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Impact of Human Activity on Biotic Communities in the Ai Qatif Oasis, Saudi Arabia

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Abstract: An account is given of the human impact and eutrophic elements on biotic community in the salinity gradient drainage networks and marine littorals, in the vicinity of the Tarut Bay, on the Arabian Gulf. Marked differences occurred in the algal vegetatidn between the origin of a spring (S = 0.3%) and the final discharge in the marine littorals (S = 23%). Influx of eutorphic elements and demolished building materials, which were dumped in the Tarut Bay, are causing perturbation to the tidal forests and marine littorals. Subsequently, a few mangroves inhabiting biotopes not described earlier were colonizing. A discussion is included to emphasis conservation and suggestions were made to monitor sites under threat of perturbation. in spite of the partial destruction of mangrove areas for the construction of corniche and urbanization, Anak and Al Awamiyah are still characterized by the best strands of mangrove swamps.

Key word: Biotopes health, *Chafe* spp, *Compsopogon coeruleus*, conservation, new records, perturbation, *Ulva lactuca*

Introduction

Construction leading to development of corniches, parks and urbanization of the reclaimed coastal areas are a common practice in most of the developing countries. Discharge of untreated effluents in the coastal areas is another hazard to the biotic community. Such incidents of impacts often cause replenishment of indigenous flora and fauna. Mangrove swamps are common in areas which are subject to receive river or wastewater (Khoja, 1998) into the coastal area. However, discharge of untreated wastewater often cause degeneration and/or stimulation of a particular species, which shows specificity to the nature of the environment. In view of the arid nature of much of Saudi Arabia, the inland and marine biotic communities are playing an important role as primary producers and deserve conservation.

National Commission for Wildlife Conservation and Development (1988) and other conservation movements placed an early emphasis on preserving resources in Saudi Arabia from human destruction. Aleem (1990) has discussed similar problems of perturbation of the mangrove areas. Al-Hassan and Jones (1986) described intensive urbanization and industrialization in the coast of Kuwait resulted in disappearance of some algae. An incident of major oil spell off Fujairah was studied by Boeer (1996) however, mangroves were unaffected by the impact.

The ecological significance of the eutrophic coastal areas is a subject of interest in many of the developing countries. In this regard Saifullah and Nizamuddin (1992) were concerned with city's sewage discharge system and reported pollution monitoring algal flora In the low saline and eutrophic waters in the vicinity of Jeddah City, bordering the Red Sea. However, uptake of ammonium by *Ulva lactuca* and ammonium and nitrate by *Hypnea musciformis* was described by Pedersen (1994) and Haines and Wheeler (1978), respectively.

The intent of the present investigation is to assess the magnitude of perturbations inflicted by the human activity and its relationship with man and to report the occurrence of algae in the salinity gradient drainage canals and in the marine littorals. Also, the biology of coastal environments and reclaimed areas are dealt with to emphasis to what extent the coastal areas are impacted by human activity and to justify measures for conservation.

Materials and Methods

Sampling strategy and programme: After a preliminary survey made on 23 October 1994, collections were made on six occasions covering five stations from Dec. 1994 to May 1995. Visually obvious algal community and invertebrate assemblage were collected in polypropylene bottles from five different habitats, one spring (Ain Al Tayaba), two drainage canals and two mangrove areas (Al Anak and Al Awamiyah).

Samples were preserved in 3 percent formalin and a sub sample was air dried to examine the live specimens after rehydration. The specimens were examined in the field with the help of a field microscope followed by a detailed assessment in the laboratory.

Water chemistry: Samples were removed for analysis from the surface water (5-10 cm deep) of each site into a beaker and allowed to stand for 5 minutes prior to the measurement. All measurements were carried out in the field and, where there was any anomaly, samples were diluted. Water temperature and salinity were measured with the aid of a portable salinometer (YSI Yellowstone), pH (VWR Scientific) and SRP and N-NH4 by a portable spectrophotometer (Hach DR-EL/2). Methods were similar to those described by Khoja (1998) and Hussain *et al.* (1996).

Description of study area: The study area covered by this work (Fig. 1) lies between 26°-28 N, 48°-49 E. Five stations have been studied; detailed description of each station is give below.

Station I. Ain Tayaba (spring): Fig. 1 shows the origin of the water to the outlet in the marine littorals. Numerous springs are scattered in the Al Qatif Oasis, but one of the springs had been selected for the present study. The study site has abundant juvenile water that rises up from shallow to deep magmatic springs (Fig. 1).

Station II, Anak drainage canal: The re-circulated water collected from various agricultural fields is tapped into a single drainage canal. Water chemistry of discarded water varies due to the effect of over/under fertilizers; long standing time in fields; leaching of saline elements present in sail and finally influx of sewage-rich effluent. However, aeration in the open drainage canal often takes place particularly, when the water gushes through drop structures and culverts.

Station III, Al-Awamiyah drainage canal: Al-Awamiyah canal drains the wastewater of agricultural fields into the Tarut Bay near Al-Nasrah. For most of the survey period aquatic weeds dominated the drainage canal (Fig. 2). The drainage canal flows slowly and sometime stagnates, particularly near its opening in the bay particularly, when the coastal area is inundated.

Aquatic angiosperms: *Ceratophyllum demersum* L, *typha* sp. Seagrasses Halophila ovalis R. Brown and *Thalassic hemprichii* (Ehr.) Aschers.

Station IV. Al-Anak mangroves: Al Anak is low lying area with a few sandy beaches while most of its coastline is covered by fill, consisting of demolished building materials. Discharge of wastewater and terrigenos mud tend to enrich the coastal ecosystem with eutrophic elements. It is a continuous process that leads to deposition of alluvial soil. Subsequently, Al-Anak is dominated by luxuriant stands of mangrove areas (Fig. 3). This station exhibits fascinating reclaimed coastline.

Salinity of mangrove area fluctuates; it is inversely proportion to the outflow of the drainage water ad wave action.

At the far end of the eastern coast of mangrove area an exposed sandy beach at low tide provides a nesting site for various sea and migrating birds.

Mangrove: *Avicennia marina* (Forsskal) Vierh.

Station V. AL-Awamiyah mangrove: Al-Awamiyah is similar in topography to Al-Anak. Coastal area, part of estuary, and intertidal channels consist of labyrinth of mangrove swamps. Avicennia marina is the dominant vegetation. Low saline mangrove area harboured migrated brackish water flora.

Aquatic weeds: *Ceratophyllum demersum.*

Results

Water chemistry: Physico-chemical characteristics of all sites are given in Table 1. The sites were monitored on six occasions, but radical changes in the water chemistry were not observed. As such only data for the month of March 1995 is presented. An increase in pH (7.8-7.9) and soluble-reactive phosphate (0.02-0.8 mg/l) was apparent from the outlet of the spring (Ayn-Tayaba) to the Anak mangrove area on the Tarut Bay. Similarly, the other parameters also ameliorated during the course of water-flow. The trophic status of the spring water is broadly determined as oligotrophic however, in the downstream the trend was mesotrophic and finally eutrophic prior to opening of the mouth of the canal in the bay.

Floristic composition and new records: Table 2 shows algae collected from five sites (Fig. 1), which include 1 spring and 2 drainage canals and 2 mangrove areas. The two latter sites revealed additional knowledge to the understanding of the marine ecosystem and include five new records to the existing checklist of the Gulf (Basson, 1992) and to the additional records (Khoja, 1998). The five main sites were chosen for a detailed assessment.

Algae in spring: A few species of algae were recorded in the spring as opposed to the other sites. A thin cover of *Microcloleus chthonoplastes* was found around the periphery of the spring, which include *Brozia triloculari*es and *Gomphosphaeria aponie* var. multilex. *Microspora* sp and *Lyngbya majuscule* were infrequent in the spring but, predominant from the outlet of the spring as well as in the downstream. Algal vegetation and water chemistry of the main two irrigation canals will be published separately.

Algae in drainage canals: Abundant growth of filamentous algae (*Spirogyra/Cladophoral* and aquatic weeds *(Ceratophyllum demersum*) *were* recorded in the Al Awamiyah drainage canal (Fig. 2). The overwhelming growth of these weeds is a constant nuisance to the drainage authorities. *Compsopogon coeruleus* and *Enteromorpha intestinalis* are basically algae of the brackish water origin and were common. *Chara vulgaris* and *C.zeylanica* were the most common in the irrigation canals.

Ceratophyllum demersum and *Chara* and *Enteromorpha* spp were dominated both in irrigation and drainage canals but their growth maximum was recorded prior to the opening of the canal in the bay.

Algae in marine littorals: The abundant growth of *Ulva* spp was visually obvious in the mangrove areas even from a distant place. High levels of eutrophic elements and low tidal amplitude are the common features of the coastal areas, these factors favoured mangrove swamps and *Ulva* spp. The overwhelming growth of *Ulva* spp on the shore and aerial roots of mangroves depicting a litterfall site (Fig. 3). *Ulva lactuca* is one of the most common species recorded in the marine littorals and the rarer was *Codium papillatum.* Sites with sewage disposal in the marine habitats are always accomplished with the growth of Ulvales (Saifullah and Nizamuddin, 1992; Anand, 1981) and, prsonal observation at Aziziya Beach and near Dammam Port, *Ulva* spp invaded such marine littorals and covered shallow pelagic sites.

Mangrove inhabiting biotopes

I. Invertebrates

Balanus tintinnaabulum: Figure 4 shows epiphytic cluster of *Balanus tintinnabulum* on pneumatophores, their overwhelming growth is usually recorded particular at reference point (ca ± 5 cm to the reference point). They caused permanent encrustation (90% of the available surface), responsible for physical hindrance to respiratory pores and ventilating buried roots. The marine shellfish showed the ability to establish itself in brackish water (S = 18-20% and also at higher salinity (S = 23%). Pneumatophores consisting of clung *Balanus* spp have been left to dry in shade (laboratory) for a week. They respond quickly to stimuli by showing active closing/opening movements of their bivalves upon rewetting in the seawater (Fig. 5). The movement was accomplished by gentle but audible sound. It is quite obvious that species of *Balanus* are capable of being viable under stress to varying degree of salinity (S = 18-23%) and well tolerant to adverse environmental conditions, such as complete emerson, submersion and desiccation.

2. Algae: Pseudoparenchymatous thallus of *Gomontia polyrhiza* was abundant as endophyte/epiphyte on pneumatophores and prop roots, and occasionally *Enteromorpha* spp. In addition to this species a few Cyanophyta *Pleurocapsa fuliginose, Nostoc punictiforme* and *Oscillatoria* spp were also recorded on pneumatophores and prop roots, these species were very much encrusted with calcite structures.

Mangrove areas: Fig. 1, shows a map of the study area. Al-Anak is densely populated by mangrove stand arranged in the order of abundance at landward and the least seaward edge of mud flat. The mangrove forest stretch ca 550-650 m wide and run parallel to the coast For ca 2.5 km. Dredging of the low-lying area destroyed a part of the mangrove community and it was reclaimed for the construction of a corniche and park. This caused degeneration/destruction of mangrove community, resulting in a narrow strip of mangrove. The coastal area of Al-Awamiyah mangrove is also partially destroyed by the impact of human activity for construction of residential area. Nevertheless, new young colonies are propagating and becoming established in the neighboring areas.

Discussion

Algal growths were conspicuous at all sites, *Microspora* sp and Lyngbya *majuscule* were dominant in the spring outlet, *Chara*

Table 1: Physico-chemical composition of water at five sites in the vicinity of Tarut Bay sampled on 24th March, 1995. Concentrations of elements as mg l^{-1} SRP = soluble reactive phosphate

Sites	Spring	Drainage canals		Mangroves	
	Ayn Tayaba	Al-Anak	Al-Awamiyh	Al-Anak	Al-Awamiyh
Time	920.0	1000.0	1130.0	1040.0	1250.0
Temperature°C	27.0	30.0	31.0	32.0	29.0
Salinity%	0.3	0.4	0.5	23.0	18.0
pH	7.6	7.8	7.8	7.9	7.9
SRP	0.02	0.8	1.8	0.3	0.8
NH_4-N	0.12	1.0	2.1	0.9	1.5

Table 2: Occurrence and distribution of algal taxa recorded from the origin of an oasis to the final discharge in the marine littorals, 1-V represent: I, spring; II, Anak drainage canals; III, Al-Awamiyah drainage canal; IV & V Anak & Awamiyah mangrove areas, respectively. New records to the Saudi coastal zone (Arabian Gulf)

Taxa	Station				
	I	II	III	IV	V
**Borzia triloculariesCohn*	+	-	-	-	+
Chroococcus turgidus (Kutz) Nageli	-	-	+	+	+
**Gomphosphaeria aponina* va. multiplex Nygaard	+	-	-	+	
Homoeothrix vanans Geitler	-	-	+		+
Lyngbya majuscula Harvey	+	+	+	+	+
Oscillatoria princepes Vaucher ex Gomont	-	-	+	+	+
Oscillatoria sp					
Pleurocapsa fuliginosa Hauck	-	-	-	+	-
Microcoleus chthonplastes Thuret ex Gomont	+	+	-	+	+
**Nodularis spumigena* Mertens	-	+	+	-	+
Nostoc punctiforme Hariot	-	-	-	-	+
Chaetomorpha aerea (Dillwy) Kutzing	-	-	-	-	+
C. linum (O.F. Muller) Kutzing	-	-	-	-	+
Ohara vulgaris L	-	+	+	-	-
C. zeylanica Kl. ex Willd	-	+	+	-	-
Cladophora glomerata (L.) Kutzing	-	+	+	-	-
C. koiei Borgesen	-	-	-	+	-
**Codium papillatum* Tseng & Gilber	-	-	-	+	+
Enteromorpha clathrata (Roth) Greville	-	+	+	+	+
E. intestinalis (Linnaeus) Ness	-	-	+	+	+
Gomontia polyrhiza (Lagerheirn) Bernet of Flahault	-		+		+
Microspora sp,					
**Phaeophila dendroides* (Crouan) Batters	+	+	+	+	-
Spirogyrra sp	-	+	+	-	-
Ulva lactuca Linnaeus	-			+	+
Ulva reticulate Forsskal	-	+	+	-	-
Vaucheria sessilis (Vauch) De Condolle	-	+	+	-	-
V. terrestris Lyngbye em Waltz	-	+	+	-	-
Compsopogon coeruleus (Balbis) Montagne	-	-	+	-	-
Hypnea cornuta (Kutzing) J. Agardh	-	-	-	+	+
H. valenticae (Turner) Montagne	-	-	-	+	+
Janie rubens (Linnaeus) Lamouroux	-	-	-	+	+
Achanthophora spicifera (Vahl) Bergesen	-	-	-	+	-
Colpomenia sinuosa (Merens ex Roth) Derbes et Seller	-	-	-	-	+
Dictyota dichotoma (Hudosn) Lamouroux	-	-	-	+	+
D, divaricata Lamouroux	-	-	-	-	+
Hormophysa triquetra (C. Agardh) Kutzing	-	-	-	+	-
Sargassum binder, Sander	-	-	-	-	+

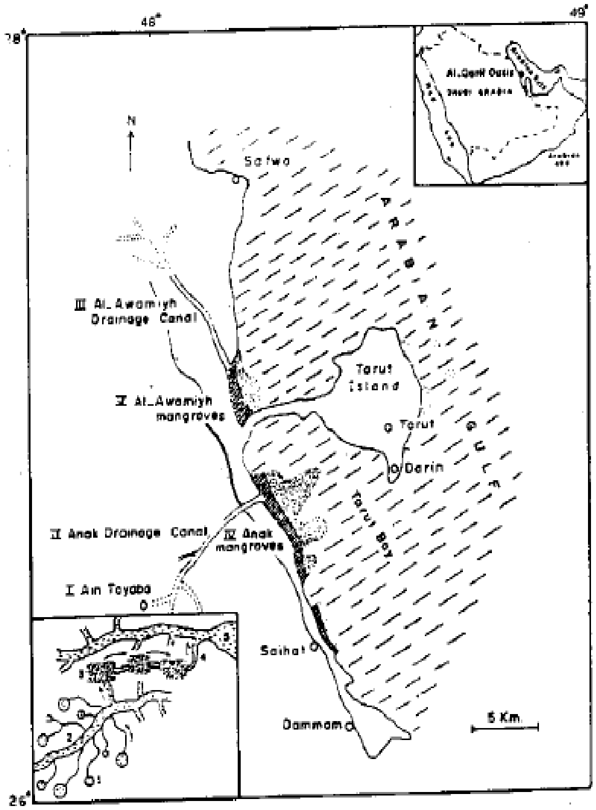

Fig. 1: Map of the study sites: I, spring (Ayn Tayabal; II, Anak drainage canal; III, Al Awamiyah drainage canal; IV, Anak mangrove; V, Al Awamiyah mangrove. Inset two maps; top, Saudi Arabia showing the Al- Qatif Oasis and bottom, a diagrammatic rrepresentation of the networks of water supply

Fig. 2: A catastrophically infested slow flowing drainage canal showing migratiion of aquatic weeds Into the coastal waters at Al-Awamiyah mangrove

Fig. 3: Al Anak trangrove area near the mouth of the drainage canal, showing unhiquitous outcrops of Ulavles

Fig. 4: Balanus spp clung to the pniumatophore of mangrove resulting in unhealthy growth

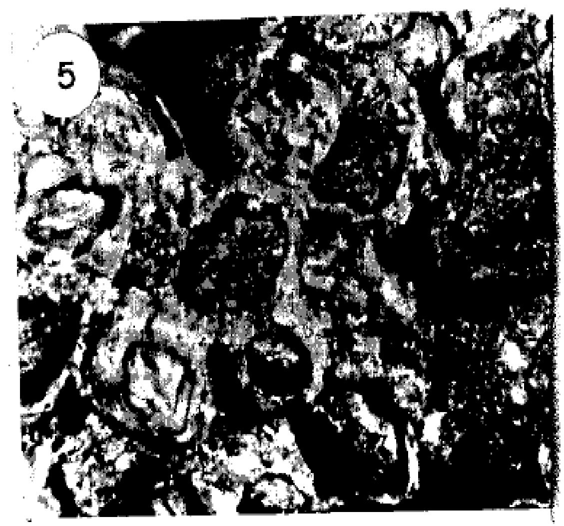

Fig. 5: Desiccated Balanus sp showing active movement aft being rehydated in the sea water

vulgaris, C. zeylanica Compsopogon coeruleus, and *Enteromoprha intestinalis* in drainage canal and Ulvales in the mangrove areas. The ubiquitous outcrops of *Ulva* spp and *Entermorpha* spp were the most common (Fig. 3) while *Codium pa,oillatum* and *Phaeophila dendroldes* were recorded for the first time *and* were rare in occurrence. Data of water supply shows a salinity gradient flora, which is in agreement with the phytogeography.

Eutrophic elements were higher in the marine littorals, the record maximum of NH4-N 1.5 mg/l and SRP 1.8 mg/l were recorded in the Ai-Awamiyah and Al-Anak mangrove areas, respectively. The major source of eutrophication is from recirculation of water from fields to fields and use of fertilizers. Nevertheless, such incidents of high levels of nitrogen ammonia and phosphate are common in Al-Hassa (Khoja, 1993). It is suggested that these elements should be checked and controlled and, some routine biological assays should be made, to monitor the quality of effluent prior to their discharge into the Tarut Bay.

Saifullah and Nizamuddin (1992) have reported a new species of *Ulva grandis* from a nitrogenous rich environment in the vicinity of Jeddah. Nevertheless, their specimen having some affinities with the present taxon *U. lactuca* that agrees well with that described previously.

Elsewhere, Pedersen (1994) also reported *Ulva lactuca* from eutrophic Danish estuary therefore, suggesting that *Ulva* spp and its varieties are common in nitrogenous water (NH4-N 0.9 mg/l (Al-Anak) and NH4-N 1.5 mg/l (Al-Awamiyah)). The ability of *Hypnea musciformis* (Wulfen) Lamouroux to uptake ammonia and nitrogen is well-documented in similar study (Haines and Wheeler, 1978). Therefore, it is suggested that *H. musciformis* and species or varieties of *Ulva* and *Enteromorpha* might be considered as indices to monitor environmental pollution.

Charophytes are susceptible to phosphate and decline with the increase of eutrophication however, a plausible explanation lies that the phosphate mostly derived from fertilization of the fields and was not a permanent feature of the water chemistry (data not provided in the Table 1). The majority of charophytes reported from Saudi Arabia are from brackish waters (Khoja and Hussain, 1990; Hussain *et al*., 1996) rather than soft waters (Hussain and Khoja 1999). Chemistry of water (Table 1) frequently fluctuates due to use of fertilizers, rapid and/or slow flow and mingling of drainage water with the seawater. Subsequently, salinity ameliorated thus, algae of the brackish water (Table 2) either flourishes overwhelmingly or dies, in relation to the tidal amplitude and change In salinity. It is not surprising to note that mangrove inhabiting, macro red algae are not found in the studied area while their occurrence were recorded in abundance elsewhere in pollution free waters in Saudi Arabia (unpublished data). Elsewhere, they are common in mangrove areas (West *et al*., 1992; Karsten and West, 1993). Colonization of blue-green algae on the pneumatophores is of common occurrence (Potts, 1980; Khoja, 1987) as sandy and muddy substrata are less suited for the growth of algae. Colonies of Rivularia polyotis (Ag) Born. et Falah was the most widely visually obvious algal growth on the pneumatophores of *Avicennia marina* in the Al-Shuaybah lagoons (Khoja, 1987). However, a peculiar habitat of *Gomontia polyrhiza* was found particularly at the juncture of pores or respiratory spaces of *A. marina.* It might be rather an easy task for the rhizoids to penetrate into the pores or respiratory spaces or a biological interaction exists between the host and the epiphytic alga.

Balanus spp are mostly found on solid substrata such as intertidal rocks, dead shells and ship bottom. Basson *et al.* (1977) have reported encrusting of oil platform piling with tremendous growth of barnacles causing fouling to the substratum. Their abundant growth in mangrove natural parks is surprising because of the absence of solid substratum for the anchorage. Nevertheless, they adapted to grow on mangrove roots, trunks and pneumatophores particularly at the emersion-immersion point (Fig. 4) in association with cyanophyta as well as intruded the empty soft-drink cans found as litterfall in the coastal water. It seems that barnacles had occurred in appreciable numbers prior to the construction of corniche. As a result of mud-fill and dredging of the area barnacles are considered to be endangered species in the Turt bay. *Balanus* spp were recorded from varied degree of salinity ranging from 18-42 percent (data not provided in the table) the can be considered as euryhaline in nature because of their wide range of distribution. They are also capable of tolerating desiccation during the low tides. Mangrove swamps are common in the Red Sea coast of Saudi Arabia, their abundance is higher particularly, in the Gizan Province (Hussain and Khoja, 1993), as opposed to the Eastern Province (Khoja, 1998). The Gizan region is subject to torrential and erratic rainfall. While, in the Al-Clatif Oasis (Eastern Province) although, precipitation is relatively low, a few other factors are responsible or the establishment of mangrove areas. These are summarized as follows: primarily the continuous discharge from agricultural field lowers salinity in the coastal waters and terrigenous substances deposited in the estuary; secondly, the long and shallow stretch of mud-flats are often inundated and finally, alluvial soil and a low tidal amplitude further allows propagation and colonization of mangroves.

Regression of seagrass beds is inflicted due to fill covers. The over all effects of huge quantities of sediments, boulders and demolished building material used as a fill in the low lying area and nitrogenous rich waste-water drains opening in the Tarut Bay, is a health hazard and inflicted species diversity of the biotopes in the marine littorals. However, a few algae which are tolerant to ammonia and nitrate-rich ecosystem were well established (Table 2) as a matter of regression of the flora endemic to the region.

Several incidents of reclamation of the coastline for the construction of corniche and sewage discharge in coastal waters brought manmade perturbation on the algal flora and fauna (Aleem, 1990) and algal flora (Saifullah and Nizamuddin, 1992). Transgression of biota is a common occurrence in Saudi Arabia owing to huge constructions of corniche, parks and roads resulting in either stimulation or regression of flora and fauna. Recently, reclaimed area along the coastline is a transgression to the mangrove and seagrases communities and their associated biotopes. These shrubs are now scattered, scarce and, restricted as oppose to their previous diversity. Their chance of recovery is likely to be dependent on the magnitude of perturbation. Similarly, transgression of mangrove vegetation for the use of fire-wood and as a fodder for livestock are a few incidents of perturbation to the mangrove *and* their biosphere (Mandura *et al.,* 1987).

In contrast to the deforestation a parallel line of reforestation of mangroves was conducted successfully in several coastal sites in the Red Sea and the Arabian Gulf (National Commission Wildlife Conservation and Development, 1994). Under their supervision ca 4800 seedlings of mangroves were planted on the coasts of Ras Al-Khafji so Shatt Al-Ghurub, in the Gulf of Saudi Arabia.

Nevertheless, Newson (1992) described some critical pathways and a few classification of criterion used to evaluate and justify the conservation of natural environment. While, Aleem (1990) suggested that cooperation and better understanding between the environmental protection agencies and urban development planners should coexist to avoid perturbation and transgression to marine life. Further, I strongly suggest that sustainable developments should not continue as an uncoupled muddle of the ethics and a preliminary thought is to be given to conserve our natural resources. Due to the arid environmental conditions prevailing in much of Saudi

Arabia, the limited flora/fauna present should be considered as a national heritage.

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