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Social environment on the northern coast of the Red Sea in the Kingdom of Saudi Arabia

サウディアラビア北部紅海沿岸における社会環境

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Keywords: conservation of coastal environment, Red Sea, Saudi Arabia, Bedouin, foreign migrant worker, development project, wadi agriculture, grazing, fishing

キーワード：沿岸環境の保全，紅海，サウディアラビア，ベドウィン，出稼ぎ外国労働者，開発事業，ワジ農業，放牧，漁業

Abstract

Al-Wajh Bank was selected as the Model Area, where is an important ecosystem representative of the entire Study Area, stretching approximately 1000 kilometers. In the northern region of the Study Area including the Model Area, that is sparsely populated and where there are a limited number of large-scale development projects, impacts from development projects on the natural biological environment along the coast of northern Red Sea, from the Gulf of Aqaba to Umluj, are insignificant. In this region, however, grazing and fishing continue to be major causes of significant human-induced impacts on the natural resources. The changing life style of full-scale nomadic Bedouins, who have become more or less settled, can be a serious environmental concern since it could cause over-grazing in the areas surrounding their settlements. The traditional practice of setting grazing land aside as "hima" should be re-evaluated and implemented by local communities to avoid major impacts from grazing. The growing demand for fish in large cities has been encouraging fishing businesses to expand their operations. While impacts from the traditional fishing practices on fisheries resources are relatively limited, the modern fishing businesses practice more indiscriminate and intensive operations. If the trend of expanding fishing businesses continues, the resulting overp-fishing may become a serious threat to the marine natural resources in the Model Area. To conserve the coastal biological environment and to implement sustainable practices of traditional industries in local areas, therefore, the following recommendation is made: 1) the changing life style of Bedouins should be continually monitored; 2) practice of the 'hima' system should be studied to sustain the grazing industry; 3) operations of fishing businesses and the marketing/distribution systems should be monitored; and 4) marine protected areas should be established upon consideration of sustaining the traditional fishing practices.

要約

約1,000kmに渡る北部紅海沿岸の広域調査の結果，生態系の最も豊かなモデル調査地域としてアルワジ・バンクを選択した。同地域は，広域調査全域の北部に当たる。人口も希薄で，大規模開発は少ないため，アカバ湾からウムルジまでの自然環境は，開発事業による影響はわずかである。しかし，この地域おいても，放牧と漁業など，人間活動が原因となって引き起こされた自然資源への大きな影響は続いている。特

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に放牧は，近年変化し，ベドウィンが定職を得て，定住化し，遊牧はすでに行っていない。このため定住地周辺での放牧地の過剰利用が懸念される。ただし，ベドウィンは熱帯乾燥地における長い歴史の間に，過放牧への対処を獲得していた。牧草保護区たる「ヒマ」がそれで，「ヒマ」は部族コミュニティーによって伝統的手法として維持されてきた。地域コミュニティーによる放牧地の計画的な利用と保護管理が必要である。「個人操業型」の伝統的な漁業活動は，小規模で，消極的であるため漁業資源への影響は少ない。一方、旺盛な大都市での魚需要に結びついて大都市市場へ出荷する「漁業ビジネス（＝ボート・オーナー商人）型」の活動は，活発になっている。今日の「漁業ビジネス型」の活動は，一段と集約的な操業になる可能性がある。「漁業ビジネス型」が現在以上に盛んになると，モデル調査地域の海洋資源に対して重大な危惧となる過剰漁業となりかねない。沿岸の生物環境を保全し，地域における伝統産業を持続可能な産業として振興していくために，次の4項目を提言する。1）ベドウィンにおける生活体系の変遷に対するモニタリングを続ける。2）「ヒマ」システムの再現を，持続可能な放牧業のために研究する。3）「漁業ビジネス型」の操業や市場出荷方法などのモニタリングを続ける。4）伝統的な漁業の持続可能性に配慮した上で，海洋保護区の設立を計画する。

1. Introduction

The Red Sea Coast holds a rich and valuable biological diversity of global importance. However the true state of the precious environment is not fully understood. The JICA (Japan International Cooperation Agency) Study Team conducted the Study with the National Commission for Wildlife Conservation and Development (NCWCD) of Saudi Arabia from December 1997 to January 2000. The Study consisted of the four components; biological inventory (coral, seagrass / algae, fish, benthos, marine mammals / marine turtles, mangrove / terrestrial vegetation and birds), social environment, habitat map and GIS / database (JICA 2000). This report is based on the Study of social environment.

Socio-economic surveys were conducted to determine the present extent and future potential impact of human activities on the coastal biological environment. The northern coast of the Red Sea belongs to an arid zone, where the annual rainfall is no more than 40 mm. The coastal region has a milder and more humid climate in comparison with the inland region due to the existence of the Red Sea. Almost all local people in the Study Area are Muslims. They subsisted traditionally on grazing, fishing and agriculture in wadis. Grazing plays an important role in providing protein for people living in the arid zone with meager vegetation. The local people continue to engage themselves in these traditional occupations in this extremely dry and sparsely populated region. The livelihood of traditional society was dependent on the available natural environmental resources. However, the recent influx of oil wealth has been radically changing the traditional ways of life (McKinnon 1990). Previous socio-economic studies in the northern Red Sea region had not been comprehensive enough to point out effects from these recent changes.

2. Methods

The socio-economic surveys consisted of three phases, a preliminary survey (Phase I), a comprehensive survey of the northern coast of the Red Sea (Phase II) and an in-depth survey of the Model Area (Phase III). The preliminary survey was conducted in February, 1998, to gain an understanding of the general condition of the Study Area. The comprehensive survey was conducted in May-June and October of 1998. The in-depth survey of the Model Area was conducted in February-March and June of 1999.

2.1. Methods of the comprehensive survey in the Study Area

The Comprehensive Survey focuses on three subject areas; 1) general information, 2) grazing and 3) fishing, to determine the impact of the human activities on the natural biological environment in the Study Area. General information consists of a) population, b) large scale development projects including oil plants, power plants, desalination plants and cement factories, c) waste disposal sites. Two survey methods were employed for this study; 1) collection of information from government offices, and 2) interviews with local people. Table 1 shows the subjects covered by the survey, the methods used and the sources of information for each subject.

Table 1. Subjects, survey methods, and information sources in Phase II.

Subject	Survey method	Information sources
Population	Interview	Municipality, state government
Proportion of foreigners	Data collection	Hospital Patients classified Saudi and non-Saudi
Desalination plants	do	The Saline Water Conversion Cooperative
Power plants	do	The Saudi Consolidated Electric Company
Oil plants	do	The Ministry of Industry and Electricity
Domestic waste water	Interview	Municipality
Hot waste water	Data collection	The Saline Water Conversion Cooperative
do	do	The Saudi Consolidated Electric Company
Grazing	Interview	Bedouins and foreign workers
Wadi agriculture	do	Saudi owners and foreign workers
Fishing	do	Saudi and non-Saudi fishermen
do	Data collection	Coast guard centres
do	Interview	Fish markets, fish businessmen
do	do	Fishery Service Station (Duba, Umluj, Yanbu')

2.2. Methods of the in-depth survey in the Model Area

The in-depth socio-economic survey focuses on two subject areas, grazing and fishing, to determine the impact of human activities on the biological environment of the Model Area. Three survey methods were employed for the in-depth socio-economic study; 1) interviews with local people, 2) collection of information from government offices and 3) visits to local markets. Table 2 shows the subjects covered by the survey, the methods used and the sources of information for each subject.

Table 2. Subject, survey method, information sources and main items in Phase Ⅲ.

Subject	Survey method	Information sources	Main items
Grazing	Data collection	Local office	No. of animals in the area
	Interview	do	Impact on grasses, bushes and trees
	do	do	Ways of conserving range-land
	do	Local marcket	Marcket prices, age, weight of animals
	do	Bedouins	Nomadic areas
	do	do	Management of animal husbandry
	do	do	Modernization of management
	do	Foreign worker	Working situations, nomadic areas
Fishing	Data Collection	Coast Guard Centres	No. of fishermen, boats by ports
	do	do	Fishing trips of fishermen
	Interview	Fisheries Service Station	Data of fishing catch
	do	Local office	Technique of fish conservation
	do	Fish Markets	Trends in fish distribution
	do	Saudi fishermen	Conditions of concession
	do	do	Fishing management
	do	Foreign fishermen	Conditions of concession

3. Results

3.1. Study Area

The Study Area stretches over approximately 1,000 km from Haql to Jeddah. Six cities, Haql, Duba, Al-Wajh, Umluj, Yanbu' and Masturah, were selected as survey sites. A survey team visited two or three villages in each site. On the basis of population distribution, two distinct regions were defined in the study area. The northern region is sparsely populated, and accounts for two thirds of the Study Area, while the southern region is relatively densely populated and accounts for one third of the Study Area.

3.1.1. General Information

3.1.1.1. Population

a) Population distribution and density

According to the census conducted in 1992, the population of Saudi Arabia was estimated to be 16.9 million, and the country's territory covered over 2.25 million square km of land. The population density was 7.5 persons per square km. The size of the Study Area was nearly 1,000 km along the coastline of the Red Sea. Two-thirds of the coastline, a 676 km section, was in the sparsely populated northern region that comes under the Tabuk administrative region (estimated 3.2 persons/km^2, 486,134 persons in 1992). The remaining one third of the coastline, a 349 km section, was in the densely populated southern region between Yanbu' and Jeddah. This section comes under the Madinah (including Yanbu', 1,084,947 persons in 1992) and the Makkah (including Jeddah, 4,467,670 persons in 1992) administrative regions, and is one of the most densely populated areas in Saudi Arabia (Table 3).

The uneven distribution of population in the region is confirmed by a comparison of the population densities of the survey sites. Table 3 shows population densities of the survey sites in the Study Area; the densities of four survey sites in the Tabuk region were relatively low, i.e., 3.4 persons per square km in Haql, 2.5 in Duba, 2.2 in Al-Wajh, and 2.8 in Umluj. In contrast, the population densities of two survey sites in the southern region were considerably higher, i.e., 42.4 persons per square km in Yanbu', and 208.2 in Masturah. Since boundaries of political units, such as districts and administrative regions are not clearly delineated in this country, areas of districts or administrative regions can not be determined, and thus exact data on population densities are not available.

b) Proportion of foreigners

The percentage of foreigners to the entire population of the country was 27.4% in 1992 (Table 4), and 31.0 % in 1995. Of the foreign nationals, 70% were male. According to the census conducted in 1992, the

Table 3. Estimated population of the Study Area.

Survey site	Haql	Duba	Al-Wajh	Umluj	Yanbu'	Masturah
Population (persons)	19,323	39,100	32,644	44,091	172,086	5,207
Area (km^2)	5,643	15,750	15,000	16,000	4,250	25
Density persons/km^2	3.4	2.5	2.2	2.8	40.5	208.3
Percentage of foreigners (1)	17.1	19.1	13.3	11.5	22.2	14.6

Source: Interview data from each municipality except Yanbu' 1. Masturah is one district of Rabigh city.
2. Percentage of foreigners (1) come from the rate of non-Saudi in public hospital in 1997.
3. The data for Yanbu' is from the population census of 1992.

Table 4. Population by nationality and administrative area (1992).

Administrative area	Total	Saudi	non-Saudi	% non-Saudi
Makka	4,467,670	2,781,075	1,686,595	37.8
Riyadh	3,834,986	2,613,915	1,221,071	31.8
Eastern	2,575,820	1,902,108	673,712	26.2
Madinah	1,084,947	837,695	247,252	22.8
Northern	229,060	178,610	50,450	22.0
Najran	300,994	240,581	60,413	20.1
Qaseem	750,979	610,566	140,413	18.7
Tabuk	486,134	401,917	84,217	17.3
Jawf	268,228	223,406	44,822	16.7
Hail	411,284	346,177	65,107	15.8
Jizan	865,961	733,968	131,993	15.2
Aseer	1,340,168	1,150,089	190,079	14.2
Baha	332,157	289,946	42,211	12.7
Total	16,948,388	12,310,053	4,638,335	27.4

Source: Ministry of Planning. *Statistical Yearbook 1996.*
1. Jeddah belongs to the administrative area of Makka, Yanbu' belongs to that of Madinah.

Table 5. Production capacity of the saline water conversion corporation plants (1996).

Plant		Daily of Water	
Location	Establishment	Cubic meter	Rate(%)
Haql	1980	3,784	0.2
Duba	1969	3,784	0.2
Al-Wajh	1969～1989	2,803	0.1
Umluj	1986	3,784	0.2
Yanbu'	1981	92,944	4.8
Rabigh	1982	1,978	0.1
Jeddah	1970～1994	402,154	20.7
Western others		282,539	14.6
Western sub total		793,770	40.9
Eastern sub total		1,145,094	59.1
S.W.C.C. Total		1,938,864	100.0

Source: Saline Water Conv. Corp. *Annual Report 1996.*

percentage of foreigners in all the densely populated administrative regions was also high. For example, foreigners accounted for 37.8% of the population in Makkah, 31.8% in Riyadh, 26.2% in Eastern, and 22.8 % in Madinah. The reason migrant foreigners are concentrated in large cities is that of jobs are available there in manufacturing, construction, oil and service industries. In contrast, the percentage of foreigners in rural areas is significantly low.

The percentages of foreigners given in Table 3 were estimated based on the proportion of non-Saudi patients in public hospitals in 1997, except the percentage for Yanbu'. The percentage of foreigners in the northern region was 17.1% in the Haql area, 19.1% in the Duba area, 13.3% in the Al-Wajh area and 11.5% in the Umluj area. There are only traditional primary industries in these rural areas. The percentage of foreigners on the other hand, was as high as 22.2%, in the Yanbu' area. The southern region from Yanbu' to Jeddah contains a higher percentage of foreigners.

3.1.1.2. Large scale development projects in the Study Area

There are a number of large plants, such as oil plants, power plants, desalination plants and cement factories, along the coast of the Red Sea (Fig. 1). High demand for electricity and water in the large cities can be satisfied only by large power and desalination plants. Table 5 shows the distribution and sizes of desalination plants.

The desalination plants in Jeddah and Yanbu' are especially large. Jeddah is the second largest city in Saudi Arabia, and the most commercially developed city, with a population of 2.5 million. The desalination plants in Jeddah supply water not only to Jeddah but also to Makkah (population 0.63 million). Similarly, the plants in Yanbu' (population 0.17 million) supply water to Madinah (population 0.61 million).

The government has been developing major oil plants and modernizing harbor facilities in Yanbu'. Table 6 shows the present and future status of the development project in the new industrial city of Yanbu', which has been directly overseen by the Royal Commission for Jubail and Yanbu'. The current population of the new

Fig.1. Distribution of large industrial plants in the Study Area.

Source: Saline Water Conv. Corp. *Annual Report 1996.*
JCCME/ JEPIC. 1998. *Survey on Electric Power Generation in Saudi Arabia.*

Table 6. Industrial development status of Yanbu' (1998).

Classification	Status	Plant /Factory	Employee persons	Area ha	Capital cost SR million
Primary industries	In operation	6	5,020	2,043	29,600
	Under construction	3	895	161	10,400
	In design	1	250	39	1,750
	Proposed	5	no data	no data	no data
Secondary industries	In operation	9	1,182	124	2,775
	Under construction	4	367	196	1,880
	In design	2	251	48	955
	Proposed	14	no data	no data	no data
Light manufacture & support industries	In operation	30	2,433	127	819
	Under construction	4	212	47	161
	In design	1	32	1	50
	Proposed	0	no data	no data	no data
Overall	In operation	45	8,635	2,293	33,194
	Under construction	11	1,474	404	12,441
	In design	4	533	88	2,755
	Proposed	19	no data	no data	no data

Source: The Royal Commission for Jubal and Yanbu'. 1998. *Industrial Development Status Report.*

industrial city is approximately 60,000. There were 45 plants and factories operating in 1998. Six plants of primary industries, four oil refineries, one liquefied natural gas fractionation and one petrochemical plant, accounted for 58% of all employees and 89% of all capital costs in the new industrial city. The large plants are concentrated in the southern part of the Study Area (Fig. 1). Because of the hot waste water discharged from the plants and harbor facilities, the water quality along the coast from Jeddah to Yanbu' is expected to be much more polluted than in other parts of the Study Area.

3.1.1.3. Waste disposal sites

All the municipal offices have sections in charge of waste management, and use disposal sites located in the desert area. In the case of the Al-Wajh area, the waste management section of the municipality uses a hillside near Habban as an open waste disposal site. Low and

Table 7. Suitability for grazing of land types along the northern part of the Red Sea coast.

Landforms	Suitability	Distance (km)	(%)
Af : Alluvial fans	Suit.	104.6	10.2
Ap : Alluvial plain	S	20.8	2.0
Cp : Coastal plain	S	301.8	29.4
Fs : Footslopes	S	13.0	1.3
Gl : Alluvial fans and footslopes	S	7.6	0.7
Wadi	S	10.0	1.0
Sub Total		457.8	44.7
As : Active slopes	Non Suit.	13.3	1.3
B : Beach and wet coastal sands	N	318.5	31.1
Hl : Hills and rock outcrops	N	2.8	0.3
Mn : Mountains	N	73.1	7.1
Pg : Gypseous pediplain	N	20.0	2.0
Tf : Tidal flats	N	125.8	12.3
Town	N	13.8	1.3
Sub Total		567.1	55.3
Total		1024.9	100.0

Source: The Ministry Agriculture and Water. 1995. *Land use in Saudi Arabia.*

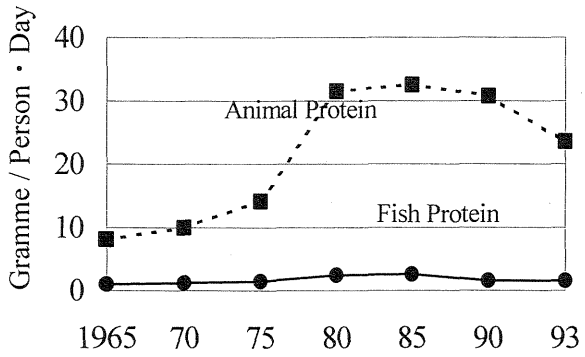

Fig.2. Daily protein intake from animals and fish.

Source: FAO Fisheries Circular No. 821 Revision 3. Fish and fishery products.
World apparent consumption statistics based on food balance sheet (1961-1993)

simple soil banks enclose the disposal site. Many Bedouins that had used the hillside as rangeland have been criticizing the municipality. In Yanbu', there is one disposal site for auto scraps, where piles of auto scrap were abandoned.

3.1.2. Grazing

3.1.2.1. Suitability of land resources for range and crops

Grazing is an essential means of storing and providing animal protein for people living in arid zones with meager vegetation. The main grazing plants on which sheep and goats feed in the dry season are small shrubs and perennial grasses such as Panicum spp., which are found on stable sand sheets. Grazing plants favored by camels are the same grasses and small shrubs that are eaten by sheep. In addition, camels also feed on the larger woody plants.

Table 7 shows the suitability for gazing of particular landforms in the Study Area. For example, "Beach and wet coastal sand" that is unsuitable for grazing accounts for 31.1% of the coastline of the Study Area. "Tidal flat" accounts for 12.3% of it. Land that is suitable for grazing accounts for 44.7% of the coastline of the Study Area (Department of Land Resources, 1995).

There are wadis where underground water flows. Farmers practice agriculture irrigated by wells in wadis. Wadis comprise 1.0% of the entire coastline of the Study Area that is suitable for agriculture.

3.1.2.2. Demand for livestock

The demand for livestock in Saudi Arabia has been increasing over the past 30 years. Fig. 2 shows that in 1993 the average intake of animal protein jumped to 2.5 times the 1970 level. 55% of the livestock slaughtered

Table 8. Livestock slaughtered in Saudi Arabia under the supervision of the municipalities. by region and type (1996), and estimated number (1995).

Unit: Head, %

	Region Type	Goats		Sheep		Cows		Camels		Sub Total	
The number of livestock slaughtered	Domestic	538,727	70.0	798,146	45.3	36,794	53.6	131,381	89.0	1,505,048	54.8
	Imported	230,882	30.0	962,726	54.7	31,815	46.4	16,206	11.0	1,241,629	45.2
	Sub Total	769,609	100.0	1,760,872	100.0	68,609	100.0	147,587	100.0	2,746,677	100.0
		28.0		64.1		2.5		5.4		100.0	
The estimated number of living livestock		4,373,137		7,752,990		249,323		421,700		12,797,150	
		34.2		60.6		1.9		3.3		100.0	

Source: Ministry of Municipal and Rural Affairs, Minstry of Agriculture and Water

under the supervision of the municipalities came from the domestic market, and the rest was imported (Table 8). The Saudis prefer domestic animal meat to imported. The high demand for domestic meat supports the grazing industry in this country. Grazing is still an important traditional industry in the rural areas.

3.1.2.3. Types of grazing

There are two types of grazing, nomadic grazing and stationary grazing combined with wadi agriculture. Table 9 shows the results of interviews with people who practice nomadic grazing, while Table 10 shows the results of interviews with people who practice agriculture combined with stationary grazing.

a) Nomadic grazing

Eleven groups of nomads were interviewed, and classified into three types. Four families were practicing full-scale grazing, while six families were practicing small-scale grazing. One group of Bedouin was classified into neither type (Table 9).

The criterion for the scale of operation was based on the number of livestock. An owner of 100 sheep can sell eight to ten sheep every month to earn 3,600 to 5,500 S.R.(=Saudi riyal). For example, Dr. Saleh Alsoghair studied the monthly income of Bedouin by interviewing 338 families in the Dilam area of the central district of Saudi Arabia in 1994. The resulting average monthly income of a family was 6,390 S.R (Alsoghair 1995). The above figure included the monthly income of all the family members. A family that practices a full-scale operation with 100 sheep can earn at least one half of the average monthly earning from the livestock operation.

A typical full-scale family operation tends 100 to 200 head of sheep/goats and 20 to 40 head of camels. One camel is worth five times more than a sheep. Sheep and

Table 9. Types of nomadic people dependent on grazing.

Type	Saudi-owner Regular job	Foreign worker	Sheep	Camel	Location	Latitude (N)	Longitude (E)
Full-scale	no data	1 S.	200	100	South of Al-Wajh	260208	364252
	No	no data	200	20	Masturah	230652	385035
	Soldier	1 S.	100	30	Al-Demigau	263654	361410
	Military officer	1 E.	50	20	Suburbs of Al-Wajh	261249	363249
Small-scale	No	No	50	5	Suburbs of Haql	290545	350349
	No	No	60	0	Suburbs of Umluj	250300	371822
	No	No	50	0	Suburbs of Al-Wajh	261249	363252
	Officer	No	12	4	Suburbs of Haql	290545	350349
	No	No	20	0	Suburbs of Haql	290545	350349
	No	No	15	0	Suburbs of Haql	290545	350349
Other	Racecamel trainer	1 S.	0	6	Suburbs of Al-Wajh	261251	363133

1. Nationality of foreign workers; E.= Egyptian and S.= Sudanese

Table 10. Types of stationary grazing combined with wadi agriculture (Phase II).

Types		Saudi-owner Regular job	Foreign worker	Farm ha	Well No.	Sheep head	Camel head	Date palms	Fodder Grass	Other Fr./Ve.	Location	Latitude (N)	Longitude (E)
Many kinds of product	Good water quality	Yes	1B. 2E.	9.0 ha	4	50	0	145	No	Fr./Ve.	Umluj	250611	371451
		Yes	2I. 3E.	5.0 ha	1	100	0	50	No	Fr./Ve.	Yanbu'	240921	380834
		Yes	1B.	4.0 ha	2	40	0	80	No	Fr.	Umluj	250333	371644
		no data	1E.	1.4 ha	2	115	0	130	Yes	Fr.	Umluj	250406	371639
		no data	no data	1.1 ha	2	40	0	100	Yes	Fr.	Umluj	250406	371639
		Yes	1B.	6.0 ha	1	50	0	55	No	Ve.	Al-Wajh	261511	363113
Few kinds of products	Brackish water	no data	1P. 1S.	25.0 ha	1	200	60	200	Yes	(Corn)	Masturah	230450	385200
		Yes	2B.	25.0 ha	1	0	0	250	Yes	No	Masturah	230457	385158
		Yes	1E.	2.0 ha	1	200	20	50	No	No	Bi'r al Qusayr	255526	365045
		No	1E.	1.0 ha	1	100	0	0	Yes	No	Bi'r al Qusayr	255706	364526
Well	No	No	No	0.4 ha	No	20	0	10	No	No	Yanbu'	240927	380835

1. Nationality of foreign workers B.= Bangladeshi, E.= Egyptian, I.= Indian, P.= Pakistani, S.= Sudanese: number is number of workers.
2. 'Other Fr. /Ve. 'means that there are some kinds of cultivated fruit trees and/or vegetables.

goats are usually seen grazing in a compact flock accompanied by a shepherd. Sheep and goats range within a radius of about 5 km from the camp where they are based. Camels range within a radius of about 12 km from their base, covering a distance of 22 to 27 km a day. General characteristics of full-scale nomadic Bedouin are as follows:

a) they keep 100 head of sheep and 20 camels or more,
b) they can afford to hire foreign migrant workers, and
c) their families live in camps, but some family members are engaged in cash earning jobs.

General characteristics of people who practice smaller-scale grazing are as follows:

a) they usually keep as few as 20 to 50 sheep and few camels,
b) they employ no foreign migrant workers,
c) they live in houses with sheep and goats in the suburbs of towns, and
d) some of them are engaged in cash earning jobs.

Families that practice small scale grazing are not nomadic. They live in houses in the suburbs of towns, and are engaged in grazing on lands surrounding their houses.

b) Stationary grazing combined with wadi agriculture

Compared with nomadic grazing, stationary grazing combined with wadi agriculture has relatively less impact on the biological environment. Table 10 shows that a typical form of wadi agriculture is a combination of sheep tending and date palm cultivation. Many wadi farmers manage to grow fodder grass, which is not seen with nomadic grazing. Nevertheless, grazing concentrated on lands surrounding the farms will inevitably have an impact on the natural vegetation. Wells, irrigation and earth banks are the essential facilities of wadi agriculture. Earth banks protect irrigated farms from grazing animals.

The two products, sheep and date palms, can be raised using the brackish water of arid zones. Fodder grass can also be grown with brackish water. Depending on the quality and quantity of available water, wadi farmers can grow additional crops. Supported by a good water well, a farmer can grow a variety of crops, vegetables and fruits, whereas a farmer who must depend on a limited amount of water of poor quality, called 'brackish water,' can grow few additional crops. Table 10 shows that six families were growing a variety of crops using water of high quality, three families were growing a limited number of crops using brackish water, and one family which did not own a well was growing date palms and tending sheep using only purchased water.

3.1.3 Fishing

There are 88 fishing ports along the 1,800 kilometer coastline of the Red Sea. The Coast Guard oversees all fishing ports and fishing boats.

3.1.3.1. Traditional fishing in the Red Sea

Table 11 shows the number of fishermen and fishery workers recorded in 1996. Over 11,000 people were engaged in fishing in the Red Sea, while about 9,000 people fished around the Arabian Gulf. Just over 30% of traditional fishermen in the Red Sea area own their own boats and practice small-scale fisheries operations. The table also shows that there are around 6,000 non-Saudi fishery workers in both the Red Sea and Arabian Gulf.

Extended coral reefs are found along most of the

Table 11. Number of fishermen and fishery workers, by category (1996). Unit: Person, %

					Total		Red Sea		Arabian Gulf	
Total		Boat owing	Fishing	Saudi citizen	20,326	100.0	11,301	100.0	9,025	100.0
Fishermen	Sub total				6,111	30.1	4,212	37.3	1,899	21.0
	Investor fishermen	○	×	○	38	0.2	28	0.2	10	0.1
	Traditional fishermen	○	○	○	5,095	25.1	3,444	30.5	1,651	18.3
	On-foot fishermen	×	○	○	724	3.6	621	5.5	103	1.1
	Temporary fishermen	×	○	○	254	1.2	119	1.1	135	1.5
Fishery workers	Sub total				14,215	69.9	7,089	62.7	7,126	79.0
	Saudi worker	×	○	○	2,209	10.9	1,029	9.1	1,180	13.1
	Non-Saudi worker	×	○	×	12,006	59.1	6,060	53.6	5,946	65.9

Source: SAKURAI, T. 1998. *Fisheries of Saudi Arabia.*
1 Actually many traditonal fishermen, who employ workers, engage themselves only in managing the fishing business.
2 Temporary fishermen are younger than 18 years old.
3 ○Yes, ×No

coast of the Red Sea. Traditional fishing gear includes hand held lines and gill nets. The use of hand-held lines on small boats is especially suitable for coral coastlines. The average number of fishermen per boat is two, and the boats are usually between 6 meters and 9 meters long. Major groups of fish caught in the Red Sea by traditional fishing methods are groupers, emperors, scads, snappers, rabbitfishes and parrotfishes.

3.1.3.2. Participation by foreign fishermen

Most fishermen who are actually working out in the sea in today's Saudi Arabia are foreign migrant workers. It is a common practice for a Saudi boat owner and non-Saudi fisherman employee to share their income evenly. This practice of income sharing greatly encourages foreign fishermen. A non-Saudi fisherman can earn between 1,500 and 2,000 SR, which is a quite high income for a non-Saudi. The majority of foreign fishermen are from Egypt, India and Bangladesh.

3.1.3.3. Fishing pressure in the Study Area

The number of fishermen can indicate fishing pressure. Fig. 3 shows the number of fishermen stationed at each fishing port in the Study Area. Al-Azeezizh is the port for Yanbu' and Al-Gad is located near Jeddah. In the southern region, the number of fishermen is much higher than in the northern region, thus the fishing pressure is considered higher in the south. In particular, increasing numbers of fishery workers and boats near large cities in the south, may intensify the pressure on fisheries resources.

3.1.4. Assessment of the Study Area

Table 12 summarizes the impact of human activities on the natural environment of the Study Area. In the northern region of the Study Area, from the Gulf of Aqabah to Umluj, the population density is very low, while the southern region from Yanbu' (42.4/ km^2) to Jeddah, in contrast, is one of the most densely populated regions in Saudi Arabia. The uneven distribution of the population affects the environmental impacts of human activities in many different aspects.

Large-scale development projects are prominent in the more densely populated southern region. The desalination plants and power plants in Yanbu' and Jeddah supply water to other large cities such as Makkah and

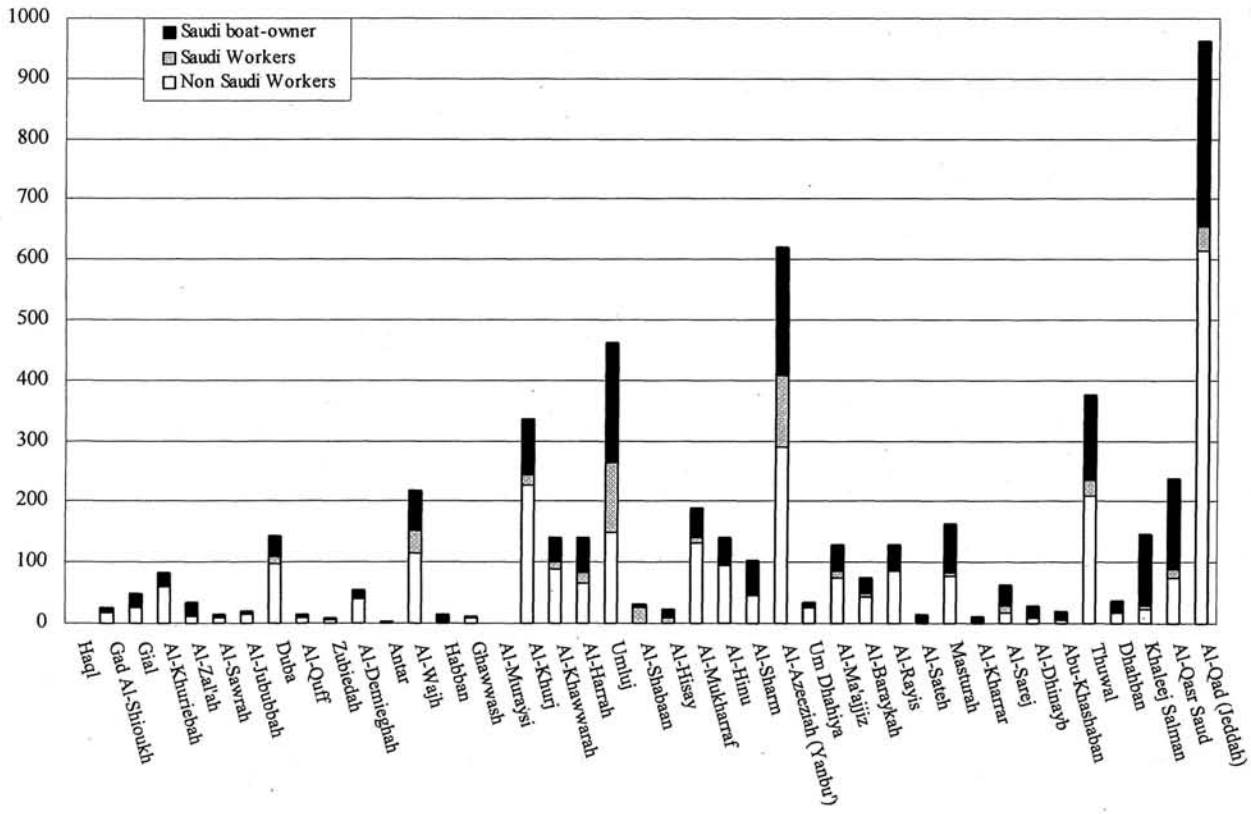

Fig.3. Number of fishermen by category at each port (1996).

Source: Ministry of Agriculture and Water, Department of Marine Fisheries. (1997) *Fisheries Statistics of Saudi Arabia 1996.* Riyadh

Table 12. Impact of human population and activities.

Impact	Subject	Location					
		Gulf of Aqaba	Tiran	Duba / Al-Wajh	Al-Wajh Bank	Umluj / Ra's Baridi	Yanbu' / Jeddah
Population		1	0	1	1	1	2
Activities							
Development	Desalination	1	0	1	1	1	3
	Power Plant	1	0	1	1	1	2
	Oil Plant	0	0	0	0	0	2
Grazing	Rangeland	1	0	2	2	2	2
	No. of Animals	1	0	2	2	2	3
Fishing	No. of Boats	1	0	1	1	2	3
	No. of Fishermen	1	0	1	2	2	3

*1. Degree of impact: 3: high, 2: medium, 1: low 1, 0: no data.

Madinah. Therefore, the degree of impact from these plants in the area of Yanbu' and Jeddah is significantly high.

Two typical traditional occupations in the Study Area, nomadic grazing and fishing, seem to be causing an excess impact on natural resources, i.e., over-grazing and over-fishing. The vegetation situation in the rangeland and the number of animals indicates the impact of grazing. According to the results of a terrestrial vegetation survey, the vegetation overall is affected significantly by grazing. Fishing pressure was indicated by the number of fishermen and boats. As the number of fishery workers and boats increases in the southern region of the Study Area, from Umluj / Ra's Baridi to Yanbu' / Jeddah, the pressure on fisheries resources will be more intensified. Furthermore, the southern region hosts a number of large scale development projects. Therefore, it is not advisable to plan a marine protected area in the southern section.

3.2. Model Area

Al-Wajh Bank was selected as the Model Area on the basis of the results of the Phase II study. The two traditional industries, grazing and fishing, were studied to determine the impact of human activities on the natural coastal environment. The coastal area between the towns of Al-Wajh and Umluj was selected as the study field for an in-depth socio-economic survey.

3.2.1. Grazing

3.2.1.1. Main grazing sites in the model survey area

To determine impact of the grazing impacts by camels, a strip along the coastline ten kilometers wide inland was proposed as the survey field. The length of the coastline between the towns of Al-Wajh and Umluj is 165 km. There is a considerable proportion of fertile rangeland between Al-Khruj and Umluj. Bi'ral-Qusayr is a small village, and stationary grazing with wadi agriculture is practiced there. Main grazing sites in the survey area are as follows:

- Bi'r al-Qusayr (25° 55' 26" N, 036° 50' 45" E)

Bi'r al-Qusayr is located 45 km south from Al-Wajh, and five km inland from the coast. There is a very small settlement which consists of only four households. The families grow a few products using brackish water. Fodder grass cultivation and camel grazing are characteristics of grazing base camps in this remote area.

- South of Duqm Sabq (25° 32' 20" N, 037° 00' 15" E)

This is located 15 km south-east from the fishing port of Al-Khurj. There are mangrove thickets in the sea since the grazing pressure by camels on mangroves is too strong for them to grow on the coast. The social survey team met a herd of forty camels with a Sudanese herdsman there.

- Abar Umm Nitash (25° 28' 35" N, 037° 10' 12" E)

There are over ten Bedouin camps on hill-slopes beside the highway, located 55 km north of Umluj. Some of the Bedouins practice full-scale camel grazing.

- Al-Harrah (25° 14' 17" N, 037° 14' 01" E)

This is a large settlement with about 200 Bedouin households, located 25 kilometers north of Umluj. Most of the people are engaged in small-scale sheep grazing, besides their cash-earning jobs. The wide scattered forest of acacia trees has been conserved by the local community and the local government. "Hima" is a traditional system in this society for the conservation of

the commons and rangeland (Child et al 1990).

- Northern and southern suburbs of Umluj (25° 03' 00" N – 24° 52' 14" N, 037° 18' 22" E – 037° 19' 55" E)

There is a concentration of small-scale Bedouin holders in the suburbs of Umluj, as observed in the town of Al-Wajh.

3.2.1.2. Changes in Bedouins' life style

Nomadic grazing is practiced by Bedouins or people of Bedouin descent. There are three important grazing sites in the model survey area, Abar Umm Nitash, Al-Harrah and Umluj. Table 13 describes the current status of the families which were interviewed in this study. Out of the eleven families that were practicing grazing, five families were in "full-scale" operations, and six were in "small-scale" operations. The small-scale Bedouins were based in the towns of Umluj and Al-Harrah. In contrast, some full-scale Bedouin families were based in Abar Umm Nitash, which is a remote area located 55 kilometres north of Umluj. Their campsites were scattered over the hillside.

The characteristics of these eleven groups of Bedouins are described below:

a) Just as it was found in the comprehensive survey that families of small-scale Bedouin holders were settled in the suburbs of towns and lived in houses, the families of full-scale Bedouin holders also had settled down. Even though they were living in tents away from towns, the families had not moved for over 20 years.

b) Four out of five heads of families of full-scale Bedouin holders were engaged in regular cash earning jobs in towns. Some of them were settled by highways in houses for the convenience of the long commute by automobile to the towns for work and for children's schooling. Their activities have become more and more dependant on automobiles.

c) Four out of the eleven families of Bedouins lived in houses, not tents. Even families of full-scale Bedouin hordes, who stay on remote rangelands, have changed their life style to settle down and be engaged in regular cash earning jobs.

d) Technical modernization in grazing practices is observed in the following areas: 1) motorization in every aspect of daily life, 2) transportation of water by water-tank lorry, and 3) utilization of purchased fodder grass and barley to feed animals.

Despite the changing practices in grazing with the shift toward more purchasing of fodder, the impact of grazing on natural vegetation will continue to be a serious concern. Although their scale of operations is small, a number of herders settled in the suburbs of towns will significantly modify the surrounding vegetation, while large-scale grazing operations in remote areas will affect the coastal biological environment including the mangrove forests. Stationary grazing practices with wadi agriculture were not observed in the Model Area as a significant part of its economy. Changes in the life styles of the people in the survey area started taking place 30 years ago when the highways and desalination plants were constructed.

Table 13. Types of grazing (Phase III)

Type	Saudi-owner Regular job	Sheep	Camel	Living in Tent /House	Location	Latitude (N)	Longitude (E)
Full-scale	Petrol station	300	15	House	Abar Umm Nitash	252835	371012
	Officer	65	45	Tent	Abar Umm Nitash	252825	371220
	C.G. soldier	80	18	Tent	Abar Umm Nitash	253003	370929
	IMARA officer	40	20	House	Al-Harrah	251417	371401
	No	100	3	Tent	South of Umluj	245215	371947
Small-scale	Desali. plant staff	30	12	House	Al-Harrah	251417	371401
	No	40	3	Tent	Abar Umm Nitash	253000	370930
	C.G. soldier	50	0	House	South of Umluj	245711	371650
	No	50	0	Tent	Al-Harrah	251351	371835
	No	20	2	Tent	Abar Umm Nitash	252741	371126
	No	10	0	Tent	South of Umluj	245214	371955

1. The border between the two scales is 100 sheep.
2. One camel is evaluated as 5 sheep.

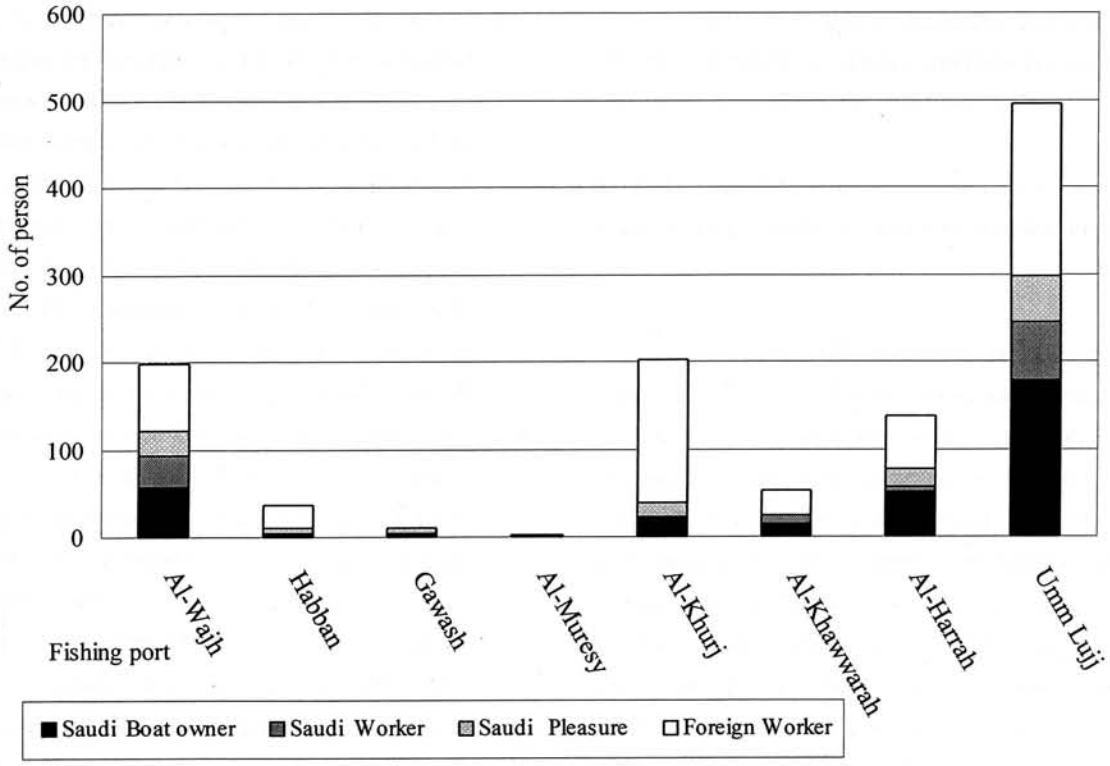

Fig.4. Number of fishermen by port and their categories by nationality.

Source: Ministry of Agriculture and Water, Department of Marine Fisheries. (1997) *Fisheries Statistics of Saudi Arabia 1996.*

3.2.1.3. Animal market

The high demand for domestic meat supports the grazing industry in this country. Every local town has a permanent animal market, which is usually located in a suburb of the town. The animal markets of Al-Wajh and Umluj are always busy. In the town of Umluj nearly 1,000 livestock are kept. Bedouins sell their livestock directly to consumers or to market middlemen. 40 middlemen belong to the market. About 300 livestock are traded daily. The price of a sheep is 450 to 550 SR. A large amount of firewood and charcoal is also traded in the market.

3.2.2. Fishing

3.2.2.1. Coastal fishing ports

There are eight fishing ports along the 165 kilometer coastline. The coast guard oversees all fishing ports. Generally traditional fishermen use small boats and hand held lines in the sea around the coral reefs. According to the latest report by the Umluj Fish Service Station (December 1998), more than 100 fishermen were working out of the ports of Umluj, Al-Harrah, Al-Khurj and Al-Wajh, while the numbers of foreign fishery workers at the same four ports were 61 in Al-Harrah, 77 in Al-Wajh, 163 in Al-Khurj, and 197 in Umluj (Fig. 4). Foreign migrant workers already account for significant proportion in the fishing industry in the Model Area.

3.2.2.2. Two types of fishing practices

Twenty Saudi boat owners, five from Al-Wajh, twelve from Umluj and three from Yanbu', were interviewed at six fishing ports, four at the Al-Wajh Port, one at Al-Muraysi, five at Al-Khruj, two at Al-Khawwarah, five at Al-Harrah and three at Umluj (Table 14).

There are two types of fishing practices. A "self-loyed" independent fisherman practices traditional small fishing with one boat, fishing daily alone or with another worker to sell fish at the local markets in Al-Wajh and Umluj. A "fishing business owner" owns two or three boats, hiring foreign workers. They sell fish to the markets in large cities such as Jeddah, Yanbu' and Madinah where fish prices are considerably higher.

Out of the twenty Saudi boat owners interviewed, eight were self-employed and twelve were fishing business owners, shown as 'employer' in Table 14. Although both types of fishing operations similarly used on small boats, the difference between their scales of operation is significant. Self-employed fishermen living

in Al-Wajh or Umluj can earn enough to live on by selling fish at a local fish market. They are content to spend their lives as traditional fishermen.

Table 14 and 15 show responses to the question of where they sell their catch, and includes duplicate responses. Out of the twenty Saudi boat owners, eight "self-employed" owners (four residents of Al-Wajh and four residents of Umluj) sell fish only at the local markets of Al-Wajh and Umluj.

In contrast, the twenty-one responses by "fishing business owners" indicated that ten sold to Yanbu'(0.17 million people), seven to Madinah (0.61 million people) and four to Jeddah (2.5 million people). They go to the fishing ports of Al-Wajh Bank, sparsely populated areas with no coast guard stations, to catch larger amounts of fish. They hire foreign migrant fishermen, and bring the fish to large cities in their pickup-vans with ice. Saudi owners bring and sell the fish themselves, thus they are called "fish-businessmen."

The fishing ports at Al-Wajh Bank are important bases for the "fish-businessmen." Some of them sell not only their own catch but also the catches of others, catch charging 10% of the sales as a commission. The growing demand for fish in large cities is encouraging these "fishing business owners" to rapidly expand their fishing operations.

Table 14. Interview data on fishing, by type (Phase III).

Type	Saudi owner Address	No. of boats	Fishing workers	Fishing day per 1time	Fishing port Location	Selling Market
Employer = Fish businessman	Umluj	4	5 E. 5 I.	4 day	Al-Khurj	no data
	Yanbu'	3	6 B.	4 day	Al-Harrah	Y.
	Yanbu'	3	6 B.	no data	Al-Harrah	Y. M.
	Umluj	2	2 B. 3E.	no data	Al-Khurj	no data
	Al-Wajh	2	2 B. 2E.	4 day	Al-Khurj	Y.
	Umluj	2	2 B. 2E.	4 day	Al-Khurj	Y. M. J.
	Umluj	2	4 Saudi(family)	5 day	Al-Khawwarah	Y. M. J.
	Yanbu'	2	3 P.	4-6 day	Al-Harrah	Y. M. J.
	Umluj	1	3 B.	4 day	Al-Harrah	Y. M.
	Umluj	1	1 I. 1 Saudi.	1 day	Al-Khurj	Y. M. J.
	Umluj	1	2 Saudi	5 day	Al-Khawwarah	Y. M.
	Umluj	1	2 Saudi	1 day	Al-Muraysi	Y. U.
Self-employed	Al-Wajh	1	No (brother)	1 day	Al-Wajh	W.
	Al-Wajh	1	No (son)	1 day	Al-Wajh	W.
	Al-Wajh	1	No (son)	1 day	Al-Wajh	W.
	Al-Wajh	1	No	1 day	Al-Wajh	W.
	Umluj	1	No	3 days	Al-Harrah	U.
	Umluj	1	No	1 day	Umluj	U.
	Umluj	1	No	1 day	Umluj	U.
	Umluj	1	No	(3 days)	Umluj	U.

1. Nationality of foreign workers: B.= Bangladeshi, E.= Egyptian, I.= Indian, P.= Pakistani. Number indicates number of workers.
2. Selling Market: J.= Jeddah, M.= Madinah, U.= Umluj, Y.= Yanbu', W.= Al-Wajh
3. Under fishing workers, ( ) indicates the hiring of family members as a temporary worker.

Table 15. Address, fishing port and selling market of Saudi owners.

Saudi owner address	No.	%	Interviewed fishing port	No.	%	Selling market	No.	%
Total	20	100	Total	20	100	Total	30	100
Al-Wajh	5	25	Al-Wajh	4	20	Al-Wajh	4	13
			Al-Muraysi	1	5			
			Al-Khurj	5	25			
			Al-Khawwarah	2	10			
			Al-Harrah	5	25			
Umluj	12	60	Umluj	3	15	Umluj	5	17
Yanbu'	3	15				Yanbu'	10	33
						Madinah	7	23
						Jeddah	4	13

1. Numbers for selling markets include duplicate responses.

3.2.2.3. Fishermen interviews

Al-Khurj is the only fishing port located inside the Al-Wajh Bank, and Al-Khawwarah and Al-Harrah are fishing ports located outside the Al-Wajh Bank. Although there are almost no settlements near these three fishing ports, these ports are important for fishing. Interview surveys were conducted at the Al-Khruj fishing port, and the interviewed fishermen listed the following islands and their surrounding areas as good fishing grounds: Jazirat Umm Rumah, Jazirat Birrim, Juzur Safa'ih, Jazirat Qumma'an, Jazirat al-'Ishsh.

Similarly, interviews with fishermen were conducted at the Al-Harrah and the Al-Khawwarah fishing ports. Good fishing grounds listed by the fishermen were Jazirat al-Wacqdi, Jazirat Shaybarah, Jazirat ar-Rudaym, and Jazirat al-A'la, all of which are located in the southern part of the Al-Wajh Bank. These fishermen fish outside the Al-Wajh Bank. The coral reefs of the Al-Wajh Bank provide good fishing grounds for fishermen. More information will be needed since fishermen sometimes did not understand the maps which we showed to them.

4. Discussion and Conclusions

4.1. Large scale development

Generally, population is the most basic indicator of human impact on natural environmental resources. The northern coastal region of the Red Sea from the Gulf of Aqabah to Umluj is sparsely populated. In contrast, the southern region between Yanbu' and Jeddah is one of the most densely populated regions in Saudi Arabia. The uneven distribution of the population affects the environmental impact of human activities in many different ways.

There are a number of large industrial plants, such as oil plants, harbor facilities, power plants, desalination plants and cement factories, along the coast of the Red Sea. The desalination plants in the northern region mainly provide the local residents with fresh water and electricity, but the desalination plants in Yanbu' supply water not only to Yanbu' but also to Madinah. Similarly the plants in Jeddah supply water to Makkah. The impact from the operations of these large plants in the area of Yanbu' to Jeddah is significant. However, the impact of development projects on the natural biological environment along the coast of the northern Red Sea, from the Gulf of Aqabah to Umluj, is limited since the region is sparsely populated, and there is no large concentration of operations.

4.2. Stationary grazing with wadi agriculture

Almost all wadi farmers tend not camels but sheep. They manage small scale irrigation systems which depend on the quality and quantity of the water wells. Their main products are sheep and dates and, the second main product is fodder grass. A half of the interviewed farmers were cultivating fodder grass for sheep. In this case, sheep are fed with cultivated fodder grass and are kept from grazing on land around the wadi farms. Therefore, the grazing impact on coastal natural vegetation of sheep raised by wadi farmers is very limited.

4.3. Grazing

Nomadic grazing has been exploiting the environment. In the case of the mangroves along the northern coast of the Red Sea, they have been seriously damaged by camels. There are very few mangrove stands left on the seashore and most of the remaining mangroves are in shallow water or on islands. Over-grazing is still a serious problem in the survey areas. Nomadic people used to move around all over the country, which thinned out the impact from grazing.

However, the changing life style of full-scale nomadic herders, who have become more or less settled, can be a serious environmental concern since it could cause overgrazing in the areas surrounding their settlements. Although some grazers have started feeding their animals with purchased grass and barley, many animals still feed on grass in the area surrounding camps and the suburbs of towns, especially along the coast.

There is a considerable expansion of fertile rangeland around Al-Harrah. Most of the local people at Al-Harrah (about 200 households) have cash earning jobs in addition to selling animal products from the grazing of sheep and camels. There are many acacia trees there, indicating rich soil. Camels feed on acacia trees, and feeding camels with acacia can be a sustainable use of the trees. The traditional practice of setting grazing land aside as "hima" should be re-evaluated and implemented by local communities to avoid major impact from grazing. Stationary grazing combined with wadi agriculture seems to create no serious environmental problems at the

present time.

Several workers have suggested the importance of studying the "hima" system and its role in the tradition of land management. Around 10 years ago Child et al outlined it, as follows:–

> "The *hima* tradition is an ancient system practice in large parts of the Arabian Peninsula that uses protected areas to conserve mainly rangeland resources. ... *himas* still occur in Oman, Syria and Yemen, in addition to Saudi Arabia. They were essential components of subsistence production in these generally semi-arid to arid regions. ... It also inculcates many of the socio-economic and ecological ingredients essential to the sustainable use of renewable resources. ... it is sufficient to note here that the system:- i) Allowed the controlled use of resources, but ensured their proper conservation and use for particular purposes and prevented their abuse. In short, it was ecologically sustainable. ii) ... The benefits from the *himas* were then allocated among the members of the community according to a system that the community perceived as being equitable. In brief the system was socially acceptable and was desired by the people who carried the cost of implementing it. and iii) The system was economically viable because of the benefits it yielded and the social security it provided (Child et al 1990)."

4.4. Coastal fishing

Fishing practices in the coral Red Sea are still very much traditional, with hand-held lines and gill nets. Fishing has been well monitored by the Coast Guard Centres. However, there are serious concerns about excess utilization of the fisheries resources. The growing demand for fish in large cities, such as Jeddah, Makkah, Yanbu' and Madinah, has been encouraging fishing businesses to expand their operations. While impact on fisheries resources from the traditional fishing practices is relatively limited, the modern fishing businesses carry out more indiscriminate and intensive operations. If the trend of expanding fishing businesses continues, the resulting over-fishing may become a serious threat to the marine natural resources in the Model Area.

4.5. Conclusion

The traditional industries are necessary for local areas. It may be due to sustainability that the traditional industries may have continued till today. All traditional industries have accepted by modernization and a change in the life style of local residents. It is hoped that the modernized and economically expanded traditional industries will be able to recover a system of sustainability. The Model Area and almost all the northern part of the Study Area is sparsely populated, and human impact on the biological environment has been limited. The impact of large-scale developments on the natural biological environment along the coast of the northern Red Sea, from the Gulf of Aqabah to Umluj, seemed very limited. Two possible cases of human-induced impact on the natural resources are identified in the Model Area. One is the impact of grazing and the other is that of intensive fishing. With regard to the grazing, stationary grazing with wadi agriculture seems to create no serious environmental problems at present.

Nomadic grazing has been exploiting the biological environment. Nomadic people used to move around all over the country, but as their life style has changed, they are becoming more stationary in feeding their animals. The "forest of trees" at Al-Harrah has been controlled as a "hima" by local government and the community leaders. This traditional system of conservation should be studied to implement management of a protected area in this particular social and cultural environment of the Model Area. The growing demand for fish in large cities, such as Jeddah, Makkah, Yanbu' and Madinah, has been encouraging fishing businesses to expand their operations. While the impact on fisheries resources from traditional fishing practices is relatively limited, the modern fishing businesses carry out more indiscriminate and intensive operations. If the trend of expanding fishing businesses continues, the resulting over-fishing may become a serious threat to the marine natural resources in the Model Area.

In order to conserve the coastal biological environment and to implement sustainable practices in traditional industries in local areas, therefore, the following recommendations are made:

1) the changing life style of the Bedouins should be continually monitored;
2) the practice of the 'hima' system should be studied in

order to sustain the grazing industry;

3) operations of fishing businesses and the marketing/ distribution systems should be monitored; and

4) marine protected areas should be established in consideration of sustaining the traditional fishing practices.

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