

CONCLUSIONS AND RECOMMENDATIONS

13.1 Conclusions

Known as Wadi Wurayah, located between the towns of Masafi, Khor Fakkan and Bidiyah, it is home to more than 100 species of mammals, birds, reptiles and amphibians as well as more than 300 species of plants. It is one of few remaining places in the world where the endangered Arabian Tahr still roams free. Conservationists believe it to be among the last places in the UAE where the Arabian Leopard, which has not been seen in the UAE since 1995, still survives. The same is true for the caracal lynx, a small, shy predator, which like the leopard is persecuted by farmers who believe it targets chickens and goats. The wadi is also home to a type of freshwater fish, the *Garra barreimiae*, which lives only in the Hajar Mountains. Among the more than 300 species of plants is a species of wild orchid unique to the UAE, *Epipactis veratrifolia*. Famous for its scenic waterfall set amid the Hajar Mountains, Wadi Wurayah is recommended as a must-see in UAE off-road and tourist guides. It is a spectacular location with streams and pools dotted around the rocky outcrops.

The following conclusions were obtained by researching the study regarding reorganization of the Wadi Wurayah and its hinterlands as a biosphere reserve:

1. The different land use and their problems were analyzed. From this point the role and the effectiveness of biosphere reserves in solving the problems of the protected area was investigated and the necessity of changing status of a protected area contradicting with its aims as a biosphere reserve was analyzed.
2. The provisions of reorganization of the Wadi Wurayah and its hinterlands as a biosphere reserve were studied. The complex assessment of natural potential of the territory was carried out and was determined that the WBR contains unequal, representative and sensitive areas of the dry lands ecosystem and it conforms to the

- principles of biosphere reserve. The main threats within and around the territory were also analyzed.
3. The maps of natural, outstanding landscapes and cultural heritage showing rare and sensitive components and features were prepared while the socio-economic situation of the WRB indicates that it has enough socio-economic infrastructures to develop new economic alternatives ecologically and economically sustainable.
 4. The zonation of the WBR was prepared in accordance with the main principles of zonation in biosphere reserves and with the assessment of the natural potential such as groundwater resources and socio-economic situation of the area. Three zones (core, buffer and transition) were established. Since its water resources depend on the runoff from the entire Wadis catchment areas and based on the field surveys, the Wadi Wurayah Biosphere Reserve is proposed to match with most of the limits of the catchment area and the boundary between Dibba in the north and Fujairah and Sharjah Emirates in the south.
 5. Although the Quaternary gravel aquifer within the study area is unconfined and has high groundwater potentiality, the groundwater exploitation from the aquifer for irrigation and domestic purposes from the villages between Dibba and Fujairah has lead to water level decline and salt-water intrusion problems where groundwater in the study area is stored into two aquifers: an upper Quaternary gravel aquifer and a lower fractured ophiolite aquifer that receive recharge from rain and tap a local groundwater flow system, characterized by low salinity and short residence time.
 6. The hydro-geochemistry of the groundwater resources shows that groundwater in the gravel aquifer varies from fresh near the water divide line in the west to brackish in the east and northeast to saline near the Gulf of Oman coast while the thickness of the fresh water zone in the aquifer varies between 1 m near the Gulf of Oman coast and 20 m at about 3 km inland and the calculated groundwater dissolved salts in the aquifer are consistent with the prevailing geological and hydrogeological conditions and evolve in the direction of groundwater flow but local high anomalies in Na^+

- concentration coincide with areas of high groundwater pumping. On the other hand, stable isotopes deuterium (^2H) and oxygen-18 (^{18}O) of Wadi Al-Warrayah Basin indicate that between 22 and 43% of water in Al-Warrayah Dam Reservoir contribute to groundwater recharge. The radio-isotope tritium (^3H) shows that the groundwater within the gravel aquifer in the area is young (< 50-years old).
7. The core zone is assumed to be the protected area with an area of 113 km^2 and the transition zones (approximately 286 km^2) represented by most of the down-stream part of the wadis catchment areas from the protected area due to its degradation, its intense use and its proximity to urbanized and farmed lands. While an area of 191 km^2 represents the buffer zone is located between both zones where the human activities are less in size and impact with a significant habitat distribution, since the wildlife of conservation interest like Tahr and Gazelle move according to the season to the upstream part of Wadi Zikt catchment and to Wadi Maqsad, in the north and north-eastern parts of Wadi Wurayah catchment area.
 8. The delimitation of the Proposed Biosphere Reserve must be done in accordance with local authorities and populations to avoid conflict of interests. Wadi Wurayah waterfalls being a tourist spot much appreciated by locals, it seems unthinkable to prevent access of waterfalls from the public. Therefore the proposed creation of a buffer zone took place along the tarmac road leading to the terminal parking above the waterfall and track through the wadi bed leading to the tourist spots.
 9. The theoretical suggestion of enlargement of the zones was prepared targeting: reduction of negative impacts of local people on the park area; conservation rare and sensitive stands around the park; establishment of new areas to local people to carry out new economic alternatives ecologically and economically sustainable.
 10. WBR will require much more sophisticated management treatment according to the varying practicalities of delivering ecosystem integrity and it needs much more research conducted by interdisciplinary teams and on the basis of the ongoing participation of all relevant stakeholder such as landowners and land users, decision

makers, representatives of NGOs etc. A further research need more (meta) data on the level of protected areas and biosphere reserves which is open to all researchers who want to work with it in order to be able to measure the success of conservation measures.

11. The Fujairah Emirate has to have a master plan to control the land use and the land degradation in the form of a land management plan. Three recommend human activities could take place in the area, the ecotourism industry, the investment in renewable energy and the green building which led to green cities. The direction of the urbanization from north to south should follow the shape of the coastline away from the buffer zone taking in consideration the water quality zones, so it is recommended that the line of industrial or commercial development takes the direction toward the northeast of the transition zone. 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. This plan will also help to move human activities located in areas of high flash floods event to another alternative areas away from this natural hazard.

13.2 Recommendations

Based on the current study, the followings are a set of recommendations for future long-term phase management and protection of the proposed biosphere reserve:

13.2.1 Protection of The Site

1. Delimiting the boundaries of the Proposed Biosphere Reserve in collaboration with local authorities and communities.
2. Establishment of Biosphere Management Committee to lead, supervise and monitor all the existing and future planning activities in the proposed biosphere reserve. This management committee has to be linked to the ArabMAB Network.

3. Reinforcing the legal protection of natural resources to prevent poaching, fire, tagging and litter deposits with implementation of trained wardens or rangers in the area.
4. Include Wadi Wurayah in local public awareness campaigns by:
 - a. Organize cleaning operations involving local communities (schools, corporations, etc.)
 - b. Display information boards positioned at the main waterfall site to highlight the importance of the wadi as both an ecological and recreational resource
 - c. Produce an Arabic pocket-size ranger technical guide booklet with information on the wildlife and identification keys, observation forms, and data entry forms to assist the rangers.
5. Limit or mitigate the urbanized development within the area. In the future, visitors centre could provide people with an opportunity to learn about the history, geography and ecology of Wadi Wurayah and could include displays of photographs, maps and audio-visual material.

13.2.2 Surveys and Monitoring

13.2.2.1 Surface and Groundwater Resources

Since the availability of surface water is the key to sustaining the rich biodiversity of the area, the following recommendations are suggested for implementation in the next stage of investigation:

1. Development of a regular surface water monitoring program with the complete mapping of all springs in all wadis within the catchment, the quantification of surface water in terms of flows and water quality through a spring and waterfall flow monitoring program, and additional full chemical analysis of spring and other surface water sources.
2. Development of a regular groundwater monitoring program (water levels and water quality) with mapping of all existing boreholes and a baseline sampling program for groundwater and full chemical analysis (access to Ministry of Environment and

- Water monitoring wells will be required) in addition to use innovative solution for water resources management, such as biosaline crops and artificial recharge for groundwater aquifers.
3. Climate monitoring with an investigation into the relationship of the Northern Emirates Rainfall and the EL Nino/La Nina phenomena.
 - a. An investigation of water resources use:
 - b. Groundwater development in the areas of agriculture and towards the coast at the bottom end of the catchments.
 - c. Water supply diversion structure upstream of the main waterfall with a view to studying the potential for a spring water bottling activity
 4. Development of a water resources database for all water related information with the Fujairah Municipality.
 5. Development of a catchment water balance in core, buffer and transition zones.

13.2.2.2 Flora and Fauna

1. Vegetation transects surveys, examining ecological aspects of the aquatic habitats and regular surveys of fauna (insects, reptiles, mammals and birds) all year round
2. Establishing a wildlife database for inclusion in GIS

13.2.2.3 Socio-Cultural Heritage

1. Socio-cultural survey of the use of the area by tourists (interview of users, counting number of vehicles and visitors)
2. Establish contact with resident archaeological experts for collaboration or archaeological investigations with proper excavations and mapping of discovered settlements.