Scleractinian Coral Health Status of Padang Shelf Reef System, West Sumatera, Indonesia

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Abstrak

Status Kesehatan Karang Skleraktinian pada Sistem Terumbu Karang Pesisir di Perairan Padang, Sumatera Barat, Indonesia

Prevalensi penyakit karang sebelumnya belum dilaporkan di perairan Padang, Sumatera Barat. Adapun tujuan penelitian ini adalah untuk mendapatkan prevalensi penyakit karang pada lokasi yang dekat dengan pantai, pertengahan dan lokasi terluar, dimana lokasi tersebut merupakan lokasi pemantauan yang berkesinambungan sejak tahun 1994 untuk data kondisi karang. Metode pengamatan yang digunakan adalah metode transek sabuk dengan ukuran 1 m kekiri dan kekanan transek garis yang memiliki panjang 30 m dan 3 ulangan. Dua jenis penyakit dan dua indicator stress karang teramati pada penelitian ini. Penyakit karang sabuk hitam (Black Band Disease, BBD) yang banyak ditemukan di Pulau Pandan (1.3%) pada kedalam 5 m. Penyakit White Syndrome (WS) terjadi di Gosong Air (0.3%). Beberapa koloni karang Montipora sp. dan Pocillopora verrucosa mengalami pemutihan di Pulau Pieh (2.1%).Focal bleaching ditemukan pada karang Galaxea sp. dan Goniastrea sp. di Gosong Gabuo (2.5%) dan pada karang Pocillopora verrucosa di Gosong Sipakal (3.9%). Penyakit BBD menginfeksi karang Montipora sp. dan Porites sp. Penyakit WS hanya menginfeksi karang Montipora sp. Karang Montipora sp, Pocillopora sp dan Porites sp banyak dan umum ditemukan di perairan Padang. Hasil ini menunjukkan bahwa infeksi penyakit karang masih tergolong rendah dan secara alamiah bisa terjadi sehingga tidak menghalangi proses pemulihan kondisi karang yang saat ini terjadi dan secara umum pada status kesehatan karang.

Kata kunci: coral disease, black band disease, white syndrome, Sumatera Barat

Abstract

The prevalence of coral disease was previously unreported on the reefs of the Padang Shelf Reef System, West Sumatra and is relatively uncommon. The objective of this study was to get coral disease prevalence of each site which located at inshore, mid-shelf reef and off-shore reefs. The research was carried out by using belt transect method with 1 m left and right of tape as long 30 m with 3 replications. Two kinds of coral disease and two indicators of stressed coral were observed. While relatively infrequent, Black Band Disease was most common (1.3%) occurring on Pandan Island at 5m. White Syndrome occurred at Air patch reef (0.3%). A few bleached colonies of Montipora sp. and Pocillopora verrucosa were observed on Pieh Island reef (2.1%). Focal bleaching was observed on Galaxea sp. and Goniastrea sp. at Gabuo patch reefs (2.5%) and on Pocillopora verrucosa at Sipakal patch reef (3.9%). BBD infected both Montipora sp. and Porites sp. WS only infected on Montipora sp. Montipora, Pocillopora and Porites were the most common genera observed on the reefs. It suggests that coral disease infection was classified as a minor and it will not hamper coral recovery processes and coral health status in Padang Waters, West Sumatera.

Keywords: coral disease, black band disease, white syndrome, West Sumatera

Introduction

Coral diseases have been recognized as a threat to coral reefs in the Caribbean (Harvell *et al.,* 2009). The occurrence of coral diseases are considered to be related to the combination of impactsfrom human activities and climate change (Sutherland *et al.,* 2010; Harvell *et al.,* 2002). Disease outbreaks can cause coral loss that makes significant changes in community structure, species

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diversity and reef-associated organisms (Beeden *et al.,* 2008).

Coral disease has been reported in several locations in Indonesia (Sabdono, 2004; Sabdono and Rajasa, 2008), (Kepulauan Seribu; Subhan *et al.,* 2007; Yusri and Estradivari, 2007), (Wakatobi waters; Hapkylla *et al.,* 2007; Hapkylla *et al.,* 2009). The observation of the presence of bacteria in infectedFungidae corals was reported by Subhan *et al.* (2011) and Johan *et al.* (2013) reported on the abundance, prevalence, progress and of the microbial community on reefs at Kepulauan Seribu over several months.

In waters subjected to antropogenic effluents such as Kepulauan Seribu, Black Band Disease (BBD) outbreak were correlated with increased temperature and light intensity (Rosenberg and Ben-Haim, 2002; Johan *et al.,* 2013). The presence of BBD coral disease is usually only found in shallow water because it was associated with a photosynthetic cyanobateria consortium that is very sensitive to light (Muller and van Woesik 2011: Johan *et al.,* 2013b).

Coral disease was reported causing coral damage on huge area such as happened in Caribbean, Australia and several other locations abroad (Croquer *et al.,* 2003; Willies *et al.,* 2004). Coral disease can cause the coral death, change the community structure, decrease the coral diversity and other organism which associate with coral reefs (Beeden *et al.,* 2008). Jonker and Johan (1999) recorded the presence of 125 scleractinian coral species in the Padang Shelf Reef System (PSRS) in the late 1990 but did not record whether coral diseases or bleaching was observed. This is the first report of the distribution and abundance of coral disease and associated health parameters on the PSRS. This study of coral disease is the first report of disease on the Padang Shelf Reef System and reports on the distribution and abundance of diseases and associated stressed corals.

Materials and Methods

Surveys of coral disease were carried out in May 2014 at 6 sites at 5m and 10m on permanent transect which was established in the 1995. The sites designed to know the impact of mainland waste to the coral disease prevalence according to different distance. Two sites of each inshore, mid-shore and offshore reefswere observed. See Figure 1 and Table 1.

The research was carried out by using belt transect method with 1 m left and right of tape as long 30 m with 3 replications (English *et al.,* 1997). On Pieh and Pandan Is., surveys were carried out at 5 m and 10 m depths.Each coral colony was recorded to the species or genus level.The number of colonies that were infected by disease, showed evidence of predation, space competition between coral or other biota, or bleaching were recorded as they indicate a condition of the coral health (CH). CH is not classified as disease but it is a measure of the health of the coral as factors such as predation, sedimentation, space competition with other corals, sponges and algae effect the coral populations. The coral disease prevalence of each site which located at inshore, mid-shelf reef and off-shore reefs can be showed in Figure 3.

Table 1. GPS coordinates of sampling sites on Padang Shelf Reef System in 2014.

Location	Date	Latitude	Longitude
Reef Gabuo	01 May	-0.90956°	100.33414°
Pisang Island	01 May	-0.99727°	100.33865°
Pieh Island	02 May	-0.87700°	100.09838°
Reef Air	03 May	-0.88398°	100.21338°
Reef Sipakal	03 May	-0.92764°	100.25074°
Pandan Island	04 May	-0.95285°	100.14035°

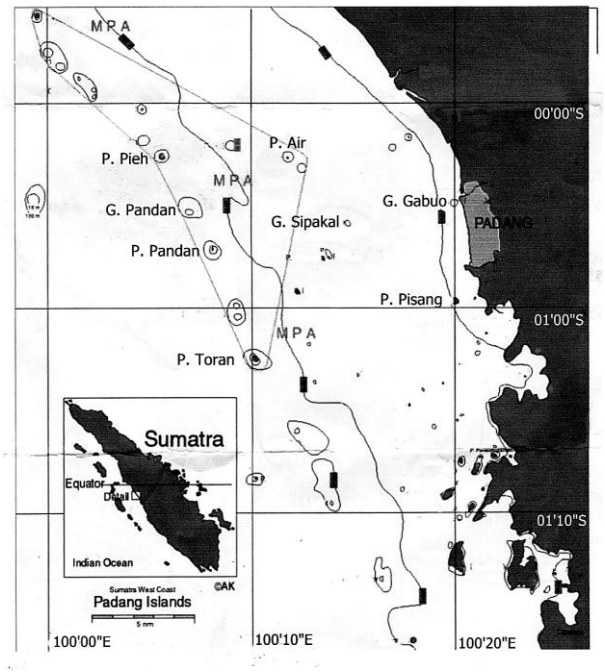

Figure 1. Research sites in the Padang Shelf Reef System Inshore reef sites (Pisang Is-P and Gabuo patch reefs-Gs.), mid-shelf reef (Air and Sipakal patch reefs-Gs.) and off-shore reefs (Pandan and Pieh Is.-P)(Modified after Kunzmann, 1994).

Especially on infected coral were identified the disease according to Raymundo *et al.* (2008).

Coral disease data were analyzed to get prevalence of each disease kinds and compared among location and water parameter by using Principle Component Analysis test by using XL-Stat 2014.

Water quality measurement

Water quality was measured by using multi-parameter Horiba U-50 to measure in situ parameters such as pH, temperature (^{0}C), salinity, (ppt), conductivity (µ.E.cm^{-1}), DO (mg.L^{-1}) and TDS (mg.L^{-1}). Other water quality for turbidity was measured by turbidimeter merk Orbeco model TB200-IR and surface current by current drought. The position recorded with GPS of Garmin e Trex H.

Coral disease identification

Infected colonies were identified using Beeden *et al.* (2008) and Raymundo *et al.* (2008). Some coral disease found in Padang waters will be give description as following on Table 1 (Beeden *et al.,* 2008).

Result and Discussion

The reefs surveyed were in good condition with an average live coral cover of 42.59%. Proceeding from from inshore to offshore the live coral cover was Gabuo (48.07%), Pisang Island (35.22%), Air patch reef (65.58%), Sipakal patch reefs (30.10%), Pieh Island (32.66%) and Pandan Island 43.90% (Figure 2).

The reefs surveyed were in bad condition with an average live coral cover of 42.59%. Proceeding from from inshore to offshore the live coral cover was Gabuo (48.07%), Pisang Island (35.22%), Air patch reef (65.58%), Sipakal patch reefs (30.10%), Pieh Island (32.66%) and Pandan Island 43.90%. The good condition found only in Air patch reef according to classification of coral condition (UNEP, 1993). Percentage of life coral cover can be showed on Figure 2.

Recovery process is taking long periods since 1997 which massive coral die off, mostly mature coral was dead and made difficult to get larvae released and recruitment. When the releasing larvae happened, the juvenile coral was hampered to encrust by unstable substrate due to most of the substrates derived from dead coral rubble from branching corals which easily move away by the waves and bottom water current. The concrete substrate is important for successful of recruitment coral. Increased adult cover and changes in substrate composition enhanced the successful of coral recruitment (Vermeij, 2005).

Coral health status

The highest prevalence of coral disease was found in Gabuo patch reefs which infected by Focal Bleaching (2.49%) and bleaching (1.25%) (Figure 3.). These sites were in inshore reefs and near with mouth of river of Air Tawar which was influenced by high turbidity, although the live coral percent was high48.07% (Figure 2.). The dominant of coral coverage was *Montipora*sp and *Acropora*spin Gabuo patch reefs and Pisang reefs. Pisang Island is near with the river mouth of Muaro Padang and is also subjected to anthropogenic effluents. Black band disease (BBD) was found on 3 sites with its prevalence on Air (0.3 %), Sipakal patch reef (0.49%) and Pandan Is (0.47%). BBD also found on Pieh Is. in 5 m depth (offshore) but outside of transect permanent. Mostly BBD infected *Montipora*sp and *Porites*sp which have encrusting growth form *Pocillopora* was not infected.

White syndrome (WS) found only in Air (0.30%) on *Porites*spand on Sipakal patch reefs (0.24%) on *Montipora*sp (Figure 2.).These areaswere located on mid-shelf reef which have higher visibility than in inshore reefs. More over WS was not found on offshore due to less coral stress by high turbidity which a far from mainland.

The bleaching was found on each sitewith prevalence range 0.39%-1.25%, most common found on all locations. The highest bleaching found on Gabuo patch reefs (1.25%), Air patch reefs (1.2%), Pieh Is. (1.66%), Sipakal Is. (0.99%) and the lowest found on Pisang Is. (0.39%) (Figure 2.).

Coral disease prevalence as a comparison between 5 m depth and 10 m depth, found the WSin depth 5 m on Pieh Is. (2.07%), Pandan Is. (1.85%) and in 10 m on Pieh Is. (0.24%) and Pandan Is. (0.13%). WS found only on Pandan Is. in depth 5 m and 10 m with prevalence were higher on the 5 m depth (1.34%) than 10 m depth (0.13%), but the WS and focal bleaching were not recorded on both 5 m and 10 m depths (Figure 3.). This difference may be related light intensity at both depths, where light intensity is greater in the shallow water than deep waters (Johan *et al.,* 2013a).

Compromise health (CH) as coral health nuisance was found on all sites, but the highest prevalence found on Sipakal patch reefs (3.89%), then followed by Pandan (2.36%) and Pisang Island (1.38%). The data of CH were included predation by fish, COT (Crown of Thorns starfish) and *Drupella*sp; a kind of gastropod, abnormal growth, space competition of sponge and algae, sedimentation and pigmentation response. Data of CH on Sipakal patch reefs was dominantly found algae competition and predation by fish and *Drupella*sp, but other location

Table 2. Diseasesand stressed corals and their description found on Padang Shelf Reef System (Beeden *et al.,* 2008; Raymundo *et al.,* 2008).

No	Kind of Disease/ Compromise health	Description	Host
1	Black Band Disease (BBD)	Clearly visible dark band at interface between live tissue and exposed skeleton (white). Dark band can vary from black to reddish-brown. Pathogen by consortium cyanobacteria, the progression 1.4 - 4.8 mm/day	Commonly affects *Montipora, Acropora, Pachyseris, Pavona, Porites*
2	White Syndrome (WS)	Visible colour gradient from bare white skeleton to brown as fouling community develops- indicates progressive tissue loss. Margins of lesions may be linear, irregular or annular (ring-like).	Commonly affects plate species of *Acropora* and a range of other genera.
3	Bleaching	Partially/whole colony to reef-wide loss of symbiotic algae (zooxanthellae). Bleaching can caused by bacteria *Vibrio shiloi* on *Oculinapatagonica,* and *Vibrio coralliilyticus on Pocilloporadamicornis*	Commonly recorded on *Montipora* and *Acropora*. It could be all coral species if it widely impact.
4	Focal Bleaching	Spots, multifocal patterns of bleaching scattered over colony. Borders between bleached patches and healthy tissue are often discrete.	Commonly recorded on *Porites, Montipora* and *Acropora*.
5	Compromise health (stressed coral)	A form of the disorder on the coral, but it is not kind of coral disease. As example competition from algae, sponge, other coral, sedimentation, flatworm	It widely impact on all coral species.

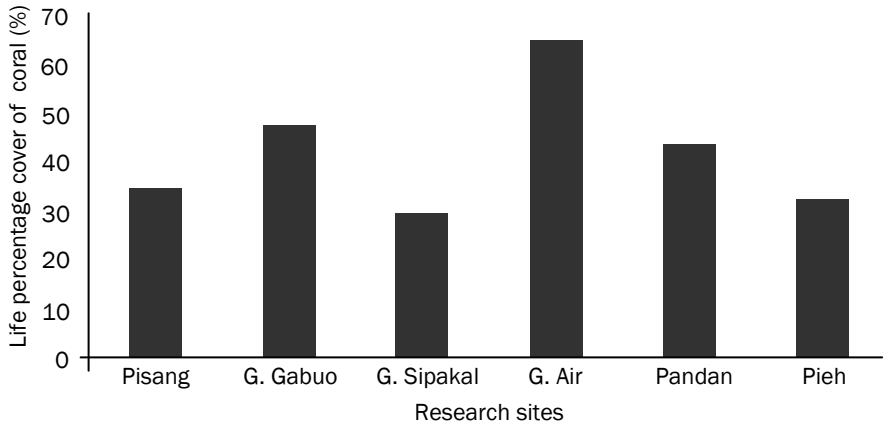

Figure 2. Percentage of life coral cover in survey sites.

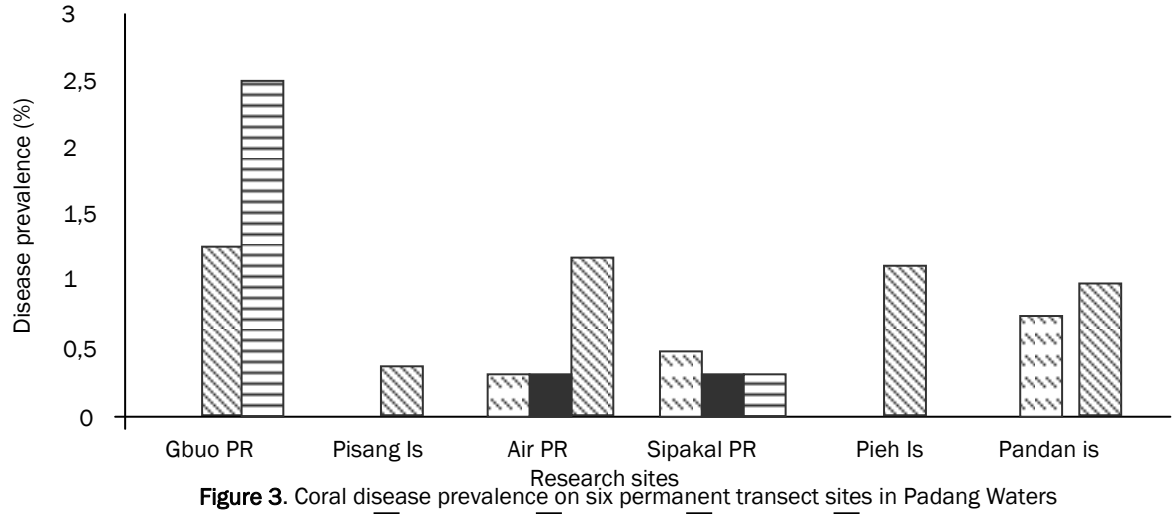

Figure 3. Coral disease prevalence on six permanent transect sites in Padang Waters
Note : ▨ = bleaching, ▭ = Focal Bl., ▩ = BBD and ■ = WS

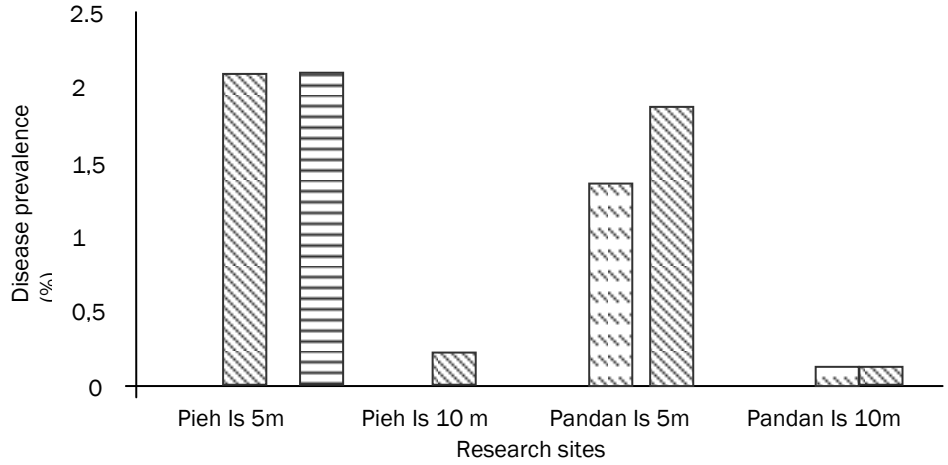

Figure 4. Coral disease prevalence as comparison between 5 m and 10 m depth on Pieh and Pandan Is as off-shore reefs.
Note : ▨ = bleaching, ▤ = Focal Bl., ⬚ = BBD and ■ = WS

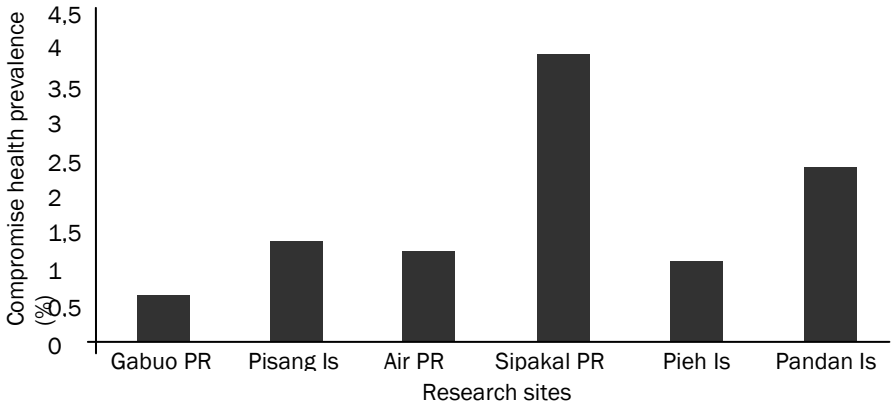

Figure 5. Compromise health prevalence on six permanent transects

Table 2. Water quality of research sites in Padang Waters. Surface Current (SC), Turbidity (T) Temperature (T), Temperature (Tem), Salinity (Sal), Dissolved Oxygen (DO), Total Dissolved Solid (TDS).

Sites	SC (m.sec^{-1})	T (NTU)	Tem (^{o}C)	pH	Sal (ppt)	DO (mg.L^{-1}l)	TDS (mg.L^{-1})
Gabuo PR	0.073	3.37	31.5	7.95	31.64	5.40	31655
Pisang Is.	0.004	0.82	31.0	8.01	33.26	4.71	33085
Pieh Is.	0.160	0.28	30.2	7.99	33.55	4.15	33475
Air PR	0.177	0.58	31.3	8.13	30.97	3.86	31070
Sipakal PR	0.151	0.69	31.7	8.01	31.17	4.20	31265
Pandan Is.	0.094	0.96	31.5	8.20	32.95	3.50	32825

the predation was caused by COT. CH was also characterized by high of surface current which found at Air, Sipakal patch reefs and Pandanislandbased on PCA analyses (Figure 5.).

Relationship of water quality parameters and coral disease prevalence

According to one time collection data of water quality found surface current higher on Air patch reef (0.18 m.sec^{-1}), then followed by Pieh Is. (0.16 m.sec^{-1}) and Sipakal patch reefs (0.15 m.sec^{-1}). The highest of surface current found on the patch reef area and offshore area. Turbidity data was the highest on Gabuo patch reef (3.37 NTU), then Pandan Is. (0.96 NTU) and Pisang Is. (0.82 NTU). The highest of turbidity was found at inshore area. Temperature found the highest value in Sipakal patch reef (31.7 ^{o}C) with range all sites between 30.2 and 31.7^{o}C. These parameters found the highest value on

different sites as following pH in Pandan Is. 8.2, Salinity in in Pieh Is. 33.545 ppt, DO in Pisang Is. 5.40 mg.L^{-1} and TDS in Pieh Is with value 33475 mg.L^{-1}.

The locations in Sipakal, Pandanisland and Air patch reefs which were infected by BBD were characterized by high of surface current. Although it was only one time collection data, but current can be as a media to transport the pathogen to other host.

According to water quality analysis and relationship with coral health data and other parameter, found that BBD found on 3 sites Air PR, Pandan Is, Sipakan PR which were characterized and positive correlated by pH, surface current and negative correlation with DO and turbidity. WS found on two sites Sipakal PR and Air PR which were characterized by surface current and temperature. Focal bleaching was found at Gabuo PR which closes characterized by high turbidity and DO and negative correlation with pH.Pieh Island which characterized with the high TDS and salinity, these parameters have negative correlation with temperature which give impact on occurrence of WS in Sipakal PR.

Infected colonies by Black Band Disease (BBD), Compromise Health (CH) and White Syndrome (WS) were characterized and positive correlation with surface current and pH according to one time collection data during the survey. This case should be continued studying for getting a long period data to prove this result. Otherwise it could be a logic that the current can be as a media to transport pathogen from one site as resource to other places (Raymundo *et al.,* 2008). According to Sokolow (2009), there are several factors which influenced the coral disease and Sokolow (2009) also declared that ocean acidification as a factor of them may play a role in coral disease.

BBD has negative correlation with DO and turbidity. These also based on one time collection data due to a limitation of research time. These kinds disease happened on Pandan Island, Sipakal and Air patch reefs. Base on the study Page and Willis (2006) that local dispersal of pathogen was caused by current on the Great Barrier Reefs in Australia, on strong tidal current in Kaledupa, Wakatobiincrease susceptibility to disease due to its cause stressful of coral colony which might reduce host resistance (Haapkylä *et al.,* 2007).The coral can be stressed by decreasingturbidity due to the best condition of water visibility let light intensity reach optimum to the bottom where the coral live there. Other reason BBD did not find on high turbidity such as happened on the inshore reefs. The coral was also infected by BBD due to high turbidity stressed. When the coral stressed by high turbidity and sedimentation, the pathogen easily infect the corals.

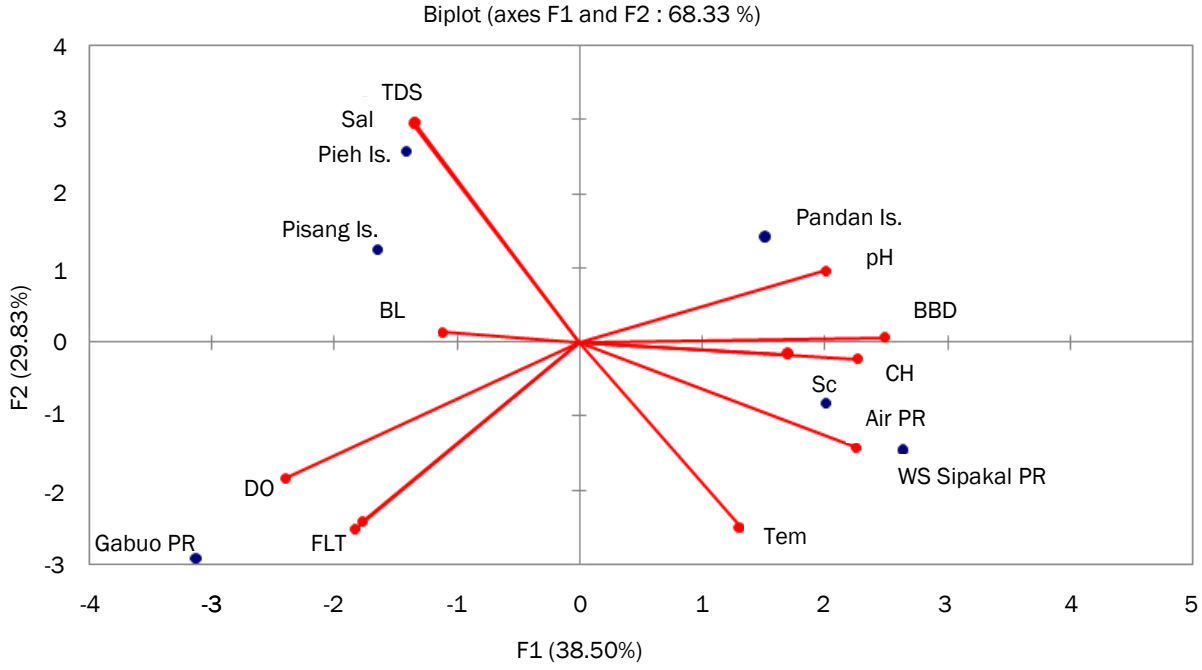

Figure 6. Biplot between water parameter and coral health parameters on research sites in Padang waters. Water parameters; Salinity (Sal), Dissolve Oxygen (DO), Surface current (SC), Temperature (Tem), Total Dissolve Suspended (TDS) and Turbidity (T).Coral health parameters; Bleaching (BL), Focal Bleaching (FL), CH (Compromise Health), White Syndrome (WS), BBD (Black Band Disease).

Focal Bleaching found higher at Gabuo patch reefs which was characterized and correlated by higher turbidity (T) and DO in Padang Waters. The turbidity was closer related with causing the Focal Bleaching. High turbidity can increase the sedimentation and hampered the light intensity reach to the bottom where the coral inhabit. This condition may a potential source of coral stress which easily infected by disease (Williams *et al.,* 2010; Kim and Harvell, 2002; Bruckner and Bruckner, 1997; Voss and Richardson, 2006), different with other state that turbidity and depthare negative correlated with disease abundance (Kuta and Richardson, 2002; Page and Willis, 2006).

Water current pattern is a factor that can influence the distribution of coral disease such found local patchiness beside other factors as following distribution of host species in the different depth, virulence of pathogen (Weil *et al.*, 2000).The bleaching can be caused by stress of turbidity and increase of temperature as well as pathogen infection.

Conclusion

Coral disease found on all site groups, focal bleaching and bleaching found at inshore reefs. Two kinds of coral disease that are BBD, WS and two tress indicator that are focal bleaching, bleaching, found in mid-shelf reefs. BBD and bleaching found at off-shore reefs. The bleaching and BBD found on both depths of 5 m and 10 m. Mostly coral *Montipora* sp. and *Porite*s sp. which encrusting growth form were infected by BBD and WS.

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