

Effects of Mesopotamian Marsh (Iraq) desiccation on the cultural knowledge and livelihood of Marsh Arab women

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Abstract. In this study, we evaluate ecological and cultural resiliency in response to desertification of the Mesopotamian Marshes of Southern Iraq. Our research illustrates that the desiccation of the marshes has caused a drastic change in how Marsh Arab women interact with their environment; specifically, in comparison to the predesiccation period, women's roles are increasingly limited to domestic rather than marsh-dependent activities. With the exception of raising water buffalo and limited horticulture activities, most families today have little opportunity to utilize women's ability to generate income by applying their traditional ecological knowledge and skills. Furthermore, these women are no longer transmitting their marsh-specific knowledge and skills to the next generation, and these valuable and ancient cultural memories are being lost. Upstream dam construction, drought, and regional climate change is depriving Marsh Arab communities of marsh ecosystem services such as potable water, water buffalo forage, fish yields, and reed production. In marsh areas, where enough water remains to sustain ecosystem services (such as in Chibayish and the Iraq Marshlands National Park), cultural knowledge has been retained and passed on to the next generations. We recommend that programs be implemented to preserve these traditional skills, to develop a market for handicrafts to support women and their families, and to support cultural knowledge. Otherwise, with the passing of the older generation, these remnants of ancient Sumerian knowledge systems and traditional ways of life will soon be forgotten.

Key words: *cultural resilience; ecosystem services; historic ecology; Iraq; Marsh Arab women; Mesopotamian Marshes; traditional ecological knowledge.*

Citation: Fawzi, N. A.-M., K. P. Goodwin, B. A. Mahdi, and M. L. Stevens. 2016. Effects of Mesopotamian Marsh (Iraq) desiccation on the cultural knowledge and livelihood of Marsh Arab women. *Ecosystem Health and Sustainability*. 2(3):e01207. doi: 10.1002/ehs2.1207

Introduction

The Mesopotamian Marshes (Marshes) were once the largest wetlands in the Middle East and Western Eurasia. The Marshes formed from annual flood pulses of the Tigris and Euphrates Rivers. In the 1970s, the Marshes covered between 15,000 and 20,000 km² of water surface and vegetation (UNEP 2001). The long-term resiliency of the southern Mesopotamian landscape provided abundant resources to humans since the time of the Ubaid-Sumerian culture (4000–6000 BCE) (Pournelle and Algaze 2010, Hritz et al. 2012). The indigenous people of the Marshes, the Marsh Arabs, have practiced sustainable traditional resource management for thousands of years, developing an iconic way of life that ties

them intimately to their wetland landscape (Salim 1962). Traditionally, women took an active role both inside and outside the home, gathering reeds, producing handicrafts, helping care for water buffalo, working in the fields, and selling in the market (Algaze 2001).

During the 1980s, the Marsh ecosystem and its inhabitants were subjected to large-scale destruction during the Iraq-Iran war. Destruction continued during the 1990s in “one of the world’s worst environmental disasters” when the previous Iraq government systematically drained over 90% of the Marshes in a military action designed to crush its inhabitants (UNEP 2001). The indigenous Marsh Arabs became either Internally Displaced Persons (IDPs) or environmental refugees exiled to other countries (UNEP 2001). The population of the Marshes was reduced from nearly 500,000 people in the 1950s to as few as 20,000 by 2003 (Nicholson and Clark 2002). With the fall of the previous regime in 2003, the Iraqi people began to re-flood the

Manuscript received 4 August 2015; revised 2 January 2016; accepted 10 January 2016.

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Marshes, and some Marsh Arab tribes returned to reclaim their lives. Good water years and Iraqi restoration efforts in 2004–2008 resulted in successful rehydration of approximately 58% of the Marshes (UNEP 2005, Al-Handel and Hu 2015). Uncontrolled releases of water partially restored some areas, whereas restoration failed in other areas because of high soil and water salinity (Richardson et al. 2005, Richardson and Hussain 2006). The re-flooding and rehydration efforts since the fall of the previous regime have thus had highly variable results. Unfortunately, recent drought years, upstream water diversions on the Tigris and Euphrates Rivers, and climate change have desiccated large areas of the Marshes, resulting in Marsh inhabitants being displaced and without a livelihood.

This research focuses on Marsh Arab women and the impacts of decades of extreme variations in the Marshes' extent, availability of culturally significant natural resources, and the ability of Marsh inhabitants to sustain a livelihood from ecosystem services. We specifically look at how the desiccation of the Marshes adversely impacts Marsh Arab women's traditional ecological knowledge. We focus on the "social memory" of Marsh Arab women, and the long-term traditional management of the Marshes for ecosystem services and culturally significant resources. We evaluate the current state of the Marshes and the social system that has sustained it through the lenses of the resilience, adaptability, and sustainability of social-ecological systems (SES) (Holling 2001, Walker et al. 2004, Rammel et al. 2007).

Resilience is defined as the magnitude of disturbance an ecosystem can tolerate before changing to a different and more simplified steady state, and controlled by different processes (Holling 2001). In this case study, we are using traditional ecological knowledge as our metric for the resilience of social systems and the ability of Marsh Arab women to retain the traditional knowledge and resource management systems that evolved over thousands of years in the Marshes (Folke 2009). The magnitude and frequency of disturbance (desiccation, rehydration, and subsequent desertification, accompanied by regional conflict and instability) tests whether either ecological or social systems can adapt and still retain the Marshes' traditional cultural knowledge and biodiversity.

Another linkage between traditional ecological knowledge and resilience in cultural and ecological systems in the Marshes is termed *biocultural refugium* (Barthel et al. 2013). The term refers to continuous food and material culture production which carries place-specific insights and experiences of stewardship (Nabhan 2008). Biodiversity of many cultural landscapes has been maintained through traditional resource management practices, developed in the context of the intimate relationship between environmental disturbances and stewardship practices based on traditional ecological knowledge (TEK) (Gomez-Baggethun et al. 2013). The role of *biocultural refugium* for carrying TEK demonstrates the ability of traditional management to enhance both cultural and

ecological resilience in the face of environmental change (Barthel et al. 2013).

To evaluate the magnitude of disturbance on the Marshes, we first impart the historic ecology of the Marshes, linking physiographic context (hydro-geomorphic, physical, and biological controls), marsh structure and function, and human traditional management activities. Second, we evaluate the impacts of regional conflicts and marsh desiccation on the social-ecological systems of marsh inhabitants derived from marsh ecological services. Third, we describe the Marsh Arab culture focusing on the roles of women, including traditional ecological knowledge systems, resource management, socioeconomics, and utilization of ecosystem services.

We present the results of interviews with Marsh Arab women that reveal how the desiccation of the Marshes impacts their relationship with ecosystem services and resources. We illustrate how the loss of culturally significant resources and TEK adversely impacts their ability to supplement their family incomes. Lastly, we draw on the theories of social-ecological systems (SES) of resilience to evaluate the magnitude and frequency of repeated environmental and social disruption, and whether the ecology and social systems of the Marshes can maintain functions and controls.

Hope for the future of the Marshes lies in eco-cultural restoration efforts similar to those occurring in the Iraq Marshlands National Park near Chibayish. Ecological and cultural restoration is occurring due to the design of engineered water structures concentrating water inflows into the marsh area (UNAMI 2011). Marsh Arab village sites, water buffalo, reeds, and traditional lifestyles are rejuvenated with marsh rehydration, along with biodiversity and ecosystem services. Many people's long-term goal, as the region stabilizes, is to develop ecotourism to support the livelihoods and well-being of local Marsh Arab communities (Rubec 2013, Al-Assadi, *personal communication*, with Al-Mudaffar Fawzi, 28 September 2015).

In the Chibayish area, the marsh ecosystem is demonstrating its cultural and ecological resilience. Consequently, Marsh Arab communities in this area will be able to retain traditional knowledge systems and continue traditional management of the Marshes. Our research area in the Hammar marsh (south of Chibayish) remains desiccated. We recommend that rehydration efforts demonstrated in Chibayish be prioritized and extended throughout the Mesopotamian Marsh ecosystem. Simultaneously, any effort to restore the Marshes must also include the Marsh Arab communities and traditional management practices in this biocultural refugium that has existed since antiquity.

Hydrologic considerations and transboundary waters

The headwaters of the Tigris-Euphrates watershed originate in Turkey, Syria, and Iran, and support approximately 70% of the water entering the basin. The

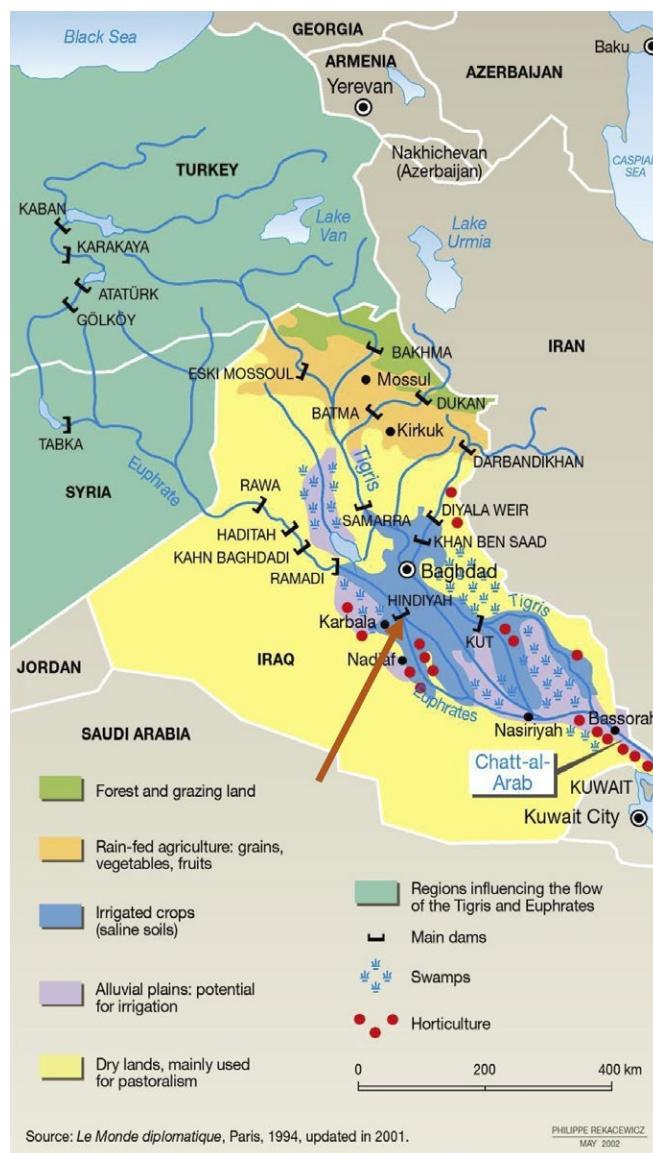


Fig. 1. Euphrates and Tigris River Basins headwaters originating in the Taurus Mountains of southeastern Turkey. The 2700 km Euphrates River and 1900 km Tigris River flow through Syria and Iraq, join together in the 193 km Shatt al Arab, and then discharge into the northwestern Gulf (Source: UNEP 2008). Arrow, Hindiyah Barrage, is a midway point on the Euphrates River; water quality (including higher salinity levels in soils and water) downstream of this point is increasingly impaired (Source: Saleh 2010).

three geographic areas of the Mesopotamian Plain include the Hammar wetlands; the Chibayish/Central Marshes; and the Al-Hawizeh and Al-Azim transboundary Marshes straddling the Iran–Iraq border (Fig. 1). The focus of this study was on the Hammar Marshes; water input to this area is derived from the Euphrates River originating in the Taurus Mountains of Turkey. Historically, the downstream Mesopotamian Marshes thrived from pulsed flood flows in the spring that renewed soil fertility, re-deposited sediment, and eliminated concentrated salts at the marsh surface (Al-Hilli et al. 2009). Unfortunately, upstream water diversions now eliminate the seasonal flooding that drove the ecological dynamics of the marshlands (Al-Ansari et al. 2012, Al-Ansari 2013).

In recent years, water flows into the Mesopotamian Marshes have been sharply curtailed by a series of trans-boundary dam construction projects, including Turkey's Southeastern Anatolian Project (GAP), Syria's Tabqa Dam, and Iran's Karkheh River Dam that desiccated the Al-Hawizeh transboundary wetlands on the Iran–Iraq border (Richardson 2010, Stevens and Salman 2015). The estimated water reduction to Iraq is approximately 80% (Al-Ansari and Knutsson 2011), with only 20% of Marshes remaining (Al-Handel and Hu 2015).

Basin-wide transboundary water management agreements between Turkey, Syria, Iran and Iraq are essential to sustain water supply and water quality in the Mesopotamian Marshes. Regional conflicts over water in the Tigris–Euphrates River basins are among the most

contentious in the world (Al-Ansari et al. 2012). Upstream dam construction has resulted in a permanent threat to human health and well-being, ecosystem services, and biodiversity that cannot easily be mitigated (Jones et al. 2008). Attempts to establish joint management of the Tigris–Euphrates basins have not succeeded, mainly due to the constantly shifting political situation and in part because of the complexity of the hydrologic regime (Lorenz 2006, Stevens and Salman 2015). The Iraqi government's original goals to restore 75% of the 1973 Marsh extent was found to be unrealistic, as there is not enough available water to meet restoration goals (Chenoweth et al. 2011). The uncoordinated and fragmented approach to re-flooding the Marshes has been disorganized and only partially successful (Keenleyside et al. 2012, Al-Mudaffar Fawzi and Mahdi 2014). Basin-wide transboundary water management agreements are essential to sustain both ecosystems and social systems.

Upstream water diversions, projected regional climate change, salt water intrusion, and water utilization by the oil industry have collectively reduced available water supply and quality for the Marshes (UNAMI 2011). Downstream users, with little available surface water, are forced to deplete their nonrenewable groundwater reserves, intensifying saltwater intrusion from the Shatt Al-Arab and contamination of freshwater. Water quality is adversely affected by irrigation return flows and untreated wastewater containing pollutants, agricultural chemicals, and high salinity (Rahi and Halihan 2009).

Marsh ecosystem services and biodiversity

The wetlands of lower Mesopotamia are comprised of shallow lakes and marshes formed on two large, flat and active fan deltas fed by the flows and flood of the Tigris and Euphrates Rivers and their distributaries (UNEP 2001). The Mesopotamian Marshes form an island of vegetation within a matrix of desert vegetation and dunes (Al-Hilli et al. 2009), providing essential resources for indigenous people as well as habitat for a diversity of plants, fish, and wildlife. The Marshes played a vital role in the maintenance of regional biodiversity in the Middle East, primarily because of their large size, the richness of their aquatic vegetation, and their isolation from comparable systems (CIMI 2010, Hamdan et al. 2010, Douabul et al. 2013). The Marshes are dominated by the common reed (*Phragmites australis*), an ecological and cultural keystone species, as well as *Typha domingensis*, *Scirpus littoralis*, and *Cyperus papyrus* (Alwan 2006, Stevens 2007).

Reeds are very resilient to environmental stressors; they re-appeared almost immediately after the rehydration of the Marshes. After years of desiccation, the Marshes have become more saline and both reed production and biodiversity have declined with reduced inflows. Resources for marsh inhabitants and wildlife habitat have deteriorated (CIMI 2010).

The Mesopotamian Marshes have played a vital role as a wintering habitat for migratory birds, supported globally threatened and endangered species, and sustained a productive shrimp and finfish fishery (UNEP 2001). Between 1 and 10 million migratory waterfowl and shorebirds have made their way in the winter from Siberian nesting grounds along the flyway to the Marshes and northern Africa (Scott 1995, Shattersfield et al. 1998, Salim et al. 2009, Porter and Aspinall 2010, Ararat et al. 2012). There are 22 species of globally endangered species and 66 at-risk avian species in the Marshes (UNAMI 2011).

Historically, the Marshes provided food and an important source of livelihood for Marsh inhabitants, sustaining an economically important local and regional fishery, providing spawning habitat for migratory finfish and penaeid shrimp. Marine and diadromous fish, dividing their life cycle between freshwater and marine habitats, occur in east Hammar because it receives water from both the Euphrates and Shatt Al-Arab Rivers (Hussain et al. 2006).

The FAO (1999) estimated that the total inland catch of fish in Iraq was 23,600 tons, with over 60% of the fish catch coming from the Marshes, compared to 10% in recent times (UNAMI 2011). Fish production in the Iraq inland waters declined by 50% between 1997 and 2002, and continues to decline (FAO-Iraq 2010). Negative impacts to fisheries in the Hammar Marsh are exacerbated by invasive species and elevated water salinity levels in the Marshes (Hussain and Alwan 2008, Hussain et al. 2009, Jawad et al. 2012, Al-Faisal and Mutlak 2014).

The wetland complex in the Hammar study area is now mostly desertified, with small remnant patches of reeds in a largely parched and barren landscape (Fig. 2a–j). Low flows in the Euphrates River contribute to increased saltwater intrusion from the Shatt Al-Arab and salinization of groundwater (Douabul et al. 2012, Al-Maaroji et al. 2013). Vegetation, fish and wildlife habitat, agricultural productivity, and ecosystem services have declined sharply.

Impacts of Marsh desiccation and conflict on Marsh Arabs

Many of the Marsh Arab communities that were exiled before the fall of the previous regime returned to the Marshes in 2003. Unfortunately, due to lack of water, the former political refugees became environmental refugees, forced into becoming internally displaced persons (IDPs) (Fig. 3). People fled their homes primarily due to lack of water rather than from security, conflicts, or lack of employment (UNESCO 2014).

Drought, water salinity, and pollution are the major factors preventing IDPs from returning to their original communities (UNESCO 2014). In the Marsh area encompassing Thi-Qar, Missan, and Basrah provinces, respectively, 81%, 33%, and 12% of IDPs were displaced due to water insufficiency. Migration is a desperate survival strategy against environmental degradation (UNESCO 2014).



Fig. 2. (a) Date palms near site 1. (b) Homes and water buffalo shelter surrounded by desertified marsh at site 2. (c) Canal and river at site 3. (d) Reeds by bank at site 7. (e) Family unloading reeds at site 7. (f-h) Village close to site 5 visited in 2013 shows desertification in the area and the approximately 2 km distance women and water buffalo walk to reach the nearest water source. (i) A tribal leader (sheikh) in front of a traditional guesthouse (mudhif) made of reeds. (j) Young woman tending to a water buffalo. Photographs a–e and i by Kelly P. Goodwin, photographs f–h and J by Nadia Al-Mudaffar Fawzi.

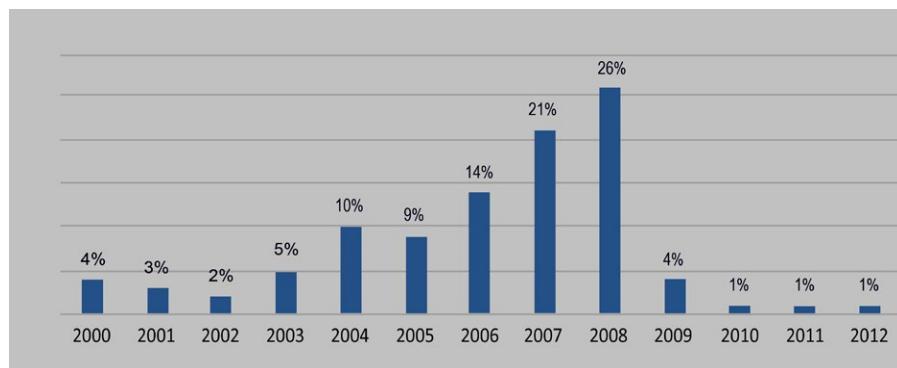


Fig. 3. Percentage of Internally Displaced Persons (IDPs) displaced by water scarcity (Source: UNESCO 2014).

The Hammar Marsh has higher salinity than the other areas of the Marshes (Douabul et al. 2013). Potable water becomes significantly unpalatable at Total Dissolved Solids (TDS) values that exceed 1.0 ppt (WHO 2003). The TDS baseline average in the Hammar Marshes in 1996 was 0.384–0.640 ppt; these levels had increased over ten-fold to unhealthy levels by the 1990s (Talal 2013). The Iraq Ministry of Water Resources engineered a diversion of the Euphrates River water to dilute TDS levels in Hammar Marsh, and TDS levels decreased to a more useful range 1.62–2.11 ppt in 2011. Inflows of additional water supply plus a good wet season improved water quality. While drinking water quality is not potable over 1.20 ppt, these TDS water levels are useful for limited agriculture, livestock, washing, and aquatic organisms (WHO 2003). Unfortunately the long-term salinity in the Marshes continues to rise, subjected to upstream water diversions and drought.

Marsh Arab culture, socioeconomics, and ecosystem services

In this turbulent environment, descendants of one of the oldest civilizations continue their struggle to survive and maintain their culture. This geographic area has been inhabited by the ancient Sumerian and Akkadian agricultural communities from 4000 to 6000 BCE (Ochsenschlager 2004, Hritz et al. 2012). Until recently the Marshes supported the traditional lifestyles of approximately 500 000 indigenous people—the Marsh Arabs.

The Marsh Arabs (also called *Ma'dan*) maintained a reciprocal relationship within the Marshes. They developed a unique way of life that tied them intimately to their environment (Stevens and Ahmed 2011). Traditional resource management included selective harvesting and burning of reeds on a seasonal and phenological basis, multiple-species management (reeds, fish, waterfowl, bird eggs, and rice), burning senescent vegetation to stimulate new growth, spatial and temporal restriction of fish harvest during spawning, and landscape patch management. These management practices were beneficial for reed growth and biomass production, maintained diverse patch dynamics, and increased microhabitat diversity.

As a result of this long history of human management, the Marshes are a culturalized landscape, with the selective harvesting of more than eight different sizes and textures of reeds, the use of fire, and hunting and fishing (Stevens 2007, Stevens and Ahmed 2011). These intermediate-scale disturbances have long been the key to ecosystem structure and function, providing important services for the local Marsh Arab population.

The only anthropological study specifically devoted to a part of the Marshes was published in Shakir Salim's "Marsh Dwellers of the Euphrates Delta." Salim lived with the Marsh Arabs during 1954–1955, and classified

the inhabitants occupationally into cultivators, reed-gatherers, and buffalo breeders (Salim 1962). According to Salim, 82% of households fished, 49% hunted, 66% farmed, 58% cultivated crops for food, 75% used reeds, 78% kept animals or birds, and 2% worked for a wage. Salim observed that traditional Marsh Arabs burned and cut reeds to obtain fodder for their water buffalo. Reeds were also used for building boats and rafts, houses, guesthouses and weaving mats, and baskets for sale. Salim (1962) estimated that about 40,000 mats were used for huts, 12,000 for guesthouses, and 10,000 for annual export. These qualitative data are indicative of the extensive ecological impact of reed harvesting and traditional management on marsh culture and ecology.

Traditional activities are important to the local economy and have brought in more than \$7.3 million per annum (Maltby 1994, Nicholson and Clark 2002). The major indigenous economic activities conducted by Marsh Arab families are fishing; raising water buffalo; collecting and processing reeds for buffalo fodder and home construction; and creating and selling handicrafts such as reed mats, baskets, fans, and pigeon houses to derive a livelihood.

Ancient Mesopotamians used a wide variety of plants for a range of medicinal, culinary, and magical uses (Potts 1997). In modern Mesopotamia, Marsh Arab also used plants from the marshes for medicinal and healing purposes, including the following: *Bacopa monniera*, *Cyperus rotundus*, *Ceratophyllum demersum*, *Nymphaea alba*, *Mentha aquatica*, *Nasturtium officinale*, and *Phylla nodiflora* (Al-Mayah and Al-Hemeim 1991).

Methods

To date, most of the documentation of Marsh Arab society has been generated from men interviewing men. This study breaks this trend by documenting and presenting data obtained through female researchers interviewing Marsh Arab women. This distinction is significant because Marsh Arab culture is a gender-separated society, where knowledge and responsibilities are different for women and men (Salim 1962, Young 1977, Fernea 1989). Since 2003, many organizations with the United Nations, NGOs, and international donors have conducted needs assessments of Marsh Arab women to determine their need for services such as clean water, health, education, and employment. This is the first study to specifically document Marsh Arab women's cultural relationship with marsh ecological services.

In our study design, we interviewed Marsh Arab women to compare traditional knowledge from the time the Marshes were hydrated and resources were abundant, to contemporary cultural knowledge and activities occurring after the Marshes were desiccated. To understand the impact of marsh desiccation on women's lives,

we asked the questions: How has the desiccation of the Marshes impacted women's interaction with the environment? What are the ways in which women previously benefited from the ecosystem services provided by the Marshes, but are no longer able to do so? How have these changes affected the generational transmission of traditional cultural knowledge among Marsh Arab women?

We conducted onsite semistructured interviews of 34 women of varying ages who currently live in the Marshes—or what used to be marshland. For their security, the identity of all women interviewed is kept anonymous. While there is no Human Subject Review (HSR) process in Iraq, we followed the intent of the HSR protocols of respecting the human subjects' sovereignty and anonymity. We present the information they provided in a general enough way to protect individual identities while retaining information relevant to this research. All interviews were conducted by women researchers in Arabic and were audio recorded.

The interviews were obtained in the Hammar Marshes north of the city of Basrah (Fig. 4a). Sites 1–7 are located west of the Shatt Al-Arab in the Hammar Marsh in Iraq's Basrah province. Sites 8 and 9 are on the border between the Hammar Marshes and Chibayish/Central Marshes. Researchers noted the proximity of the nine village sites to water and wetland resources. Field observations noted that sites were surrounded by water, on the banks of distributary channels feeding the Marshes, or were in drained Marshes.

Interviewees were selected according to the researchers' ability to access Marsh Arab women. They were selected randomly and opportunistically. This required a trusted contact providing introductions to relatives or tribal leaders who presided over the area. Upon arriving at a site, the researchers requested contact with older women for the interviews, as they had direct knowledge of life when the marsh ecosystem flourished, as well as life after marsh desiccation. While interviews were being conducted, other women in the family and neighbors came out of curiosity and were added to the interview pool. Some women were from other tribes or areas in the Marshes, expanding the demographics of the interviews. Overall, the interviewees were eager to answer questions and talk about their lives; only a few women declined the request for an interview.

Thirty-eight interviews were conducted in total. The data from four interviews was subsequently removed because of failure to meet quality assurance standards of the study; thus only 34 cases were included in the data analysis. Individual interviews averaged 17 min in length. Interviews were conducted in the field during 5 days distributed between December 2013 and February 2014.

Interviews concentrated on the following six variables, each representing activities of women in the Marshes: (1) Gathering Reeds/Handicrafts, (2) Animal Husbandry, (3) Fishing, (4) Agriculture, (5) Selling goods at the market, and (6) Utilization of locally available medicinal herbs

(see Appendix S1). Interviewees were asked whether they participated in each of these activities during the time when marsh ecosystems were hydrated and then if they currently engage in these activities. This enabled the researchers to evaluate changes in women's interactions with the marsh environment before and after desiccation.

1. **Gathering Reeds/Handicrafts:** At one time reeds for handicrafts, wildlife and water buffalo forage were plentiful. Reeds were used for water buffalo fodder, house and mudhif construction, sun shades, winnowing trays, and reed mats; and young, tender reeds were enjoyed as a snack (Hritz et al. 2012). Historically, handicrafts made of reeds were a significant part of the Marsh Arab lifestyle and economy (Kubba 2011). According to archaeologists, the techniques used to create these products are passed down through families from the time of the Sumerians (Ochsenschlager 1998, 2004). There are regional differences in Marsh Arab handcraft traditions. The Marsh Arabs of Basrah and Thi-Qar regions are famous for reed products, whereas in Maysan weaving wool carpets was more traditional (UNEP 2009). The women in the Hammar Marsh primarily made woven items from reeds or date palm fronds (*Phoenix dactylifera*). They used reeds to make mats, hand fans, serving platters, baskets for dates and other foods, and other items (Fig. 5a–c).
2. **Animal husbandry:** Most Marsh Arab families raised the iconic water buffalo (*Bubalus bubalis*), and some also raised chickens, cattle, and sheep. Women were generally responsible for feeding them (Thesiger 1964). Women used the high-fat water buffalo milk to make a variety of dairy products and used buffalo dung to make patties for fuel (Alwash 2013).
3. **Fishing:** Many Marsh Arab families fished for their subsistence from the rich biodiversity of the Marshes, and some would sell fish in the markets. Fish caught in the Marshes provided approximately two-thirds of the nation's fish catch (Kubba 2011). Fishing was generally a male-dominated activity, although some women also fished or played a supporting role, helping handle the fish once they were in the boat.
4. **Agriculture:** Marsh Arabs who lived on the edges of the Marshes benefited from both wild harvesting of reeds and agricultural activities. Agriculturalists utilized irrigated alluvial plains, tributaries to adjacent rivers, canals, marshes, and permanent lakes). Local agriculture included growing wheat, barley, corn, rice, dates, and citrus (UNEP 2009, Garstecki and Amr 2011). Women worked in small-scale family owned fields close to where they lived.
5. **Market:** While some families considered it undignified to sell in the marketplace, others sold items and then bought family necessities with the supplemental income (Alwash 2013). Usually, women would sell fish, dairy products, and handicrafts such as reed mats.

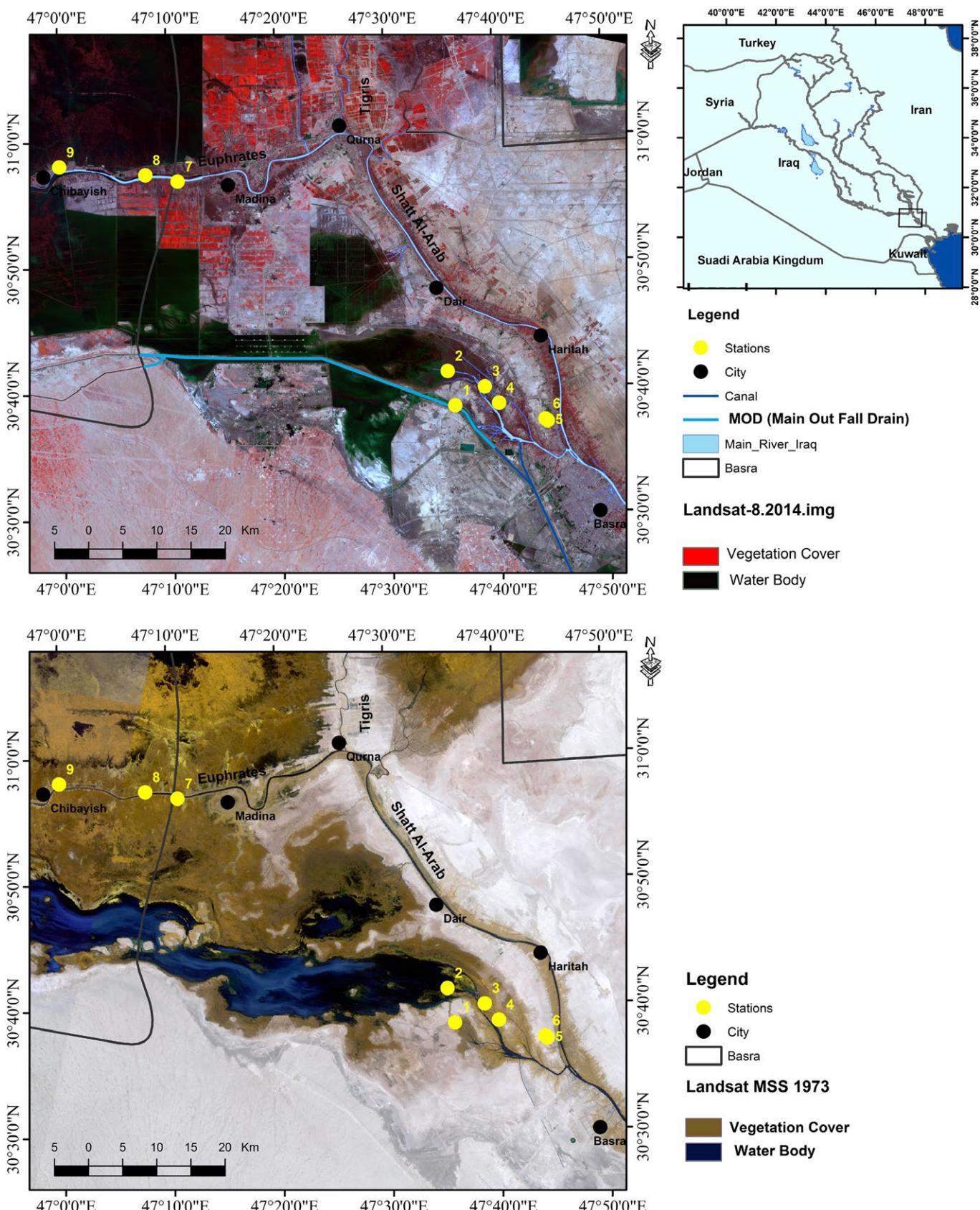


Fig. 4. Sites (numbered 1–9) of the villages visited in the Hammar marsh for women interviews. (a) The sites at the time of the interviews in 2014. (b) The same sites taken by Landsat MSS 1973 before the desiccation of the marshes. The villages were very close to water bodies and surrounded by vegetation cover. Sites 8 and 9 are close to the Central marshes and the newly designated Iraqi Marshlands National Park.



Fig. 5. (a) Marsh Arab woman weaving pigeon homes from reeds (site 8). (b) Reed mats and pigeon homes ready for sale (site 8). (c) Kelly P. Goodwin with Marsh Arab women (near site 5). Photographs by Kelly P. Goodwin.

6. Medicinal plants: Since antiquity, marsh ecosystems provided medicinal plants that benefited the health of the Marsh peoples. Historically, a village or region would have a woman knowledgeable in the uses of medicinal plants (Kubba 2011). The local herbalist would diagnose and administer herbal remedies from locally available plants (Fernea 1989, Al-Assadi, pers. comm. with Al-Mudaffar Fawzi, 28 June 2015).

During data analysis, the term “Domestic” was added to the other variables as a term that many women used to describe their current status. This is the designation for women who describe themselves as no longer doing the above activities because they “stay at home.” For young women, this denotes that they take care of the cleaning, cooking, and children. For older women, their status allows them to stay home and let others care for them, or have responsibility for light work around the home.

With the exception of “Domestic,” the abovementioned activities were central to the Marsh Arab lifestyle during the thousands of years the marsh ecosystem was intact. Other iconic Marsh Arab activities such as bird and boar hunting and boat making were male-dominated activities and were not included in our interviews, as this research emphasizes women’s interaction with the environment. Socially, men’s and women’s duties were

divided, and the division of duties varied among tribes and regions.

Results

Thirty-four women from a range of social statuses and life stages were interviewed. Special emphasis was given to interviewing women over forty, who participated in the marsh lifestyle as adults or young adults before 1991 when the Marshes were intact. Table 1 presents the number of interviewees per location, distribution of age groups juxtaposed, and proximity to water sources.

More than half of interviewees were over fifty years of age. Born before 1964, these women lived in the Marshes up to the 1980s when the country was embroiled in the Iran-Iraq war adjacent to the Shatt Al-Arab. These women have a living cultural memory and traditional knowledge of the marsh environment prior to the desiccation in the 1990s. They offer an unrecorded and unique “memory landscape,” providing a representation of life and cultural activities specific to women and family life in the intact Marsh ecosystem. We juxtaposed the knowledge and lifestyle of younger women to these. Proximity to water was older women, to provide us the ability to observe changes in the lives and activities of Marsh Arab women before and after the Marshes were desiccated.

Table 1. Marsh Arab women interviewees: location of interviews, distribution of age groups, and proximity to water were estimated using GPS coordinates.

Location number	Number of interviews	Approx. distance from water (meters)	Age 10–19	Age 20–29	Age 30–39	Age 40–49	Age 50–59	Age 60–69	Age 70 +
1	4	1400	1	1		1			1
2	2	250						2	
3	3	40			1		1	1	1
4	7	30	1	2	1	1	1	1	1
5–6	8	1700–2000					5	1	2
7	7	200		3	1	1	1	1	
8	1	150				1			
9	2	500		1			1		

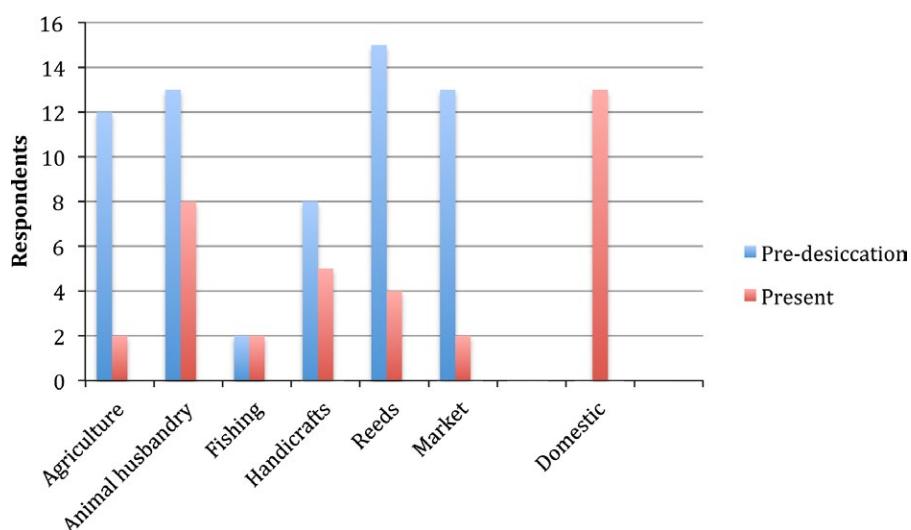


Fig. 6. Women's activities and changes that occurred, comparing the time period when the marshes were hydrated to the time period after marsh desiccation.

Traditionally, women took an active role both inside and outside the home, sharing the responsibility of providing for the family by working in the fields, gathering reeds, caring for water buffaloes, and selling fish, dairy products, and handicrafts in the market. Women's lifestyles and interactions with the environment have changed drastically after the desiccation of the Marshes (Fig. 6). With the loss of wetland ecosystem services, women's lifestyle has changed to staying in the home and caring for household activities. Today, very few women continue to engage in activities that include the traditional knowledge and practices that integrate with the marsh environment and water buffalo. Many women now describe themselves as having primarily domestic responsibilities; no respondents reported this activity prior to desiccation. The frequent response was: "I am just at home." The exception is the women living in Sites 8 and 9 close to the restored

Marshes near the Chibayish area, where they continue to occupy themselves with traditional marsh-related activities.

Two points are illustrated by Fig. 7. First, before marsh desiccation, women's lives were integrated with environmental resources. Women engaged in activities that utilized local ecosystem services and helped manage and maintain the productivity and resilience of both the ecosystem and cultural system, promoting a long-term sustainable subsistence economy. Second, women with the cultural knowledge and skills for subsisting and producing a livelihood from marsh ecosystem services now no longer utilize this intellectual capital. Most of them are no longer teaching this traditional knowledge to their children, families or communities. Traditional management and gathering of culturally important materials also contributed to physical freedom, health, and well-being for the women and their families.

Older Women Comparison

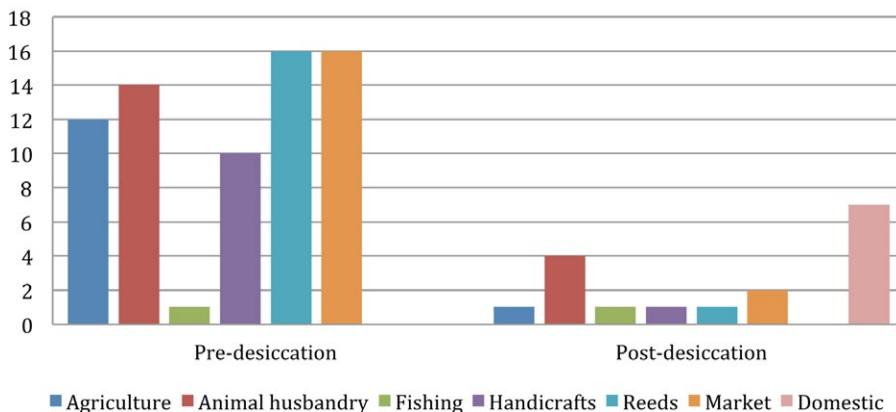


Fig. 7. Change in women's activities, before and after desiccation of the Marshes. This figure compares the activities of older women (aged 40 and older) who retain cultural knowledge from before the drainage of the marsh environment.

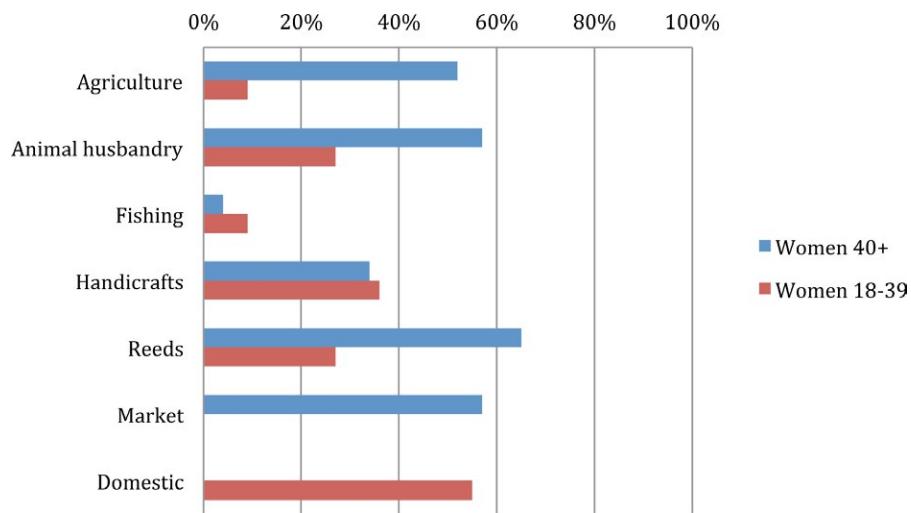


Fig. 8. A comparison of the previous activities of the older generations when women were younger and the Marshes were hydrated, with contemporary activities of younger women after Marsh desiccation.

To assess the change in women's interactions with the pre- and post-desiccation environment, we compared what older women described as their daily activities before the Marshes were desiccated with younger women's current activities (Fig. 8). This comparison of women's activities has the advantage of comparing similar life stages and ages, when they were either recently married or had young children. The majority of the older women (40%–70%) reported having participated in agriculture, animal husbandry, utilizing reeds, or selling goods at market. Today, less than 40% of younger women participate in these activities. While most women reported having sold goods at the market during the pre-desiccation period, there are no longer any women who engage in this activity. Also, while no women over 40 reported having been "domestic" during the pre-desiccation period,

almost 60% of younger women currently describe their activities as exclusively domestic.

We compared activities of older women when the Marshes were hydrated, to current activities of younger women when the Marshes are desiccated. Women traditionally continued these activities into old age, as the only retirement system is respect and care for the elderly by family and community members. Changes in activities of older women are attributable to a mixture of becoming respected elders, health issues, and desiccation of the Marshes. When older women gain social status as matrons, much of the work in the home is done by younger women in the family as a sign of respect. Also, older women sometimes have health issues that prevent them from engaging in physically demanding activities. Many of the women we interviewed who were over 40 described

themselves as “elderly” and thus no longer participated in these activities. One 58-year-old interviewee explained: “I get up and do light work. I can’t anymore... I am an older woman now... Light work, like cooking food, I get up and make dough to bake bread, and so on” (Interview by Goodwin and Al-Mudaffar Fawzi with Interviewee #1 at Site 4, Hammar Marsh, December 17, 2013).

Discussion

The data demonstrate that Marsh desiccation has resulted in a distinct decrease in traditional ecological knowledge (TEK) and traditional resource management by Marsh Arab women, leaving few opportunities to engage in traditional activities. TEK provides great cultural significance and socioeconomic benefits to Marsh Arab women and their families. While some TEK is still utilized today, most traditional knowledge is being lost due to lack of application. A clear example of this is that there are no longer traditional uses of medicinal plants by women. Other traditional ecological practices that are at particular risk include: rhythms of seasonal reed harvest and use, handicraft construction and sale from reeds, water buffalo husbandry and dairy production, and agricultural production. It may take only one generation for these practices to be forgotten, as the younger generation is not being taught how to perform them. The tribal leader of Sites 5 and 6 commented, “These women would not return to the Marshes... They do not know [how to live there anymore]” (Interview by Goodwin and Mehdi with Tribal Leader, Site 5, Hammar Marsh, February 17, 2014).

We evaluated the following information, based on field interview data, with the same organizational structure as reported in *Methods*.

Gathering reeds/handicrafts

Of the women interviewed, 59% (20 of 34) either never learned how to make traditional handicrafts or have discontinued making them (of the 8 who used to make handicrafts, 6 have discontinued). Reed production has declined precipitously, creating a lack of materials for handicrafts such as baskets or mats, construction, shelter, or livestock fodder (Pournelle and Algaze 2010). Today reed mats are only occasionally seen on rooftops to provide shade for plastic water containers. Even in one of the most restored areas, an interviewee’s relative observed: “There are fewer handicrafts because there are fewer reeds” (Interview by Goodwin and Mehdi with Marsh Arab man, Site 7, Hammar Marsh, February 19, 2014). In areas where the Marshes are still flooded, some families are still able to make a meager living from sale of reed items. An interviewee weaving pigeon houses while we spoke with her told us that it takes her

an hour to weave each house, which she sells for approximately \$3.32 US. Even so, she said sales are few and hard to come by these days.

Animal husbandry

Many families continue to keep animals, particularly water buffalo, though on a much smaller scale, and this activity appears to be no longer sustainable. In Site 5, one family used to keep 21 water buffalo, but now only two remain. Buffalo often get sick from the polluted and saline water and die. Because there are so few reeds, many families sell one buffalo in order to buy fodder and water for the remaining buffalo. The Basrah buffalo dairy closed down because of the decreased availability of buffalo milk. When asked whether she sells buffalo milk, one interviewee said: “No, there is no milk. They are so thin, how can they have milk? We don’t sell milk” (Interview by Goodwin and Mehdi with Interviewee #1 at Site 8, Hammar Marsh, February 19, 2014). According to UNAMI (2011), there used to be 80,000 buffalo, but now only 5,000 remain. In some areas, the government provides fodder for families with animals. Those who can afford it purchase cut reeds and fodder to give their animals, allowing them to raise animals without depending on their local marshes.

Fishing

Only 2 out of 34 (5%) interviewees currently engage in fishing. These two women live very close to water (Sites 8 and 9), with reeds and marshes available to them (Fig. 4a). For most of the Hammar marsh area, fishing is no longer a significant activity in which marsh inhabitants are able to participate. Fish populations in these areas are drastically reduced due to environmental degradation, overfishing, and invasive species (UNAMI 2011).

Agriculture

Since 2003, when Iraqis began reflooding the Marshes, many Marsh Arabs began small-scale agricultural production for the first time as land became available for cultivation. Most agriculture consists of small-scale farming or horticulture on land adjacent to the families’ homes. In 2009, 22% of former marshland was being used to grow wheat or vegetables on land that used to be under water, now dry (CIMI 2010). Areas that were formerly agricultural are now desertified due to increased salinization. For example, Site 3 used to be productive agricultural land, with residents growing rice, vegetables, fruit, and henna. Today, most of these agricultural activities have been discontinued due to salinization of soil and water.

Market

Marsh Arab women who sell in the market primarily offer fish and buffalo dairy products in the main markets of urban cities, while some sell fish from door to door in the suburbs. They also sell reed baskets, hand fans, and mats; the availability of reeds depends on water availability. Prior to the 1990s, young women would sell goods in the market; now, most of the women who sell in the market are older women.

Medicinal herbs

Of the interviewees in this study, only one old woman remembers using a locally available plant for medicinal purposes. Most village women with the social memory of gathering and utilizing medicinal plants for healing have died, and no one has taken their place. Instead, families go to nearby government clinics to receive treatment and pharmaceutical medication for illnesses.

Domestic

None of the interviewees described themselves as engaging in domestic activities during the pre-desiccation period. Most Marsh Arab women now commonly stay at home and leave the financial support of the family completely to the men. There appear to be two primary reasons for this shift. One is a cultural shift throughout Iraq toward Islamic conservatism, in which families do not want their women in public areas where they would be exposed to men to whom they are unrelated. The second is a lingering fear from the ongoing volatile security situation. As one interviewee commented: "I have come to be at home. My husband works, so I do not go out anymore" (Interview by Goodwin and Mehdi with Interviewee #3 at Site 7, Hammar Marsh, February 19, 2014).

The withdrawal of women from activities that helped sustain the family through the creation and marketing of goods leaves the family economy entirely dependent on men. Sources of earning a livelihood are very limited for men as well, and many are unable to secure jobs. Not only is intellectual capital being lost, but women's ability to assist the family economy is not being utilized. The family suffers from poverty and lack of opportunities to earn a livelihood.

Currently, marsh residents over-exploit the limited biological and environmental resources available to them in order to survive. In addition, ongoing oil exploration and development is very water-intensive and has exacerbated the desertification process, depriving the local communities of potable water. This leaves the Marsh Arab women with few opportunities to engage in traditional activities.

The Mesopotamian Marshes have dealt with significant change and threats over the millennia, each time adapting, recovering, and arising again (Pournelle and Algaze 2010, Alwash 2013). Traditional resource management was integral to fostering the resilience, adaptability, and sustainable harvesting of resources from the marsh ecosystem. Without traditional resource management (such as marsh burning practiced by humans over the millennia), reeds and aquatic plants become decadent and the quality of fish and wildlife habitat diminishes. Observations of the interaction of humans with their environment continually reveal a reciprocal relationship in which the social system impacts the environment and the environment shapes the social system (Rammel et al. 2007).

The historic reciprocal relationship between Marsh Arabs and the Mesopotamian Marshes is threatened by large-scale transboundary water diversions and regional climate change causing regional desiccation of the Marshes. Social and environmental stressors on the Marsh system have degraded the resilience and adaptability of the Marshes into a simplified, impoverished, and degraded state. In addition, regional conflicts are creating large-scale disintegration of the social system, which once managed and harvested marsh resources. The adaptability of an ecological system is greatly determined by human actions and management (Walker et al. 2004). If humans manage for resilience, the system remains sustainable. If not, the system degrades, becomes depleted, and cannot provide sustenance for human inhabitants. In the case of the Mesopotamian Marshes, the magnitude and frequency of catastrophic change has resulted in an altered system that is unlikely to recover. In most areas of the Hammar Marsh, ecological and social resilience and integrity are spiraling into disorganization and dissolution. This is the moment in which the social-ecological system of the Mesopotamian Marshes and the Marsh Arabs find themselves.

For the Marshes, a primary question will be whether the social-ecological system is resilient enough to establish a new stability to the Marsh system (Walker et al. 2004). Life-giving inflows are required to sustain the Marshes. In the case of Iraq Marshlands National Park, restoration practices are emerging that appear to successfully restore social and ecological systems (Hamdan et al. 2010, Keenleyside et al. 2012). The hydrologic modifications engineered to provide inflows to the Marshes require careful monitoring and adaptive management to ensure they are sustainable.

Conclusion

For Marsh Arab women to continue to play their traditional roles in their community, and to preserve cultural traditional knowledge for future generations, assistance is needed from local and national government to rehydrate and manage portions of the Marshes as cultural and environmental heritage sites.

For traditional ecological knowledge to be maintained, preservation of the ecological landscape is essential. TEK systems are increasingly acknowledged for their contribution to sustaining biodiversity and ecosystem services, and to building resilience in the face of environmental changes (Gomez-Baggethun et al. 2013). What is needed is both adaptive management and adaptive governance that will foster resiliency and transformability so that the Mesopotamian Marshes and the Marsh Arabs can continue to constitute a mutually beneficial socioecological system (Walker et al. 2004). Some issues that will need to be addressed are problems posed by pollution; salinity; impaired water quality and quantity; regional and international government policies affecting water releases into the marsh areas; and exploitation of oil reserves (Adriansen 2004). Above all, the Marshes need a consistent and reliable water supply, with a mechanism to enforce release of water to Iraq from upstream countries. Iraq also needs to work with relevant international organizations to develop programs to support the Marsh Arabs. Women, in particular, need assistance to maintain their cultural traditions and source of earning a livelihood to improve their health, education, and well-being.

Results from our research illustrate the intrinsic connection between the ecological health of the Marshes and the continuance of ecological cultural traditions of Marsh Arab women and families who live in the Marshes. Iraq Marshlands National Park is a prototype of successful ecological and cultural restoration, demonstrating that when enough water remains to sustain the Marshes, cultural knowledge has been retained and passed on to future generations. We recommend that programs be implemented to preserve these traditional skills, to develop a market for handicrafts to support women and their families, and to support cultural knowledge. Otherwise, with the passing of the older generation, these remnants of ancient Sumerian knowledge systems and traditional ways of life will soon be forgotten.

Acknowledgments

Dr. Nadia Al-Mudaffar Fawzi would like to thank the Marine Science Centre for providing partial funding to support Kelly Goodwin's field work and project logistic support. Dr. Michelle Stevens would like to thank the CSU Sacramento Provost's Research Incentive Fund for partial support for this project. The authors would also like to thank Mr. Meelad A. Hussein, Iraq Marine Geology Department, for providing the map of the Marshes and study sites, and Mr. David Merritt for manuscript editing.

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