CHAPTER 2
ASSESSMENT OF PREVAILING THREATS IN THE STUDY AREA

Around the world, corals are distributed in tropical and subtropical waters. India is home to around two percent of the coral reefs of the world (Spalding et al., 2001). The majority of these are located in the Andaman and Nicobar Islands and Lakshadweep atolls. The other two important coral reef regions are Gulf of Mannar and the GoK. There are a few small patches of reefs located off the coast of Maharashtra (Malvan) and Tamil Nadu. The reefs of Andaman and Nicobar, Gulf of Mannar and the GoK are fringing reefs, while the Lakshadweep reefs are the only Atoll reefs existing in Indian waters (Bahuguna et al., 2010) **(Figure 2.1)**.

2.1 Study Area

The state of Gujarat has the longest coastline of any Indian state, nearly 1650 kilometres. Gujarat is famous for its coastal biodiversity, which has been the topic for a number of studies (Singh, 2002; Misra and Kundu, 2005; Venkataraman and Wafar, 2005; Dave, 2011). Gujarat is also home to many ports and leading fisheries centres. Many leading marine institutes have their centres in Gujarat, including Central Marine Fisheries Research Institute (CMFRI), Marine Products Export Development Authority (MPEDA), Central Institute of Fisheries Technology (CIFT) and Gujarat Fisheries Department. The state is surrounded by sea from two sides and has three different water bodies sharing the boundaries, the Arabian Sea, the Gulf of Khambhat, and the GoK. The environment of each of the water bodies and their inhabitants varies.

The Arabian Sea covers the majority of the south and west coast. The Gulf of Khambhat and the GoK are extensions of the Arabian Sea. The Arabian Sea has subtropical waters, with low turbidity (Raghunathan et al., 2003). It has many leading fish landing centres and ports, including Veraval, Porbandar, Mangrol, Jafrabad, and Navabandar.

The Arabian Sea penetrates mainland Gujarat at two locations in the form of the Gulf of Khambhat and the GoK. Gulf of Khambhat involves the southern portion of Gujarat state. It has a narrow funnel shaped Gulf causing high tidal fluctuations. It has low salinity and high turbidity due to the inflow of terrestrial runoff from major rivers such as Sabarmati, Mahi, Dhadhar, Purna, Narmada, Tapi, Daman, Ganga, and many other small rivers and streams. Due to the high sediment load in the Gulf of Khambhat, it harbors less diverse biota than the GoK. It has many leading fish landing centres and ports, due to the extensive industrial development in south Gujarat. Major ports including Bhavnagar, Dahej, Magdalla, Mahuva, and Pipavav have been developed. Dahej is one of the major ports for oil industries due to its close proximity to oil refineries and oil wells.

Out of all the three water bodies, the GoK is the most diverse and, biologically, is considered to be a highly productive region of the state. Gujarat has been blessed with the presence of coral reefs and mangrove forest ecosystem around the GoK **(Plate 2.1)**. Beautiful coral islands and mangrove forests increase primary productivity, aesthetic beauty, and contribute to the economy of this region. The area contains few of the northern most reefs in the world, and the presence of these reefs in the GoK

is considered a miracle. This is because the climatic conditions of the Gulf are very different to the basic requirement of corals. The GoK is highly turbid due to the influx from the river Indus (Nair et al., 1982; Kunte et al., 2003). The hydrodynamics of the Gulf make it a highly turbid zone. Moreover, due to its funnel shape, the tidal fluctuation is very high – the range of the tide varies from four meters near the mouth of the Gulf to up to seven meters in the intricate creeks (Chauhan and Vora, 1990). This area is home to many endangered species of flora and fauna (Dave, 2011). The high turbidity, high salinity and high tidal fluctuation make this area difficult for the survival of coral colonies. In addition, recent trends in environmental conditions have made it increasingly difficult for corals to survive in these micro tidal conditions of the GoK (Chauhan et al., 2006). Since 1982, coral reefs have been given protection through legislation by the Government of Gujarat's Forest department, and through the Marine National Park and Marine Sanctuary (Rashid, 1985).

The GoK is a habitat for 42 small and large islands, including reefs, that are part of the Marine National Park and Sanctuary. This study involved a survey of the whole area, and study sites were selected based on the severity of the threats prevailing in the study area. The locations and purposes for selection of each of the study sites have been described in the individual chapters. The study area included Pirotan reef, Paga reef, Dwarka, and Bural Chank reef. Locations of individual reefs have been given in **Figure 2.2**. The habitat of the individual site has been presented in **Plate 2.2**.

2.2 Present scenario

Global warming and climate change are exerting pressure on the reef ecosystem. As corals require a narrow range of environmental conditions, including sea water temperature, salinity, turbidity, and photosynthetically active radiation (PAR), for their growth and flourishment, their survival is placed at a high risk as a result of these pressures. For coral reefs outside the GoK region, the major threat is bleaching due to increased temperatures, global warming, and increased ocean acidity (Hughes et al., 2003; Hoegh-Guldberg et al., 2007; Baird et al., 2009). In contrast, the major threats to corals of the GoK are various abiotic and biotic threats (Arthur, 2000).

2.2.1 Abiotic threats

In the GoK, the abiotic threats include sedimentation, temperature, impact of industrial development, fishing methods, and other anthropogenic pressures. Some of these are represented in **Plate 2.3.**

Out of these threats, sedimentation is the major cause for the loss of coral communities in the GoK region. Corals are exposed to highly turbid water daily, and settlement of these sediments over the coral colonies makes survival of corals difficult (Bhattji et al., 2011).

As discussed, temperature-related bleaching is a less significant problem in the Gulf of Kachcch due to the low penetration capacity of sunlight secondary to sedimentation (Arthur, 2000). However, as shown by remote sensing images, temperature rises do contribute to an

increasing amount of algae in the reef ecosystem. This increased algal growth further adds to the pressure on already stressed coral colonies. Thus a rise in temperature, an abiotic threat, leads to the biotic threat of increased algal growth.

Several small and large industries are operating on the southern coast of the GoK, and most release their waste into the Gulf. Some of these were involved in the manufacturing of cement and, as a result, coral reefs were dredged for calcium carbonate (Singh, 2006). After the enforcement of the Marine National Park and Sanctuary, however, this activity has been banned. Nevertheless, a significant amount of effluent from industries still flows into the system making the environment more difficult for coral survival (Boesch and Rabalais, 1987; Singh, 2006).

The GoK region provides a major source of income for many fishing communities living in coastal villages whose livelihood depends on fisheries. Previously, the major fishing method used in the area was trawl net fishing, which was done by dredging the bottom of the Gulf. This method caused significant breakage and damage to coral colonies. It also resulted in disturbance of the sediments at the bottom of the ocean floor, further increasing the turbidity of Gulf waters. As a result, to maintain and sustain the ecosystem, this practice has now been banned by the Marine National Park authorities. Trawl fishing is no longer allowed in the Marine National Park area. It is allowed outside

the Gulf and towards the northern rim of the Gulf (Mohanraj et al., 2009).

2.2.2 Biotic threats

The major biotic threats include algal overgrowth on corals, *Palythoa* intrusion, and deforestation of the mangroves of the Gulf.

Algae are common inhabitants of reefs. But the overgrowth of fleshy marine algae over coral colonies limits the growth of corals. The change from a coral-dominated habitat to an algae-dominated habitat is called phase shift. Phase shift is seen among many coral reef regions of the world (Endean and Stablum, 1973; Smith et al., 1981; Done, 1992; Rogers and Miller, 2006). The already stressed coral colonies are overgrown by fast growing fleshy algae. Although algal growth is a seasonal phenomenon in the GoK, in the past two decades it seems that the growth pattern and period of growth of fleshy macro algae may be changing.

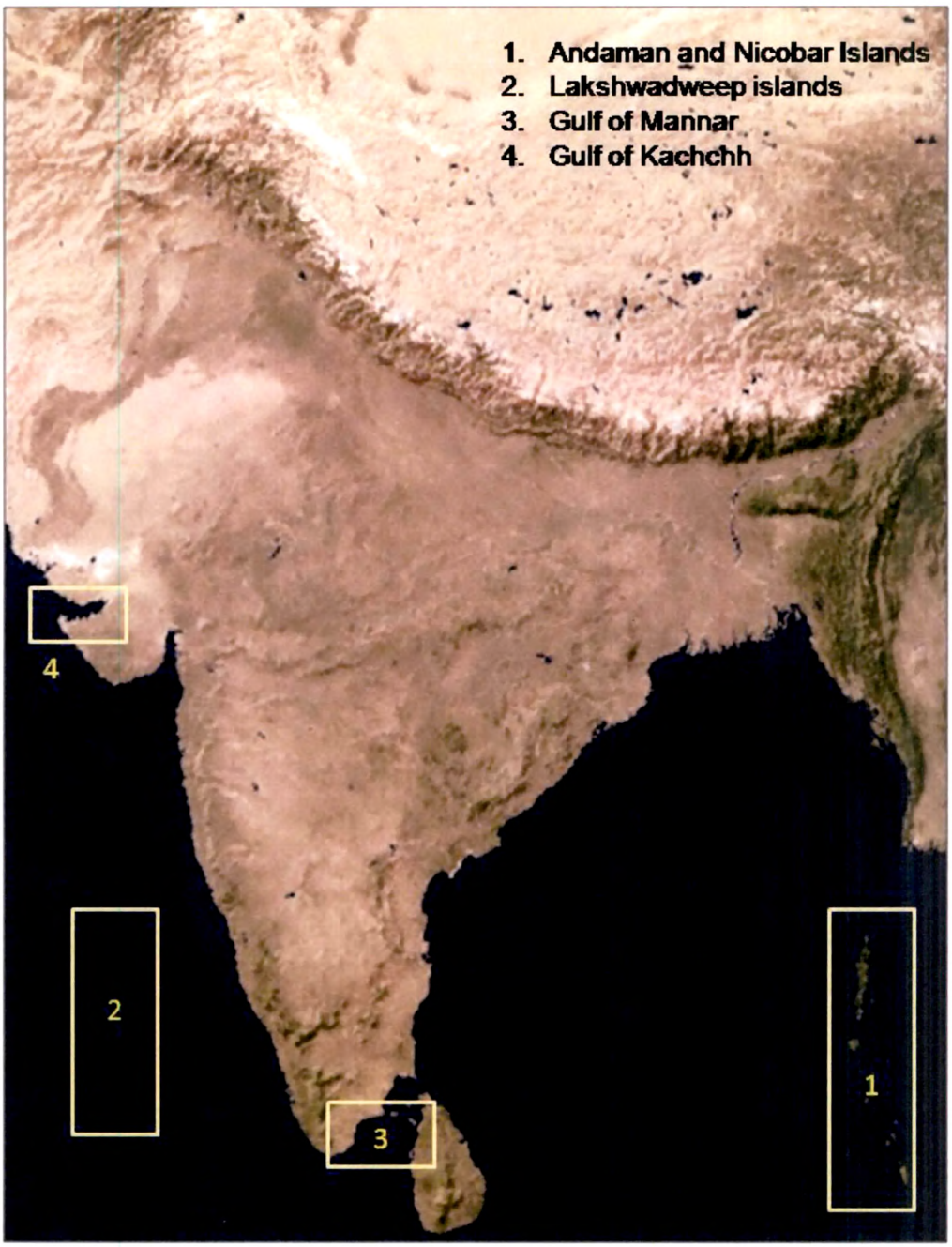
One newly emerging threat to corals of the GoK is the Zoanthid of the genus *Palythoa*. These have actually been misunderstood for many years as corals. They are a relatively new member of the Marine National Park and Sanctuary, and may be causing significant damage to coral colonies. The genus is fast growing and territorial (Suchanek and Green, 1981; Shiroma and Reimer, 2010). Hence, the speed of growth must be checked in order to minimize damage to corals. A detailed explanation of the genus is given in Chapter 4 of this thesis.

Deforestation of mangroves has played a major role in the degradation of corals. Mangroves are plants whose prop roots retain land-derived sediments and prevent their entry into the coral reef ecosystem. Due to the loss of this natural protection, sediments from land runoffs starts settling over the coral colonies, and cause destruction of the reefs long-term (McCook et al., 2001; Victor et al., 2006). As a result, a regular check on the deforestation of mangroves, is required to prevent further damage to this valuable ecosystem. In the last decade, due to the efforts of the Forest department, the use and exploration of mangroves by local communities has been restricted. Furthermore, it is hoped that efforts to create new mangrove plantations may result in regeneration and rejuvenation of corals as well (Biswas, 2009).

All the threats discussed above contribute in a large or small capacity to the degradation of the coral reefs of the GoK. Reducing their impact on corals is a major challenge for authorities and conservationists. Current research must focus on how technology can help in this mission. Remote sensing technology is a revolutionary way of understanding the damage to the reef ecosystem, habitat-inhabitant relationships, and the possible interventions that can take place to prevent further deterioration in reef health. This thesis also emphasizes the importance of such technology for broad data collection, and the benefits this has over previously used time consuming, site specific surveys.

In the subsequent chapters, specific abiotic threats and biotic threats are discussed in detail.

Figure 2.1 Coral Reef Regions of India



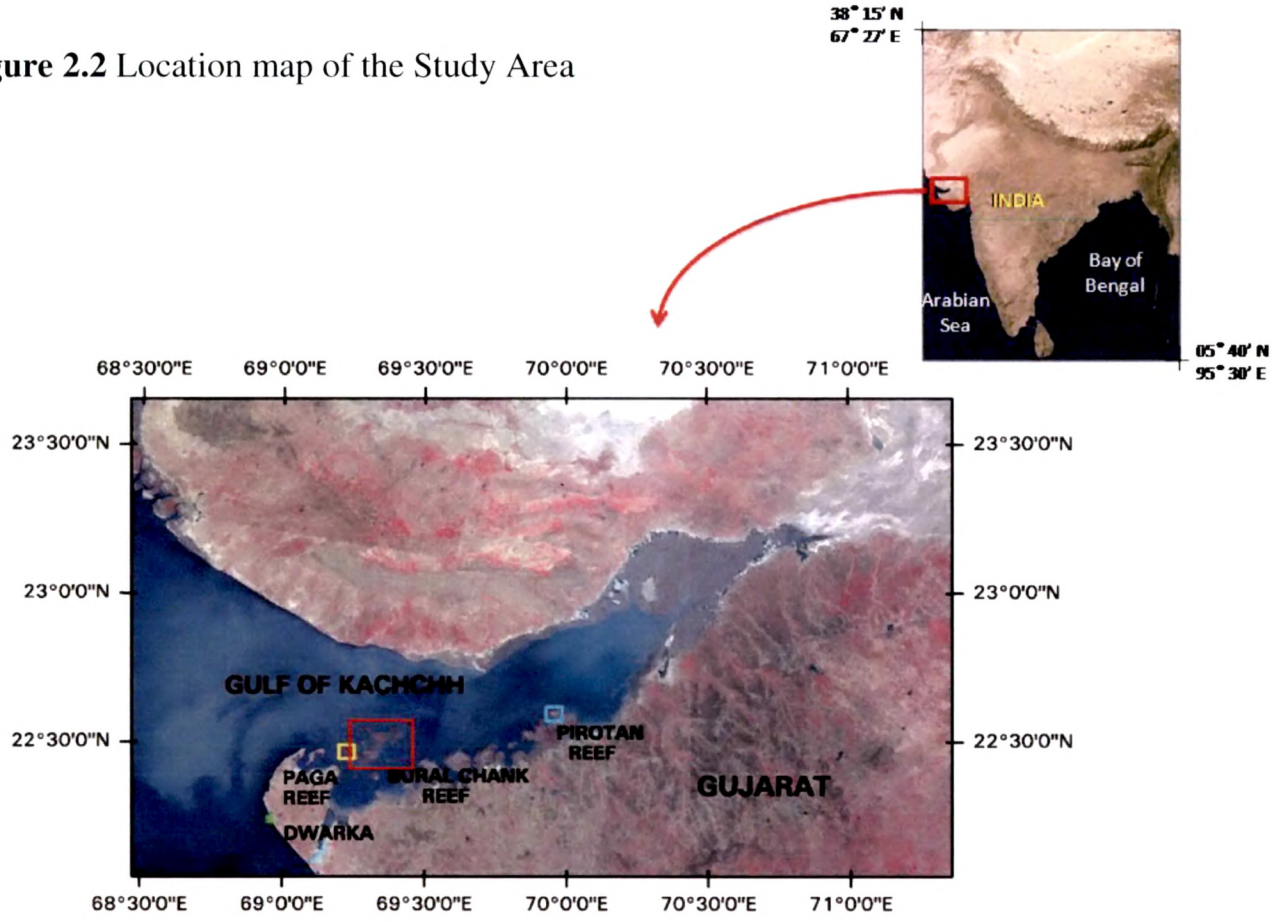


Figure 2.2 Location map of the Study Area

Figure 2.3 Distributions of Reefs in the Gulf of Kachchh

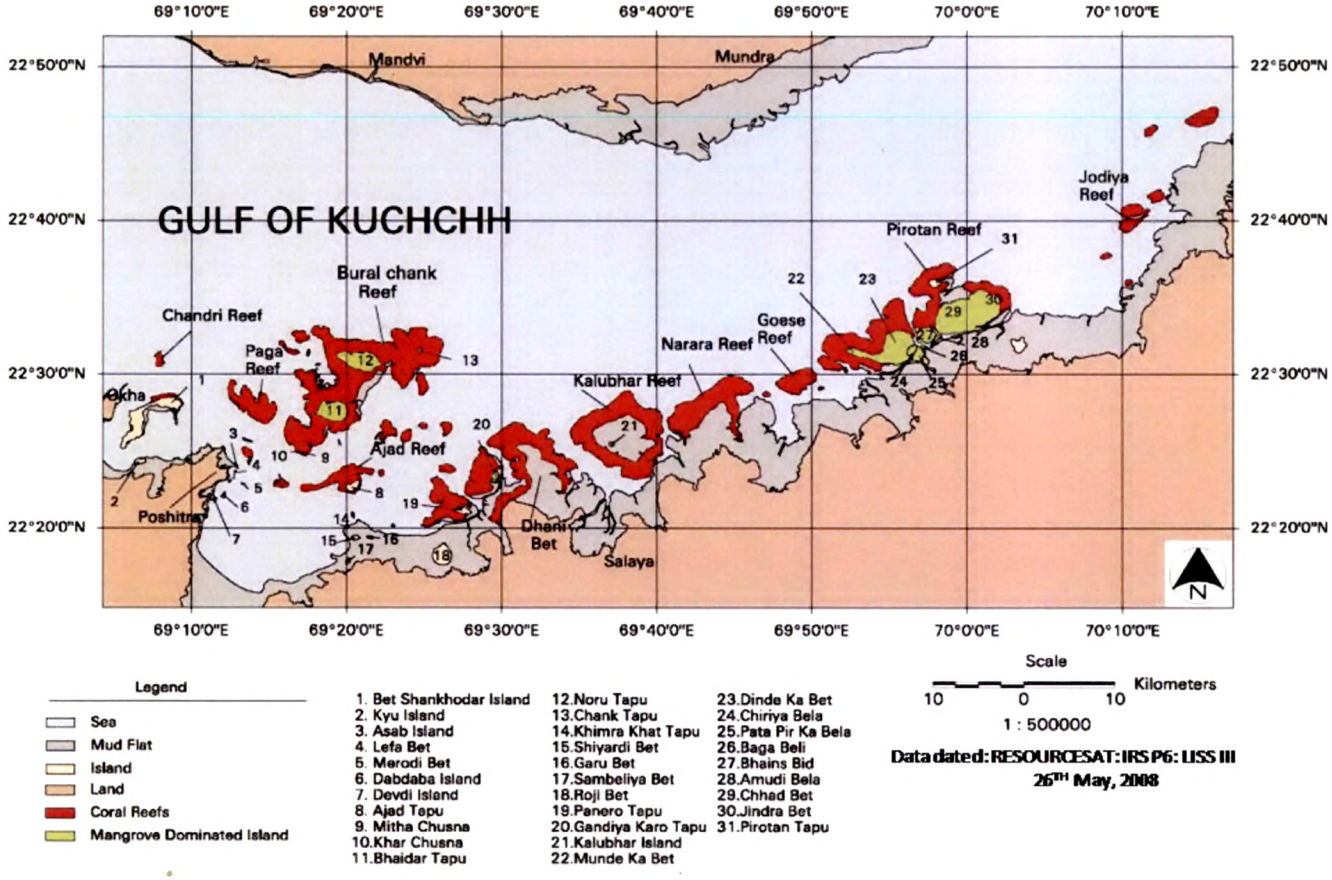


Plate 2.1 Various Biota are present in the Gulf of Kachchh: A) Sponges are regular associates of coral reefs B) Various corals and algae together make the small tide pool ecosystem C) A sea Anemone on reef flat D) Sea anemones in seagrass beds E) Reef octopus is a common sighting on the GoK reefs F) *Bonelia*: found in plenty on selected reefs of the GoK

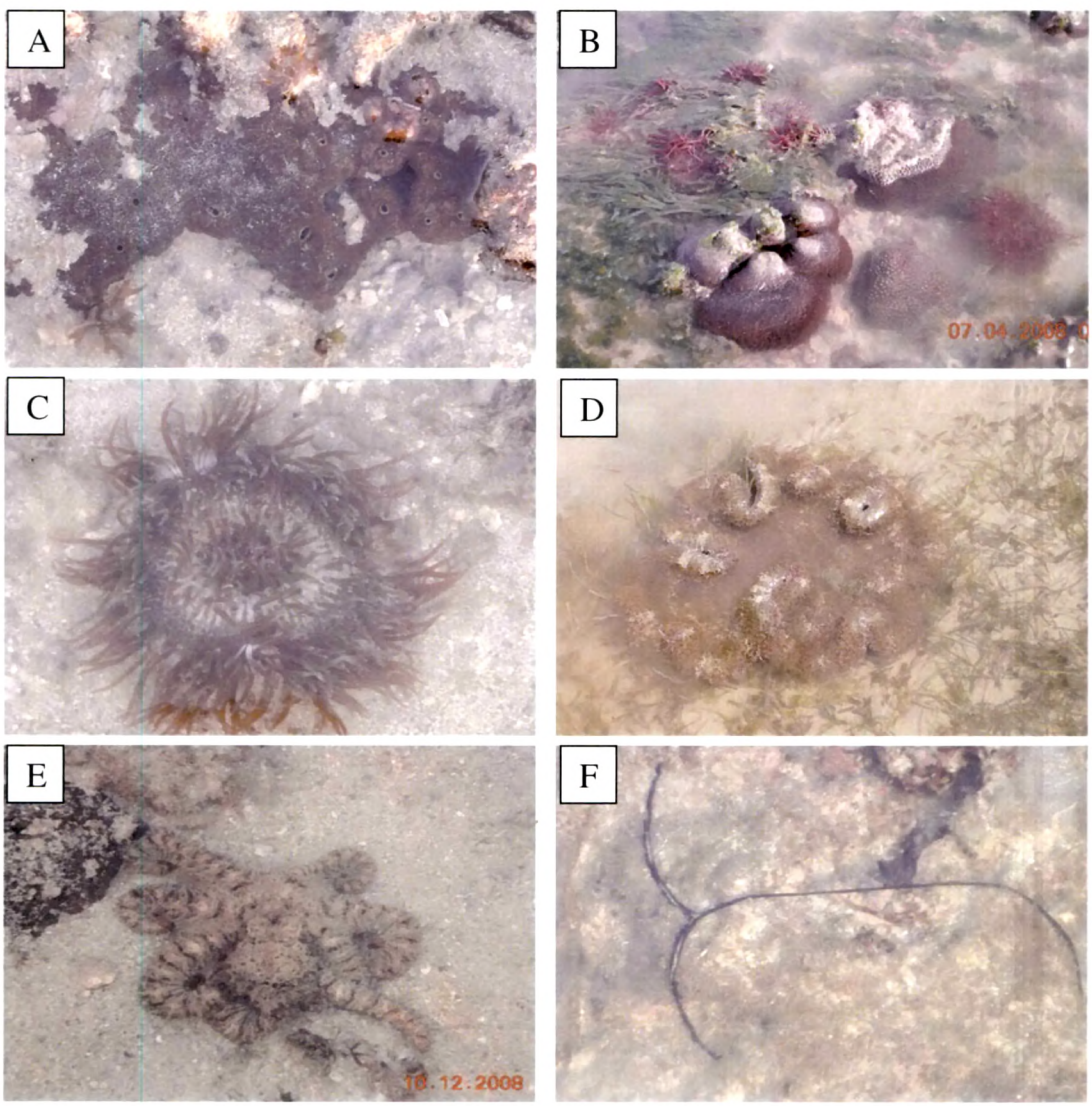


Plate 2.2 Study site: A) Pirotan reef: Reef flat showing dead coral boulders B) Sunset at Pirotan reef C) Dwarka intertidal region D) Paga reef: presence of extensive fleshy algae E) Reef Front at Bural Chank reef F) Seagrass and Sargassum beds near Chank Island, Bural Chank reef

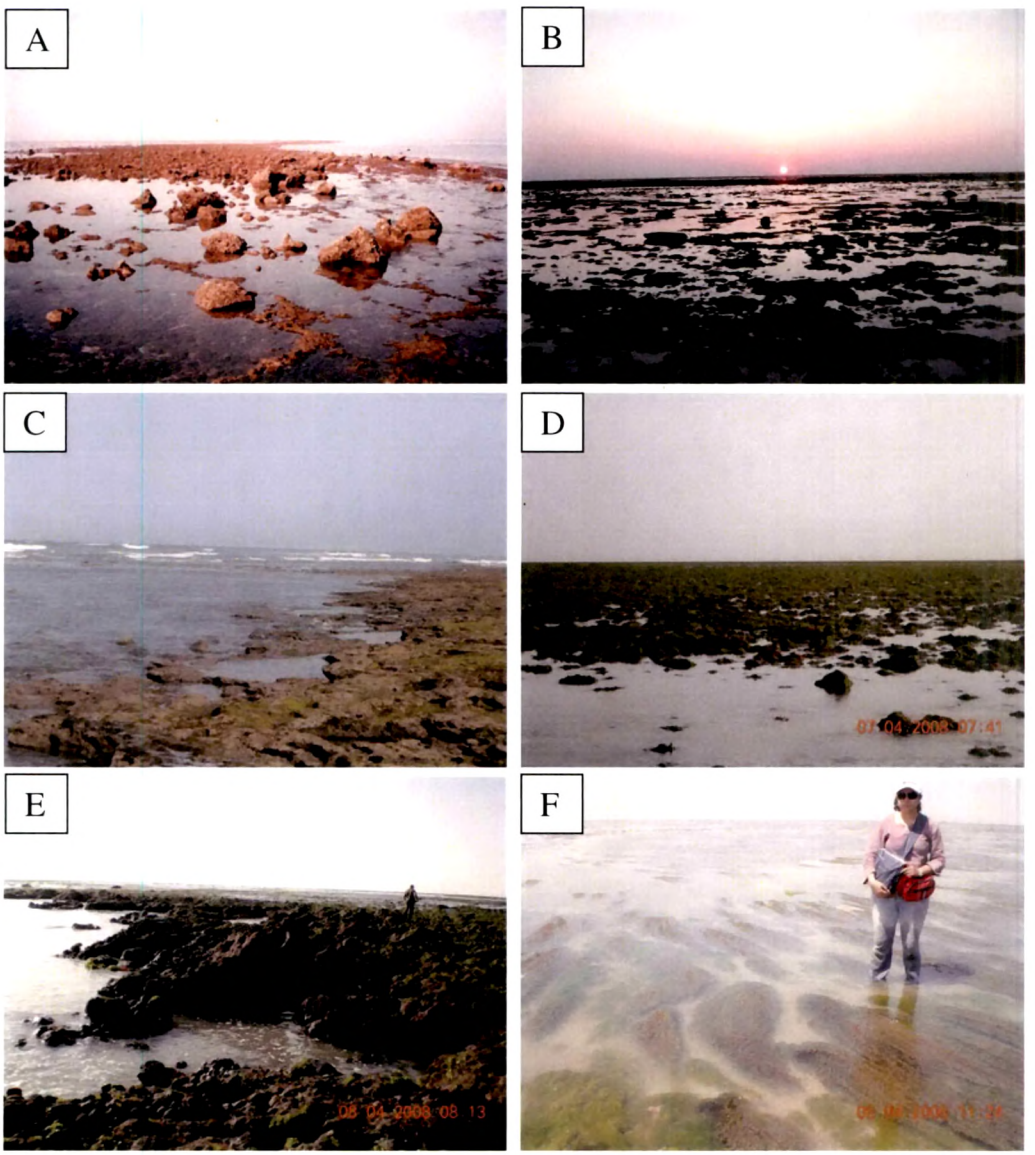


Plate 2.3 Major threats prevailing in the area: A) Sediments covering live coral colonies B) Industries running day and night C) Algal overgrowth D) *Palythoa* an invading species