Chapter Twelve

RESULTS AND DISCUSSION

The Eastern Coast Region of the UAE is a good example of dryland ecosystem, including the proposed Wurayah Biosphere Reserve and would represent a perfect site for UNESCO Man and Biosphere Program in Arab Region.

The main purpose of implementing this study in the case of the UAE site is to identify the basic elements needed for sustainable management of a dryland ecosystem, as a model, and building on the existing data on the natural resources.

The criteria set out in the Statutory Framework for Biosphere Reserves has been used to check whether the proposed Wurayah Biosphere Reserve complies with it or not. The biosphere reserve concept has been used as a methodology to provide a land use zonation model that integrates the conservation of the environment with the development plans of the study area.

To evaluate the effectiveness of existing practices the assessment methodology has been applied to all parts of the study area with a degree of uniformity in gathering and evaluation for the natural resources, the environmental stress on these resources and considering various management approaches. The same methodology has been used in different biosphere reserves in the Arab Region such as; Omayed Biosphere Reserve in Egypt, Dana Biosphere Reserve in Jordan and Al-Reem Biosphere Reserve in Qatar which share the proposed Wurayah Biosphere Reserve in some conditions and factors that are in need to be managed for sustainable development and use of arid lands. Human activities that cause stresses impacting the life of endangered species, the vulnerability of water resources and providing opportunities for the sustenance and revival of local livelihoods are examples of these factors. This Methodology has been successfully applied to the these biosphere reserves and it gives good results for establishing zonation

(core, buffer and transition) as an examples for promoting biodiversity conservation and sustainable development in theses countries.

The first step was recognition then it has been followed with a long way of assessment, verification and manipulation of data to preserve the area which represents one of the country's richest and most diverse habitats.

A Geographic Information Systems (GIS)-based comprehensive study has been conducted to assess the natural resources in the Eastern Coast Region of the UAE with a special emphasis on Wadi Wurayah and its hinterlands. The study was carried out based on the integration of various disciplines of sciences including geomorphology and geology, climate, hydrogeology, water chemistry, land use and biodiversity. In addition to the modeling and office work, the investigations included field work and lab analyses. As a result a baseline Environmental Information System (EIS) has been designed to represent the required master database of the study area. The EIS shows the following:

12.1 Value of the Proposed Biosphere Reserve

As a result of this preliminary study on the natural resources and socio-cultural values of the proposed Wurayah Biosphere Reserve, the reserve will have a strong potential to the Eastern Coast Region and Fujairah Emirate based on:

12.1.1 Delimitation of the Proposed Biosphere Reserve.

Three zones different zones were proposed in the Wurayah Biosphere Reserve; the first is the core zone surrounded by a buffer zone and the third zone is the outer zone will represent the transition zone.

12.1.1.1 Core Zone

The main principles for delineating of the core zone are rarity and sensitivity of the natural components. The boundary of the core zone was delineated by the complex

assessment of the natural components and landscape features of the Wurayah protected area and its hinterlands. Table 12.1 shows the stages of the delineation of the core zone.

Table 12.1 Stages of delineation of the core zone

No.	Stage	Methods
1	Complex assessment of the natural components, landscape features and taking into consideration the cultural values occurring in the proposed core zone	Overlapping the maps of: • Valuable areas of geomorphology, geology and hydrology; • Habitats for wildlife; • Valuable areas for landscape; • Valuable sites for culture.
2	Analysis of the socio-economic situation	Overlapping the maps of: • Complex assessment prepared in the first stage • Land use
3	Synthesis of the conflicts	• Comparative analyze of the proposed core zone in accordance with the principles of the Seville Strategy
4	Delineation of the core zone	• Result of the stage 3.
5	Determination of the areas needing environmental protection measures	• The map of conflicts.

The complex assessment of the core zone was carried out by overlapping the maps grouped as unequal, valuable and typical in the seventh chapter. The map of conflicts was prepared to identify the areas needing environmental protection measures (Figure 12.1).

The analysis of the Conflicts map shows that:

- Two sites used for quarry are assumed to be risky due to their environmental impacts on the wildlife habitat. One of them is located near the Wurayah Dam Lake and the other one is at the northwest of the first. Another site has been recorded in Khor Fakkan south to the core zone. While quarries can cause significant impact to the environment, with the right planning and management, many of the negative effects can be minimized or controlled and in many cases, there is great opportunity to protect and enhance the environment, such as with the translocation of existing habitats or the creation of new ones.
- The two graveyards at the northeast of the core zone have to be shutdown and to be declared as cultural protected sites for memorial visits.
- One hunting hide site has to be closed and monitored to stop any hunters from practicing such type of activity which represents a real threat on the habitat of the core zone.
- Due to the impact of uncontrolled overgrazing, cutting, illegal hunting, rock painting and swimming along the Wurayah Dam Lake, waterfalls and water pools was considered in the core zone in order to protect the sensitive areas and to reduce the impact of men on them.
- Groundwater resources of the core zone is in good quality, but there is a need for continuous monitoring program to make sure that the activities of the buffer zone will not impact this resource.

The unequal and valuable habitat stands were involved in the proposed core zone by taking into consideration their rarity and sensitivity. Tables 12.1, 12.2, 12.3 and 12.4 show the WWF-EWS (IUCN Red List) references and the current study references (Hornby 1996a) used to determine the conservation status of these types of habitats. Table 12.5 shows the plants stands which were considered in the proposed core zone regarding their rarity and sensitivity.

Table 12.1 Mammal species recorded in the study area and their conversation status

Common Name	Scientific Name	IUCN Red List-2004	UAE Red List (Hornby 1996a)
Brandt's hedgehog	*Hemiechinus hypomelas*	NL	LC
muscat Mouse-tailed bat	*Rhinopoma muscatellum*	NL	DD
Naked Bellied Tomb Bat	*Taphozou nudiventris*	NL	DD
Trident Leaf-nosed Bat	*Asellia Tridens*	NL	DD
Persain Leaf-Nosed Bat	*Triaenops persicus*	NL	DD
Sind Serotine Bat	*Eptesicus nasutus*	Vu	DD
Kuhl's Pipistrelle	*Pipistrellus kuhlil*	NL	NL
Hemprich's Long-eard Bat	*Otonycteris hemprichii*	NL	DD
Red Fox	*Vulpes vulpes*	LC	LC
Blanford's Fox	*Vulpes cana*	VU	VU
White - Tailed Mongoose	*Ichneumia albicauda*	NL	NA
Gordon's Wildcat	*Felis silverstris gordoni*	NL	EN
Caracal Lynx	*Felis caracal schmitzi*	NL	VU
Arabian Leopard	*Pethera pardus nimr*	CR	CR
Arabian Tahr	*hemitragus jayakari*	EN	CR
Mountain Gazelle	*Gazella gazella cora*	Vu	VU
Rat unidentified	*Rattus sp*	NL	LC
Egyptian Spiny Mouse	*Acomys cahirinus*	NL	NT
Wagner's Gerbil	*Gerbillus Dasyurus*	NL	DD
Baluchistan Gerbil	*gerbillus nanus*	NL	DD

Table 12.2 Bird species recorded in the study area and their conversation status during the current study

Species	Scientific Name	IUCN Red List-2004	UAE Red List (Hornby 1996a)
Lappet faced Vulture	*Torgose tracheliotos*	VU	GTV
Lesser Kestrel	*Falco naumanni*	VU	GTV
Barbary Falcon	*Falco pelegrinoides*	NL	ND
Desert eagle Owl	*Bubo ascalaphus*	NL	ND
Desert Lesser Whitethroat	*Sylvia minula*	NL	RR
Plain Leaf Warbler	*Phylloscopus negalectus*	NL	RR

Table 12.3 Bird species recorded in the study area and their conversation status during the WWF-EWS survey (Trouqen et al 2006).

Species	Scientific Name	IUCN Red List -2004	UAE Red List (Hornby 1996a)
Bonelli's Eagle	*Hieraaetus fasciatus*	NL	ND
Sand partrridge	*Ammoperdix heyi*	NL	RR
Yellow -vented Bulbul	*Pycnonotus xanthopygos*	NL	RR
Red tiled Wheatear	*Oenanthe xanthoprymna*	NL	RR
eastern Pied Wheatear	*Oenanthe picate*	NL	RR
Hooded wheatear	*Oenanthe monacha*	NL	RR
Hume's Wheatear	*Oenanthe alboniger*	NL	RR
Upcher's Warbler	*Hippolais languide*	NL	RR
Menetrie's Warbler	*Sylvia mastacea*	NL	RR
Arabian Babbler	*Turdoides squamiceps*	NL	RR

Table 12.4 Reptile species recorded in the study area and their conversation status during WWF-EWS survey (Trouqen et al 2006).

Common Name	Scientific Name	IUCN Red List -2004
Sinai Agama	*Pseudotrapelus sinaits*	NL
Bar-tailed semaphore Gecko	*Pristurus celerrimus*	NL
Rock semaphore Gecko	*Pristurus rupestris*	NL
Fan-footed Gecko	*Ptyodactlyus hassaeluisitii*	NL
Spatulate gecko	*Bunopis spaturrarus*	NL
House Gecko	*Hemidactrylus sp*	NL
Blue- Tailed Lizard	*Omanosaura cyanura*	NL
Jayakar's Lacertid	*Omanosaura jayakari*	NL
Wadi Racer	*platyceps rhodorachis*	NL
Hissing Sand Snake	*Pasmmophis schokari*	NL
Saw-scaled Viper	*Echis carinatus*	NL
Oman Saw-scaled Viper	*Echis omanensis*	NL
Arabian Toad	*Bufo arabics*	NL
Dhofar Toad	*Bufo dhufarensis*	NL

Analysis of the cultural heritage shows that eight of old settlements are distributed along the two main branches of Wurayah catchment; Wadi ash Shamah sub-catchment and Al Wurayah. The existence of old settlements is relevant to the Third Millennium BC as mentioned by Peter Hellyer in Hornby (1996b). For that reason, they were considered in the proposed core zone to conserve the historical value of these settlements as a part of the eco-tourism activities.

Table 12.5 Assessment of the unequal and valuable plants stands

Family	**Scientific Name**	**Annual/ Perennial**	**Status**	**Traditional uses**
Adiantaceae	*Onychium divaricatum*	P		
Adiantaceae	*Adiantum capillus-veneris*	P	Common	Infusion for chest diseases as an expectorant.
Apocynaceae	*Nerium oleander*		Fairly common	All parts poisonous, not grazed. Steam from boiled leaves inhaled to relieve sinusitis. Leaves used as insecticide. Pounded leaves applied to skin for itch, ulcers and tumors.
Asclepiadaceae	*Calotropis procera*	P	Locally common	Milky sap is poisonous. Latex used to treat all kinds of skin ailments, toothache. Powdered dried leaves in small amounts to treat worm infestations. Dried leaves smoked for asthma. Underbark for repairing and decorating household items. Hair attached to seeds were used to stuff pillows.
Boraginaceae	*Heliotropium calcareum*	P	Common	

Family	Scientific Name	Annual/ Perennial	Status	Traditional uses
Convolvulaceae	*Convolvulus virgatus*	P	Common	
Cyperaceae	*Cyperus conglomeratus*	P	Ubiquitous	Sedges once used to make snails, ropes, baskets and mats. Also used as fuel. Rhizomes sometimes used as food.
Euphorbiaceae	*Euphorbia larica*	P	Very common	Dried branches used for thatching of roofs. Latex used as glue to catch birds.
Gramineae	*Saccharum ravennae*	P	Locally common	Often found grazed to the ground.
Gramineae	*Arundo donax*	P	Common	Stems traditionally used for fencing, for making musical instruments and tools.
Gramineae	*Cymbopogon commuttum*	P	Common	In India and Pakistan, Cymbopogon spp. cultivated for the extraction of aromatic oil citronella (perfume, insect repellant)
Labiatae	*Lavandula subnuda*	P	Common	Crushed leaves are insect repellant.
Leguminosae	*Tephrosia apollinea*	P	Very common	Leaves boiled with water used as eardrops for earache. Powdered bark with water pout into camel's ears to remove

Family	Scientific Name	Annual/ Perennial	Status	Traditional uses
				ticks. Powdered leaves applied as a paste to relieve wounds.
Leguminosae	*Acacia tortilis*	Tree	Very common	Extensively browsed by camels and goats
Moraceae	*Ficus cordata Subsp. salicifolia*	Tree	Locally common	Sap of new leaves used to treat bruises and scorpion strings. Milky juice from stem used to remove warts. Also applied on skin inflammations. Underbark used in tanning of leather to give it a dark red colour.
Moringaceae	*Moringa peregrina*	Tree	Uncommon	Oil extracted from seeds used to treat headaches, fever, muscle pain and burns. Mixed with cloves and cardamom oil used during labour as a drink. Extract of leaves rubbed on skin to treat skin rash.
Nyctaginaceae	*Boerharvia elegans*	P	Common	
Orchidaceae	*Epipactis veratrifolia*	P	Fairly common (becoming rare)	Typically grows in association with the fern Adiantum capillus-veneris; flowers used to flavour butter.

Family	Scientific Name	Annual/ Perennial	Status	Traditional uses
Polygonaceae	*Pteropyrum scoparium*	P	Common	Leaves are eaten to treat dyspepsia and as a blood purifying tonic.
Polygonaceae	*Rumex vesicarius*	A	Common	Leaves have a citrus taste and are eaten as a salad green or cooked with meet. Eaten raw as treatment for liver diseases and bad digestion.
Resedaceae	*Ochradenus aucheri*	P	Common	
Resedaceae	*Reseda aucher*	P or A	Common	
Rhamnaceae	*Ziziphus spina-christi*	Tree	Common	Wood used for making poles and pillar and as fuel. Thomy branches as livestock barrier. Boiled leaves as shampoo, or applied to soften skin. Ash of wood mixed with vinegar applied to snake bites. Tea as a treatment for measles. Flowers important for honey production of wild bees (Apis florea)
Solanacae	*Lycium shawii*	P	Common	Stem boiled used as a laxative and diuretic. Leaves used to treat jaundice. Berries are edible when ripe, to treat colic. In spite of its spines, heavily grazed by

Family	Scientific Name	Annual/ Perennial	Status	Traditional uses
				livestock, when growing on its own. Often found interwined with Acacia tortilis trees, where it is not browsed and can grow larger.
Tamaricaceae	*Tamarix aphylla*		Rare	Died powered leaves boiled with water ingested to treat prolonged labour, and to saddle sores and rope burns in animals. Wood resistant to termites and used for construction.
Typhaceae	*Typhadoming ensis*	P	Uncommon	Dried crushed flowers applied to burns for COOlingeffect.
Zygophyllaceae	*Fagonia indica*	P	Common	Powdered leaves and roots boiled in water taken by mouth as a treatment for colic or fever. Whole plant boiled mixed with thyme taken by mouth to treat kidney stones or eye problems.

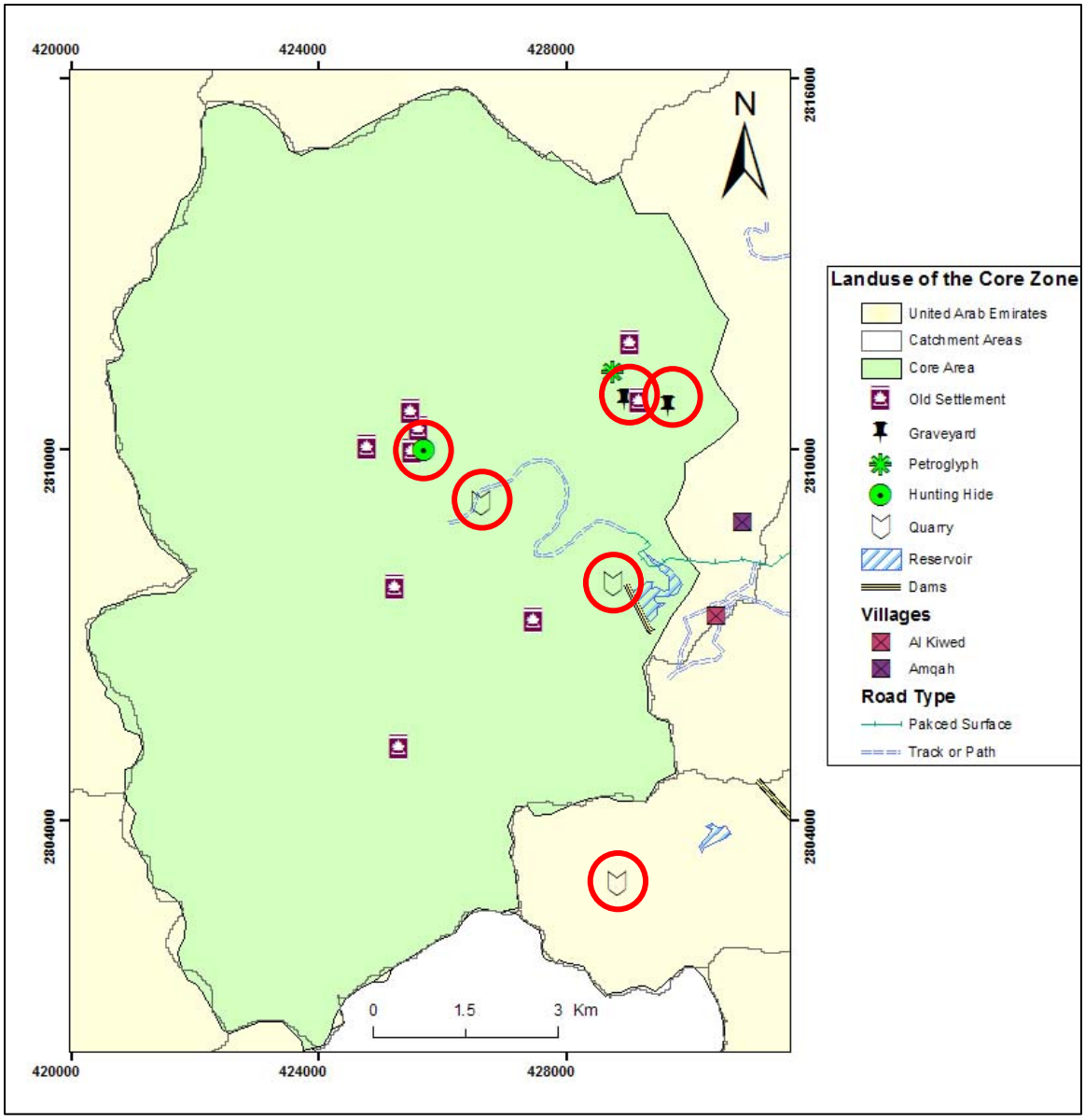

Figure 12.1 The map of conflicts of the core zone. Red circles used to identify the areas needing environmental protection measures (ALHOGARATY).

The socio-economic situation of the above-mentioned area was analyzed in the second stage in the light of the land use of the proposed core zone which shows that the two small villages (Al Kwied and Amaq) were built among the Wurayah sub-catchment with traditional houses and complex of agricultural stonewalled terraces surrounding. Agriculture on stonewalled terraces is preventing erosion and does not have negative impact on the environment. This activity being ecologically carried out and the villages were considered out of the proposed core zone. On the other hand, there are currently no more agricultural activities within the proposed core area. Intensive farming is concentrated in the down – stream part of the wadi, near the coast at the buffer and transition zone respectively.

The boundary of the core zone was delineated by the result of this assessment to reach the target of conserving and maintaining rare and sensitive natural components such as:

- Fauna species those are endemic to mountains of UAE and northern Oman such as: Arabian Tahr, Blue-tailed Lizard, Bar-tailed Semaphore Gecko, Rock Semaphore Gecko, Arabian Toad as well as Dhofar Toad.
- The range of endemic plant species;
- Groundwater resources which legally belonging to the government;
- Sensitive areas of geomorphology and geology.

The size of the core zone is 11,300 ha, while the regime of the core zone is also a classical one where no villages and pastures exist at the area. Some human activities such as gathering of herbs and medicinal plants, honey production should be allowed over time. The assessment of effectiveness of the core zone should be arranged by investigation of natural complexes and long-term monitoring of the dynamics of natural processes to evaluate and predict ecological situation. The forbidden and allowed activities in the core zone are shown in tables 12.7 and 12.8.

12.1.1.2 Buffer Zone

The main principles for establishment of the buffer zone in Wurayah Biosphere Reserve are:

- To reduce impact of men on the core zone;
- To restore deteriorated vegetation stands;
- To provide rational use of natural resources.

The complex assessment of the proposed buffer zone was prepared by analyzing the sensitive natural components and landscape features. According to this assessment the natural potential of buffer zone and its delineation were analyzed below.

Table 12.6 Stages of delineating the buffer zone in Wurayah Biosphere Reserve

No.	Stage	Methods
1	Complex assessment	• Analysis the sensitive natural components, landscape features; and the cultural monuments surrounding the core zone.
2	Analysis the areas needing environmental protection measures	• The map of conflicts.
3	Assessment of the socio-economic situation of the proposed buffer zone	• Assessment of the land use map and the map of conflicts.
4	Synthesis of the conflicts	• Taking decisions in accordance with the principles of buffer zone located in the Seville strategy
5	Delineation of the buffer zone	• Result of the stage 4

The Analysis of the sensitive natural components, landscape features; and the cultural monuments surrounding the core zone led to a map of conflicts which used to identify the areas needing environmental protection measures in the buffer zone (Figure 12.2).

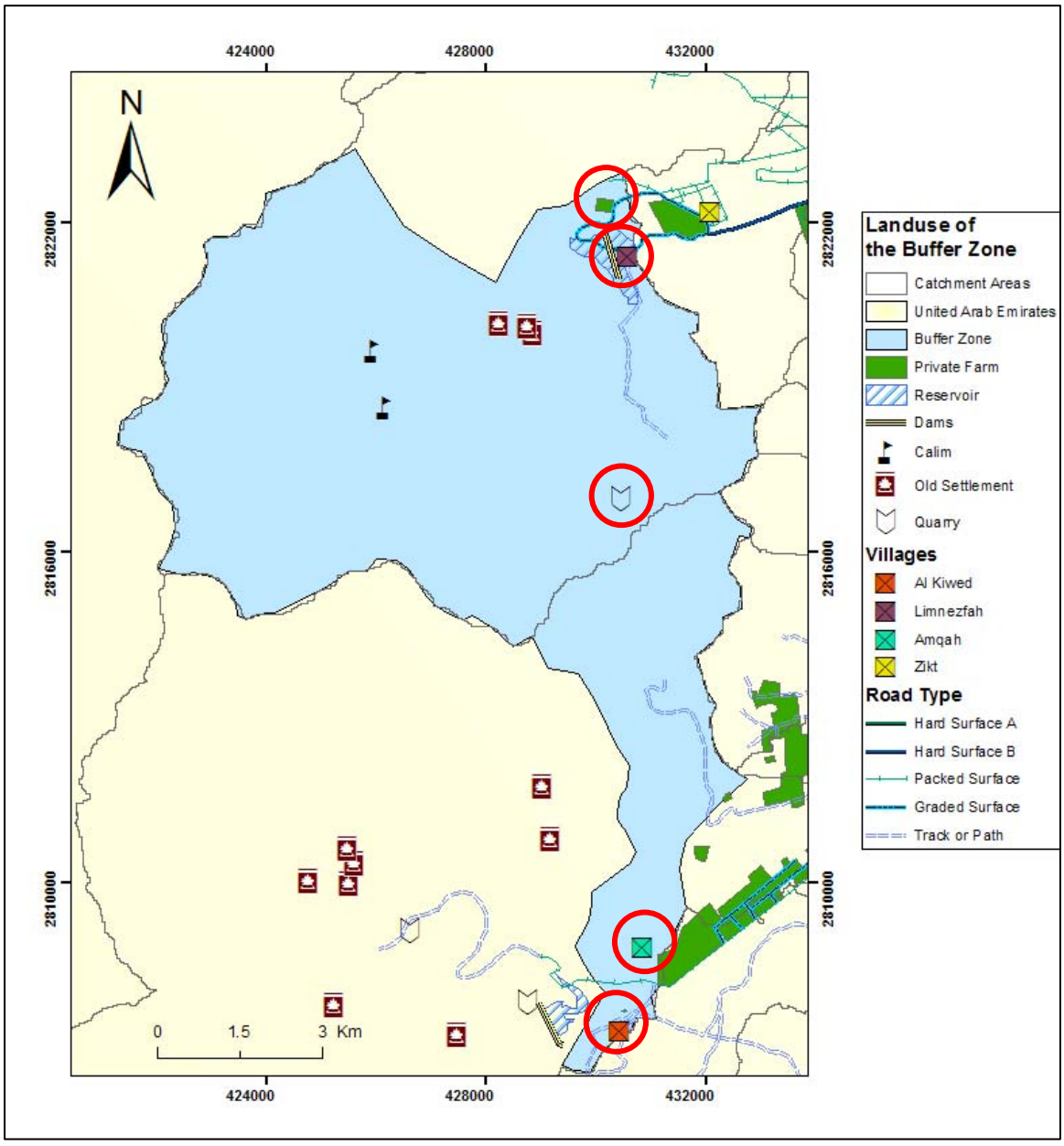

Figure 12.2 The map of conflicts of the buffer zone. Red circles used to identify the areas needing environmental protection measures (ALHOGARATY).

The analysis of the Conflicts map shows that:

- The habitat stands that involved in the proposed buffer zone are: Water Fauna and Flora, Mountain Gazelle, Red and Blanford's Fox, Cats and Dogs. These habitats were considered in the proposed buffer zone to support population.
- Three small villages have been recorded in the buffer zone; two are in south and one in the north near the Zikt dam. The main activity of these three villages is agriculture which has an impact on the groundwater resources of the buffer zone. Other agricultural activities are taking place near the boarders of the two south villages from the east which will impact also the quality and quantity of the groundwater. However, according to the Seville strategy (UNESCO, 1996), buffer zone does not contain permanent settlement areas. Buffer zone is used for cooperative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism, applied / basic research and seasonal use of natural resources. For that reason, these villages and their agricultural lands has to be excluded from the proposed buffer zone.
- Deteriorated areas due to overgrazing and cutting could be seen around the three villages. These areas were considered in the proposed buffer zone for restoration. Since the livestock husbandry (grazing) represents another economic activity of the local people, it is impossible to forbid grazing in the region today. However, establishment of alternative economic activities for the local people could reduce the number of the goats.
- One site used for quarry has been recorded located east of the buffer zone and near the area which is enrich with habitat like Mountain Gazelle which is endangered, so there is a need to minimize and control the negative effects to protect and enhance the environment by the translocation of existing habitats to the core zone.

- The outstanding land use of the buffer zone shows two mountain's camping sites with three old settlements located west to the Zikt Dam have a culture value and ecotourism potentiality especially if they are declared as ecotourism sites.
- Along the Zikt Dam Lake, waterfalls, water pools and the sensitive areas of hydrology were considered in the proposed buffer zone to reduce impact of local people on them.

The socio-economic situation of the above mentioned areas were analyzed in order to delineate the boundary of the buffer zone and to reach to the following targets:

- To protect the habitats of water fauna;
- To conserve the sensitive areas of hydrology;
- To restore the degraded areas and to have natural landscape and cultural value;
- To develop ecotourism.

The size of the buffer zone is 19,100 ha and the legal status of the natural resources in the buffer zone is belonging to the government.

12.1.1.3 Transition Zone

The transition zone should have permitted developments that have minimal negative impact on the natural resources environment but yield benefits for the community.

The assessment of the high intensive use of the land and the distribution of the human activities in the downstream of the study area outside the core and buffer zones used to delineate the transition zone of the proposed WBR. Figures 12.3 and 12.4 are showing the developments of the zone as follows:

- This zone contains about eight villages, settlements and a variety of agricultural, industrial and residential activities located mainly at the vicinity of Wadis near the down streams to make use of the available groundwater.
- The residential areas consist of traditional houses, modern villas, schools and governmental buildings.

- The agricultural lands are located around the villages and most of these farms dealing with Palm others are dealing with crops. The agricultural activities are booming down streams of the Wadis at the study area and it took place at the north near Dadinah and Rul Dadinah villages and south near the Bidiyah village.
- Most of the commercial activities are related to small shops dealing with food, beverages, fruits and vegetables, clothes, stationeries, traditional coffee shops and gas stations. The most famous settlement is the old market opposite to the narrow beach road of Bidiyah village. Fishing represents another main activity to the residents at this area due to the role of the old harbor of Bidiyah.
- Next to the south border of the buffer zone at the area located between Bidiyah and Khor Fakkan small and intermediate industrial activities were recognized at the southern coastal entrance of the Wadi Wurayah.
- Tourism is one of the flourishing activities in the coastal plain of the transition zone to make use of the spectacular natural merge between the coast and the mountains. Hotels and resorts are ranging between 2-5 stars classes. The most famous archeological site is the Bidiyah Old Masjed.
- There are very few roads and tracks within the area connecting the villages with each other and also give an easy access to the two main dam in the area Al-Wurayah and Zikt.
- Water resources development within this zone is currently restricted to agriculture and municipal uses in addition to one commercial use by a mineral water production factory. The impact of high extraction of groundwater could be seen in some areas near the coastline with yellowish dead trees due to the salt-water intrusion.

In general the impact of human activities of the transition zone on the pristine habitat upstream is negligible, but the impact on the natural resources especially groundwater led

to slat-water intrusion, so there is a need to manage the agricultural activities in this area in sustainable manner.

The target of the transition zone is to manage and sustainable develop the area's resources within a size of 28.600 ha in a legal status belonging to the local communities.

The assessment of effectiveness of the transition zone should be arranged by monitoring, so carrying out the following works in the region can fulfill this aim:

- To encourage the cultivation of traditional fruit-trees that is ecologically more sustainable and economically more profitable. Furthermore, the traditional economic alternatives such as gathering herbs and medicinal plants, beekeeping and agriculture on stonewalled terraces, which do not negatively effect the ecological situation of the area, should be supported.
- To make use of the touristic resources of the area will support the ecotourism as economic alternatives to increase income within the region.
- Residential, industrial and commercial activities are impacting the environment of the zone by dumping the industrial or municipal wastes randomly. It is important to find a new landfill these activities at the down stream away from the groundwater resources. Also there is a need to have waste management plans that control the by-products of these activities in the way of reducing, recycling and reusing of the generated wastes.
- To have a land management plan as a part of federal master plan of Fujairah Emirate to control and monitor the land uses of the zone. The direction of the urbanization from north to south should follow the shape of the coastline away from the buffer zone, while the industrial area has to be moved from the current location to another one away from the south entrance of the wadi which represents a main entrance that led to the core and buffer zone. The agricultural activities should be controlled to not intrude to the buffer zone.

The regime of the transition zone are shown in tables 12.7 and 12.8 that described the allowed and forbidden activities in core, buffer and transition zones.

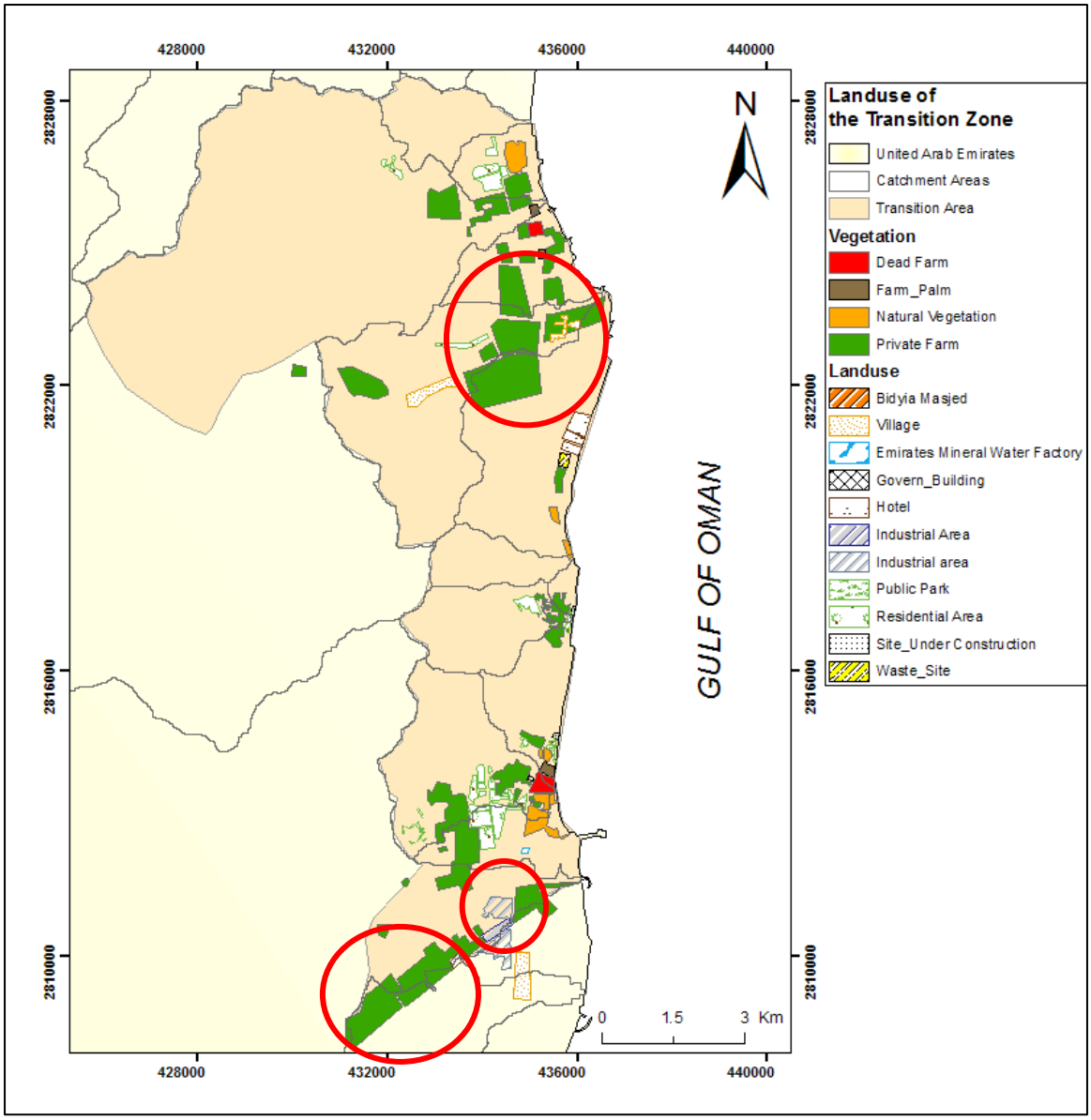

Figure 12.3 The land use developments of the transition zone. Red circles used to identify the areas needing environmental protection measures (ALHOGARATY).

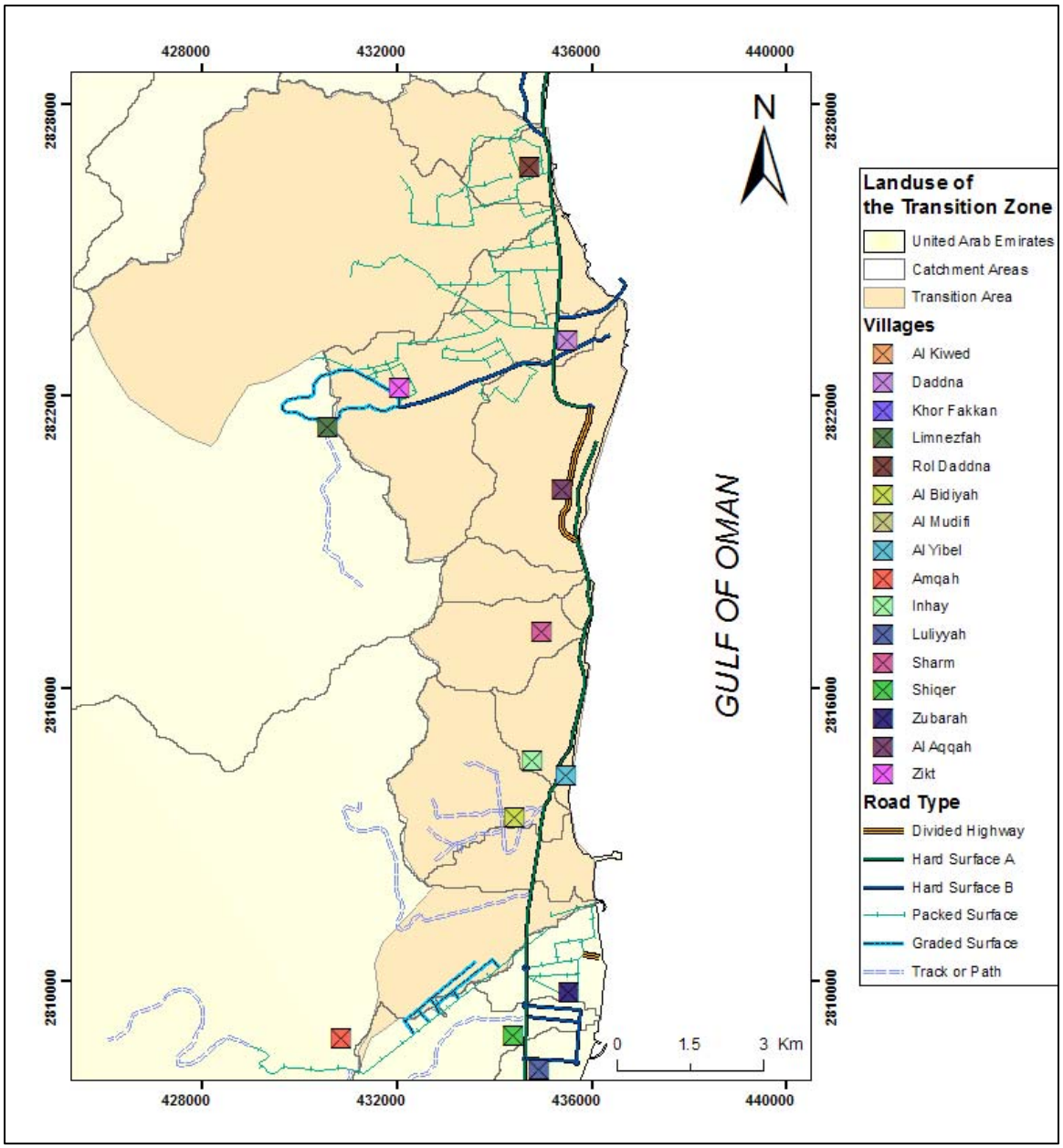

Figure 12.4 Villages included in the transition zone (ALHOGARATY).

Table 12.7 Forbidden activities in the core, buffer and transition zones

Forbidden activities	WBR Zones		
	Core	Buffer	Transition
Activities altering the hydrological regime	x	x	x
Clear and illegal cutting, hunting for trade and pleasure, illegal fishing	x	x	x
Activities altering relief, mining of the minerals, disturbance of soil cover and rocks	x	x	x
Construction of new roads and water ways of common use	x	x	
Building and setting of new industrial and agricultural enterprises and their objects	x	x	
Introduction of living organisms aimed at their acclimatization	x	x	x
Using mineral nutrients and chemical means of plant protection	x	x	x
Gathering of zoological, botanical and mineral collections	x	x	x
except for those predetermined by planes of scientific research	x	x	x
Procurement of soft resin, wood-sap and wild fruits	x	x	x
Gathering of herbs and medicinal plants before they leave their seeds	x	x	x
Grazing except pastures. Grazing can be allowed time to time in some areas where the risk of fire is high	x	x	x
Other activities that disturb the natural development of natural processes	x	x	x

Table 12.8 Allowed activities in the core, buffer and transition zones

Allowed activities	WBR Zones		
	Core	Buffer	Transition
Development of villages under a plan	x		
Preservation of natural complexes, restoration and preventing of chances in natural complexes and their components as a result of anthropogenic influence	x	x	x
Maintenance of conditions that prevent fire risk	x	x	x
Grazing in pastures		x	x
Gathering of herbs and medicinal plants after they left their seeds		x	x
Visiting of the old settlements and ecotourism activities	x	x	x
Using the transportation road extending to the villages		x	x
Using the present transportation road	x	x	x
Conduction scientific research including ecological Monitoring	x	x	x
Eco-educational work	x	x	x
Realization of management functions	x	x	x
Seasonal using of natural resources		x	x

12.1.2 Natural Settings of the Proposed Biosphere Reserve.

12.1.2.1 Geology and Geomorphology

The Eastern Coast Region in the UAE and the area of the study as apart of it is distinguished into four geomorphic units include: mountains, alluvial plains, coastal plain and drainage basins. The core zone is a mountainous area and the buffer zone is ranging between mountains and Alluvial plains, while the transition zone is mostly coastal plain. The drainage basins are exists in all of the zones with different distribution.

The geological structure of the study area is influenced by three pronounced fault trends which are the NE trend (Dibba zone), the NW trend (Ham zone), and the WNW trend (Hatta zone). These zones have a greater thickness of weathered material and mostly utilized by major surface drainages, implying possible development of fracture rock aquifers. Trends of these lineaments are found to be in agreement with the main fault trends previously mapped in the Eastern Coast Region, with fault displacements ranging from 70 m in NW-SE-trending faults to 320 m in the NE-trending faults (Rizk and Garamoon 2006). These lineaments extend in length for tens of kilometers, which possibly reflects the existence of several connecting horizontal aquifers in the subsurface.

The upper parts of the area of study are mostly ultra basics, comprising peridotite, serpentinized peridotite and serpentinite, with locally banded Magnesite. Thin chrysotile and calcite veins are common. Under extreme temperature, the calcite has transformed to marble. The serpentinite is generally highly fractured and rock falls and minor avalanches are seen along contact planes. On the other hand, the lower part of the area of study contains complex of gabbro with intermixed ultrabasic rocks.

The upper catchment Wadis and lower wadi plains comprise wadi gravel deposits. These deposits comprise rounded gravel, cobbles and boulders, usually within a poorly sorted sand/still matrix. In the vicinity of active Wadis, the gravel becomes increasingly compact with depth. The fluviatile deposits are boulders, gravel, sand and silt and occur within the active Wadis and in old undifferentiated terrace deposits and cemented wadi walls. The sediments spread out into an out wash fan downstream of the recharge dams.

In general, the core and buffer zones are dominated by ophiolites structures. Upper areas of the transition zone are structurally consist of ophiolites and the lower areas are varying between Alluvium and Gabbros (Figure 12.5).

Rainfall provides low salinity and low temperature run off water which infiltrates the fractured ophiolite and the recent and older wadi gravel terraces in the upper parts of the catchments mainly located in the core and buffer zones. In the transition zone the run-off quickly finds its way downstream in flash floods which also provide significant recharge

to the alluvial aquifer in the mid and the end parts of the wadi Wurayah and wadi Zikt catchments.

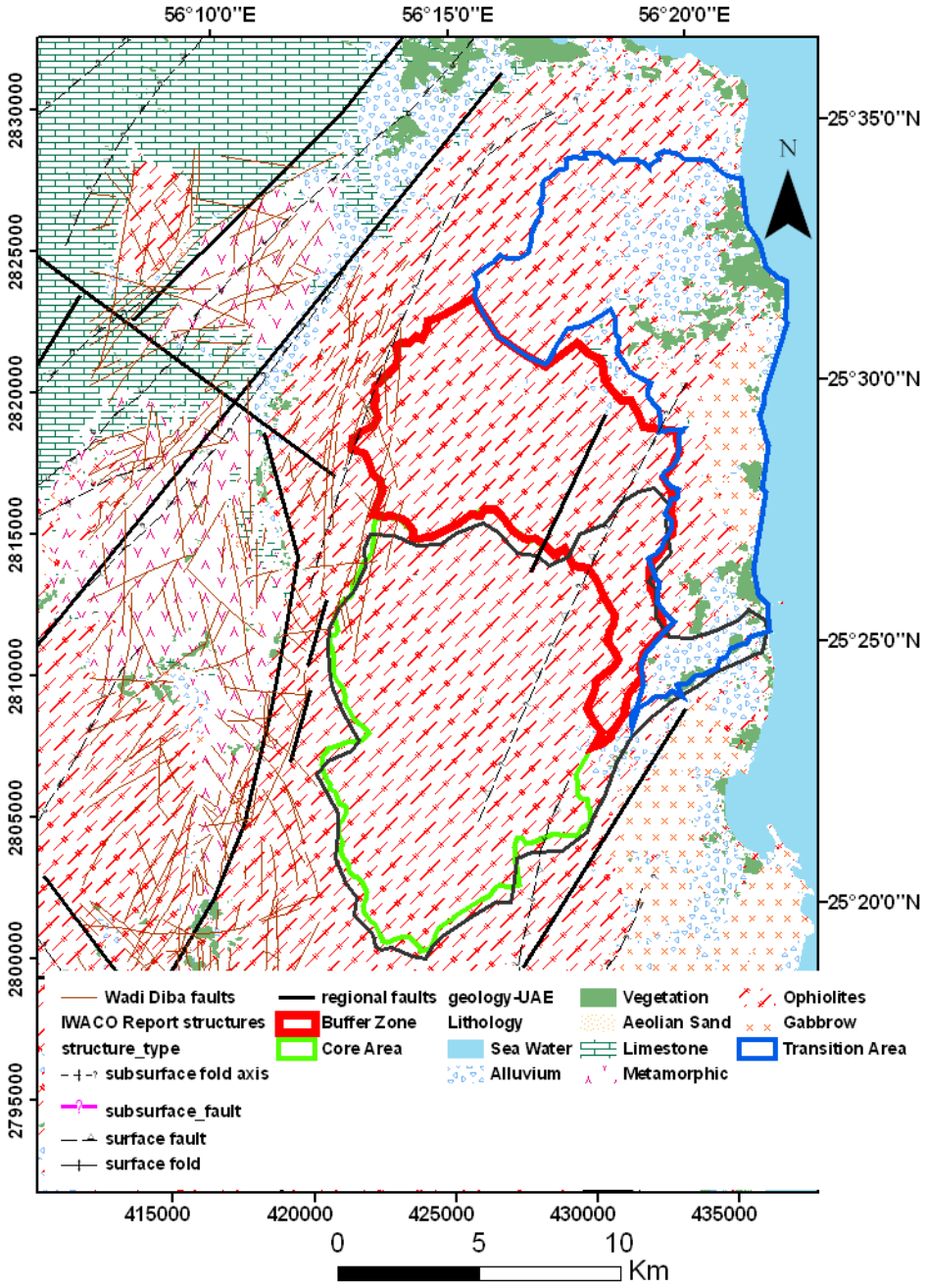

Figure 12.5 Geologic map of the study area, illustrating the core, buffer and transition zones of the proposed WBR (modified after Ebraheem et al., 2008).

12.1.2.2 Climatic Conditions

The Eastern Coast region in the UAE and the area of the study are characterized by dry desert climate and scarce rainfall with high air temperatures in summer and mild in winter and a few rainy days. The results of the climatologically investigations shows that the area of the study as a apart of UAE land receives the highest solar radiation during June and the lowest in December, with a general increase from December towards June and a decrease from June to September.

Generally the area is characterized by high air temperatures high throughout the year. The annual average temperature varies between 25 and 30°C with minimum winter temperatures as low as 4°C. and maximum summer temperatures reaching up to 50°C.

Two maxima of relative humidity in January and August and two minima in October and May are showed by the annual curve for relative humidity. The daily mean relative humidity may range from 50 to 70% while the annual mean relative humidity of 54%.

One of the phenomena affects the study area are the Monsoon Winds originating on Rub' al Khali Desert. The annual wind speed shows two maxima in February (5.90 knots) and August (5.97 knots) and two minima in May (1.92 knots) and (1.81 knots).

The natural evaporation is extremely high during summer months, exceeds 20 mm/day. June has the highest evaporation values of 22.4 mm/d mean maximum and 11.2 mm/d mean minimum, while January has the lowest evaporation rates of 6.4 mm/d mean maximum and 2.6 mm/d mean minimum.

The average annual rainfall in the UAE is 111 mm/yr, varying greatly in space and time depending on climatic condition, geographic location, topography and rainfall-driving mechanism. The Eastern Coast Region has an average annual rainfall of 120 mm/yr.

12.1.2.3 Hydrology and Hydrogeology

The existing water resources in the WBR are groundwater and seasonal floods which represent irregular, occasional water source in the Eastern Coast Region and the study area. Wetlands and sabkhas are other forms of surface water resources.

Floods mostly occur in association with strong, short lasting, rain storms. Because the porosity and permeability of the prevailing igneous and metamorphic rocks are low, relatively large volumes of rainwater move over the land surface as surface runoff. This flow begins in the mountainous areas in the west of the WBR near the proximal end of watersheds and moves towards the Gulf of Oman in the east or towards the desert plains in the west. Topographic maps, aerial photographs, and satellite images show that the mountain ranges of the WBR have 11 drainage basins. Some large Wadis have more than one runoff event per year, others may have surface runoff once in several years, and the rest of the Wadis may remain dry for even longer periods. The annual contribution of seasonal floods to water resources of the UAE, as estimated as the Ministry of Agriculture and Fisheries in 1993, is 125 MCM.

The Ministry has constructed 14 large dams across the outlets of main Wadis of the Eastern Coast Region. These dams protect against flood and assist the recharge of groundwater. The two main groundwater recharge dams constructed in the WBR are Wurayah and Zikt dams with reservoirs capacities of 5.5 MCM and 3.5 MCM respectively (Rizk and Alsharhan, 2003). According to the current drainage analyses and comparing to Ghoniem 2008, the analysis of the hydrological characteristics of the drainage basins data showed that the eastern drainage basins discharge, on average, 70% of the total precipitation in the form of sharp peaks.

The eastern basins are characterized by high surface runoff. This can be attributed to their rock types, which are mainly composed of basement rocks with low matrix permeability. Such characteristics enable surface runoff to proceed faster with the reduction in the surface absorption capability. The drainage basins of Zikt and Wurayah could be considered to be a low groundwater potentiality and primarily distinguished by steep slope and high channel gradients, which trigger a rapid concentration of overland flow with small magnitude, but strong flash-flood effects. Therefore, it is necessary to benefit from these floods for improving the storage of wetland, improving water quality and enhancing recharge of groundwater.

Two wetlands have been identified in core and the buffer zones beyond the two major dams one at Wurayah dam and the other at Zikt dam used now for recreational and environmental purposes. There is no evidence for artificial surface water body or ponds.

In general the sabkhas plain are dry for the most part of the year, but contain surface water when strong onshore winds drives sea water inland, after period of heavy rainfall and also in winter when groundwater levels rise within the coastal belt. The inland sabkhas indicate groundwater discharge areas whereas coastal sabkhas represent relics of sea water evaporation in coastal depressions (Rizk et al. 1997). One sabkha has been recorded at the proposed transition zone of the biosphere reserve between the area located between Aqqa and Sharm at the coastal plain of the transition zone.

Using the interpretation of the available data and the constructed hydrogeologic map (Figure 12.2), two aquifers were identified within the study area, namely: the Quaternary alluvial aquifer and the fractured Ophiolites aquifer. The Quaternary aquifer, the main aquifer within the study area, is composed of alluvium gravel and course sand.

The gravel aquifer receives recharge from rains falling on the Northern Oman Mountains. The wells tapping the aquifer receive water from a local groundwater flow system characterized by low salinity, high ^{3}H and ^{14}C activities and short residence time.

The aquifers of the study area are susceptible to different stresses due to human activities. One of the purposes of this study was to measure hydraulic heads in the core, buffer and transition zones and to construct a potentiometric surface map for the both aquifers at the study area.

Potentiometric surface in the 16th observation wells of the WBR was calculated by subtracting depth to groundwater from elevation of each well. The potentiometric surface map of the Quaternary aquifer at WBR reveals that groundwater generally moves from the west to east in the direction of groundwater flow in the gravel aquifer in the Eastern Coast Region of the UAE, including the study area (Alsharhan et al. 2001; Rizk and Garamoon 2006). The values of hydraulic conductivity (K) of the eastern gravel

aquifer range between 6 and 17 m/d in recent sediments and between 0.09 and 0.86 m/d in old sediments.

The potentiometric surface map for the Quaternary gravel aquifer within the study area shows that the hydraulic head has decreased between 2005 and 2009 which reflect a clear decline in groundwater levels especially in the buffer and transition zones due to the human activities uses in irrigation and domestic applications.

Groundwater pumping at wells at the transition zone has caused local deviations, or even inversion in the direction of groundwater flow which is obviously clear in the south of the zone in case of wells no. Wur-5, Wur-6 and Wur-7. This may induce salt water from the west to intrude into the relatively better-quality groundwater in the east. The cones-of-depression resulting from groundwater pumping at wells no. Wur-5, Wur-6 and Wur-7 can also accelerate movement of surface pollutants from point pollution sources towards residential areas causing serious groundwater pollution.

The maximum groundwater level decrease of 20 m (Well WUR5) in four years (between 2005 and 2009) and it started to impact the levels of the groundwater in the buffer zone. If the drop will continue without management of the human consumption, it will impact also the water quality of the core zone.

The main reason behind the serious groundwater level drop within the study area and, the UAE in general, is excessive groundwater pumping for all purposes. The natural recharge of groundwater from rain is one tenth of groundwater exploitation (Rizk and Alsharhan, 2008). However, because of gravity and topography, any deterioration of the general water situation in the lower catchment and coastal plain can never have a hydrological impact on either the surface or groundwater resources of the mid-upper catchment.

12.1.2.4 Hydrogeochemistry

The groundwater pollution in the study area can result from natural and human-related sources.

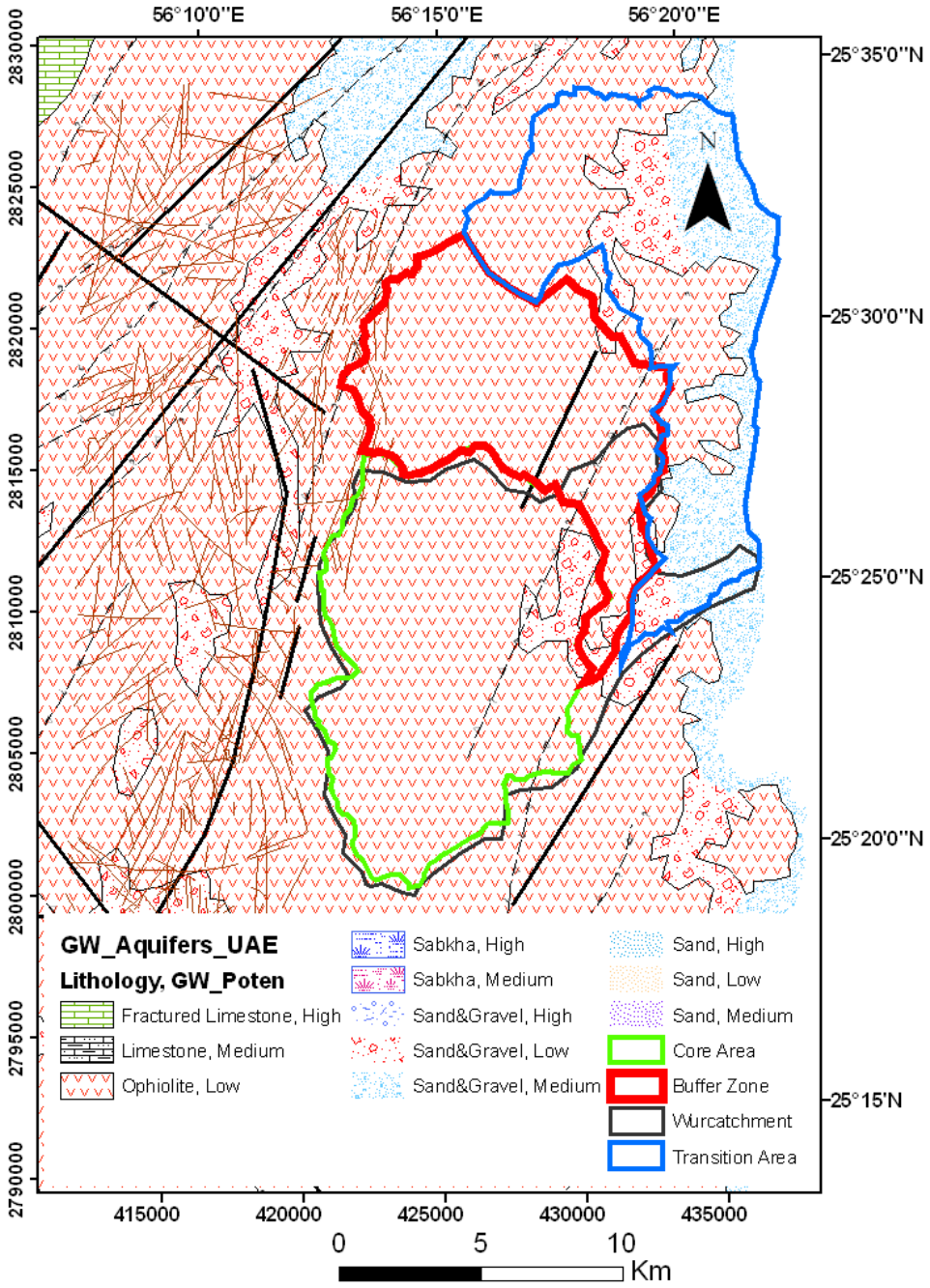

Figure 12.6 Hydrogeological map of the study area, illustrating the core, buffer and transition zones of the proposed Wurayah Biosphere Reserve (modified after Ebraheem et al., 2008).

The unconfining nature of the Quaternary alluvial aquifer within the study area can increase its vulnerability to pollution. The fresh groundwater within the study area is bounded on its eastern side with a huge salt water body; the Gulf of Oman. Excessive groundwater pumping has already induced salt-water intrusion the southern part of the east coast area (Sherif et al., 2005), directly south on the study area. The prevailing aridity and scarcity of rain reduce groundwater recharge. This allows pumping of poor-quality from deep horizons in the aquifer. To study the hydrogeochemical parameters of the groundwater in the proposed WBR were investigated based on two rounds of sampling in 2005 and 2009 and the results are discussed in the following:

- According to the TDS content, groundwater in the WBR varies from fresh water (TDS ranging from 500 to <1,000 mg/l near the water divide line) in the core zone to brackish water in the eastern and northeastern parts of the buffer zone (TDS ranging from >1,000 to 10,000 mg/l). Saline water (TDS >10,000) occurs in the outlet area of main wadis, near the Gulf of Oman coast in the transition zone.
- Groundwater salinity increases naturally in the directions of groundwater flow, towards the Gulf of Oman coast and towards west. Investigation of period between 2005 and 2009 isosalinity contour maps show inland shift the same isosalinity contour in 2009 compared with 2005, indicating increase of groundwater salinity because of the salt-water intrusion phenomenon at the transition zone. Heavy groundwater pumping in Rul Dibba and Dadinah areas leads to increasing groundwater salinity. If salty water is used for irrigation, the capacity of soil with respect to transmitting of water and air reaches undesirable limits. That's why, the amount of moisture decreases and plants don't take necessary nutrition from the soil. Because of high evaporation in dry climate salinity may be high. Shortly it can be said "the more hot climate, the more salinity".
- Except for the western parts of the study area (the core zone), most of ground water in the eastern gravel aquifer is hard in the buffer zone to very hard in the transition zone. The iso total hardness contour map of groundwater within the study area in 2005 and

2009 illustrate that the groundwater in the eastern and northeastern parts of the study area is hard (TH > 200 mg/l) to very hard (TH > 300 mg/l), which stops the soap action and make water use for domestic purposes difficult. The reason for high groundwater hardness within the study area can be attributed to saline water influence and high Ca^{2+} and Mg^{2+} ions in the Ophiolite rocks dominating the area. Upon dissolution, these rocks enrich groundwater with Ca^{2+} and Mg^{2+} ions, which increases total hardness.

- According to the SAR values, the use of groundwater for irrigation in the Dadinah area in the transition zone (SAR >10) can have limited hazardous effects on both plants and soil where the electrical conductance of the collected water samples varied between 1,750 and 81,900 μS/cm (Almatari, 2010). Based on the measured EC and calculated SAR values, most groundwater in the eastern gravel aquifer is good for irrigation purposes. A few groundwater samples are not suitable for irrigating traditional crops and can cause harmful to plants and soils when used for irrigation especially in the transition zone.
- According to the pH analysis the groundwater in the study area varies from slightly acidic, due to dissolution of the various gases in the atmosphere by rainwater and the decay of natural vegetation, to slightly alkaline caused mainly by water enrichment in carbonates (CO_3^{2-}) and bicarbonates (HCO_3^-) ions.
- The sequence of cations dominance in groundwater of the Quaternary alluvial aquifer in the Eastern Coast Region of the UAE has the order: $Na^+ > Mg^{2+} > Ca^{2+} > K^+$ in the Fujairah area, and $Mg^{2+} > Na^+ > Ca^{2+} > K^+$ in the Wurayah and Zikt areas located in the core zone and buffer zone respectively.
- Concentration of Ca^{2+}, Mg^{2+}, Na^+ and K^+ all increase from the water divide line towards the east in the core zone and west in the transition zone, in the directions of groundwater flow. Local high anomalies in Na^+ occur in areas where heavy groundwater pumping for agricultural and domestic purposes is taking place. High

concentrations are limited to the Rul Dibba, Dadinah and Khor Fakkan areas, where excessive groundwater exploitation is taking place and possible salt-water intrusion is affecting groundwater quality.

- The sequence of anions dominance in groundwater in the area of the study has the order: $Cl^- > SO_4^{2-} > HCO_3^-$ in the middle of the transition zone and $HCO_3^- > Cl^- > SO_4^{2-}$ in the north and south of the zone.
- Opposite to all cations and anions, HCO_3^- levels in groundwater is high near the water divide line in the core zone (415 to 1,190 mg/L) decreasing in the direction of groundwater flow towards the Gulf of Oman coast in the transition zone (59 to 122 mg/L). The high Cl^- at Dadinah area is related to heavy groundwater exploitation for all agricultural purposes.
- The calculated groundwater dissolved salts in groundwater of the study area are consistent with the prevailing geological and hydrogeological conditions and evolve in the direction of groundwater flow, according to the Chebotarev series (Freeze and Cherry, 1979). The compositions of the groundwater within the study area vary from north to south. The predominance of groundwater dissolved salts changes from magnesium bicarbonate in the north of the transition zone to sodium chloride in Dadinah in the middle to magnesium bicarbonate again in the south of the zone. The spatial distribution of hypothetical salt combinations reflects the influence of both natural hydrogeologic conditions and human-related activities.
- The NaCl dominate the eastern strip of the transition zone parallel to the Gulf of Oman coast. The dominance of NaCl salt generally increases from the west to east, in the direction of groundwater flow. Local increases in NaCl salt reflect the influence of salt water intrusion from the Gulf of Oman into the eastern gravel aquifer within the study area (Sherif et al., 2005).
- The KCl is the least dominant salt within the study area, reaching maximum concentration in Dadinah and decreases throughout the Wurayah and Zikt drainage basins.

- The $Ca(HCO_3)_2$ salt is dominate in the Wadi Zikt and Wadi Wurayah basins in the northern and southern parts of the study area.
- The Mg-rick ultramafic rocks are the main rock types within the study area, therefore the $Mg(HCO_3)_2$ is the most dominant salt throughout the region. Two dominance of $MgSO_4$ salt prevailed all over the study area, except the area around the outlet of the wadi, which is characterized by NaCl followed by $Mg(HCO_3)_2$ water types. The $MgCl_2$ salt is the fourth dominant salt within the study area and it decreased from the west to east.

12.1.2.5 Isotope Hydrology

Hydrochemical and isotopic data (^{18}O, ^{2}H and ^{3}H) were used to calculate the contribution of Al-Wurayah dams to recharge the eastern gravel aquifer within the study area.

- The TDS of groundwater in the wells located downstream the dam site is generally higher than that of the dam reservoir. The water of these wells is most probably recharged by water coming from the dam reservoir, and suggests the increase of TDS in the direction of groundwater flow.
- By considering only the non-evaporated water, mostly responsible for the recharge of the shallow aquifer, the sample representative points fit clearly a line close to that of the eastern Mediterranean meteoric water. This line ($^{2}H=8^{18}O+17$) reveals that a significant air masses are coming from the northwest, and most probably crossing over the Mediterranean region.
- Stable isotopes data of Wadi Al-Wurayah Basin indicate that the groundwater in the observation wells may mostly be recharged from the dam reservoir water.
- Calculation of the contribution of recharge coming from Al-Wurayah dam reservoir water towards the shallow aquifer in Wadi Al-Wurayah Basin indicate that the aquifer recharge varies between 22% and 43%.
- The result of this isotopic mass balance showed that groundwater in the observation wells represents a mixture of the dam reservoir water and the present-day rains. The

computed values indicate the importance of the dam reservoir water in recharging the observation wells tapping the shallow aquifer.

12.1.3 Management of the Proposed Biosphere Reserve

As part of management of the proposed Wurayah Biosphere Reserve there is a need for the contribution of government institutions, non-government organizations and academic bodies whose scope includes research, management, awareness-raising they could lead or be involved in the management committee and directing cooperative projects.

The core area has to be managed legally in the light of the Amiri Decree, their long term role as protected area and according to the participatory approach of the stakeholder. I order to mange the buffer zone, it is important to keep the human activities compatible with the conservation objectives of the core areas. The issues like dynamic of economic activities and then development of infrastructure and services, the population density in comparison to the other areas of the biosphere reserve, the pressure on the groundwater resources and the water supply systems and the traditional developed rural energy supply system are issues that need to be taken into account within the transition area.

All around the world, the main problem is implementation. Although the management of the natural resources in the form of zonation will support the sustainable development of this part of the Eastern Coast Region in the UAE, additional challenge in the UAE is public ignorance of the concept, because what constitutes a protected area is vague since there is no set of unified country standards. Few protected areas have management plans, while in many places it is difficult to enforce laws protecting rare animals.

The proposal to protect and manage the area as a biosphere reserve comes as large agricultural, industrial, residential and tourist projects are fast changing the landscape in the Fujairah Emirate. The area needs to be sustainable managed because it faces some serious threats. Overgrazing, poaching and hunting, the dropping of litter by visitors, quarrying and over-exploitation of the water feeding the wadis are the main threats.

When a decree was issued by the Ruler of Fujairah, Sheikh Hamad bin Mohammad Al-Sharki, the protected area which is assumed to be the core zone of the WRB is off-limits for development such as construction and quarrying. But preserving habitats will require efforts to ensure the law is respected.

The management plan calls for the hiring of local people to work as in different green jobs as managers for the WBR and executives for the zones or rangers to ward off poachers targeting the rare animals of the WBR and to prevent littering.

There is high tourism pressure, so it is hoped the management plan will help the core zone avoid the fate of other picturesque spots that have in recent years been unable to deal with the impact from a rising number of visitors.

Dibba Rock is an example. It is a marine protected area also in the emirate, which attracts hundreds of divers and snorkellers. During weekends, a large number of visitors arrive on boat excursions offered by nearby resorts and it is common to see tourists walking on the reef surrounding the rocky outcrop – which damages the coral. A boat with staff from the Ministry of Environment and Water patrols daily but their main concern is to protect it from fishing, leaving the tourism problem unaddressed. In contrast, the most of the wadis located in the study area is much more difficult to reach and there the negative impact from visitors – litter – affects the most popular area around the main waterfall, so the management plan includes the suggestion of fines for people who litter not to have them run away from the project but to attract people by make it as logical as possible to not make mistakes so they can be fined.

Besides dealing with visitors who litter, rangers are also to target poachers, who hunt gazelles and the Arabian tahr. The poachers are not only from Fujairah but other emirates as well. While hunting is illegal, activities such as honey and medicinal plant gathering will be allowed, because it is is an old tradition and it is important to keep it rather than stop it. On the other hand nature trails, barbecue and camping areas and an eco-resort are all will support the concept of the ecotourism in addition to a visitor centre if it is established as a green building. Besides municipal officials, the management plan will

also be reviewed by the tribal communities in the area, whose support will be essential for the success of the project. It needs to go step by step because this is still a new concept in this area.

Sponsorship is another issue that is vital to the success of the project in order to cover the design of biosphere reserve, the facilities, their cost and the number of people needed to staff them. The project of establishing WBR would not have succeeded if it were not for fund donated by the Ministry of Environment and Water, Fujairah Municipality and local tribes.

12.1.3.1 Water Resources Management

With regard to water resources, the groundwater in the transition zone is suffering fast water quality degradation due to saltwater invasion toward the main well fields used for domestic purposes. In general, groundwater levels in all observation wells are declining since 1996 (the last wet year). The groundwater levels monitored in observation wells show significant variations in response to rainfall events. There is a need for a detailed map of all governmental and private water wells, as well as more assessment of water quality and quantity in relation to use. A good contribution of the current study would be rehabilitation of selected wells, and supporting the construction /reconstruction of water catchments areas or underground dams for water harvesting. Another dam assessment should take place in order to protect the urbanized areas from flash floods and to make use of water in recharging the aquifers. There is a need to review and rationalize the current monitoring network to assess if it provides the data needed in current and future groundwater management decision making. This assessment should not only consider the data needs but also evaluate the cost and maintenance of the network to ensure adequate budget is available for current operations and any future expansion.

One of the un-intended consequences of irrigated agriculture is water logging and salinisation of the landscape which impacts on the land and water environments resulting in environmental damage and economic loss to farms and rural communities. Irrigation

application in excess of crop requirements is a major contributor to this problem. Various estimates on a global scale indicate that only 30 to 40% of irrigation water applied may be used by crops. The remainder contributes to surface runoff, recharge below the crop root zone to the groundwater, or evaporates directly into the atmosphere concentrating salts in the soil. As this excess water exceeds lower recharge rates under natural conditions, particularly in arid and semi-arid regions of the world, it results in rising water tables, which often brings saline groundwater near the surface and which in turn results in loss in crop productivity and land salinisation. Water table and salinity management at the farm level calls for new and innovative solutions for managing shallow water tables such as the application of optimization techniques for sustainable management of irrigation areas affected by high water table. Optimization of pumping in order to distribute pumping stresses spatially and temporally whilst minimizing impacts on the aquifer is required. Optimization of crop water demand and matching crops to soils so that irrigation applications match crop water requirement is required to reduce over pumping.

In order to have a beneficial impact on managing supply and demand, the development of a supply-demand model is needed for the Emirate. The model must be based on accurate estimates of groundwater supply for agriculture and forestry which are two big unknowns and are broadly estimated from crop water requirements. The time scales for groundwater level decline is an important consideration for assessment of aquifer susceptibility to imposed stresses. In general the more rapid the decline in water levels the higher the susceptibility of the aquifer to stress. Aquifers that respond rapidly to declining levels require close monitoring and a rapid response strategy to mitigate impacts on water quality and groundwater users.

Conversely, where aquifer responses show slow progressive declines, it offers opportunity to evaluate the problem, explore technical options, and institute change in management practices over time. These changes can include economic incentives to reduce groundwater withdrawals, strengthening policy and institutions, enforcing stricter

controls on groundwater abstractions, time limits before new allocation policies come into effect, and most importantly community awareness and education.

A range of techniques are available which include monitoring and modeling to assess the availability of the resource, impact of controlled depletion of the resource, and putting in place intervention strategies to allow for aquifer recovery. Some of these beneficial strategies will be elaborated on in the section on water security; subsidies to limit pumping in parts of the aquifer and the use of indicators to provide early warning guidance on aquifer stress. Due to the lack of fresh water resources there is a need to support the research on development, management and conservation of brackish groundwater supplies. This research initiative could form part of a broader research initiative encompassing the Arab Region where there is increasing reliance on brackish groundwater resources for agriculture.

12.1.3.2 Potentiality for Renewable Energy Resources

The UAE land receives the highest solar radiation during June and the lowest in December, with a general increase from December towards June and a decrease from June to September. The Monsoon Winds, originating on Rub' al Khali Desert, affect the study area. The annual wind speed shows two maxima in February (5.90 knots) and August (5.97 knots) and two minima: in May (1.92 knots) and (1.81 knots). These information could support a detailed study for using renewable energy as an alternative sustainable power source in the proposed Wurayah Biosphere Reserve.

12.1.3.3 Biodiversity

As a part of long-term management of the biodiversity a regularly survey and monitor the area should be implemented for management and conservation of fresh water resources, vegetation transects surveys in the main habitat types of the area, identify annual plants and assessing conservation status of the habitats and potential environmental threats. The current study provides a preliminary data base for the habitat distribution in the area, but

the Fujairah Municipality has to establish a wildlife database for inclusion in GIS with GIS and Cartography Department.

12.1.3.4 Socio-Cultural Heritage

Involving the local communities in the management and supporting the quality of life of the local community would be central for the successful implementation of the Management of the Wurayah Biosphere Reserve. Since the area is rich in different cultural heritage according to the field survey, an Archeological map has to be generated with archaeological investigations to discover the settlements. This will support the ecotourism industry side by side with an establishment of collaboration with cultural and tourism local authorities to examine the potential to include sites in archaeological and cultural tours. Thus it will propose an alternative and complementary tourism activity to the coastal development in progress in the Emirate.

12.1.3.5 Possible Obstacles when Establishing and Managing the Proposed Biosphere Reserve

In the literature a collaborative, flexible, stakeholder-oriented process is recommend as the potential successful biosphere reserve management approach which at the same time considers local concerns and seeks local ownership and support. The issue here is that in many instances, strict protection from excessive use is not politically feasible, despite the strength of the scientific case for safeguarding these sites. Consequently, managers must constantly balance monitoring with negotiation. In this sensitive dialogue, they have to provide options for local users while simultaneously keeping users from destroying the biosphere reserve (Stoll-Kleemann 2005b).

In biosphere reserves problems at the operational levels are closely linked with broader governance issues (Stoll-Kleemann 2005a). This means that biosphere reserves differ substantially in their dependence on the political setting. Biosphere reserve management is subject to conflicts caused by political interests, and frequently, managers have to

adapt to a highly politicized environment. Therefore, one critical aspect shaping successful biosphere reserve governance is the degree of political support in national and international policy. One example of an unfavorable political condition drawn from the data is a contradictory pattern of responsibilities among governmental administrative authorities. A second unfavorable condition relates to the lack of political support at the local as well as national levels of government. A third aspect of insufficient political support is the resultant lack of funding for managing biosphere reserves. In general, lack of resources strongly inhibits biosphere reserve activities. Public political support for a project without sufficient allocation of funds will never compensate for poor infrastructure, unpaid staff and missing outreach arrangements. High financial insecurity makes planning obsolete and often causes serious conflicts.

The more room there is for the biosphere reserve manager to maneuver politically, the better the possibility to implement rules and longer-term activities adapted to the site-specific circumstances (Stoll-Kleemann et al 2006). Important aspects are the degree of leadership, the financial situation, supporting actors, effective networking, conflicting interests, the national conservation discourse, the constellation of actors, and the general political situation. Though conservation concerns can claim to be of fundamental importance, in daily management they have to compete with several other highly politicized concerns.

12.1.4 Establishment of the Proposed Biosphere Reserve

When established, the Wurayah Biosphere Reserve will be the unique natural sustainable area in the mountains of UAE, and an example not only for other emirates but also for the GCC Countries integrating tourism, local use and conservation of unique natural resources and it will meet international standards established by WWF as well as by the IUCN and the UNESCO.

Table 12.9 shows a comparison between the proposed Wurayah Reserve and another GCC Biosphere reserve recently declared in Qatar and named by Al-Reem Biosphere

Reserve. The comparison shows that Al-Reem is sharing Al-Wurayah as the home for endangered species such as native Gazelles and Oryx. Both Reserves offers unparalleled research opportunities for sustainable development and use of arid lands and potential investigations include the use of saline water for irrigation, zonation for sustainable grazing, culturally sensitive tourism among others and providing opportunities for the sustenance and revival of local livelihoods.

Another initiative concerning the application of the biosphere reserve concept in the UAE has been started in Abu Dhabi Emirate since 2008 by EAD, but with specially emphasis the marine habitat. The Marawah Marine Biosphere Reserve off the coast of Abu Dhabi with a territory of more than 4,000 sq km, could represent the largest reserve in the UAE when established. Its coral reefs, seagrass beds and mangroves are home to more than 70 species of reef fish, as well as dolphins and turtles. In addition it is home to 60 per cent of the UAE's dugongs, large marine mammals. The area also has important archaeological sites dating to the Stone and Bronze Ages. It was established as a protected area in 2001 and gained UNESCO recognition in 2007.

12.2 The Theoretical Suggestion to Enlarge the Boundaries of the Zones

By analyzing the vegetation distribution and the zones of the water quality of the proposed WRB the boundaries of the core, buffer and transition zones could be enlarged:

- To preserve rare and sensitive components of the nature in their natural condition;
- To reduce the negative impact of the local communities on the protected area;
- To give alternative areas to the local people to provide their own needs.

The suggested areas for core, buffer and transition zones are shown in table 12.10. The theoretical suggestion for enlarging the boundaries of the zones is based on the analysis of the vegetation distribution and the water quality zones due to the lack of socio-economic information of about these areas. The theoretical suggestion of the enlargement of the zones is shown in figure 12.7.

Table 12.9 shows a comparison between the proposed Wurayah Reserve and another GCC Biosphere reserve recently declared in Qatar and named by Al-Reem Biosphere Reserve.

	AL-REEM	**AL-WURAYAH**
Brief description	At present the Reserve is home to a breeding center for native Gazelles and Oryx, and has pioneered reintroduction programs in the Country. The Reserve offers unparalleled research opportunities for sustainable development and use of arid lands. Potential investigations include the use of saline water for irrigation of halophytes as animals' fodder, zonation for sustainable grazing, camel farming and culturally sensitive tourism, among others.	It lies within a priority World Wide Fund for Nature (WWF) Global 200 Ecoregion (Ecoregion 127, Arabian Highland Woodlands and Shrublands), sheltering a rich diversity of rare and endangered mountainous and freshwater habitats and species, and providing opportunities for the sustenance and revival of local livelihoods.
Major ecosystem type	Arid-Climate Desert	Mountain-Dryland
Major habitats & land cover types	Desert Gravel Plains, Sand Sheet / Sabkha, Mesa / Foothill	Mountains, Coastal Plain, Draining basins
Location	25°45'N, 51°00'E	25° 05' and 25° 40' N , 56° 00' and 56° 20' E
Area (hectares)	118,888	59,000
Core area(s)	23,271	11,300
Buffer zone(s)	95,617	19,100
Transition area(s) when given	Terrestrial: 46,555 Ha, Marine: 36,931	28,600
Altitude (m)	0-60m	0-956m
Year designated	2007	2010/2011
Administrative authorities	Supreme Council for the Environment and Natural Reserves	Fujairah Municipality

	AL-REEM	AL-WURAYAH
Abiotic	Abiotic factors, air quality, air temperature, climate, drought, erosion, geology, geomorphology, groundwater, habitat, hydrology, meteorology, monitoring/methodologies, pollution, soil, topography.	Water Quality, air temperature, evaporation, precipitation, geology, geomorphology, groundwater, habitat, hydrology, meteorology, monitoring/methodologies, pollution, topography.
Biodiversity	Alien/Invasive/Exotic/Introduced species, arid/semi-arid, biodiversity, biogeography, biology, birds, breeding/reproduction, coastal/marine, community studies/communities, conservation, desertification, ecology, ecosystem functioning/ecosystem structure, fauna, flora, home gardens, invertebrates/insects/spiders, lichens, mammals, mangrove, natural resources, plants, population genetics/population dynamics, productivity, rare/endangered/threatened species, reintroduction, reptiles, restoration/rehabilitation/redevelopment, species inventorying/inventory, taxonomy, vegetation studies/plant cover, wildlife.	Arid/semi-arid, biodiversity, biogeography, biology, birds, conservation, ecology, fauna, flora, invertebrates/insects/spiders, mammals, natural resources, plants, population population dynamics, rare/endangered/threatened species, restoration/rehabilitation/redevelopment, species inventorying/inventory, vegetation studies/plant cover, wildlife.
Socio-economic	Agriculture/Production systems, aquaculture/mariculture, archaeology/paleontology, capacity building, cottage industry/artisanal industry, cultural aspects, economic studies, economically important species, human health, hunting, indigenous people, livelihood measures, livestock and related impacts/overgrazing, local participation, pastoralism/pastoralists, people-nature relations, recreation, resource use, sacred sites, socio-economic aspects, tourism, traditional practices/ethnology/traditional knowledge.	Agriculture, fishers, mining, commerce, archaeology, capacity building, cultural aspects, economic studies, economically important species, hunting, indigenous people, livelihood measures, livestock and related impacts/overgrazing, local participation, people-nature relations/man/nature, recreation, resource use, sacred sites, social/socio-economic aspects, tourism, traditional practices/ethnology/traditional knowledge.
Integrated monitoring	Carrying capacity/Sustainability, ecosystem approach, GIS, infrastructure, institutional and legal aspects, interdisciplinary studies, land tenure, land use/land cover, landscape inventorying/monitoring, management issues, zonation, rural systems, sustainable development use, transboundary/transfrontiers.	Ecosystem approach, GIS, infrastructure, , urbanization, institutional and legal aspects, interdisciplinary studies, land use/land cover, management issues, eco-tourism, planning and zoning measures/zonation, water resources management, sustainable development.

Table 12.10 The suggested areas for core, buffer and transition zones

Zones	The type of stand / settlement	The main reason for protection
Core Zone		• To ensure maximum conservation of the rare and sensitive stands
Buffer Zone	The natural areas of the sensitive stands	• To reduce the impact of men on the protected area. • To protect the core zone. • To protect the Zikt Dam from all type of pollution. • To reduce the impact of overgrazing in small villages. • To conserve the threatened species in Zikt protected area.
Transition Zone	Settlements and their agricultural lands	• To provide alternative areas for local people

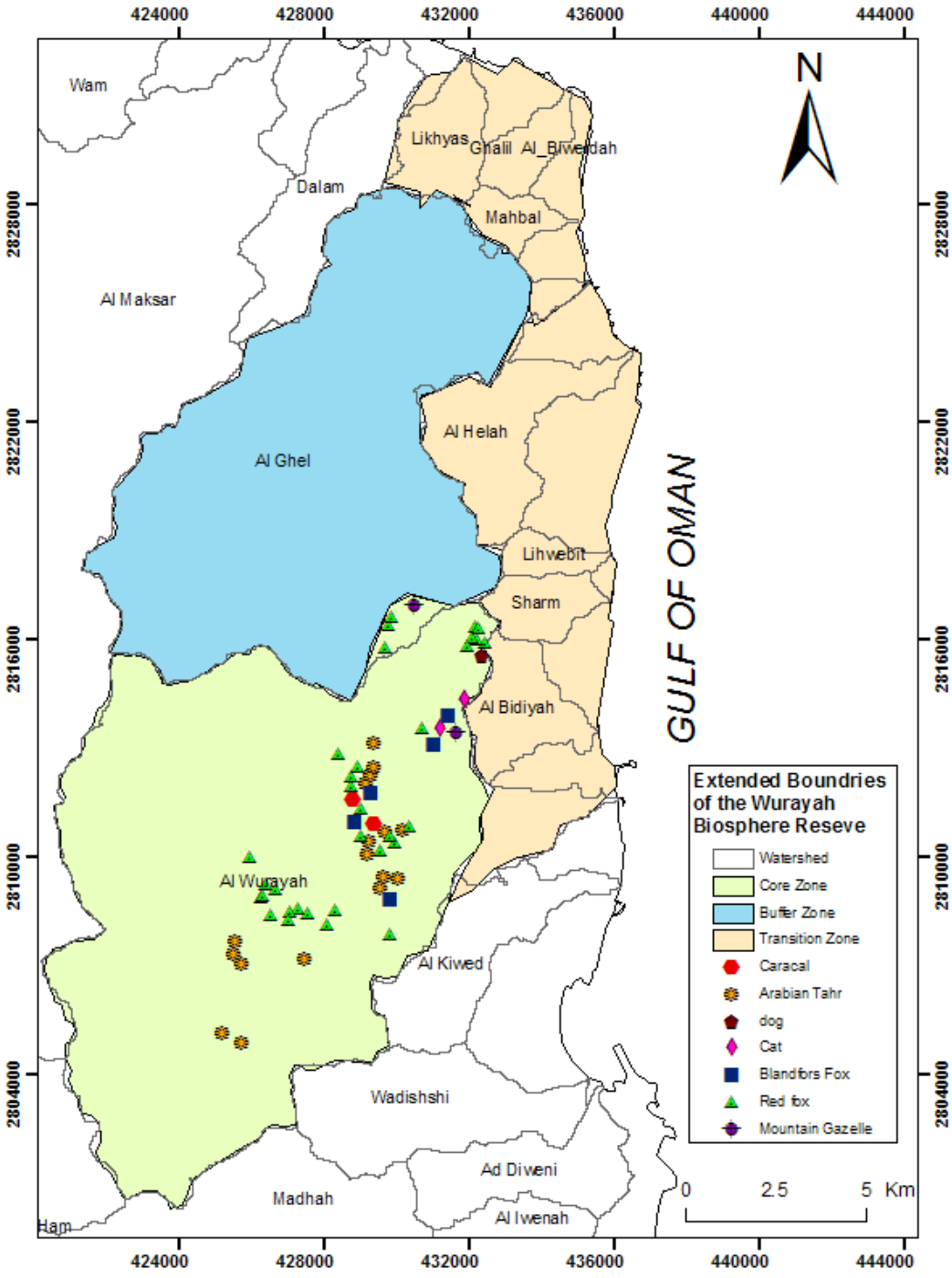

Figure 12.7 The theoretical suggestion to enlarge the boundaries of the core, buffer and transition zones (ALHOGARATY).