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Threat analysis for a network of sites in West Bank (Palestine): An expert-based evaluation supported by grey literature and local knowledge

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A B S T R A C T

This study names, assesses and ranks the indirect and direct threats into a network of eight focal sites of high value ecological value located in West Bank (Palestine). A panel of local experts followed IUCN standards, reviewed local literature and used a Delphi approach to assign scores to each threat in each site assessing: (1) its magnitude (significance analysis) and (2) its level of knowledge (knowledge analysis). Threats with the greatest averaged magnitudes were intensive grazing (code IUCN 2.3), (water and soil) pollution (code 9.1, 9.2, 9.3), collecting wild plants (code 5.2), recreation (code 6.1), fire (code 7.1) and urbanization (code 1.1). The sites with the greatest mean magnitude threat scores were Bani Naim, Wadi Al Quf, Siris and Wadi Qana. The level of knowledge of threats was lowest for reforestation (code IUCN 2.2), active quarries (code 3.2), collecting wild plants (code 5.2) and hunting (code 5.1); research into these threats is necessary to evaluate their magnitude, scopes and intensity. Threat magnitude and knowledge of a threat were directly and significantly correlated (i.e., well-known threats were also observed to have a greater magnitude). We did not observe a significant correlation between mean threat magnitude and site population density. Among threats, intensive grazing is a historical long-term disturbance. Differently, pollution, collecting wild plants, fire and urbanization recently increase due to socio-economic driving forces (unsustainable activities, increasing population density, and poverty) consequent to a critical political status and related conflicts. When field information is lacking, uncertainty and urgency are high and threat-specific data are difficult to obtain in crisis context of conservation concern, expert knowledge from specialists with local backgrounds could be useful in defining priorities for conservation management strategies. However, experts should be aware of possible bias in their evaluations induced by different perspectives and lack of local knowledge.

1. Introduction

Although relatively small in area, Palestine includes a large number of landscapes with varying topographies and associated climates (ranging from Mediterranean ecosystems to deserts): it makes this area a recognized biodiversity hot spot of the Middle East (Isaac & Gasteyer, 1995; Environment Quality Authority, 2010; Ghattas, 2011).

However, Palestine is also globally known as an area in political crisis, a situation resulting from the division of Palestinian accessible areas, land confiscation and political conflicts (Isaac, 2000a,b; Applied Research Institute, 2007; Environment Quality Authority, 2010; Abdallah & Swaileh, 2011). Consequently, as in other geographic areas threatened by wars and political conflicts, the biodiversity of this region is largely threatened (Hanson et al., 2009). Un-planned urban settlement, overgrazing, habitat fragmentation, deforestation, desertification and drought, presence of invasive species, pollution in agriculture and urban areas, hunting and collecting wild plants are the main local driving forces and threats acting both at landscape and patch scale (Gutman & Seligman, 1979; Applied Research Institute, 2007; Ghattas, 2011). Furthermore, the lack of environmental legislations possesses a significant legal constraint to biodiversity conservation and management efforts. All of these factors have resulted in direct changes to wild plant and animal species composition, richness, distribution and density and are leading to the loss of a valuable ecological her-

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itage (Applied Research Institute, 1997, 2007; Environment Quality Authority, 2010).

It is crucial to both list and measure human-induced disturbances (hereafter, threats) to sites of conservation concern and crisis to establish management priorities that address their mitigation and, hopefully, their eradication (Soulé, 1986; Groom, Meffe, & Carroll, 2006; IUCN-CMP, 2006; Kiringe & Okello, 2007; Balmford et al., 2009). In this sense, the field of threat analysis emerged out of the disturbance ecology arena to address these issues (White, 1979; Sousa, 1984; White & Pickett, 1985).

A threat can be defined as a factor or process that has caused, is caused, or may cause the destruction, degradation and/or impairment of biodiversity and/or natural processes (Salafsky, Margoulis, Redford, & Robinson, 2002; Salafsky, Salzer, Ervin, Boucher, & Ostlie, 2003; IUCN-CMP, 2006). If a site (or a network of sites) of conservation concern is to be actively and efficiently managed, we must identify with urgency how many, what types, and to what extent (e.g., the scope and intensity of the threat on a specific target) threats are present (Hobbs & Huenneke, 1992; Gershman, 2000; Sutherland, 2000; Salafsky et al., 2003). Such a priority list of threats, ranked in a decreasing order of impact (e.g., magnitude), could facilitate the formation of site specific strategies to minimize threats in critical areas of concern (Latour & Reiling, 1994).

However, the establishment of these priorities can be a difficult task (Margoulis & Salafsky, 1998). Indeed, each threat may require specific measurements and metrics, and comparisons between threats may prove problematic. Salafsky et al. (2003) provided a standard organized hierarchical nomenclature of threats (threat taxonomy), as well as systems for measuring the magnitude of each threat and for comparing several independent threats acting concurrently on target system. They measured various threats by assigning continuous or categorical values to a set of selected variables using an expert-based approach. Of the variables considered in their model, magnitude was identified to be one of the most comprehensive in term of assessing the impact of threats to local biodiversity targets, because this variable includes two relevant threat attributes, scope and intensity (Salafsky et al., 2003). As a result, this approach may be useful in defining management strategy priorities to be adopted in specific contexts, especially those that are situated in human altered, multiple-disturbance contexts that lack data and where uncertainty and urgency is high (see also Margoulis, Stem, Salafsky, & Brown, 2009).

In developing a list of threats to a study area, it is important to rank the various threat types in a manner that allows managers to act on priority threats first, and then to address less important threats. However, because many conservation agencies have limited access to funds, priority is often given to charismatic and easily perceivable threats (facing a "flagship" target) rather than assigned on objective, experience-based criteria that identify the most critical threats to biodiversity targets (Groom et al., 2006; Battisti, Luiselli, & Teofili, 2009). Adopting an expert-based scored evaluation to identify priority threats may help reduce these discrepancies (Salafsky et al., 2003).

Even though many researchers have focused on documenting threats and their extents over large geographical areas in North America (e.g., CAP program; TNC-WWF, 2006) and Africa (Kiringe & Okello, 2007), data for medium to small sites of conservation interest are still scanty in other geographic regions, including the Mediterranean and Middle East (see Battisti, Luiselli, Pantano, & Teofili, 2008; Battisti et al., 2009). Nevertheless, ecosystem threat analysis is a priority issue in this wide region, recently called a "full world" (Farina, Johnson, Turner, & Belgrano, 2003), where long-term historical human presence has heavily transformed and modelled ecosystems and landscapes (Blondel & Aronson, 1999).

In this study, we apply this approach to a set of poorly studied remnant sites in West Bank, Palestine, a context of high ecobiogeographic interest and conservation concern, embedded in anthropized landscapes characterized by complex political and ecological crisis. In particular, the aim of this paper are: (1) to define a check-list of human-induced threats to a set of medium to small-sized focal sites, grouped according to taxonomy proposed by Salafsky et al. (2003) and IUCN-CMP (2006); (2) to assess the magnitude of each threat using a 'significance analysis' based on an expert screening of the available local grey literature; (3) to rank each threat magnitude and identify priority threats at the network level; and, (4) to assess the local level of knowledge to determine which threats require further research (Cole, 1994). We correlated the magnitude of each threat with the population density of each site to prove a hypothesized direct correlation between the two. Furthermore, we tested whether threats with higher magnitudes were also better known by the experts. To our knowledge, this is the first threat analysis performed for sites of conservation concern in the Middle East.

2. Materials and methods

2.1. Study area

Palestinian wildlife is distributed across 16 bio-geographical areas, indicating its high environmental heterogeneity belonging to the Mediterranean hotspot (Environment Quality Authority, 2010; CEPF, 2016). In particular, the vegetation of Palestine comprises a variety of plant formations ranging from dense forests to small patches of desert herbs (2076 plant species have been recorded, including 60 native tree species, 90 native bush species, and up to 636 endangered species, of which 90 are very rare and 15 are endemic taxa; Zohary, 1962, 1972; Al sheikh & Salman, 2000; Applied Research Institute, 2007). These plants can be grouped into the following communities and associations: coniferous and broadleaved mixed forests, evergreen park-maquis, deciduous steppe-maquis and steppe-forests (dominant species: *Pistacia atlantica, Crataegus azarolus* and *Amygdalus communis*), deciduous thermophilous scrubs (predominantly, *Ziziphus lotus*), halophytic forests (*Tamarix* spp. and *Suaeda* spp.), riparian woods (*Salix* spp., *Populus* spp.), savannah forests (including tropical trees such as *Ziziphus spina-christi*, *Moringa aptera* and *Salvadora persica*), Mediterranean batha or garigue (genus *Cistus*, *Phlomis*, *Salvia* and *Thymus*), dwarf shrub steppes (*Artemisia herba-alba*, *Noea mucronata* and *Helianthemum* spp.), leaf and stem succulent dwarf shrub formations (*Salsola* spp. and *Atriplex* spp.) and rush and reed vegetation (Zohary, 1962, 1972; Al sheikh & Salman, 2000).

Palestinian terrestrial fauna includes 427 bird species, 92 mammal species (5 endemism taxa mainly belonging to the genus *Spalax*; Wilson & Reeder 2005), 81 reptile species (1 endemic taxa: *Acanthodactylus beershebensis*; Uetz & Hošek, 2013) and 7 amphibian species (2 endemic taxa: *Discoglossus nigriventer* and *Hyla heinzsteinitzi*; Isaac & Gasteyer, 1995 and unpublished data).

West Bank is divided into four major phyto-geographical, geomorphologic and topographical regions: (i) The Jordan Valley, a semi-arid region that lies east of the West Bank highlands, between the eastern slopes and the mountains of Moab in Jordan; it is a continuation of the African Rift Valley; (ii) Eastern Slopes ("Jerusalem wilderness"), an area that runs from Jenin in the north to Hebron in the South. The eastern slopes host greatest number of Palestine's wild fauna and much of its native flora; (iii) Central Highlands, a region approximately 3500 km^2 that includes the mountainous portion of the West Bank. The elevation in this area reaches slightly more than 1000 m a.s.l.; (iv) Semi-Coastal Region (Jenin and Tulkarem districts), an extension of the land inside the Green Line (1967 border; Environment Quality Authority, 2010). The climate in this

Table 1
Description of the eight focal sites in West Bank, Palestine: site name, area (in km^2), elevation (in m a.s.l.), geographic coordinates (latitude and longitude), general description (presence of protected areas, species and habitats), socio-political contexts. Threat categories follows IUCN (2016): LC: Least Concern; VU: Vulnerable; NT: Near Threatened.

Site	Area; population density	Elevation	Coordinates	General description	Socio-political critical issues
Ein Al Fashkha Region (Jericho district)	25; No Available data	390 under sea level (depressed area)	31 42′N, 35 28′E	Protected wetland area on the Dead Sea. Local presence of fresh water and brackish springs with semi-tropical vegetation (important wetland area for migratory birds). Species of conservation concern: *Capra nubiana* (VU), *Gazella gazella* (VU), *Procavia capensis* (LC), *Canis lupus* (LC). The area is the habitat for threatened species such as the Dead Sea sparrow (*Passer moabiticus*, LC) and the lesser kestrel (*Falco naumanni*, LC)	Conflicting area: The Israeli occupation forces control a large part of this area and prohibit Palestinians from entering or accessing it
WadiAl-Quf/Beit Kahel	24.5; 7000	600–700	31 33′N, 35 07′E	Large region located west of Hebron. The area is rich in biodiversity because of its trees and plentiful water. Mammals of main conservation and ecological concern include *Hyaena hyaena* (NT); *Hystrix indica* (LC), *Canis lupus* (LC), *Gazella gazella* (VU). Birds include many sedentary and migratory birds (raptors, storks, partridges, waders and other water-related species)	Conflicts for pasture lands. High number of checkpoints resulting in the closing of several main village entry points, with implication on land use. There are no regulation for the tourism in the area
Shobash	55.53; 2700	200–350	32° 25′ N, 35° 23′ E	Foothills of the central highlands facing the eastern slopes (Eastern watershed). Forest of *Ceratonia siliqua – Pistacia lentiscus*. The plant communities here are more drought and heat resistant than those dominated by *Quercus calliprinos*. In addition to the main tree species, various species, including but not limited to *Calicotome villosa*, *Rhamnus alaternus* and *Ruta chalapensis* occur	Bedouins with their livestock live in the area (intensive grazing)
Siris	1.38; 5400	500–630	32° 18 N, 35° 19 E	Open savannah of trees and shrubs of *Quercus calliprinos*, accompanied by a remarkable number of *Q. boisseri*, *Ceratonia siliqua* and *Pistacia palaestina*. The undergrowth at the reserve is covered in low shrubs including *Sarcopoterium spinosum*, and herbaceous vegetation	Most of inhabitants work inside the green line area inside occupied Palestine with environmental implications (e.g. high motor-vehicle traffic)
BaniNaim Wilderness (Beth-lehem/Hebron district)	172; 900	250–600	31°30′ N, 35° 09′ E	It is a protect area ranging from southeast of Bethlehem to the south of Hebron with remnant agro-ecosystems. The most important animals of this area are *Capra nubiana* (VU), *Gazella gazella* (VU), *Procavia capensis* (LC), *Hyaena hyaena* (NT). Large raptors of conservation concern are present, including *Neophron percnopterus* (EN), *Gyps fulvus* (LC)	This area is used for training Israeli soldiers year round in the use of heavy machines. Presence of permanent checkpoints have implications on people dispersal and land use change
Wadi Qana	9.39; 3106	500–775	32° 09′ N, 35° 08′ E	This site is considered one of the most prominent natural attractions in Palestine. The valley is famous for its natural beauty, its abundance of water, and its many springs. The area is also known for the prevalence of trees, crops and livestock	The occupation forces, through the Israeli Civil Administration's (ICA) Protection of Nature Committee announced its control over the region, which it claims to be an Israeli nature reserve area, as because it is located within Area "C" (Oslo II Agreement). Israeli occupation forces, established settlements at the top of the Qana Valley, and today they have almost complete control over the water sources of this valley
Khirbit Quis: Sector South of Salfit administrative zone	0.49; 250	400–490	32° 03′ N, 35° 10′ E	This site is a populated West Bank location. The nearest town has more than 50,000 inhabitants. The site is unprotected, but considered an IPA Site (Important Plant Area). The semi-arid landscape is mostly covered with mosaic vegetation/croplands as well as some remnant evergreen broadleaved sclerophylous woodland	Conflicting area between Israeli occupation and Palestinian Authority
Um AL-Tout	0.51; 1250	250–600	32° 25′ N, 35° 20′ E	This is a protected site located in the northern part of the West Bank. The reserve includes a forest of carob and Pistacia lentiscus and semi-natural coastal zones, limited to the eastern slopes of the mountains of Palestine (Tubas and east of Nablus and Jenin). There is limited vegetation and dendritic trees in this forest of carob and bushes, in addition to many types of dwarf shrubs (Batha)	Conflicting area between Israeli occupation and Palestinian Authority

area is Mediterranean, characterized by long, hot, dry summers and short, cool, rainy winters.

We studied eight focal sites of high ecological interest located in West Bank, Palestine (31°21′–32°33′ Lat; 34°52′–35°32′ Long; Table 1; Fig. 1). For each site, we collected all the information on biodiversity of conservation concern by local recent literature.

2.2. Descriptive taxonomy of direct threats

From 2013 to 2015, all possible information and data on the direct and indirect human-induced threats to biodiversity targets were collected for each of eight selected focal sites ('target' refers to those biological/ecological entities that appeared to suffer a reduction in population abundance or experienced stress related to a key ecological attribute due to specific threats; Salafsky et al., 2003). In particular, a panel of five local experts reviewed a number of available local sources (Abed Rabboh, 1995; Albaba, 2014; Applied Research Institute, 1997, 2007, 2013; Isaac, 2000a,b; Basim, 2001; Environment Quality Authority, 2010; Ghattas, Hrimat, & Isaac, 2006; Ghattas, 2011; Isaac & Gasteyer, 1995; Helal & Khalilieh, 2005; Khalaf, 2010; International Women's Peace Service, 2012; Merlo & Croitoru, 2005; Palestinian Environmental Authority, 1999; Shtayeh & Kalil, 1995). Each locally referred expert had a strong knowledge in the region; they either lived in Palestine, and had a professional background in the environmental sector with specific direct or indirect knowledge of individual study sites or spent at least one year frequenting the studied sites (see Acknowledgments). This approach is somewhat similar to other experience-based methodologies (Delphi method; Linstone & Turoff 1975; multi-criteria analysis and Bayesian belief networks; Saarikoski, Mustajoki, & Marttunen, 2013), and is effective in the evaluation of those threats that are empirically un-known, have different metrics, are difficult to compare, and thus potentially have a very high degree of uncertainty (e.g., Hess & King 2002).

This assessment resulted in the production of a list of direct and indirect threats to the eight focal sites (threat taxonomy; Table 2). List items were based on the original threat check-list developed by Salafsky et al. (2003) and more recently by IUCN-CMP (2006).

2.3. Measurement of direct threats

Following Cole's approach (Cole, 1994) the panel of experts performed a paired analysis of each threat at each site. The approach consisted of: (1) a significance analysis, where each expert assigned a threat magnitude score; and (2) a knowledge analysis, where each expert scored their estimated level of knowledge for each threat.

2.3.1. Significance analysis

In December 2014, the panel of experts provided an assessment of the magnitude of each threat at each site (see study area, Table 1). Magnitude refers to the degree to which a threat has had an impact on the viability/integrity of specific targets in each study area within the last 10 years. A score of 4 was assigned if the threat induced a very serious impact or loss of the targets; 3 was assigned if the threat induced a medium-high impact; 2 was assigned if induced a medium-low impact; and 1 was assigned if the threat induced a minimal or no impact (Salafsky et al., 2003). Here, threat magnitude includes both the scope (e.g., size area of threat) and severity (i.e., the impact on a set of local targets) of a specific threat (Salafsky et al., 2003). Each expert assess each threat in each site independently, without any deliberative step between the judgements sessions.

At the network level, we derived a mean score of threat magnitude (and ±standard deviation) for each site and for each threat across sites from the scores assigned by individual experts. Then, the magnitude scores for each threat and each site were ranked. At the individual site level, we obtained a mean score of the magnitude (and ±standard deviation) of each threat, as an averaged value of the expert scores.

2.3.2. Knowledge analysis

The panel of experts provided a self-evaluation of their level of knowledge regarding each threat magnitude at each site. A score of 4 was assigned if the knowledge of a specific threat at a specific site was very high; a 3 was assigned if it is relatively high; a 2 was assigned if it was relatively low; and a 1 was assigned if it was very low (adapted from Cole, 1994). Analogously to significance analysis, each expert assess each threat in each site independently, without any deliberative step between the judgements sessions.

At the network level, we obtained a mean score of threat magnitude (and ±standard deviation) for each site and for each threat.

For each threat, we calculated the experts' total level of knowledge as the sum of the ratings for each site and for each threat. Then, the magnitude scores for each threat at each site were ranked. Moreover, at the individual site and threat level, we calculated a mean score of knowledge (and ±standard deviation), as the averaged value provided by the experts.

Both in the significance and the knowledge analysis, scores were relative to the total effects of threats on identified target. No values were obtained related to the magnitude or knowledge of the effects of each threat on individual targets (e.g., single species/community).

2.4. Statistical analysis

We used the non- parametric Friedman test to compare the mean scores of significance (magnitude) and knowledge among threats and among sites with the same number of cases ($n = 8$ and $n = 11$, respectively). The null hypothesis states that the values have the same medians (Dytham, 2011). We used a non-parametric Wilcoxon paired test to compare the scores obtained from the significance (magnitude) and knowledge analysis at each site and for each threat with the same number of cases (related samples; respectively, $n = 8$ and $n = 11$). The null hypothesis in this case also states that the values will have the same medians (Dytham, 2011).

A non-parametric Spearman rank correlation test (two-tailed) was performed to compare the averaged magnitude scores (significance analysis) with the human population density of each site ($n = 7$: data from Al Fashkha site were not available).

We used the SPSS 13.0 software for Windows (SPSS Inc., 2003). Alfa was set at the 0.05 level.

3. Results

Averaged scores from the experts' significance and knowledge analyses are reported in Tables 3 and 4 for the site level, and Table 5 and 6 for the network level.

3.1. Significance analysis

The mean magnitude scores were significantly different among site or threats ($\chi^2 = 17.939$, $p = 0.012$, d.f. = 7 and $\chi^2 = 42.286$, $p = 0.000$, d.f. = 10; respectively; Friedman test). At the network level, the highest mean threat magnitude scores were (in decreasing order) for intensive grazing (code IUCN 2.3), pollution (code 9.1, 9.2, 9.3), collecting wild plants (code 5.2), recreation (code 6.1), fire (code 7.1) and urbanization (code 1.1) (Table 5, Fig. 2). The sites with the greatest threat magnitude values were Bani Naim, Wadi Al Quf, Siris and Wadi Qana (Table 6, Fig. 3). The lowest mean threat magnitude scores were given to cutting wood (code IUCN 5.3), active quarries (code 3.2) and reforestation (code 2.2); the sites with the

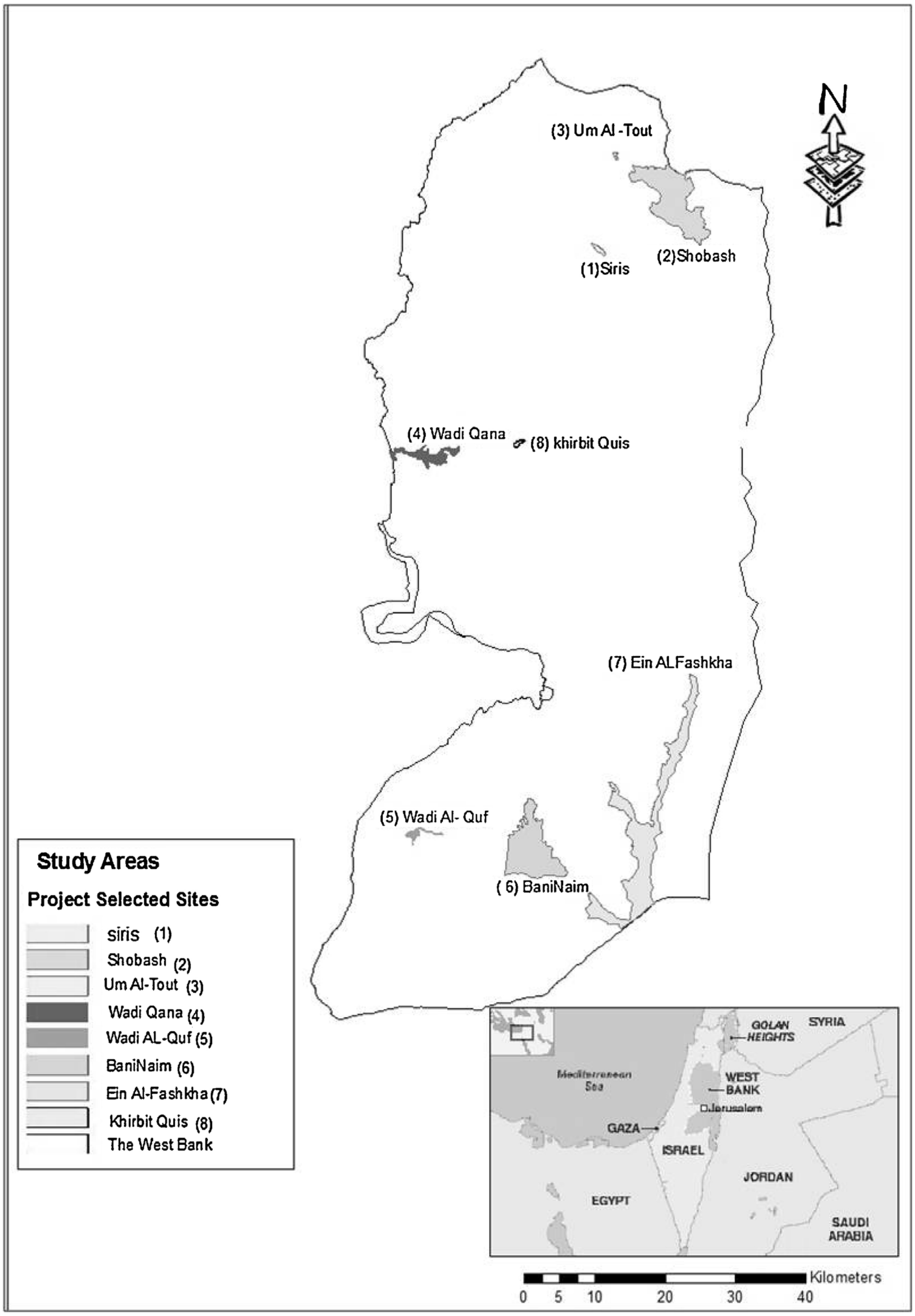

Fig. 1. Map of the study area (West Bank, Palestine).

lowest threat magnitudes were Shobash, Khirbit Quis and Ein Al Fashkha.

Comparing the mean magnitude scores of sites with population density we did not observed a significant correlation ($r_s = 0.414$, $p = 0.355$; $n = 7$; Spearman rank correlation test; 2 tail).

3.2. Knowledge analysis

The mean knowledge scores were significantly different among sites ($\chi^2 = 55.085$, $p = 0.000$, d.f. 7) and among threats ($\chi^2 = 24.639$, $p = 0.006$, d.f. = 10; Friedman test).

Urbanization (code IUCN 1.1), conversion to agriculture (code 2.1) and intensive grazing (code 2.3) were the better known threats (highest mean knowledge values; Table 5, Fig. 2). Experts also indicated that they understood the threats at Wadi Al Quf, Siris, Wadi Qana, and Bani Naim (Table 6, Fig. 3). Experts knew the least about the threats of reforestation (code IUCN 2.2), active quarries (code 3.2), collecting wild plants (code 5.2) and hunting (code 5.1) with low level of knowledge for Shobash, Khirbit Quis and Ein Al Fashkha (Table 6, Fig. 3).

3.3. Comparison between magnitude and knowledge

Averaged values of magnitude (significance) and knowledge scores in 8 sites were significantly and directly correlated ($r_s = 0.850$, $p = 0.007$, $n = 8$, Spearman rank correlation test; 2 tail).

Table 2
List of the identified direct and indirect local threats. The IUCN code, nomenclature (level 2 of classification) and definition (threat taxonomy) are reported (IUCN-CMP, 2006).

Local threat	IUCN code	Nomenclature	Definition
Urbanization	1.1	Housing & Urban Areas	Human cities, towns, and settlements including non-housing development typically integrated with housing
Conversion to Agriculture	2.1	Annual & Perennial Non-Timber Crops	Crops planted for food, fodder, fiber, fuel, or other uses
Reforestation	2.2	Wood & Pulp Plantations	Stands of trees planted for timber or fiber outside of natural forests, often with non-native species
Intensive Grazing	2.3	Livestock Farming & Ranching	Domestic terrestrial animals raised in one location on farmed or nonlocal resources (farming); also domestic or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (ranching)
Active Quarries	3.2	Mining & Quarrying	Exploring for, developing, and producing minerals and rocks
Hunting	5.1	Hunting & Collecting Terrestrial Animals	Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/by catch
Collecting Wild Plants	5.2	Gathering Terrestrial Plants	Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons
Cutting Wood	5.3	Logging & Wood Harvesting	Harvesting trees and other woody vegetation for timber, fiber, or fuel
Recreation	6.1	Recreational Activities	People spending time in nature or travelling in vehicles outside of established transport corridors, usually for recreational reasons
Fire threat	7.1	Fire & Fire Suppression	Suppression or increase in fire frequency and/or intensity outside of its natural range of variation
Pollution	9.1, 9.2, 9.3	Domestic & Urban Waste Water (9.1), Industrial & Military Effluents (9.2), Agricultural & Forestry Effluents (9.3)	Water-borne sewage and non-point source runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments (9.1); Water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that use nutrients, toxic chemicals and/or sediments (9.2); Water-borne pollutants from agricultural, silvyculture, and aquaculture systems that use nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied (9.3)

Table 3
Significance analysis. Expert scores of threat magnitude for the 8 sites in West Bank, Palestine. Mean values (and ±standard deviation, s.d.) for each threat at each site are reported (in bold, the highest scores for each threats in each site). Local threats are classified following the IUCN standard (IUCN-CMP, 2006).

IUCN code	Local threat/Site	Siris	Shobash	Um Al Tout	Wadi Qana	Wadi Al Quf	Bani Naim	Khirbit Quis	Ein Al Fashkha
2.1	Conversion to Agriculture	2.20 (0.84)	2 (0.712)	2.20 (1.10)	2 (0.71)	1.4 (0.55)	1.8 (0.84)	1.8 (0.84)	1 (0)
1.1	Urbanization	1.6 (0.89)	1.6 (0.89)	2 (1)	2.4 (1.34)	2.2 (0.83)	1.8 (1.30)	**2 (0.71)**	1.4 (0.55)
2.3	Intensive Grazing	**3.4 (0.55)**	**2.8 (1.3)**	**3 (0.71)**	**3 (0.71)**	2 (1)	**3.2 (0.84)**	1.8 (0.84)	1.2 (0.45)
5.3	Cutting Wood	2 (1)	1(0)	1.8 (0.84)	1.4 (0.55)	2 (1)	1.2 (0.45)	1.4 (0.55)	1 (0)
3.2	Active Quarries	1(0)	1(0)	1(0)	1.2 (0.45)	1 (0)	2.8 (1.30)	1(0)	1 (0)
5.1	Hunting	1.6 (0.55)	1.8 (0.84)	1.2 (0.45)	1.6 (0.89)	1.4 (0.55)	1.8 (0.84)	1.4 (0.55)	1.4 (0.55)
5.2	Collecting Wild Plants	2.6 (1.14)	2 (0.71)	2 (0.71)	2.4 (0.79)	1.8 (0.84)	2.8 (0.84)	**2 (1)**	1.2 (0.45)
6.1	Recreation	2 (0.71)	1.6 (0.89)	1.8 (0.84)	1.8 (0.84)	3 (0.71)	1.8 (0.84)	1.6 (0.55)	**2.8 (0.45)**
7.1	Fire Threat	2.2 (0.84)	1.4 (0.55)	2.2 (0.45)	2 (0.71)	**3.2 (0.84)**	1.6 (0.55)	1.6 (0.55)	1.8 (0.84)
2.2	Reforestation	1.6 (0.55)	1.4 (0.55)	1.4 (0.55)	1(0)	1.8 (0.45)	1.2 (0.45)	1 (0)	1 (0)
9.1, 9.2, 9.3	Pollution	1.8 (1.3)	1.8 (1.3)	2.4 (0.55)	2.8 (0.84)	2.2 (0.84)	2.2 (1.3)	**2 (1)**	2.4 (1.52)

Table 4
Knowledge analysis. Expert scores of threat knowledge for the 8 sites in West Bank, Palestine. Mean values (and ±standard deviation, s.d.) for each threat at each site are reported (in bold, the highest scores for each threats in each site). Local threats are classified following the IUCN standard (IUCN-CMP, 2006).

code IUCN	Threat/Site	Siris	Shobash	Um Al Tout	Wadi Qana	Wadi Al Quf	Bani Naim	Khirbit Quis	Ein Al Fashkha
2.1	Conversion to Agriculture	3 (1)	2.2 (1.10)	**2.8 (1.1)**	3.20 (0.84)	2.8 (0.45)	2.6 (0.89)	1.6 (0.55)	2.2 (0.45)
1.1	Urbanization	2.4 (0.55)	2 (1)	2.6 (0.55)	**3.85 (0.45)**	**3.6 (0.55)**	2.8 (0.84)	1.6 (0.55)	**2.4 (0.55)**
2.3	Intensive Grazing	**3.2 (0.84)**	2 (1)	2.6 (0.55)	3 (0.71)	2.8 (0.45)	**3 (0.71)**	1.6 (0.55)	2.2 (1.1)
5.3	Cutting Wood	2.6 (1.34)	**2.4 (1.52)**	2.6 (1.34)	2.2 (0.84)	3 (1)	2 (0.71)	1.6 (0.55)	1.6 (0.55)
3.2	Active Quarries	2.2 (1.64)	1.8 (1.1)	2.2 (1.64)	2.4 (1.52)	2.4 (1.52)	2.8 (1.1)	**2 (1)**	1.6 (0.55)
5.1	Hunting	2.2 (0.84)	1.6 (0.55)	1.8 (0.45)	1.8 (0.45)	2.2 (0.84)	2 (0.71)	1.6 (0.55)	1.6 (0.55)
5.2	Collecting Wild Plants	2.2 (0.84)	2 (1)	2.2 (0.84)	2.2 (0.84)	2.2 (0.84)	2.8 (0.84)	1.6 (0.55)	1.4 (0.55)
6.1	Recreation	3 (1.22)	1.6 (0.55)	2.4 (0.89)	2.2 (0.84)	3.4 (0.89)	2.6 (0.55)	1.6 (0.55)	**2.4 (1.14)**
7.1	Fire Threat	2.8 (1.30)	2.2 (1.64)	**2.8 (1.3)**	2.6 (1.14)	**3.6 (0.89)**	2 (0.71)	1(0)	1.4 (0.89)
2.2	Reforestation	2.6 (1.34)	1.8 (1.1)	2.6 (1.52)	2 (0.89)	3.2 (1.09)	2.2 (0.45)	1.4 (0.55)	1.6 (0.89)
9.1, 9.2, 9.3*	Pollution	2.4 (0.89)	1.8 (1.1)	2.4 (0.55)	3 (0.71)	3.4 (0.55)	2.6 (0.89)	1.4 (0.55)	2.2 (1.31)

Excluding Khirbit Quis (for sites) and collecting wild plants (for threats), knowledge showed everywhere higher values when compared to paired magnitude with significant differences in some cases (Wilcoxon paired test; Tables 5 and 6).

4. Discussion

Recent reports have highlighted the critical state of Palestine's biodiversity as a result of a large number of human-induced direct and indirect threats (Applied Research Institute, 2007, 2011). These threats are a consequence of several driving forces related to a highly unsustainable economic activities; increasing population density; and the critical regional political status, including the division of Palestinian accessible areas by Israeli occupation activities (e.g., intensive building of settlements and associated roads and related activities, expansion of the segregation wall, and land confiscation; Sultan & Abu-Sbaih, 1996; Applied Research Institute, 2007). As a result, many biological species and habitat types are

Table 5
Averaged scores of magnitude for local threats (total value for all sites; in bold, the highest values for significance and knowledge analyses). Statistic comparisons have been reported (value of coefficient W and probability, p; Wilcoxon paired test).

Local threat	Significance	Knowledge	statistic	
	mean (±s.d.)	mean (s.d.)	Wilcoxon	p
Urbanization	9.38 (1.69)	**13.25 (3.73)**	−2.328	0.020**
Conversion to Agriculture	8.88 (1.96)	12.75 (2.60)	−2.319	0.020**
Intensive grazing	**12.75 (3.92)**	12.75 (2.82)	−0.256	0.798
Cutting wood	7.38 (2.07)	11.25 (2.49)	−2.536	0.011**
Active quarries	6.25 (3.15)	10.88 (1.89)	−2.384	0.017**
Hunting	7.63 (1.06)	9.25 (1.28)	−2.157	0.031*
Collecting wild plants	10.5 (2.51)	10.38 (2.13)	−0.322	0.748
Recreation	10.25 (2.71)	12 (3.12)	−1.802	0.072
Fire threat	10 (2.83)	11.5 (4.17)	−1.496	0.135
Reforestation	6.5 (1.51)	10.88 (2.99)	−2.536	0.011**
Pollution	11 (1.69)	12 (3.16)	−0.949	0.343

* $p < 0.05$.
** $p < 0.01$.

Table 6
Total averaged scores of magnitude for each site (total value for all threats; in bold, the highest values for significance and knowledge analyses). Statistic comparisons have been reported (value of coefficient W and probability, p; Wilcoxon paired test).

Sites	Significance	Knowledge	statistic	
	mean (s.d.)	mean (s.d.)	Wilcoxon	p
Siris	10 (3.13)	13 (1.79)	−2.683	0.007**
Shobash	8.36 (2.54)	9.73 (1.27)	−1.481	0.139
Um Al-Tout	9.45 (2.81)	12.27 (1.49)	−2.620	0.009**
Wadi Qana	9.82 (3.22)	12.91 (3.02)	−2.608	0.009**
Wadi Al Quf	10 (3.29)	**14.82 (2.64)**	−2.956	0.003
Bani Naim	**10.1 (3.3)**	12.45 (1.86)	−2.503	0.012**
Khirbit Quis	8 (1.84)	7.78 (1.19)	−0.669	0.503
Ein Al Fashkha	7.36 (3.07)	9.36 (2.01)	−1.966	0.049*

* $p < 0.05$.
** $p < 0.01$.

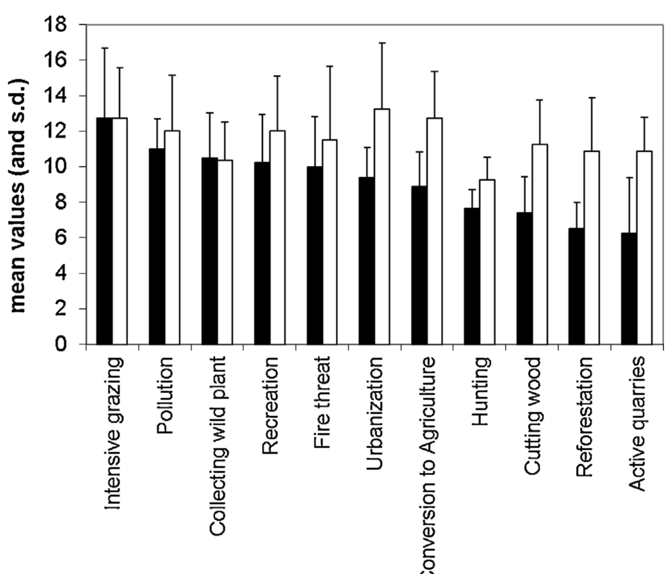

Fig. 2. Histogram reporting the averaged scores (and ±standard deviation) for magnitude (black columns) and knowledge (white columns) of local threats (total value for all sites). Values are in order of decreasing magnitude.

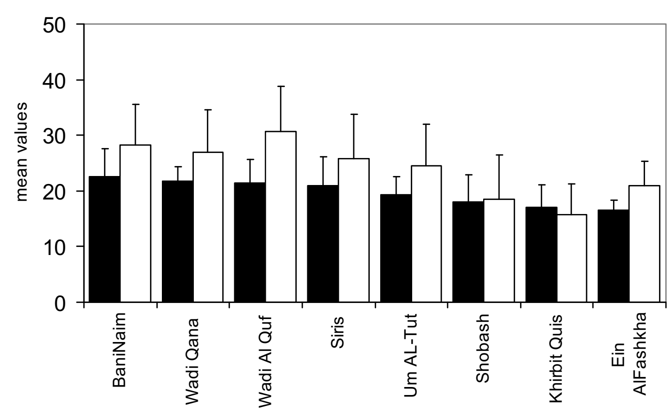

Fig. 3. Total averaged scores (and ±standard deviation) for magnitude (black columns) and knowledge (white columns) at each site (total value for all threats). Values are in decreasing order of total magnitude.

under serious threat of becoming rare or disappearing altogether. More particularly, local threat impacts are primarily felt at the ecosystem and community level on shrub vegetation, water and soil quality, remnant bush patches and Mediterranean forests that host peculiar diversity (Al sheikh & Salman, 2000).

Our expert-based approach identified intensive grazing, generic pollution, collecting wild plants, recreation, fires and urbanization to be the greatest threats to biodiversity at the network level and, therefore, the most important priorities for regional management actions. These threats are widely recognized to be either short-term or long-term processes that strongly affect biodiversity targets at the local, regional and Mediterranean level (Ayash, Neiroukh, & Salah, 1995; Mysterud, 2006; Ukmar, Battisti, Luiselli, & Bologna, 2006; Irwin & Bockstael, 2007). More particularly, our threat analysis largely match with analogous studies carried out in the Middle East where intensive grazing, water and soil pollution, fires and un-planned urbanization have been considered the main human-induced disturbances inducing evident land use changes, degradation and desertification (Winslow & Thomas, 2007) with an irreversible impact on biodiversity, mainly during the last three decades (Perevolotsky & Seligman, 1998; Rundel, 1998; Naveh & Carmel, 2004; Wittenberg & Malkinson, 2009; Alrababah, Alhamad, Suwaileh, & Al-Gharaibeh, 2007; Tourenq & Launay, 2008).

Intensive grazing by sheeps and goats may be considered a long-term disturbance historically occurring in Palestine (Applied Research Institute, 2011) and in a large part of Middle East wherever livestocks exceeds the land carrying capacity (e.g. Naveh & Carmel, 2004). This anthropogenic disturbance (inconstant among seasons, being particularly high in intensity during spring; Applied Research Institute, 2011), together to fires and stochastic drought events act to prevent the natural vegetation dynamic toward dwarf shrub communities, leading to a reduction of seed regeneration and inducing effect at level of plant populations and communities (disrupting density, species richness, diversity, biomass, and cover), with cascade effects on soil invertebrates and habitat-related vertebrates (Zaady, Yonatan, Shachak, & Perevolotsky, 2001; Wittenberg & Malkinson, 2009). In a long-term span grazing, fires and drought events may favour habitat degradation and desertification at landscape scale (Winslow & Thomas, 2007).

Water and soil pollution is a threat having strong implication at socio-political and economic level, as well as ecological ones, being a causal factors for further conflicts (Kliot, 1994). Probably, water, in terms of their quality, quantity and availability is the local key resource, both for human populations and for biodiversity targets (Vőrősmarty et al., 2010). In this sense, water pollution may be considered the "key threat" for the whole socio-ecological systems in this geographic area.

Water pollution is strictly related to urbanization (mainly unplanned urban sprawl) and (secondarily) to un-managed recreation activities. With the building of settlements, bypass roads and military outposts, Segregation Wall, confiscation of their land for building settlements and related agricultural and industrial activities, people has been largely restricted to specific areas. Here a process of positive feedback have induced a rapid land use change and urbanization (high population density and birth rate, need for Palestinian housing and buildings for other activities, high pressure on ecosystems) with cascade effect on water quality, risk of fires and other threats (Palestinian National Authority, 2006). More particularly, regarding the fires there are evidences that their frequency and intensity have markedly increased in Palestine, matching a trend at Mediterranean and Middle East scale (Wittenberg & Malkinson, 2009): the role of urbanization (and road/Wall construction) and related human activities could be considered the main causal driver also in this case.

Other threats also affect biological diversity and ecological systems in the study area. For example, collecting wild plants and hunting is common in Palestine (and, at least for large mammals, throughout the Middle East; Quemsiyeh, Amr, & Budari, 1996; Tourenq & Launay, 2008). Hunting and consequent illegal trade typically affects large mammals, desert reptiles (mainly endemic taxa) and songbirds. In addition, farmers have been reported to use poisons to kill wolves and hyenas as precautionary measures to protect their herds (Applied Research Institute, 1997, 2007). Analogously to the previous main threats, also in this case, exploitation of animal and plant resources may be partially due to socio-economic driving forces. Many Palestinians are living in extreme poverty (Palestinian National Authority, 2006). As they seek new sources of income, many Palestinians are compelled to exploit natural resources (physical and biological) in marginal lands and wilderness areas so acting as a significant factor of pressure on biodiversity. Interestingly, our results suggest that hunting is a neglected threat of particular concern because its magnitude is little understood by experts, as shown in the knowledge analysis (lowest values).

The initial findings presented here also suggest that priorities at the network scale should focus on conservation strategies and actions that control intensive grazing, pollution, un-managed collecting wild plants, recreation and fire. However, since we obtained significant differences in magnitude among sites, specific site-scale strategies should also address additional local threats locally emerging (e.g., the impacts of hunting and of active quarries).

Recently, the Palestinian Authority (through the Palestinian Legislative Council) has adopted a number of laws and regulations on agriculture, soil conservation and biodiversity (Palestinian National Authority, 2006; Applied Research Institute, 2011). Nevertheless, a large number of international reports (e.g. inside the United Nations Development Programme) and guidelines have stressed that it is necessary update these acts making them more effective. Moreover, among the suggested measures it has been highlighted also the necessity to increase in skill in rangeland managers and practitioners developing specific conservation projects, listing actions in order of priority and taking into account the close connection between environmental problems and political and social issues in this crisis context (Palestinian National Authority, 2010).

When analysing threats at the local level, we identified four sites (Bani Naim, Siris, Wadi Qana and Wadi Al Quf) that were of particular concern. These sites include many relevant targets of interest because of the presence of water bodies and tree vegetation: e.g., in Wadi Al Quf and Bani Naim are present *Gazella gazella, Hyaena hyaena, Hystrix indica*, *Canis lupus*, *Capra nubiana*, and *Neophron percnopterus*, all species of conservation concern (EQA Report 2006; some of them vulnerable, near threatened or endangered sensu IUCN, 2016; see Table 1). In these sites several critical threats occur, including all of those identified to be priorities at the network level.

Counter-intuitively, we did not observe a direct correlation between population density and the threat magnitude at the network level. Likely, other economic and political driving factors (poverty, conflicts, new Israeli settlements) contribute as further causal processes determining the type and magnitude of existing threats. For example, new settlements constructed at certain sites (e.g., Wadi Qana) have induced a strong urban sprawl and water pollution independently from demographic density (Applied Research Institute, 2013). Lambin et al. (2001) at global level yet highlighted as population density alone should not considered the only and major underlying causes of land-cover change: rather, poverty and peoples' responses to economic and political opportunities may mainly drive land-cover changes.

Our preliminary, cursory approach may help increase knowledge and facilitate conservation strategies both at the site and network levels (e.g., for ecological network planning and connectivity conservation; Crooks & Sanjayan, 2006) in critical circumstances and in areas where urgent protection is needed (Salafsky et al., 2002).

However, despite the general importance and the potential of Salafsky et al.'s (2003) conceptual approach, there is a clear subjectivity in this expert-based tool: a methodological weakness that may lead to serious mismanagement (see MacMillan & Marshall, 2006; Game, Kareiva, & Possingham, 2013). For instance, potential problems associated with the measurement of threat magnitudes may arise from perception-based evaluations and the differing reliability of bibliographic sources as well as from the individual performance and perspectives of reviewers with different areas of expertise. In addition, the significant correlation between magnitude and knowledge scores should be carefully examined, especially if the greatest threats (i.e., with higher magnitude) are perceived to be better known. For this reason, further analytical approaches using specific metrics of diversity as indicators of stress, pressure and impact of local threats may also be required to inform management priorities (Dornelas, Soykan, & Ugland, 2011; see also the DPSIR approach: Kristensen, 2004). Moreover, the limited number of panel of experts may affect the data's variance. In the case of this study, the small sample size was due to the limited number of scientists and technicians living in this critical geographic area where data on conservation targets and threats are very difficult to obtain. Nevertheless, in conflict areas (Hanson et al., 2009), where there is a lack of quantitative field data, and when the definition of strategies is an urgent priority, expert-based approaches may support first steps in decision making regarding conservation actions (Auld & Keith, 2009). In this regard, our research (the first available in the Middle Eastern area) serves as a pilot study for additional, more in-depth surveys.

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