015-2019)	HYCOM
Wind	1.1 km	Season (2015-2019)	ECMWF
Rainfall	3 km	Monthly (2015-2019)	BMKG and TRMM

Primary data measured include; the width and slope of the beach and other biophysical parameters of the green turtle nesting habitat in the Pangumbahan Beach area. Secondary data observed in this study include; satellite image data, wind data, wind data, current data, significant wave data and data on the number of green turtles that landed in the Pangumbahan Beach area. Secondary data processing using *Ocean Data View 4*, *ArcGIS* 10.3 and *OpenGrads*.

The width and slope data of Pangumbahan Beach uses reference data from the journal The Influence of Tidal on the Nesting Activity of Green Turtle (Chelonia mydas (Linnaeus, 1758)) at Pangumbahan Beach, Sukabumi Regency, West Java, Indonesia [2]. Secondary data showed in Table 1.

2. 3. Data Analysis Data analysis

This research uses comparative descriptive analysis. The function of the comparative descriptive is to compare the image data from the identification of wind, currents, waves and rainfall with the total landing of Green Turtle (*Chelonia mydas)* to get an idea of the effect of season on the Green Turtle (*Chelonia mydas)* landing rate for five years in Pangumbahan Beach. In addition, to strengthen the results obtained, the researchers conducted a linear regression analysis to see the size of the influence of the season on the Green Turtle Landing (*Chelonia mydas)* in the Pangumbahan Beach area. The data from season identification and the number of Green Turtle (*Chelonia mydas*) landings were analyzed comparatively to determine the effect of season on the number of Green Turtle landings.

3. RESULTS AND DISCUSSION

3. 1. Physical Condition of Pangumbahan Beach

The width of the beach required by the Green Turtle (*Chelonia mydas*) to lay eggs ranges from 30-80 m. The results of in-situ measurements of the beach width at six stations obtained the Pangumbahan beach width of 28 m to 98 m, with the highest beach width of 98 m at Station 6 and the lowest beach width at Station 2, which is 28 m [2]. Station 6 has a beach width that does not match the nesting habitat characteristics of the Green Turtle (*Chelonia mydas*).

The slope of the beach is one of the factors in the selection of nests by turtles for laying eggs [17]. The ideal beach slope can increase the hatching rate of turtles [18]. The average slope of Pangumbahan Beach is 3.36° [2]. Station 2 has a high slope level of 5.77°, and Station 5, with a slope of 1.54°, is the station with the smallest slope angle value [2]. Green turtles will choose the beach as their nesting place with a slope angle of less than 30°. Based on the measurement results of the coastal slope in the Pangumbahan Beach area, the beach slope is suitable for all stations because it has a beach slope of less than 30° [19].

3. 2. Analysis of Seasonal Dynamics of Pangumbahan Coastal Area The

Wind dynamics, rainfall, currents, and waves are undoubtedly related to each other. The wind is the primary driver of currents and waves [20]. In addition, the wind also regulates the distribution of rainfall to the territory of Indonesia. From 2015 to 2019, the West Monsoon winds of Pangumbahan Beach moved at a speed of 1.3 m/s - 8 m/s. This affects the intensity of rainfall. The current velocity during the west monsoon moves at a speed of 0.00 m/s - 0.34 m/s, and the average significant wave generated is 1.04 meters.

Entering the Transitional Season-I, which occurs in March, April and May, the wind distribution becomes complex because this period is a transition period from the West monsoon to the East monsoon [21]. The wind moves at a speed of 1.4 m/s - 4.1 m/s and moves from various directions. The intensity of rainfall decreased when compared to the previous season. The current speed during the West Season moves at a speed of 0.00 m/s - 0.48 m/s, and the average significant wave that is generated is 1.32 meters.

East Season, which occurs in June, July and August, wind conditions change. The wind moves with a dominant speed of 2.8 m/s - 6.6 m/s. The intensity of rainfall decreased drastically [22]. In addition, the current speed during the East Season moves at a speed of 0.00 m/s - 0.48 m/s and the average significant wave generated is 1.65 meters. This wave height is the highest wave height from other seasons.

Entering the Transitional Season-II, which occurs in September, October and November, the wind distribution becomes complex because this period is a transition period from the east monsoon to the west monsoon [23]. The wind moves at a 2.4 m/s - 5.8 m/s and moves from various directions but predominantly moves from the southeast. The intensity of rainfall also increased when compared to the previous season. The current speed during this season moves at a speed of 0.00 m/s - 1.61 m/s, and the average significant wave generated is 1.39 meters.

3. 3. Analysis of Beach Physical Conditions on Green Turtle (*Chelonia mydas*) Egg Laying Activity

Green turtle landing data on Pangumbahan Beach showed a variety of numbers. Several factors that influence turtle landing are the beach's physical and biological characteristics, including beach width, beach slope, sand percentage, sand temperature, light intensity, food availability, and coastal vegetation [24].

Table 2. Comparison of Green Turtle (*Chelonia mydas*) Landing Number with Physical Condition in Pangumbahan Beach 2015-2019.

Year	Number of Landing Turtles (tails)	Beach Width (m)	Beach Slope (°)
2015	575	31-45	28
2016	1150	20-51	24
2017	1664	26-38	13
2018	668	6-15	40
2019	1560	20-62	17

(Source: Pangumbahan Beach Turtle Park Report 2015-2019)

The analysis of Pangumbahan Beach's physical condition shows that Pangumbahan Beach meets the requirements as a habitat for Green Turtles to lay eggs. The width of the beach and its slope are following the characteristics of the turtle habitat.

In 2015, the condition of the width and slope of the beach was appropriate, but the number of Green Turtle landings was relatively small. This happened because many fishers caught shrimp fry in the Pangumbahan Beach conservation area. In the same year, the number of re-landings increased in the following two years. However, in 2018 the number of landings again dropped dramatically to 668. The big waves have changed the topography of the beach. It caused the width of the beach to be shorter and the slope of the beach to increase.

The number of Green Turtle (*Chelonia mydas*) landings rose again the following year. This condition happens because the beach condition is improving. The width of the beach and the slope is back to normal. The comparison of the number of Green Turtle landings with the physical condition of the beach (beach width and beach slope) forms a relationship where habitat conditions are a factor that affects the number of Green Turtle (*Chelonia mydas*) landings, the higher the beach width, the more turtles need to land to lay their eggs. Meanwhile, the coastal slope parameter forms a relationship where the Green Turtle landing will be many if the beach slope is low.

3. 3. 1. Relationship of Beach Width Condition with Number of Turtles Landing

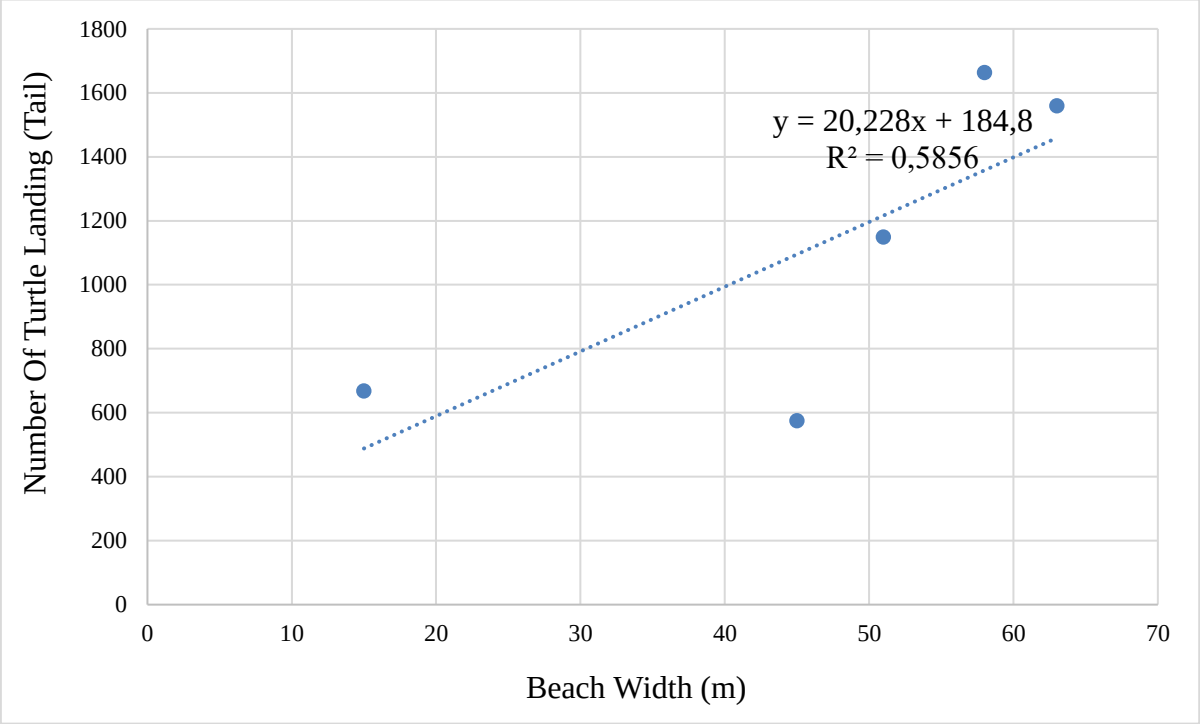

Figure 2. Graph of Relationship of Beach Width with Number of Turtles Landing

In Figure 2, it can be seen that the value of the regression analysis of the relationship between beach width conditions and the number of Green Turtles landing in 2015 is R^2= 0.5856, which means the relationship between the two is sufficient. However, the regression value from 2016 to 2019 is R2 = 0.8826, which shows a close relationship between the landing number and the beach width. The regression analysis results follow the Mustaqim in 2020, which says that green turtles tend to choose beaches with a width of more than 30 meters.

3. 3. 2. The Relationship between Coastal Slope Conditions and Number of Green Turtles Landing The

Relationship analysis between the slope of the beach and turtles landings' number on Pangumbahan Beach is supported by the results of linear regression analysis with $R^2 = 0.7806$ (Figure 3). Conditions which can be considered a strong relationship as it approaches the value 1. The research results following the results of research Mustaqim 2020 green turtle nesting on the beach Cipatujah tend to prefer gently sloping beach conditions and strengthened by regression analysis with a value of $R^2 = 1$. The steep slope makes it difficult for turtles to reach the nesting area [19].

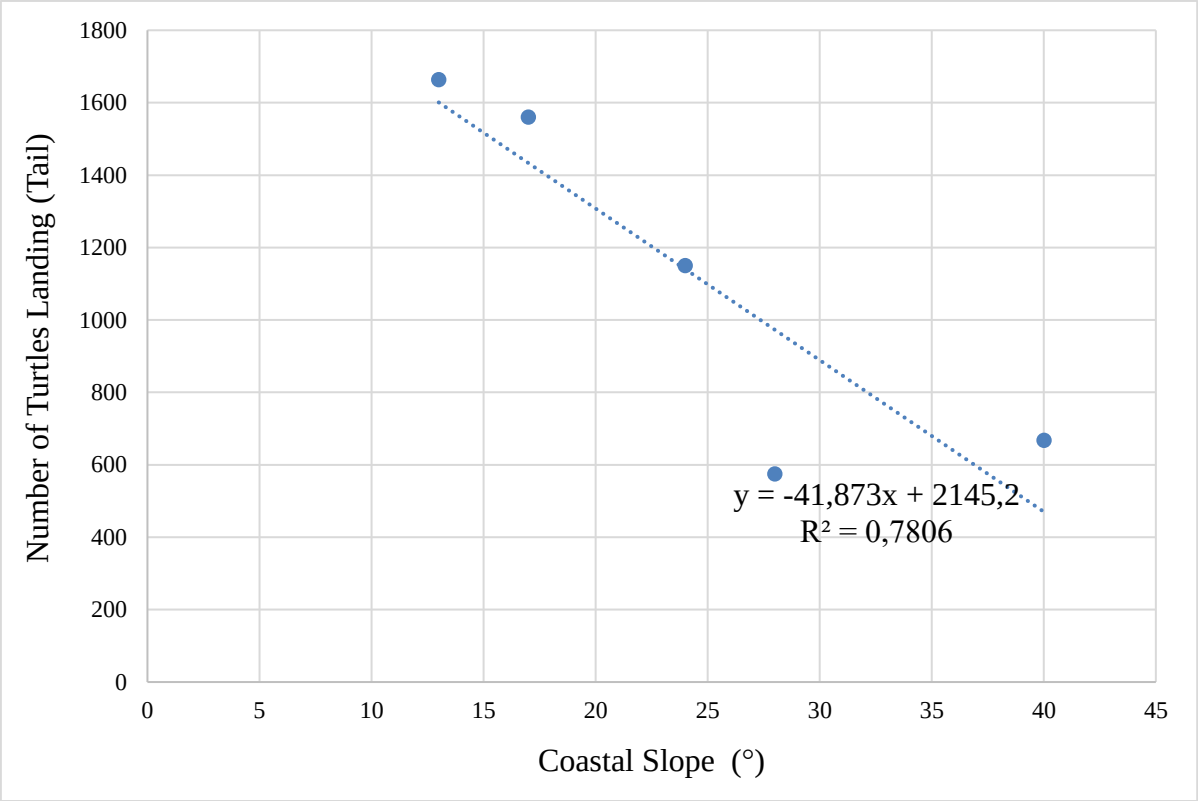

Figure 3. Graph of Relationship between Coastal Slope and Number of Turtles Landing on Pangumbahan Beach

3. 4. Analysis of the Effect of Seasons on Green Turtle (*Chelonia mydas*) Laying Activities Pangumbahan Beach

Overall, the relationship between seasonal dynamics and the number of Green Turtle landings on Pangumbahan Beach does not show a causal relationship. It can be seen in Table 3 where the correlation coefficient value of the relationship of each variable with the number of Green Turtle landings per season is not significant. It is strengthened by the results of the regression analysis with $Rvalues^2$ are very small.

Table 3. Correlation Coefficient Value of the Relationship of Each Variable with Green Turtle Egg Laying Activity.

Season	Variable	R^2 Value Landing	R^2 Eggs
West Monsoon	Wind	0.022	0.1127
	Flow	0.0005	0.3446
	Rainfall	0.0099	0.2838
	Wave	0.572	0.1962
Inbetween I	Wind	0.012	0.1543
	Flow	0.0011	0.3686
	Rainfall	0.528	0.0086
	Wave	0.2154	0.0478
East season	Wind	0.189	0.0728
	Flow	0.0088	0.003
	Rainfall	0.016	0.0004
	Wave	0.0018	0.1259
Transition II	Wind	0.054	0.4034
	Flow	0.0618	0.0218
	Rainfall	0.245	0.0861
	Wave	0.0642	0.0129

The relationship between the conditions of each variable of wind, rainfall, currents and waves to the number of Green Turtle (*Chelonia mydas*) landing and laying in the Pangumbahan Beach area of Sukabumi, has a different time. Judging from the results of the regression analysis, it shows that the wind and current conditions in each season have no correlation at all.

The wind itself plays a more dominant role in regulating the distribution of sand in the coastal area [25]. The size of the sand grains that are spread by the wind around the beach does not affect the green turtles to lay eggs. A mother Green Turtle (*Chelonia mydas*) has behaviour *remigration* where the turtle will return to lay eggs in the same place when the turtle was born [26].

Entering the West Season, significant wave heights have a significant relationship with the number of Green Turtle (Chelonia mydas) landings. The ideal wave height can help turtles in nesting activities. The waves help when they land on the beach so that the turtles can save

their energy [27]. The wave characteristics in the west monsoon period have a height of 0.87-1.22 meters. However, the rainfall variable is the opposite. Rainfall has a correlation coefficient of 0.099 during the West Season.

Rainfall during the Transitional Season-I showed a sufficient correlation, indicated by the correlation coefficient value of 0.528. The intensity of rainfall that fell in the Pangumbahan Beach area positively affected turtle nesting activities. Entering the East Season and Transition-II, all variables do not correlate to the number of Green Turtle (Chelonia mydas) landings on Pangumbahan Beach. This is indicated by the correlation coefficient value below 0.4 [28].

3. 5. Comparative Analysis of Green Turtle (*Chelonia mydas*) Pangumbahan Beach, Sukabumi

Egg-laying activity at Green turtle (Chelonia mydas) egg-laying activity involves the process of mother turtles going up to the beach and then looking for a safe place to lay their eggs. Not a few turtles abort nesting due to various factors, one of which is the biophysical condition of the beach. The mother turtle that lays all of its eggs is relocated from the natural nest to the Semi Natural Hatchery (PSA) nest. The success rate of hatching eggs can be maintained, and hatchling production increases. In addition to avoiding threats from predators and humans who try to take turtle eggs for sale [29].

Table 4. Number of Green Turtle Eggs and Hatchlings in Hatching Nests Spring Natural Pangumbahan Beach

Season	Number of Eggs			Average	Number of Hatchlings			Average	Hatching (%)
	2017	2018	2019		2017	2018	2019		
West Season	21468	7479	12456	13801	19294	6238	10072	11868	85.99
Transition Season I	15403	4463	4657	8174	15099	2945	4657	7567	92.57
East Season	19955	6485	9686	12042	19110	3933	9686	10967	91.07
Transition Season II	92456	10368	112697	**71840**	79050	7338	101761	62716	87.30
Total	**149282**	**28795**	**139496**	**105.86**	**132553**	**20454**	**126176**	**93061**	**87.9**

Transition Season I is the highest season where turtles land and lay eggs with a hatching rate of 92.57%. Of the 8174 eggs relocated to PSA, a total of 7567 hatchlings have been successfully hatched. This is because the Transitional Season I is the most ideal condition for turtle eggs to hatch in the Semi-Natural Hatchery (PSA). The lowest hatching rate was recorded in the West Season with a hatching percentage of 85.99%. Of the 13801 eggs that were relocated to PSA, 11868 hatchlings have been successfully hatched. The factors that can affect the hatching of turtle eggs are rainfall, nest depth, and temperature [30].

2018 was the year with the fewest number of landings and spawns. This condition was caused by high waves that hit the entire Pangumbahan Beach. These waves cause a decrease in the width of the beach and an increase in the slope of the coast. These waves have caused coastal abrasion as deep as 4 m. The width and slope of the beach are the main factors for turtles in nesting activities [2]. Changes in the physical condition of the beach drastically affect the nesting activity of Green Turtles at Pangumbahan Beach due to the difficulty of reaching land that is suitable for turtle nesting sites [3]. The following is a documentation when green turtles lay eggs on Pangumbahan Beach, Sukabumi Regency.

Figure 4. Parent Green Turtle (*Chelonia mydas*) Laying Eggs at Pangumbahan Beach, Sukabumi Regency.

Figure 5. Green Turtle (*Chelonia mydas*) Egg

4. CONCLUSIONS

The condition of the width of the beach and the slope of the beach are the main factors that determine the Green Turtle to carry out nesting activities. This is confirmed by the results of regression analysis with Rvalues^2 of 0.8826 and 0.7806.

The effect of season on the nesting activity of Green Turtle (*Chelonia mydas*) at Pangumbahan Beach, Sukabumi Regency, showed varied results. Wind and current variables have no relationship with the number of Green Turtle landings. Rainfall has a strong enough relationship with the Green Turtle landing in the Transitional season I with a correlation coefficient of 0.528. The waves have a fairly strong relationship with the Green Turtle landing in the Transitional season I with a correlation coefficient value of 0.572. While the relationship between each variable and the number of Green Turtle eggs does not show a relationship. This is indicated by the correlation coefficient value below 0.4.

The highest percentage of eggs occurred during the Transitional Season II with a value of 73% while the lowest percentage of eggs occurred during the West Season with a value of 54%. The highest hatching percentage occurred during the Transitional Season I with a value of 92.57% while the highest hatching percentage occurred during the West Season with a value of 85.99%

References

[1] R. Nel, A. E. Punt, G. R. Hughes, Are coastal protected areas always effective in achieving population recovery for nesting sea turtles. *PLoS One* 8(5) (2013) 1-12

[2] Adiluhung, M., Riyantini, I., Sunarto, S., & Faizal, I. The Influence of Tidal on the Nesting Activity of Green Turtle (Chelonia mydas (Linnaeus, 1758)) at Pangumbahan Beach, Sukabumi Regency, West Java, Indonesia. *World Scientific News*, 154, 48-65, 2021

[3] Mustaqim A.R. Abrasion impact towards green turtle Chelonia mydas (Linnaeus, 1758) nesting areas in Sindangkerta, Tasikmalaya Regency, West Java Indonesia. *World Scientific News* 147, 124-139, 2020

[4] Adnyana, W., Soede, L. P., Gearheart, G., & Halim, M. (2008). Status of green turtle (Chelonia mydas) nesting and foraging populations of Berau, East Kalimantan, Indonesia, including results from tagging and telemetry. *Indian Ocean Turtle Newsletter*, 7, 2-11.

[5] Limpus, C. J., Miller, J. D., Parmenter, C. J., & Limpus, D. J. (2003). The green turtle, Chelonia mydas, population of Raine Island and the northern Great Barrier Reef: 1843-2001. *Memoirs-Queensland Museum*, 49(1), 349-440

[6] Oceanography of the Southeast Asian Waters. The University of California, Scripps Institution of Oceanography, La Jolla California, NAGA Report, 2, 17-27, 1961

[7] Wismadi, T. & Handayani, S. Tidal Characteristics in Raja Ampat, Indonesia. *Geomatics Scientific Journal* 20 (1): 73-78, 2014

[8] Putra, B.A., Edi, W.K., & Sri, R. Study of Biophysical Characteristics of Habitat for Laying Green Sea Turtle (Chelonia mydas) on Paloh Beach, Sambas, West Kalimantan. *Journal of Marine Research*, 3, 173-181, 2013

[9] Witherington, Blair E. & Martin, R. Erik. Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches. St. Petersburg, FL, Florida Marine Research Institute, Technical Report, TR-2, 3, 9-10, 2003

[10] Shadrin, N.V. Coupling of Shoreline Erosion and Biodiversity Loss: Examples from the Black Sea. *International Journal of Marine Science* 3 (43), 352-360, 2013

[11] Bara. Study of Laying Habitat Green Turtle (Chelonia Mydas) in Pangumbahan Beach, Sukabumi, West Java. *Journal of Marine Research* 2 (3), 147-155, 2013

[12] J. Castroviejo, J. Juste B, J. Del Val Pérez, R. Castelo, R. Gil, Diversity and status of sea turtle species in the Gulf of Guinea Islands. *Biodiversity and Conservation* 3(9) (1994) 828–836

[13] C. N. S. Poonian, R. V. Ramilo, D. D. Lopez, Diversity, habitat distribution, and indigenous hunting of marine turtles in the Calamian Islands, Palawan, Republic of the Philippines. *Journal of Asia-Pacific Biodiversity* 9(1) (2016) 69-73

[14] Zaenal, M. Ali. Green Turtle Conservation in the Cipatujah Area. *Geomatics Scientific Journal* 53-68 pp. 12 (2), 2006

[15] Harahap, S. A., Prihadi, D. J., & Virando, G. E., Spatial characteristics of the Hawksbill (Eretmochelys imbricate Linnaeus, 1766) nesting beach on Kepayang Island, Belitung - Indonesia. *World Scientific News.* 146(6), 152-169, 2020

[16] Hindar, H., Muchlisin, Z. A., & Abdullah, F., Characteristics of nesting habitat of sea turtle Lepidochelys olivacea in Lhoknga Beach, Aceh Besar District, Indonesia. *Aceh Journal of Animal Science*, 3(1), 25–32, 2018

[17] Symthe, R.H. Vision in the Animal World. London, United Kingdom: The Macmilion Press ltd. 1975.

[18] Mochamad R. Ismail, M. Wahyudin Lewaru, Donny J. Prihadi. Microplastics Ingestion by Fish in The Pangandaran Bay, Indonesia. *World News of Natural Sciences* 23 (2019) 173-181

[19] Vetthy Fatimah, Atikah Nurhayati, Isni Nurruhwati, Indah Riyantini, Study Social Economy Green Tree Conservation Area (Chelonia mydas) as a Daily Ecowism in Pangumbahan, Sukabumi District, Indonesia. Case Study of Green Turtle Conservation Areas for Local Communities. *World Scientific News* 130 (2019) 82-98

[20] T. A. Stewart, D. T. Booth, & M. U. Rusli, Influence of sand grain size and nest microenvironment on incubation success, hatchling morphology and locomotion performance of green turtles (Chelonia mydas) at the Chagar Hutang Turtle Sanctuary, Redang Island, Malaysia. *Australian Journal of Zoology* 66(6), 356-368, 2019

[21] Troll, C. (1965). Seasonal climates of the earth. In Weltkarten zur Klimakunde/World Maps of Climatology (pp. 19-25). Springer, Berlin, Heidelberg.

[22] Athoillah, I., Sibarani, R. M., & Doloksaribu, D. E. Spatial Analysis of the Effect of Strong El Nino Events in 2015 and Weak La Nina in 2016 on Humidity, Wind and Rainfall in Indonesia. *Journal of Weather Modification Science & Technology,* Vol. 18 No. 1, 33-41, 2017

[23] Dian, N. R., Nurhadi, B., & Sasninto, B. Analysis of the Effect of the Indonesian Ocean Dipole (IOD) phenomenon on Rainfall in Java. Journal of Geodesy Undip Vol 7 No 1, 2018

[24] Segara, R.A. Biophysical Characteristics Study of Green nesting habitat (*Chelonia mydas*) in Pangumbahan Sukabumi, West Java. Journal of Marine Technology and Science. Bogor: Bogor Agricultural University. 2008.

[25] Sihotang, W. M., Subardjo, P., & Saputro, S. Analysis of the Effect of Oceanographic Parameters on the Distribution of Sand Dunes on Parangtritis Beach 2005-2009. *Journal of Oceanography*, 3(2), 246-256, 2014

[26] Hitchins, P.M, Bourquin, O., Hitchins, S. & Piper, S.E. Factors influencing emergences and nesting sites of hawksbill turtles (Eretmochelys imbricata) on Cousine Island, Seychelles. *Phelsuma* 11, 59-69, 2003

[27] Witherington, Blair E. & Martin, R. Erik. Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches. St. Petersburg, FL, Florida Marine Research Institute, Technical Report, TR-2, 3, 9-10, 2003

[28] Sunarto, M. N. Malawani, M. H. D. Sasongko, I. Elvira, I. P. Nastiti, P. Arlinda, E. E. Arinda, A geomorphological evaluation of sea turtles nesting in the southern sea of West Java. *IOP Conference Series: Earth and Environmental Science* 256 (012028) 1-7, 2019

[29] M. R. Heithaus, Predators, prey, and the ecological roles of sea turtles. The biology of sea turtles, volume III, J. Wyneken, K. J. Lohmann, J. A. Musick, (ed.), Boca Raton, Florida*:* CRC Press (2013) 249-284

[30] Lolavar, A., & Wyneken, J. (2015). Effect of rainfall on loggerhead turtle nest temperatures, sand temperatures and hatchling sex. *Endangered Species Research*, 28(3), 235-247

[31] Christian Ebere Enyoh, Andrew Wirnkor Verla, Md. Refat Jahan Rakib, Application of Index Models for Assessing Freshwater Microplastics Pollution. *World News of Natural Sciences* 38 (2021) 37-48

[32] Mochamad R. Ismail, M. Wahyudin Lewaru, Donny J. Prihadi, Microplastics Ingestion by Fish in The Pangandaran Bay, Indonesia. *World News of Natural Sciences* 23 (2019) 173-181

[33] Siti Nirmala Hapsari, Mega Laksmini Syamsuddin, Indah Riyantini, Sunarto, Seasonal Variations of Sea Surface Temperature and Sea Current in the Celebes Sea. *World News of Natural Sciences* 35 (2021) 135-143

[34] Fajri Ramdhani, Liyantono, Gatot Pramono, Ibnu Faizal, Suitability Study for Tourism Sites in the Southern Coast of West Java. *World News of Natural Sciences* 34 (2021) 127-143