



Coral reefs and community around larak island (Persian Gulf)

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Field surveys pertaining to coral reef studies were performed from November 2010 to August 2011 around Larak Island in the Persian Gulf. The Line Intercept Transect (LIT) method was applied to record biotic and abiotic components of the coral reefs at two sites around Larak Island: North East (NE) and South West (SW) with two stations per site. Mean "Live Coral Coverage" (LCC) and "Dead Coral Coverage" (DCC) at SW $21.74\% \pm 1.92\%$, $4.58\% \pm 0.65\%$ and NE sites were $5.69\% \pm 0.54\%$, $35.64\% \pm 3.28\%$ respectively. Dead Coral Coverage was more prevalent in the NE than in SW. Based on Mann-Whitney U-test LCC and DCC showed significant difference ($p < 0.05$) among these two sites, ($p < 0.05$); The Kruskal-Wallis test also showed significant difference ($p < 0.05$) among four stations within two sites. This study indicated that coral communities of the NE site have been more destroyed by human impacts such as municipal run-off, breakwater construction, trap fishing, over-fishing and several other human activities.

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1. Introduction

One of the most biological diverse habitats (Spalding et al., 2001) and valuable ecosystems on earth are coral reefs because they provide several environmental applications to millions of people (Bryant et al., 1998). However, these applications are beneficial to human being. Human activities are the main threat to their survival all over the world (Bryant et al., 1998; Hoegh-Guldberg, Wilkinson, 1999; Goreau et al., 2000; Downs et al., 2005).

Natural and anthropogenic disturbances including cyclones, climatic change, bleaching, disease outbreaks and removal of grazers have greatly influenced coral reefs and caused changes to their community structure (Downing & Roberts, 1993; Foster et al., 2011).

Coral reefs face several disturbances and show significant variability relation their responses to these stressors (Foster et al., 2011). For instance, in the past years, there has been a sharp decrease in live coral cover in most areas of the Persian Gulf (Rezai et al., 2004). According to Goldberg and Wilkinson (2004), global warming has resulted in the frequency and severity of the coral bleaching phenomenon. Considering the global climatic changes and El-Nino phenomenon in 1996 and 1998, many coral reefs of the Persian Gulf were affected by the bleaching phenomenon, and a large portion of the corals of the region were killed (Wilkinson, 2000). Recovery has been observed in these corals, but this is limited to only one-third of the total Population (Wilkinson, 2004; Rezai et al., 2010a). Until 2002, because of sea-surface temperature anomalies, almost all types of

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branching corals were completely destroyed in the low water depth regions of the Persian Gulf (Riegl, 1999; Sheppard & Loughland, 2002; Rezai et al., 2010a).

There are other coral areas e.g. the northern part of Persian Gulf which faced bleaching phenomenon (Rezai et al., 2010a). Fringing reefs in the Persian Gulf (Sheppard & Sheppard, 1991; Sheppard et al., 2010) are limited around the islands and appear in shallow waters less than 10 m depth (Rezai et al., 2010b). Relatively low number of coral species are distributed around the islands and the coastal regions (Sheppard & Sheppard, 1991; Sheppard et al., 2010), due to harsh environment such as high salinities, sea temperatures and extreme low tides (Coles, 1988; Sheppard & Sheppard, 1991; Riegl, 1999) (Coles, 1988; Sheppard & Sheppard, 1991; Riegl, 1999). Larak Island in general has greater coral diversity than other islands and a relatively large coral coverage of the branching corals (Rezai et al., 2010a). It is assumed that since disturbances occur at a greater frequency in the north eastern side of Larak Island and their constituent corals should be also highest in south-western of Larak Island.

The purpose of this study was to collect information on coral reef structure and health of the reefs around Larak Island.

2. Materials and Methods

2.1. Study area

Larak Island is located at 26° 49'-26° 53' N and 56° 19'-56° 25' E near the Strait of Hormuz at the boundary of the Persian Gulf and Oman Sea. Maximum depth reached was 7 m in low tides.

Regional reported water salinity is 33-44 ‰, and water temperature ranged from 25.0 °C in winter to 34.0 °C in summer. With increasing depth, there was a decrease in hard substrate and increase in extent of sand and muddy beds.

2.2. Site selection

The largest coral coverage was observed in northern east (NE) and south-western (SW) region of Larak Island by "Manta tow technique". These two sites and their relevant two stations (NESt1, NESt2) and (SWSt1, SWSt2) were selected for this study (Figure 1).

Field surveys were performed from November 2010 to August 2011. Line Intercept Transect (LIT) method was applied to determine biotic and abiotic components of the coral reefs at two sites based on English et al. (1997). At each station, a total of 3-5 transects, each is 20 m long were fixed along the depth contour parallel to the shore. However, transects were fixed with 10 m intervals.

Coral species were identified to the genus level in situ and by a series of underwater photographs for later photography in the lab. Identification followed (Veron, 2000; Claereboudt, 2006).

To examine differences between sites in inorganic sediment deposition, three sediment traps were spread out at each site for 528 hrs in January and February of 2011. Sediment traps consists of a PVC tube (11.5 cm in length and mouth diameter of 5 cm) mounted on a metal base. Ratio of height to diameter of the tube was approximately 2.3 cm, which is thought as optimal to prevent sediment re-suspension and to measure gross sediment input (Wielgus et al., 2004).

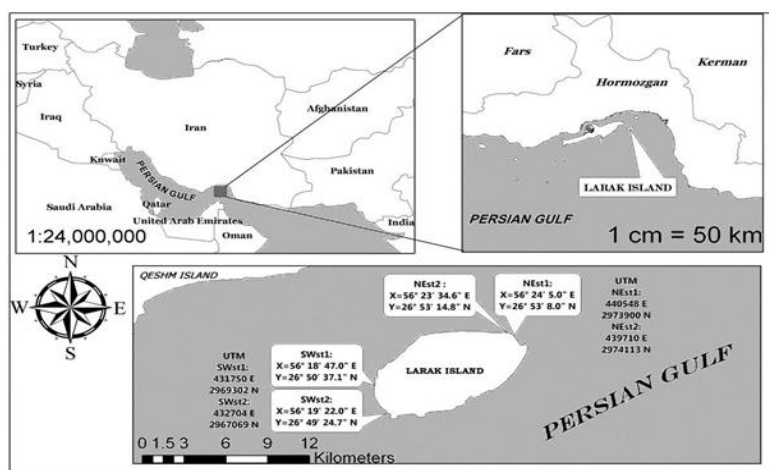


Figure. 1: Location of study sites and stations

At each site, a description sheet was employed for to record observations in the locations and other data. These included impacts at the site following one of four values of 0 (none), 1 (low: less than once per month), 2 (medium: more than once per month) and 3 (high: once per week or more).

Kruskal-Wallis one way analysis of variance (ANOVA) was used for comparing substrate of coral coverage (live and dead) among 4 stations. A Mann-Whitney U-test was applied for comparing coral coverage of two sites.

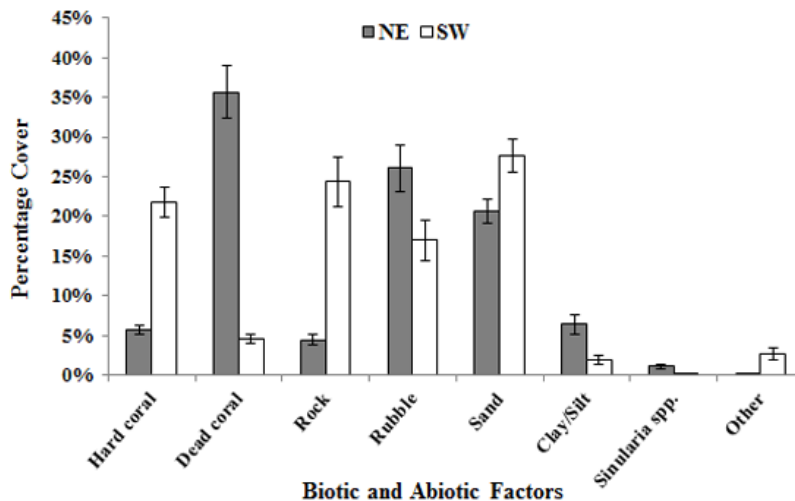


Figure. 2: Biotic & abiotic factors at study sites ($\bar{X} \pm SE$)

3. Results

Mean live coral coverage (LCC) extents at SW and NE sites were $21.74\% \pm 1.92\%$ and $5.69\% \pm 0.54\%$ respectively (Figure 2). For LCC, a considerable significant difference was seen among these two sites ($p < 0.05$); a significant difference

was also found among four stations within two sites ($p < 0.05$). Maximum and minimum LCC extents were observed for stations SWSt2 ($27.55\% \pm 4.52\%$) and NEST1 ($5.51\% \pm 1.13\%$) respectively (Figure 3).

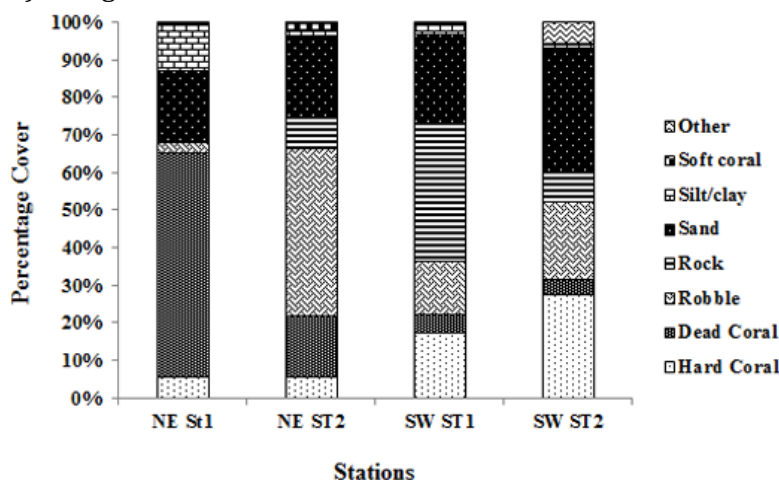


Figure. 3 Biotic & abiotic factors at study stations

Mean dead coral coverage at the SW and NE Sites were (4.58% ± 0.65%) and (35.64% ± 3.28%) respectively. The DCC of SW and NE was significantly different (p < 0.05), but the difference was significant (p < 0.05) among the four stations within these two sites.

Dominant corals were *Platygyra* in NEST1 (32.9% ± 8.2%), *Porites* in NEST2 (38.77% ±

4.38%), *Acropora* in SWSt1 (45.54 ± 7.01%) and *Acropora* in SWSt2 (42.89% ± 4.01%). A total of 16 corals genera in 7 families are reported from SW and NE areas. Comparing these two sites showed that SW had the highest dominant *Acropora* coverage (37.17% ± 5.57%) while NE had the highest *Porites* coverage (33.81 ± 23.83) (Figure 4). In each of the two sites SW and NE, 13 genera were identified, ten of which were common in both sites.

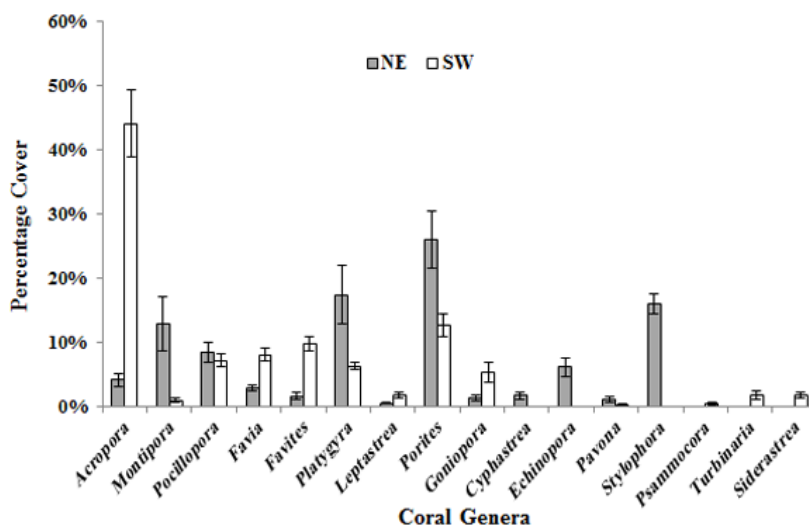


Figure 4 Coral genera coverage at the study sites (X ± SE)

Only one or two colonies of some genera such as *Turbinaria*, *Pavona*, *Psammocora* and *Cyphastrea* were found in the study area.

Sedimentation rates per day in SW and NE areas were 1.27 ± 0.063 g.cm⁻¹ and 0.053 ± 0.011 g.cm⁻¹ respectively.

The level of destructive factors and their existence / absence at these sites are shown in Tables 1 and 2.

Table 1: Level of destructive factors in the sites

0 (none), 1 (low: less than once per month), 2 (medium: more than once per month), 3 (high: once per week or more)

Destructive factors	NE	SW
Trap Fishing	3	1
Illegal ornamental fishing	2	3
Spear fishing	1	3
Line fishing	1	1
Boat anchoring	2	2
Boating	3	2
Illegal coral mining	0	1

Table 2: Destructive factors at the studied sites, presence (+) or absence (-)

Destructive factors	NE site	SW site
Human Impacts		
Breakwaters & Dredging	+	-
Desalination Plants	+	-
Human Settlement	+	-
Urban Run-off	+	-
Military/Naval maneuvers	+	+
Diving & snorkeling	+	+
Lost net and fishing gear	+	+
Oil pollution	+	+
Natural Impacts		
Harmful algal blooms	+	+
Coral disease	+	+
Sea urchin (<i>Echinometra mathaei</i> (Blainville, 1825) & <i>Diadema</i> spp.)	+	+

4. Discussion

Studies related to coral community structure are valuable means to evaluate their environmental implications (Riegl & Branch, 1995; Riegl, 1999). The live hard corals are considered as the most important coral-reef composition and an indicator of coral health (Rezai et al., 2010a, b).

The SW site contained areas with the highest coral coverage and genera diversity in which *Acropora* species were dominant, while they were lowest in NE site, dominated by *Portia* (Figures 2 and 4).

In the NE region, composition of coral community changed significantly resulting from high cover of *Porites*, and a reduced cover of *Acropora*. The mean DCC was more prevalent in the NE than in SW; this is related to the fact that NE site was closer to human settlements and the entry of flowing municipal run-off.

In addition, the acute and high occurrence of harmful algal blooms (HAB) in the region may have caused some negative impacts on the NE site than in the SW site. In October/November 2008, a HAB

event (*Cochlodinium polykrikoides* Margelef, 1961) in large scale (> 500 km²) occurred in the Persian Gulf and caused reductions in the abundance, richness and trophic diversity of the associated coral reef fish communities (Bauman et al., 2010).

Impairing coral health in near shore coral reefs are associated with higher concentration of stressors in near shore waters influenced by run-off and expansion of human activities (Smith et al., 2008).

During the survey, some coral lesions including pink spot and pigmentation response were observed on *Porites* colonies with little effects. However, outbreak of coral diseases can lead to sharp decline in live coral cover, reef resilience and coral resistance (Goreau et al., 1998; Rosenberg et al., 2004; Kavousi et al., 2013).

Rezai et al., (2010a) have predicted that shallow water *Acropora* reefs were unlikely to recover due to the fact that sea surface temperatures cause unfavorable conditions for coral growth in future. Based on our observations, all natural destructive factors existing in the study area may cause further stress on coral reefs.

Natural processes causing partial mortality of corals with direct damage by a colony of organisms such as fish grazing would also cause acute demolition events or chronic and acute disease (Smith et al., 2008).

A total of 16 hard coral genera were recorded in the study sites. This is higher than those in nearby Qeshm Island (Fatemi & Shokri, 2001; Kavousi et al., 2011) lower than Kuwaitis waters with 25 genera (Carpenter et al., 1997), with those in UAE (Sheppard, 1988). This is despite of the fact that there approximately 40 genera are distributed along the Persian Gulf (Riegl et al., 2012).

Sea bed dredging for breakwater construction in shallow waters around NE site directly removed areas with productive coral habitat and was thought to be, in some cases, the most important adverse effect that increased sedimentation. Due to breakwater construction in the NE site, water flow decreased and the site was continually affected by water flow and turbulence caused by waves. Other studies have showed a similar relationship between sedimentation rates and coral tissue mortality (Loya, 1976; Cort'es & Risk, 1985; Wielgus et al., 2004). However in the SW site, water flow has not changed.

In SW site, sedimentation rate per day was found to be 25 times more than that of the NE site due to the occurrence of storms and more waves in SW site. Sedimentation that may be enhanced by human activities (Loya, 1976; Rogers, 1990) is also known to affect coral community structure and damage coral colonies (Wielgus et al., 2004).

According to Riegl, (1999), *Porites compressa* can survive well in high sedimentary conditions. On the other hand, *Acroporids* are less tolerant to suspended sediments than *Poritids*, and that *Faviids* prefer substrates with less sand and lower suspended sediments (Rezai et al., 2010a).

In the present investigation, the North region (NE site), where breakwater construction and fishing activities had taken place, large, healthy colonies of *Porites* spp. were found; whereas the branching corals were mostly destroyed by human activities and algal overgrowth.

Given the continued trend of stressors affecting coral colonies, probably *Porites* will completely replace *Acropora* in NE site of Larak Island within a few years. But a low prevalence of young *Acropora*

spp. and *Stylophora pistillata* (Esper, 1897) (1-5 cm) colonies were found in the NE site.

Given the continual effect of human stressors and the increase in shallow water temperature (both having their own destructive factors on corals), recovery may be at lower rate in the future.

In station 'NESt2, the quantities of broken coral skeletons (recent broken pieces and rubble) was considerable. Their occurrence could be related to diving activities, trap fishing and boat anchors.

Anchoring cause significant and long lasting damage to coral communities in some locations (Glynn, 1994; Jamie & Timothy, 2001). Because of the fragile nature of *Acroporiids*, which are dominant in shallow waters, they can be easily broken away by divers (Riegl & Velimirov, 1991).

Partial mortality of coral tissue was followed by algae and/or sessile benthic organisms (Smith et al., 2008). In addition, an increase in illegal ornamental fishing has reduced reef fish populations throughout the study area. One result of over-fishing is the reduction in the number of coral fish species, but over-fishing of key fish species can result in severe physical breakdown of coral reef ecosystems (McClanahan, 1995; Roberts, 1995; McClanahan et al., 1996; Hodgson, 1999).

Pollution in the last three decades may have also caused lower diversity in this region (Fatemi & Shokri, 2001).

The dead corals of NE area were completely covered by algae (Figure 2). Dead coral covered with turf algae may be interpreted as a sign of disturbance over a long period (i.e., the final stage of partial or total coral mortality) and thus might be useful as an integrated measure of past disturbance (Smith et al., 2008).

Tanner, (1995) reported that macro-algae were major competitors with coral communities. They found that grazers such as fish and sea urchin play an important role in distribution and abundance of most macro-algae species. Removal of grazers had a negative impact on the coral environment, which lead to an increase in algal cover and overgrowth on corals (Mohammed & Mohamed, 2005). This pattern supports our hypothesis that coral reefs of NE site would display the greatest signs of degradation; it is unlike the pattern of the reefs located in SW sites (Figures 2 and 3).

Coral communities have been negatively influenced by various human activities such as over fishing, coastal development, marine and inland pollution, industrial and urban run-off (Turner et al., 2000). This study investigates that coral communities of NE site have been more destroyed by human settlements, municipal run-off, breakwater construction, trap fishing, over-fishing and other anthropogenic influences. With the increased pressure of stressors on coral reefs, conservation requires willingness among stakeholders, the public and decision-makers to protect resources and marine ecosystems, along with providing proper information in relation to management guidelines.

5. Conclusion

Coral communities have been negatively influenced by various human activities such as over fishing, coastal development, marine and inland pollution, industrial and urban run-off (Turner et al., 2000). This study investigates that coral communities of NE site have been more destroyed by human settlements, municipal run-off, breakwater construction, trap fishing, over-fishing and other anthropogenic influences. With the increased pressure of stressors on coral reefs, conservation requires willingness among stakeholders, the public and decision-makers to protect resources and marine ecosystems, along with providing proper information in relation to management guidelines.

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