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Ecosystems as Commodity Frontiers—Challenges Faced by Land Set Aside as Protected Areas (PAs) in the Dubai Emirate, United Arab Emirates (UAE)

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Introduction

Land development in the UAE rapidly expanded with the arrival of oil wealth in the late 1950s in the Emirate of Abu Dhabi.[1] The rise of the oil economy brought with it the increasing commodification of land. The first manifestation of this was with the introduction of modern agriculture in the mid-twentieth century. British colonial authorities working closely with coastal rulers took a keen interest in developing land and water resources during this period, partly in the hopes that this would improve local people's standard of living, support emerging urban centres, and allow for the spread of modern agriculture. The emergence of protected areas (PAs) as commodity frontiers must be looked at in the context of the history of land commercialization in the country.

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In their study of nature tourism and forest conservation in South India, Daniel and Ursula Munster argue that the commodification of nature and landscape is the continuation of an earlier process of capitalist transformation instigated by the spread of modern agriculture. According to this perspective, nature tourism is simply a new opportunity for accumulation.[2] This is all the more relevant in the United Arab Emirates (UAE) given the harsh environmental conditions that work against agricultural expansion and necessitate other 'marketable' uses of land. Ultimately, the rise of capitalist agriculture in the region transformed customary farming practices (which were more communal in nature), spurred land privatization, altered labour arrangements on farms, and impacted the desert ecology itself. With the establishment of the United Arab Emirates in 1971, the new government built on earlier efforts by the British to introduce modern agriculture, including for instance fodder production and cash crop farming. From 1978 to 1980, the government supported various agricultural trials.[3] With the spread of cultivated areas also came the spread of forestry plantations. State discourses have highlighted how such 'greening the desert' initiatives promote economic diversification and combat desertification.[4] In practice, however, such cultivation has depleted groundwater resources and threatened biodiversity.

Customary practices of sharing natural resources among tribes gave way to boundaries, private property, and centralized state control over natural desert lands and water resources.[5] Using Jason Moore's concept of the 'commodity frontier' to understand the development and function of PAs in Dubai allows us to situate the emergence of these areas within the broader context of capitalist expansion in the region.[6] Furthermore, while environmental degradation has certainly been a consequence of capitalist expansion, the latter has also given rise to conservation agendas, which in turn have reinforced processes of land commodification that were already in place.

Further diversification into tourism has grown in the past two decades, and currently, Dubai is bracing itself for the arrival of crowds from around the globe as it hosts Expo in 2020. The population of the UAE has grown exponentially in the past few decades (both expatriate and local), as has the country's infrastructure including road networks, residential areas, schools, academic institutions, industrial facilities,

airports, seaports, commercial outlets, and land reclamation creating megastructures such as the offshore island projects. While many of the terrestrial projects have modified existing strata, some terrestrial remodelling has altered the land utterly such as the recently completed Dubai Canal. In deserts, such advancement is seen as the development of apparently barren landscapes. Such development has resulted in ecological degradation, which in turn has instigated a significant shift in recent years towards environmental protection with the creation of PAs. The Emirate of Fujairah declared a mountain wadi (Wadi Wurayah) a PA in 2009. This site is listed as an IUCN category II PA as well as having the recognition of being a Ramsar site of international importance.[7] While the creation of PAs in the UAE should mitigate the impact of development, there are significant challenges to be overcome.

The UAE's land surface is mostly a sand desert.[8] Despite the appearance of sparsely vegetated sandy expanses, sand dunes and their related microhabitats, and gravel plains are diverse both in habitat type[9] as well as being home to innumerable amounts of species biodiversity, most of which are very specialized in order to survive the extreme heat of the summer, and the relative coolness of the winter months. Lying within the approximate geographical range of latitude 22–26° N and longitude 51–56° E, and being situated in the Northern Hemisphere, the deserts of the UAE experience seasons although transitional seasonal changes are subtle, whereas the extremes are noticeable such as intense heat during April to October with relatively cold winter months. During 2017, the hottest day in Dubai was recorded to be July 19th reaching 47 °C, and the coldest temperatures during the winter season were registered as 18 °C on February 3rd diurnally, and a night-time temperature of 11 °C on February 4th according to Weather Underground data collected at Dubai Airport.

Life in the Desert—An Example

Organisms living in such environments have specific adaptations to survive; many reptiles and small mammals are nocturnal, spending most of their time awake during the night, and many trees, shrubs, and other annual/perennial plants have either no leaves, reduced leaves, or

leaves that are grey or sport other mechanisms of reflection of harmful UV rays. Other organisms (e.g. insects) have life cycles whereby they occur as adults during the colder months, remaining either as juvenile or pupal stages in the ground during the hotter months. Despite the challenges faced by desert fauna and flora, they exist in high numbers. Rather than describe all taxa that occur, we illustrate species richness using a proxy taxon, namely arthropods, and of those mainly insects, and how recent studies have added to the overall knowledge of this taxon in the UAE. Insects are an integral part of ecosystems contributing vast amounts of ecosystem services. Ecosystem services are intricately linked processes that are exceedingly difficult to quantify and evaluate due to their complexity.[10] A tangible and frequently discussed ecosystem service is the contribution of social bees as pollinators. However, there are many other bees and other insects such as flies, butterflies, beetles, and ants to name a few that are active and essential pollinators.[11]

Until 2005, the information on insects in the UAE was scattered in the literature, and the first publication to bring together insect records was a checklist of published records.[12] Subsequently, in 2008, a further publication drew on records from the literature, data held by the entomology section of the Environment Agency—Abu Dhabi (EAD), and data held by the authors in their private collections.[13] At this stage, a total of 1528 insects had been recorded from the UAE.[14] While there are further scattered records in the literature that have been added to the total number of species since then, with some being significant in their contributions, a systematic approach to create an insect/arthropod inventory culminated in the publication of six volumes of arthropod fauna from 2008 to 2016, the data of which are summarized in Table 5.1.[15] These publications have added an additional 2507 species to the total count, of which 434 were records 'new to science'. The records that are classified as 'new to science' are species that have thus far been recorded from the UAE only, and therefore their status is currently 'endemic'. This means that almost 11% of the known arthropod fauna of the UAE is endemic and, to date, no further studies exist to understand the individual habitat requirements and contributions of each of the recently added endemic species, and it is unknown

Table 5.1 Consolidated data published in 6 volumes of arthropod fauna of the UAE between 2008 and 2016

Publication	Arthropods new to the UAE	Arthropods new to science
van Harten, Volume 1	570	87
van Harten, Volume 2	390	85
van Harten, Volume 3	400	71
van Harten, Volume 4	469	90
van Harten, Volume 5	341	45
van Harten, Volume 6	337	56
Total	**2507**	**434**

what the impact would be on the ecosystems they are a part of if these organisms became extinct.

As is the case in habitats around the world, the likelihood is that endemic species are significant contributors in the complex food chains and food webs and the loss of any of these species would signify a negative change in the respective ecosystems. In many areas of the Dubai Emirate, development has brought about habitat reduction, fragmentation, modification, and destruction, reducing species biodiversity significantly to the point that habitats are becoming 'impoverished'. Impoverished and fragmented ecosystems no longer fulfil their ecological roles resulting in diminished ecosystem services.[16]

The Birth of PAs in the Dubai Emirate

In recent years, the UAE has ratified a number of international conventions (e.g. Ramsar; Convention on Biological Diversity [CBD]). The UAE has been involved in documenting the state of the environment (e.g. State of the Environment Report, The Executive Council, Dubai; Biodiversity Strategy [federal Ministry of Climate Change and Environment, formerly the Ministry of Environment and Water]) and has made a number of protection provisions in federal laws (e.g. Federal Law No. [24] of 1999 for the Protection and Development of the Environment). In addition, the Dubai Emirate, and specifically the government of Dubai, declared six PAs as 'natural reserves' in 2014 (Decree No. [22] of 2014 which details the establishment of reserves

based on the provisions of Law No. [11] of 2003 on Nature Reserves within the Dubai Emirate).[17] As it is the government that takes the lead in the development of Dubai,[18] it is not surprising that this includes decision-making surrounding PAs. After the initial six regions being protected, two more reserves were added, bringing the total to eight PAs with specific names for each (see Table 5.2).

Given that the area of the Dubai Emirate is 4114 km^2, with the entire UAE area occupying approximately 83,600 km^2, it means that the Dubai Emirate has set aside 31% of its surface area as PAs. The intention of setting aside land for protection is articulated in the objectives (Article 4) of Law No. (11) of 2003 on Nature Reserves within the Emirate of Dubai (https://www.ddcr.org/en/board-sponsors.aspx?Menu=1):

- Protecting the natural environment, preserving their original states, and ensuring the maintenance of their aesthetics in any development thereof.
- Preserving the natural resources and the biodiversity of life within the PAs, including the preservation of vegetation, animals and migrant and resident birdlife.
- Protection of the geology and geographic features of the reserves.
- Actively manage the reserves in a manner which assists in the propagation of rare and endangered species, and their reintroduction.

Table 5.2 List of protected areas in the Dubai Emirate

Protected area	Size (km^2)	% of Emirate of Dubai
Al Marmoum Conservation Reserve	990	24
Al Wohoosh Desert Conservation Reserve	15.1	0.4
Dubai Desert Conservation Reserve	225	5.4
Ghaf Nazwa Conservation Reserve	0.1	0.002
Hatta Mountain Conservation Area	27.4	0.67
Jebel Ali Marine Sanctuary[a]	21.9	0.53
Jebel Nazwa Conservation Reserve	1.1	0.03
Ras Al Khor Wildlife Sanctuary	6.2	0.15
Total	**1286.8**	**31.18**

[a]It should be noted that JAMS mostly comprises a marine protected area offshore, with a reduced surface area being protected on land

- The monitoring of wildlife and naturally occurring species, their numbers, areas of breeding, the growth of populations, and the natural habitats in which they occur.
- The protecting of locations that are considered the natural range and environment of the species, whether animal or plant and specifically protecting areas critical to the breeding, growth or development of the populations.
- Contributing to the development of ecologically based tourism in the emirate.

Pressures on the PAs

Deserts in the UAE are utilized or exploited in many ways, which include farming (livestock and agriculture), residential, and commercial development that translates into urban sprawl (e.g. Dubailand, Academic City Dubai, Academic City Abu Dhabi, etc.). Also, commercial safari tour operators that are either based in camps set up in patches of desert, with activities that radiate out into the dunes such as camel riding, and 'dune bashing', or visiting tour operators, offering desert drive experiences also impact the desert greatly. While some of the camps usually operate during the cooler months, skeleton staff and the infrastructure remain throughout the year, and other camps remain fully operational, though with fewer tourists visiting them. During peak times, camps receive hundreds of guests per day. These types of activities occur within the PAs. One of the PAs (Dubai Desert Conservation Reserve or DDCR) which has a total of four tour operators using base camps within the reserve and one visiting tour operator offering desert nature drives receives 250,000–300,000 tourists per year. Another PA (Al Wohoosh Desert Conservation Reserve) includes several camps in the Northern part of the reserve, with the authors recording five during their October 2017 field survey. Patches of PA deserts have also been used to grow artificially irrigated plantations of mainly native and regional trees, but also including exotic species (i.e. species that do not naturally occur in the UAE). Unlike naturally occurring groves, e.g. ghaf (*Prosopis cineraria*), plantations of any sort in the UAE require

regular irrigation as root systems of trees artificially planted usually can't tap into the groundwater. The addition of water to the sandy ecosystem changes the nature of desert ecosystems. Recreational uses of the PA deserts include gatherings for BBQs, off-road driving, cycling tracks, horse endurance tracks, camping, and peripheral impacts due to traditional falconry (e.g. off-road driving on gravel plains and dunes). All the activities above impact the natural ecosystem of the desert in many ways, all of which can be classified into habitat fragmentation and destruction. As was first discussed in 1967 by MacArthur and Wilson in their article on island biogeography, habitats can be compared to habitat 'islands', and as such, habitats that are smaller and more isolated support fewer species, and several large-scale studies have provided empirical evidence to support this theory.[19]

The eight PAs are not immune to development that continues to grow and impact the reserves. To understand the pressures currently associated with the PAs, some of the eight PAs are examined more closely. Data are presented for three of the four sandy desert and dune habitat PAs (Al Wohoosh Conservation Area; Al Marmoum Conservation Reserve; DDCR) as these share similarities.

As each infrastructure on the reserves represents fragmentation of or a threat to the habitat in question, infrastructure recorded is therefore referred to as 'fragmentation type' in Table 5.3. Threats are also added to Table 5.3 insofar as they impact on biodiversity on the reserves.

It should be noted that the list provided is not exhaustive and that further fragmentation types and threats are likely to be present on both reserves, but not recorded by the authors to date.

Perhaps the most destructive activity impacting the sandy desert PAs is related to camels. In its 2017 Abu Dhabi State of the Environment Report, EAD state that '*Over-grazing has been a significant threat to natural desert vegetation over the past few decades, leading to the degradation of some of these areas. Grazing by camels and other livestock is a major issue and limits regeneration in overgrazed areas*'.[20] Camel farms are found throughout the UAE in every Emirate. An example of a camel farm can be seen in Fig. 5.1.

Although total numbers of camels are not available for the whole of the UAE, data presented for the Abu Dhabi Emirate by EAD in 2017

Table 5.3 Fragmentation types and threats recorded at Al Marmoum Conservation Reserve and Al Wohoosh Desert Conservation Reserve

Fragmentation type/threat	Description
Groundwater abstraction (wells and manhole covers)	Wells usually comprise two structures, a pump and a metre. Manhole covers take up the same amount of space as wells as a concrete infrastructure has to be built in the sand
Groundwater abstraction (pump house)	Larger buildings, occasionally with a fence
Plantations	Include irrigated local and exotic plant species
Fencing	Fences are either for farms (e.g. camel farms, temporary or permanent fencing), protected area boundaries, or to fence off private and military land
Roads and tracks	Some of the tracks are compacted sand tracks, others are asphalted roads and/or bicycle tracks
Developed areas	Include military areas, solar parks, hotels, shops, desert safari camps, stables, and recreational areas
Habitat re-modelling	E.g. man-made lakes, plantation of oasis, crop plantations in irrigated fenced areas
Off-road driving	Off-road driving on both reserves includes large 4 × 4 vehicles, as well as lighter four-wheel dune buggies or motorbikes
Over-grazing	Grazers such as camels, and to a lesser extent two species of gazelle. Oryx is considered to contribute minimally to grazing pressure
Littering (small scale and large scale)	Large-scale littering includes disused structures such as wells, farms, fences, shacks, houses, whereas small-scale littering includes domestic waste left by campers/visitors to the reserves or safari parks, as well as domestic waste from the work force that tends the farms and safari parks

estimated that there were a total of 25,200 camel farms, with a total of 408,470 camels.[21] Camel farms can be divided into four types as follows:

- Grazing camel farms
- Racing camel farms

Fig. 5.1 A typical camel farm at the Al Wohoosh Conservation Reserve. The pen holds a large amount of camels, with a fencing structure that interrupts the natural habitat also. It should be noted that pens are often located along gravel plains in sandy habitats making access to the farms easier, causing negative impacts on the ecology of gravel plains

- Breeding farms (including camels, goats, sheep)
- Camel milk farms

Narratives collected from a local Emirati camel owner indicate that camels in racing, breeding, and milk farms are generally not released from the farms for grazing, whereas camels kept as grazing herds rely on both, feeding with subsidized imported, and sometimes locally grown fodder, as well as grazing of natural vegetation in the vicinity of the camel farms, in whatever habitat the farm may be (e.g. while camel farms are mainly found on flat surfaced habitats (sand and/or gravel plains), camel farms are also found at the foothills of mountains; camels will roam in rocky terrain, even though they are usually a sandy desert dweller). The impact of grazing camels cannot be underestimated, especially given the large number of camels in the UAE. To an untrained eye, sandy deserts can often have an outward appearance of being sparsely vegetated, and frequently the descriptions of arid and hyper-arid sandy deserts that occur in the UAE portray the landscape as 'barren'. There can be arid years where rainfall has been sparse, and annuals[22] usually seen in March and April following sufficient winter rains remain absent. However, the sands of the UAE are in fact a seed bank that house both annual and perennial seeds that can remain dormant for many years and then germinate under the right conditions. Camel grazing mainly affects small perennials,

e.g. perennial grasses,[23] though camels feed on annuals as well as larger perennials. Perennial seeds that germinate will not grow into larger plants unless their roots reach a permanently wet layer before the beginning of the dry season.[24] In addition, many of the perennial plants that may appear to be desiccated often have live roots that will resurrect during good rainy seasons. This in part is due to many perennial shrubs having extensive root systems below the surface. In a description of the shrub *Leptadenia pyrotechnica*, a shrub commonly found in many of the PAs, its roots were found to extend to approximately 12 m below the surface, with a radius of 10 m.[25] To find out whether grazing impacted the recovery of the flora, one of the studies conducted within the DDCR involved excluding grazers by building fences of 250 × 250 m in two different habitats within the reserve during September 2011 (www.ddcr.org). The two habitats included a sand dune enclosure as well as a sandy gravel plain. While the study is still ongoing, recovery of vegetation has already been observed when compared to outside of the fence. The improvement can be seen in Fig. 5.2 of the sand dune enclosure.

Given the above, many stakeholders gain to benefit from their operations in the PAs discussed, and as such, the pressure on biodiversity in the reserves is high. Al Marmoum Conservation Reserve comprises a non-fenced reserve, and as such, fragmentation types/threats listed above occur throughout the Al Marmoum designated area. Al Wohoosh Desert Conservation Area is fenced; however, there is no access control, and apart from the southern part of the reserve which includes large dunes and is, therefore, less accessible, the remainder of the reserve is severely degraded, and thus impoverished, due to the fragmentation types/threats mentioned in Table 5.3. The authors make a note of the massive water abstraction infrastructure observed at Al Wohoosh Desert Conservation Area. Within the 15.1 km^2 area, more than 70 double structures and pump houses were recorded, many of which appear to be no longer in use (Fig. 5.3).

It is suspected that initially further development for livestock farming and possibly commercial and residential development was planned and that this might account for the high number of wells/utility hole covers/metres/pump houses that exist on the reserve.

Fig. 5.2 The sand dune enclosure at the DDCR shows the difference in vegetation cover between the outer unfenced area in comparison with the fenced area. Excluding grazers, including ungulates and camels, allows the natural seed bank in the ground to germinate under the right conditions with both annuals and perennials then recovering due to not being grazed

One of the main differences between the last two reserves is the encouragement at Al Marmoum Conservation Reserve for the survival of some of the larger desert fauna by supplementary feeding (e.g. spiny-tailed lizards, ungulates). Supplemental feeding becomes necessary when populations of grazers exceed carrying capacity on a reserve. As such, a large number of feeding stations were recorded scattered throughout the reserve totalling 67 (Fig. 5.4, white circles), to enhance or supplement feeding. During fieldwork, a census of the ungulates was carried out, with 615 Arabian Oryx, 1098 Arabian Gazelle, and 650 Sand Gazelle counted.[26] Furthermore, Fig. 5.4 clearly shows how Al Marmoum Conservation Reserve is fragmented by roads, infrastructure, plantations and other impacts discussed above.

Fig. 5.3 Water abstraction includes a number of structures such as the one depicted photographed by the authors on the Al Wohoosh Desert Conservation Area

In essence, the PA desert ecosystems are thought of as 'commodities', much as was stated by Worster in his explanation of land becoming commodified. In his discussion of the beginnings of environmental history, Worster describes how 'historians' have often recounted the use of natural resources without including an ecological perspective. What actually happened, though, was the transformation of natural environments into 'agroecosystems', described by Worster as '*an ecosystem reorganized for agricultural purposes – a domesticated ecosystem*'.[27] This, essentially, is habitat fragmentation, which, together with habitat destruction, reduces the overall biodiversity of ecosystems and as such, ecosystems are not 'functioning' as they should, leading to further degradation and impoverishment of the environment. While experts have suggested possible mitigation measures,[28] many of the measures have not been researched in the UAE context to date. Management planning of the PAs is crucial in ensuring the negative

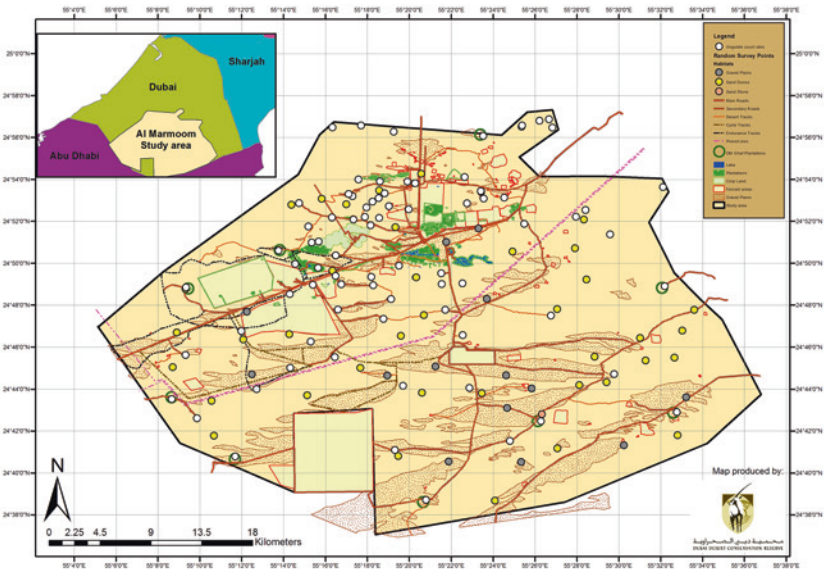

Fig. 5.4 Socio-economic infrastructure of the Al Marmoum Conservation Reserve (*Source* Al Marmoom Desert Conservation Reserve, Preliminary Internal Report, Greg Simkins and Tamer Khafaga, Dubai Desert Conservation Reserve, 30 August 2016, created using ArcMap software)

impact on biodiversity is halted, and one of the eight reserves has made great strides in conservation and highlights of the transformation are discussed below.

The DDCR as an Effective Management Model

As highlighted, impacts on PA desert ecosystems are linked to many anthropogenic activities that directly or indirectly reduce biodiversity. In the late 1990s in the very southern part of the Dubai Emirate, an area of the desert was commodified for the construction of an exclusive resort and spa complex that was opened by Emirates Airlines (Al Maha Desert Resort and Spa) on land allocated to them by Dubai Government. The concept of this hotel was to offer visitors a unique

wildlife and desert experience in natural surroundings. The southern part of Dubai was primarily home to camel farms and activities impacting the desert in much the same way as has been described above. To build the resort, an area comprising 27 km^2 was fenced, excluding grazing camels. From the time of opening of the resort, 5% of the profits have been invested in conservation projects. Following an environmental audit carried out by resort managers of the surrounding area adjacent to the resort in 2001, current and potential threats to the desert ecosystem were highlighted. This led to a proposal of a more comprehensive conservation area to be created around the resort and was presented by the owner of Emirates Airlines to the Ruler of Dubai. The Ruler of Dubai approved the proposal and allocated a total of 225 km^2, which includes the land occupied by the resort. The initial steps of creating the DDCR included the establishment of a governing board originally comprising of the head of Emirates Airlines and other influential leaders of governmental organizations (e.g. utility organizations). The board outlined the goals and values that continue to be the main remit of the reserve, which are listed below:

- To create a permanent PA which ensures the future of the region's desert habitats and biodiversity managed according to sound scientific ecological principles, aimed at protecting natural resources (water being the most obvious one, but extending to many others as well), and maintaining original desert landscapes.
- To ensure that the community and visitors have access to the Reserve through the sustainable and responsible development of commercial practices that would not impact on the primary role of conservation and habitat protection.
- To protect the heritage of traditional activities which have become a part of the region's history and culture and maintain the identity of Dubai's tribal beginnings.
- To register and gain international recognition for the Reserve under the United Nations' PAs Management principles, amongst others and to ensure that the DDCR is adequately protected under law.[29]

In 2003, a fence surrounding the whole reserve was built, along with a perimeter track inside of the fence comprising 92 km. This excluded activities and people entering, however, at that time nine tourist camps belonging to four tour operators remained operational inside of the reserve, as well as ten camel (grazing) farms, the latter significantly impacting the aims and goals of the newly established reserve. Over a period of five years, the camel farms were relocated to areas outside of the reserve. The tour operators remained within the reserve and to date have to adhere to strict conduct regulations implemented by a newly appointed reserve management team that first became operational in 2003. Tour operators contribute towards conservation projects by paying a per capita nominal fee for each visitor they bring to the DDCR.

The day-to-day activities (both conservation and administration) on the reserve are managed by senior conservation managers who have established the reserve's rules such as no off-road driving except on designated paths, with fines imposed for violators. Ongoing research and monitoring are providing evidence that the management practices at the DDCR have helped restore the desert ecosystem over the past 15 years of intense management.

Following extensive clean-up operations ridding the reserve of old farm buildings, construction, and other anthropogenic debris, the management approach of the senior conservation team involve the following:

- On-site presence. The DDCR has three security-controlled gates that record and control access to the reserve and the resort. The DDCR office is located on the reserve, with a 24-hour presence of staff to deal with emergencies after working hours. The senior conservation officers actively patrol the reserve during working hours, which are flexible with an on-site presence for 9 hours minimum per conservation officer daily. Occasionally, evening and night surveys mean the team is on the reserve after hours. In addition to the senior conservation officers, the team comprises of reserve artisans (technical and mechanical support), animal helpers, and casual workers.

- Succession without interference. The reserve actively conserves endangered large mammals. However, the ecosystems included within the area are left to recover at their own rate.
- Supplemental feeding to preserve natural vegetation. Over-grazing by the large mammals is not observed in the reserve due to the maintenance of feeding points that are frequently relocated to enhance natural roaming behaviour of the ungulates. Also, feeding occurs once a day in the morning and feed is not replenished which further encourages natural roaming behaviour.
- The integrity of the reserve through holistic practices. Fragmentation, as mentioned above, causes many negative impacts on the habitats and the biodiversity it supports. Ecosystems are interconnected with food chains and food webs that are complex. The reserve has a modest 'track' infrastructure of underlying gravel tracks covered by sand that have been placed strategically to connect tour operator activities, with narrower tracks traversing sensitive habitats. The sand-covered tracks, therefore, create a continual habitat with the surrounding sand sea.
- Conservation through collaboration. One of the strategic initiatives of the DDCR is to interface with local higher education institutions and researchers, pursuing research activities in collaboration with the senior conservation officers. In addition, volunteers and internship students support the research agenda. Research topics include ecological, botanical, and zoological studies, most of which help inform conservation management practices. Senior conservation officers also interface with national and international organizations to share their accumulated knowledge and experience in conservation.

To date, of the three sandy desert and dune habitat PAs, the DDCR represents the most natural environment which was achieved through the implementation of basic management interventions, including controlled tourism. Success at the DDCR required the fencing of the reserve. One of the social impacts often reported as a result of reducing access to land for conservation purposes is discontent among the local population with frequently the poorest people being impacted.[30] While this angle would be problematic if livelihoods depended on

income from camel farms, farmers who were relocated to areas outside of the DDCR received equal land as they had occupied within the reserve.

Discussion and Conclusion

The main difference between the DDCR and other PAs is that clearly articulated objectives informed the commodification of nature, with the primary goal being conservation. Given that the conservation objectives of the DDCR are dissimilar to the activities discussed that impact the PAs ecosystems, in essence, the conservation model implemented by the DDCR is an example of green capitalism whereby aspects of the natural world are being brought into the economic sphere.[31] The difference at the DDCR in comparison to other PAs is that a balance is maintained between profit gained from the commodity (PA) and implementation of ecologically friendly measures aimed at mitigating degradation of the environment. In a rapidly developing country with a relatively modest surface area in comparison with other countries, land is commodified in several ways, including infrastructure building, urban sprawl, the expansion of industry and other commercial expansions that are in direct competition with conservation agendas. The government has recognized this, and thus the PAs were created. However, the intent to protect is interpreted in a variety of conflicting ways by stakeholders, specifically those that intend to pursue wealth accumulation through projects within the PAs that do not enhance the conservation aspects, but also by a variety of interpretations of the intent of the PAs protective status.

In an article published in the local newspaper *The National* in early 2018, the launch of the '*Marmoom Desert Conservation Reserve*' is announced, along with the types of activities that are planned for the reserve.[32] These include some of the activities one might associate with a nature reserve (e.g. bird observation platforms), but it also mentions other initiatives (e.g. cultural; sports and sport events; lakes; plant nursery),[33] many of which will bring their own impacts on the reserve alone for the infrastructure they will require. The law that establishes the nature reserves in Dubai states the following, '*Protecting the natural environment, preserving their original states, and ensuring the maintenance of their aesthetics in any development thereof*'[34] where protection of

the natural environment is placed alongside the development of the PA. The use of the word 'development' in the context of the maintenance of the aesthetics of the natural environment in any development thereof could be argued to assume development will take place in the PAs. This could be an indication of PAs being seen as reserved land for development. It should be noted that on closer inspection of the English translation of Law No. (11) of 2003 on Nature Reserves within the Emirate of Dubai, there appears to be a discrepancy between the original Arabic text and the English translation thereof, e.g. the word 'propagation' in the English text, does not occur in the Arabic version. With the inclusion of this word in the context of '*actively manage the reserves in a manner which assists the propagation of rare and endangered species, and their reintroduction*', it shifts the aim towards propagation and reintroduction, negating the conservation agendas.

In his article discussing the commodification of nature, Scales[35] alludes to the taming of nature through technologies, and several examples of this are seen in proposed developments for the PAs (e.g. hydroelectric power production in the Hatta Mountain Reserve).[36] Within the PAs discussed, there is a risk that the implementation of projects will adversely affect species biodiversity and therefore ecosystem services they render as well as overall ecosystem health. Moore eloquently dissects the friction of capitalism, nature, and its interface in his essay 'The Capitalocene, Part 1: On the Nature and Origins of Our Ecological Crisis'.[37] Quite frequently, capitalism is placed at the centre of the reasoning behind the current ecological crisis. However, in ancient history, it was not unusual for areas of land to be protected for reasons other than protecting the natural environment altruistically, but for safeguarding common land or resources for instrumental reasons, e.g. hunting for food, in parts of the world.[38] In more recent years, activities such as tourism have played a vital role alongside species protection in PAs globally.[39] However, it is essential that effective management practices are put in place as there have been many examples of PAs not meeting their conservation targets due to inadequate management, resulting in the loss of species biodiversity.[40] The PAs in the Dubai Emirate are not unusual in facing pressures from economic development, the difference being that without a clear articulation of conservation targets, the PAs are in danger of only being seen as new profitability frontiers.

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