Analysis of the Porites Coral Reef Growth Based on Natural Causes in Central Tapanuli Sub Region, North Sumatra Indonesia

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Abstract

The drilling of the Porites Coral Reef type in Ungge Island, Tapanuli Sub Region, and North Sumatra Indonesia was carried out by using a hand drill Pneumatic at the depth of 5 m. The aim of the research is to analyze the growth of annual ring formed at dry and rainy seasons from 1997-2012, based on two natural causes: earthquake and climatology by used of X-ray Rontgen methods. The chemical compotion of coral reef was analyzed by Thin Slice, X-RD Diffraction, Scanning Electron Microscope (SEM), Transmission Electron Microscopy (TEM), UV-Vis Spectrofotometer. The result showed that the average growth of coral reefs is 9.1 mm/year, Thin Slice showed that the porosity is 55% - 60%, in the dry season, 35% - 43%%. in rainy season and got disturbance in porosity from 47% - 53% when 2005 earthquake occured. UV-Vis spectrofotometer showed that maximum absorbance value is 0.441 in dry season and 0.549 in rainy season. X-RD showed that coral is dominated 99.67% by $CaCo_3$. Climatolgy data showed that highest temperature of sea water surface occured at 1998, about 29.89 ^{0}C. Its caused the growth of coral reef decreased about 1 mm (10.5%) from the previous year.

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The based on earthquake data, the strongest earthquake occured in 2005 with magnitude 6.8 Ricther scale and iteration frequency of 33 times in this year, this phenomena caused the growth of coral reef decreased 6.5 mm/year (29%). It concluded that at earthquake more dominant on influencing the porites coral reef type growth than climatology.

Keywords: Coral Reef growth rate; Earthquake; Climatology.

1. Introduction

Indonesia, especially North Sumatra is an area of the highest coral reef growth diversity in the world, (34%). It had been known as the Indomalayan triangle area [1]. Coral reefs have existed since million years ago formed from the deposition of massive calcium carbonate ($CaCO_3$) [2]. Coral reefs are created by natural caused and formed by thousands of unique and high valuable plants and animals. Coral reefs give income and resources for the world's population through sea biota and the beach protector from wave barrier. The effect of rainy and dry season changes in Indonesia, the growth of coral reefs have annual ring. The black color indicates the coral growth reef in rainy season caused the clasification rate of coral growth reef is low, and density of lime formed is high (high density). Bright color indicates the coral reef growth rate in dry season, is very fast and the density lime formed is low [3,4,5].

Coral reefs ecosystem in Indonesia are extremely sensitive from natural causes affect such as earthquake and clymatology. There are 400 years earquakes occured in Indonesia . These are caused by two plates traversed in Indonesia , Mediterania (Alpen-Himalaya) Plate and Pasific Plate. Based on researh result, the earthquake that occured at Sumatera coast in 2014, with magnitude 9.3 Richter scale had broken the coral reefs [6]. At 1998 an extreme climated occured causing coral reef bleaced about 16% and decrease $CaCo_3$ concentration [7]. At 2010, in area of Loke Howe Island in Australia increase temperature exceeded above 28 °C that caused an extensive coral bleaching [8]. Analysis result of [9,10,11,12]. And also of observed that the extreme change of climates El-Nino and La-Nina at Seribu island Jakarta Indonesia. It showed that the rate of coral reef growth decrease, especially around the maindland [13].

2. Method of Research

Drilling of coral reef Porites was carried out by using a hand drill pneumatic which is connected to air tube of diving tool. The coral reef was drilled vertically in its center, and then cut and cleaned by steril water. This sample was irradiated by X- ray Rontgen with electric power of 48 KV, 200 mA, 3.2 mAs about 1 minute, and the result was alike a negative film [14]. The patterns of coral reef growth on each specimen were analyzed vertically, the top annual ring is the youngest year and the second annual ring is coral reef formation in the second years, and so on. This results are equal with the research [15,16,17,18,19].

3. Research Result

3.1 UV-Vis Spectrofotometry Analysis

Analysis of UV-V are done on ultraviolet wavelength (200 nm - 400 nm) and visible light (400 -750 nm). The result showed a decline of ligt intensity absorbed by $CaCo_3$ coral reef, pirotes type at dry season and rainy season. At 2007, maximum absorbance value of formed coral reef at dry season is 0.441. Meanwhile at rainy season, the maximum absorbance is 0.549. This indicates that the growth rate of coral reefs in the rainy season (High Density) is lower than in dry season (Low Density).
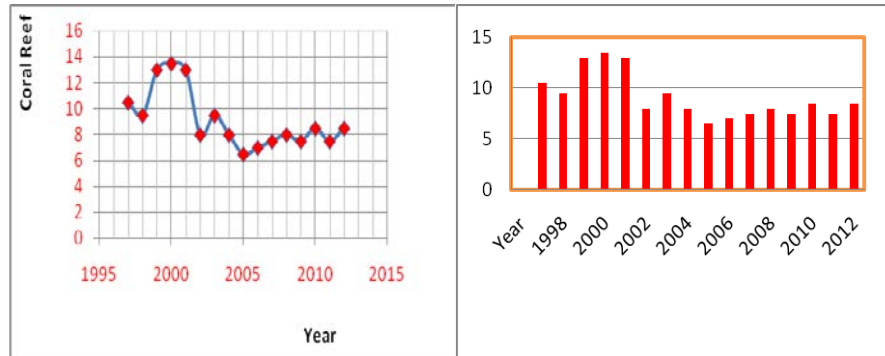

Figure 1: Trend of the coral reef growth
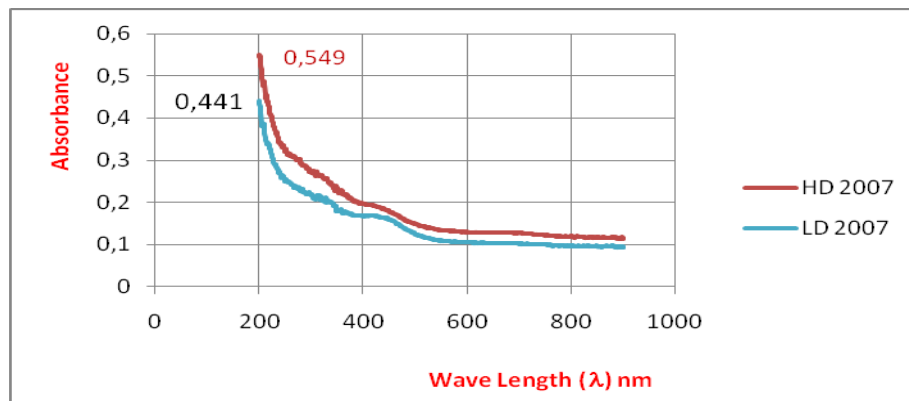
Figure 2: Absorption value at High Density and Low Density

3.2 Thin Slice Analysis

 The result of thin slice analysis of the coral reef with field of view of 3mm and magnification 40 times showed that porosity at dry season is ± 55-60% and at rainy season (high density) is ± 35-43%. Cavity type contained carbonate mud. At both of season, this slice reef showed gray-brownish colour rock in parallel nikol and bright-gray and even rainbow colour on cross nikol.

3.3.   Scanning Electron Microscope Analysis

The observation result of surface morphology of coral reef using SEM showed that during rainy season (HD) the porosity is more massive than the porosity at dry season (LD). Based on dispersion energy of X-ray (EDX), the main elements of coral reef growth were dominated by element O, C, Ca (Fig 4a, 4b).
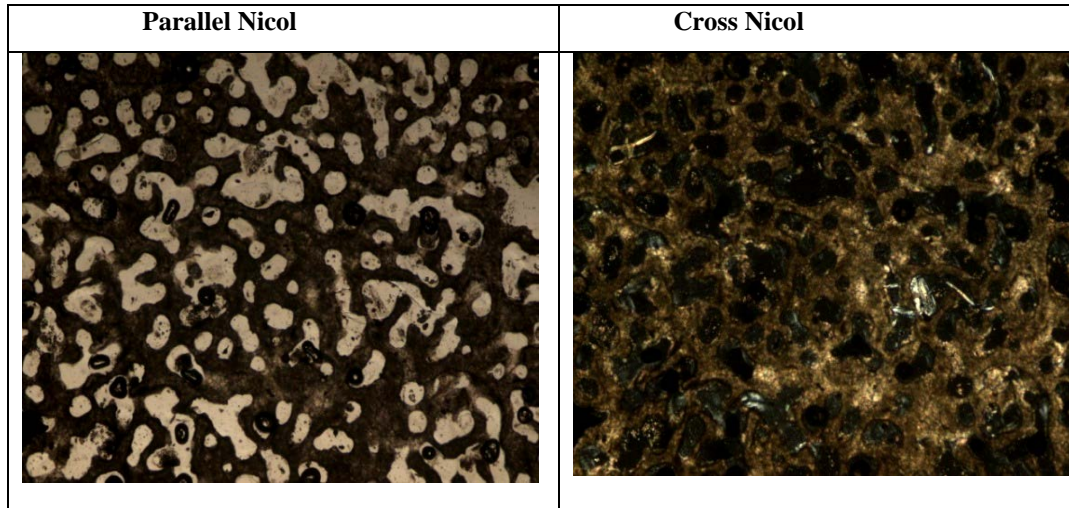
Parallel Nicol	**Cross Nicol**

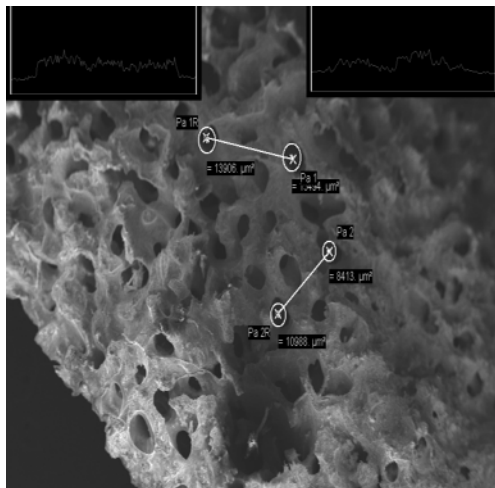**Figure 3:** Parallel and cross nicol

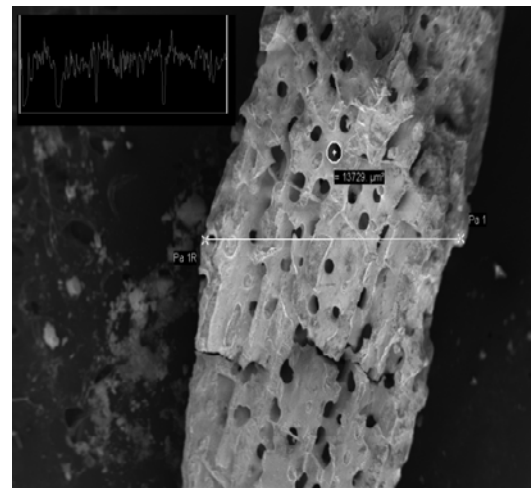**Figure 4.a:** Low Density condition   **Figure 4b:** High Density condition

3 .4 Analysis of X-RD Diffraction

Analysis results of X-RD diffraction Porites Coral Reef type in 1997-2012 showed that the formed particle was dominated by aragonit of CaCO3 about 99.67% with Orthorhombik crystal system at the highest peak shown in the hkl plane (111) and (221). This result is equal [20] with aragonite 98% dominated.

3.5 Analysis of Transmission Electron Microscopy

The analysis of crystal kind by using Transmission Electron Microscopy type JEOL / EO JEM-1400 with voltage source 120 kV had been done in *dark field image* with Mag 20.000 and Micron_Marker 200.0 nm. The result showed that the formation of coral reef in dry season (Low density) was more dominated by crystal than in rainy season (High Density) (Fig 6a, 6b) .
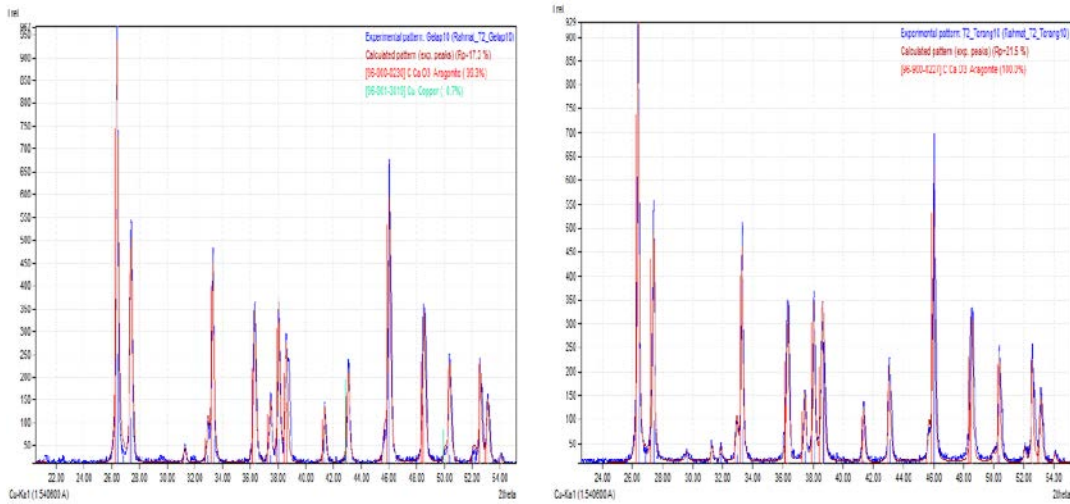
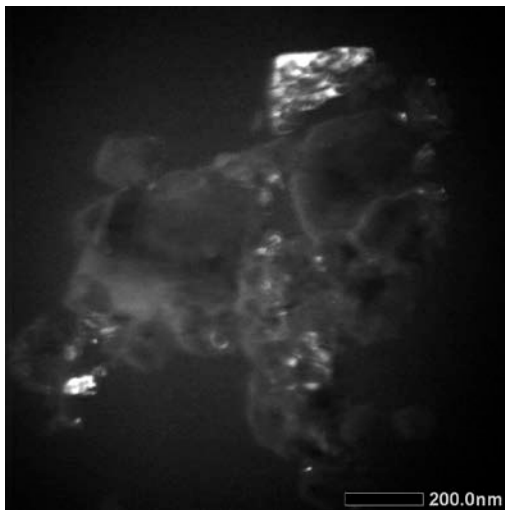**Figure 5:** Result of X-RD of coral reef High density and Low density 2007

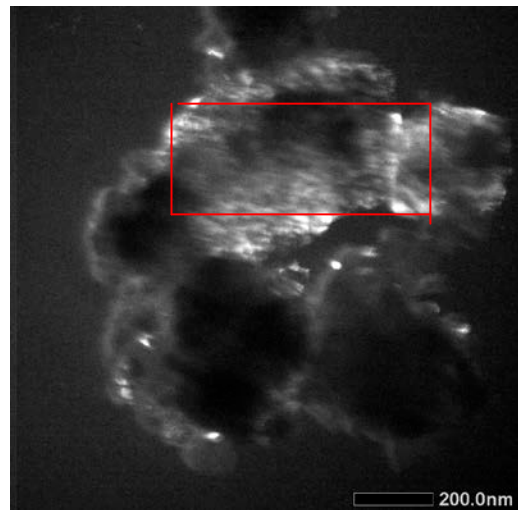**Figure 6a:** High Density condition   **Figure 6b:** Low density condition

3.6   Earthquake analysis

Earthquake occurred in Central Tapanuli since 1997-2012 was observed with magnitude below of 3 Ricther scale at 1997, 1998, and 2001 caused no growth rate. An earthquake at 2004 with frequency of 2 times and magnitude 4.5 Richter scale showed the coral reef growth rate decreased 18.8%. At 2005 the earthquake with frequency of 33 times and magnitude 6.8 Richter scale caused coral growth decreased 6.5 mm/yr (23.1%). At 2006, earthquake with frequency of 6 times and magnitude 6.4 Richter scale, the coral reef growth decreased 7 mm/yr. At 2011 earthquake with the frequency of 2 times and magnitude 5.5 Richter Scale caused coral reef growth decrease 13.3%. So the growth average is 9.1 mm/yr (Fig 7).
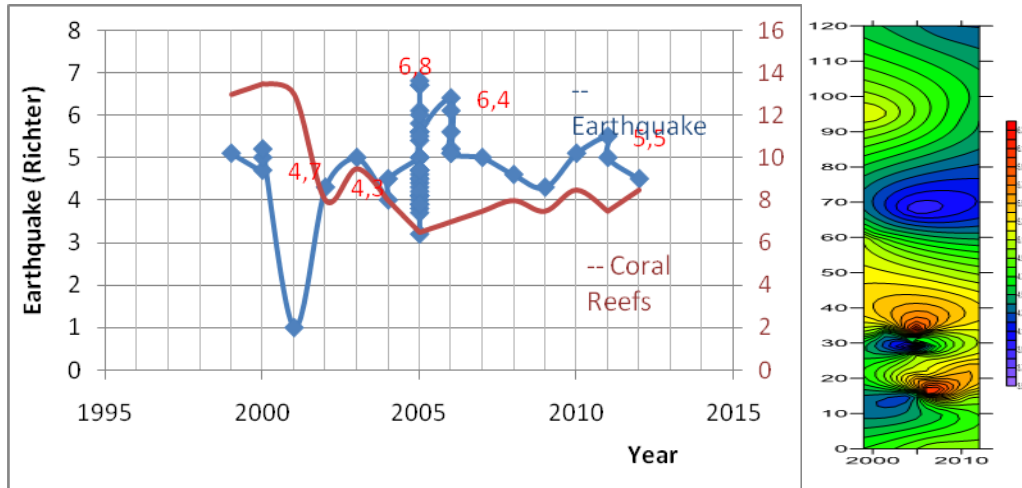
Figure 7: Trend of earthquake toward the coral reef growth
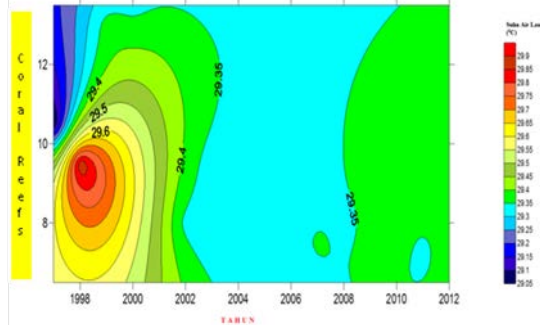
3.7   Climatology Analysis

3.7.1 Air and Sea Surface Temperature

Air temperature and sea surface temperature since 1997-1998; 2004-2005; 2009-2010 showed that the air temperatures increased 0,5 ^{0}C (1.8%); 1.1% and 2.4% meanwhile the sea surface temperature increased 0,9^{0}C (2.8%); 0.3% and 0.5%. The most influential impact on coral reefs growth occured in 1997-1998. This caused the coral reefs growth decreased 10.5%.

(a)

(b)
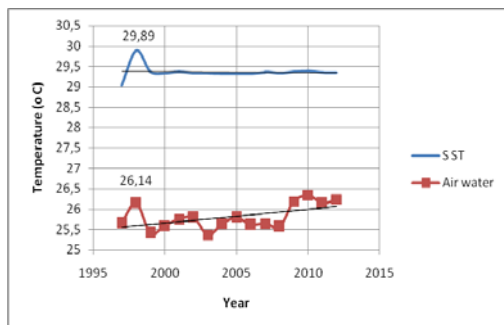
Figure. 8.a: Trend of Air and **SST**   **Figure 8.b:** Contour SST and Coral

3.7.2 Rainfall Analysis

The trend rainfall in 1997-2012 increased by equation y = 1.4 x + 364.7 mm. At 1998 rainfall intensity was 447.6 mm (increased 50.6%), it caused the coral reef growth rate decreased 9.5 mm, (10.5%). At 2002 rainfall intensity was 414 mm(increase 22.8%). it caused coral reefs growth rate 8 mm (decreased 62.5%). At 2005 rainfal intensity was 397.08 mm (increased 22.3%) of coral reefs decreased 23.1%. At year 2009, rainfall

intensity was 367.3 mm rose up 13%, the coral reef growth rate (decreased 6.7%). At 2010, rainfall intensity was 455.4 mm (increased 19.3%), the coral reefs growth rate 8.5 mm. The coral reef growth rate average 8.5 mm less than the average coral reef growth rate average 9.1 mm in 1997-2012. These results are equal to the effect of climatology increased rainfall intensiiy which reach 62% more than the average coral reef growth rate for 38 years that caused the decreasing of coral reef growth 11%-69% [21].
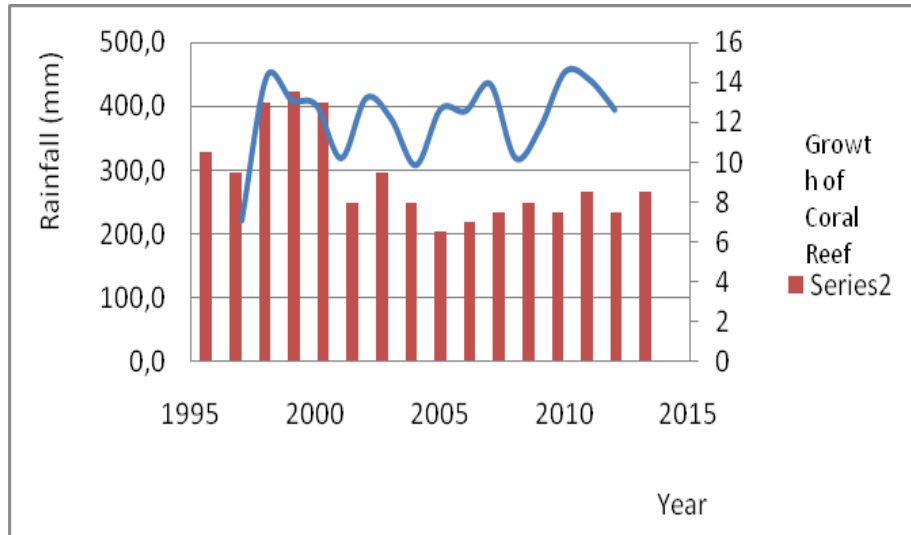

Figure 9: Pattern of rainfall intensity and coral reef growth

3.7.3 Time of Solar Radiation (%)

The patterns of solar radiation since 1997-2012 fluxtuated every month, the low percentage of solar radiation occur at September 38.6% and the highest fluxtuated on May was 55.9% . Patterns of the percentage decreased since the 1997-2012. Its inversely proportional to the increase of rainfall intensiy trend (Fig 10). Its influence on the rate of coral reef growth at the macro level has decreased.
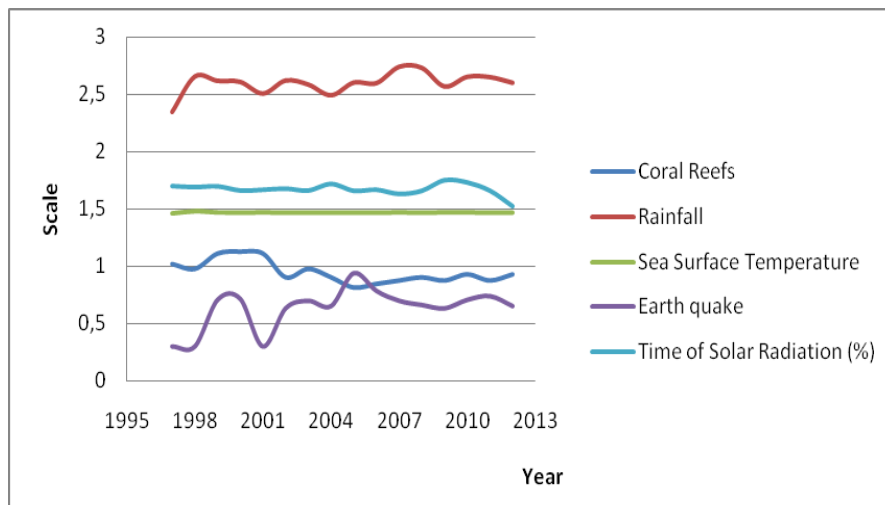

Figure 10: Influence of natural causes toward coral reef growth

4.　　Conclusion

1) The analysis results of Porites Coral Reef type in 1997-2012 showed that the formed particle was dominated by aragonit of CaCO3 about 99.67% with orthorhombik crystal system and the porosity with range 55% - 60%.

2) The Porites Coral Reef Growth rate based on natural causes in central Tapanuli Sub Region, North Sumatra since 1997-2012 was influenced by earthquakes, air and sea surface temperature, rainfall intensiy, and solar radiation with the average of coral reef growth rate 9.1 mm/year.

3) The most dominant influence was caused by earthquakes at 2005 with a magnitude of 6.8 Richter scale that caused the growth rate decrease 29%, more than the influence of the air and sea surface temperature that increased at 1998 about 0.9 ^{0}C and caused the coral reef growth rate decrease 10.5% .

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