Exploring Program Sustainability and Impact Twelve Years Later

USAID Iraq Marshlands Restoration Program (IMRP)

November 2018

DAI

Photographs on cover page:

Top left: Truckload of tilapia, an invasive species, caught in Central marsh and destined for sale in middle Iraq governorates.

Top right: Date palm offshoots in a nursery in Maysan governorate, initially planted by IMRP in 2006.

Lower left: Buffalo wading in Hawaizah marsh, Basra governorate.

Lower middle right: Ecosystem monitoring team's ornithologist taking photos of aquatic birds in East Hammar marsh.

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The impact assessment team in a traditional, newly built guesthouse found only in the southern marshlands of Iraq

The team would like to thank a number of people at DAI, who gave us a remarkable opportunity to revisit the Iraq Marshlands Restoration Program more than decade after it closed, and others in Iraq, who could not have been more welcoming as we explored the complexities and nuances of development.

Bruce Spake, Vice President for the Middle East, North Africa, and Afghanistan Region, and Tamara Stanton, Managing Director for New Business, offered constant encouragement and support, even adding a major ecosystem monitoring component months after the assessment had begun, agreeing that it would enrich the overall effort.

Zan Nothrip, Senior Vice President of the U.S. Government Business Unit, approved carrying out the assessment initially. Megan Kehs, Regional Finance and Operations Manager for MENA/Afghanistan, kept the activity in motion by magically having key paperwork for team members appear at strategic times.

Kurt Olsson, Chief Growth Officer for Global Health, was the initial mover behind the assessment. It was he who first thought of conducting a number of post facto explorations of program sustainability and was a behind the scenes advocate from the beginning.

The assessment could not have taken place without Ali Sada, Principal of IRFAD. He generously agreed to ensure that the team had an administrative structure that provided the 13 Iraqi team members with

smooth, professional support. From the start, he believed this assessment would be a contribution to national rebuilding and national healing and was dedicated to making it as useful as it could be.

In Iraq, the General Manager of the Center for the Restoration of Iraqi Marshes and Wetlands in Baghdad, Engineer Smera Abed Shebeeb, offered valuable assistance and clarity in our discussions about the center's past efforts and future activities. Working under severe resource constraints, her commitment to the marshlands is an inspiration to all who know her. The Dean of the College of Agriculture at the University of Basra, Professor Nawfal Abdulameer Hussain Al Haleffi, was constantly gracious in offering his needed assistance. We are indebted to them both.

We are also pleased to acknowledge the engaged interest and important assistance of the managers of the agricultural offices in the three southern governorates of Maysan, Dhi-Qar, and Basra, where IMRP operated more than a dozen years ago. The field and office visits by the impact assessment and ecosystem monitoring teams were enriched by their active support and knowledge.

Our thanks also go to the manager of the Basra branch of the Center for the Restoration of Iraqi Marshes and Wetlands and to the Chair of the Department of Ecology, College of Science at the University of Basra for giving up their valuable time and help.

Finally, we would be remiss not to thank John Wilson of the USAID Bureau for the Middle East who shepherded the Iraq Marshlands Restoration Program for the U.S. government more than 15 years ago. We remain indebted to him for his constant encouragement, support, and wisdom. Finally, we want to express our gratitude to Andrew Natsios, then USAID Administrator, who was deeply concerned about the plight of the Marsh Arabs and the state of the marshlands and was steadfastly supportive of the program.

We hope that our understanding of IMRP sustainability and impact will be used by donors and governments to develop and carry out new and improved initiatives in this truly unique and tragically fragile region.

Najah A. Hussain and Peter Reiss, editors

Abbreviations and Terms

ABRI	Advancing the Blue Revolution Initiative
ANE	Asia and Near East
ARDI	Agriculture Reconstruction and Development Program
BOD	Biochemical oxygen demand
CIDA	Canadian International Development Agency
CRIMW	Center for the Restoration of Iraqi Marshes and Wetlands
DO	Dissolved oxygen
donum	2,500 square meters
FABRI	Further Advancing the Blue Revolution Initiative
HEC	Hydrologic Engineering Center (USACE)
IMRP	Iraq Marshlands Restoration Program
mudhif	reed constructed guesthouse
MOWR	Ministry of Water Resources
NTU	Nephelometric turbidity unit
pH	Hydrogen potential
ppt	Parts per thousand
psu	Practical salinity unit
TN	Total nitrate
TP	Total phosphate
UNEP	United Nations Environmental Program
UNHCR	United Nations High Commissioner for Refugees
USAID	U.S. Agency for International Development
USACE	U.S. Army Corps of Engineers

Summary

The USAID Iraq Marshlands Restoration Program (IMRP) is the only broad based development initiative to have been carried out in Iraq's southern marshlands since the U.S. invasion in 2003. While active, IMRP was frequently lauded within the U.S. government and by other donors, and it attracted a level of global media attention that was unusual for an effort of its kind. But during the 12 years since it ended, there has not been a single major environmental, social, or economic initiative in the marshlands.

Typha domengensis in Central marsh

International contributions have been meager, with only small pools of funds offered by a handful of donors. Resources and assistance from the Government of Iraq to the region have also been limited.

IMRP's scope was ambitious: to design and implement a strategy to restore what had been one of the world's largest wetlands and bring a wide range of economic and health resources so desperately needed to its population. There was widespread consensus that the program made significant contributions to our understanding of damaged ecosystem dynamics; made strides in breathing new life into long isolated institutions; dramatically improved the livelihoods of Marsh Arabs in agriculture, livestock herding, and capture fishing; and improved their health.

Given that the program ended more than a decade ago and that little additional funding has reached the marshlands, a question arises: What remains of the apparently successful, or at least well-meaning and promising, initiatives introduced by IMRP? Is there evidence of program sustainability? It is a question that is often asked about development projects but rarely answered.

It is highly unusual for governments, donors, or implementers to look back critically at their efforts years later. There are few examples of post-program impact assessments that measure long-term program sustainability. Contrary to this usual pattern, DAI decided on IMRP's tenth anniversary to self-finance an impact assessment that explores what happened to the wide range of ostensibly successful interventions that were introduced during the program's three-year life.

Development assistance is inherently unstable. Project-limited funding ends, staffing shifts, national and local priorities change, and international donor interest focuses elsewhere. This report examines years later what happens after the all too usual course of events. Can and do the benefits and progress spurred by a development program continue? Discussions of project impact usually dwell on the nature of sustainability, as measured by continuity and longevity. This report explores sustainability, but it also examines how the program's initiatives may have become transformed in different ways. For example, alfalfa cultivation introduced into the marshlands by IMRP is clearly sustainable, since the area has remained sable for the past 12 years. The emergence of a dairy industry started by Marsh Arabs after IMRP ended is transformational. What initiatives introduced by IMRP have indeed taken hold and become woven into the fabric of Marsh Arab life?

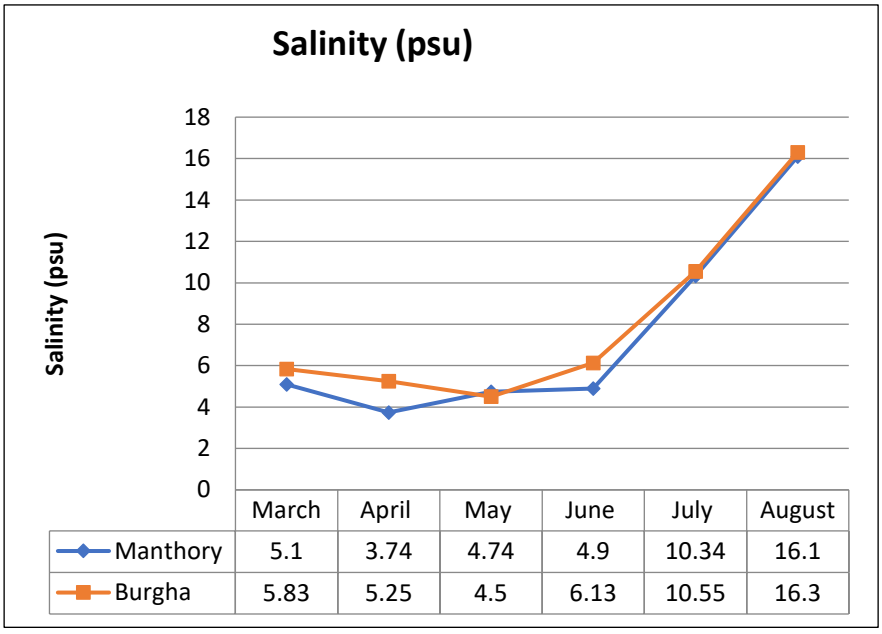
MARSH ECOSYSTEM MONITORING

The Marsh Arabs' livelihood has historically depended, and still depends in large part, on the products of the aquatic ecosystem. The marsh ecosystem even now supplies them with basic resources and physical access used daily and enables them to continue that life style into the future. Their basic requirements are crude freshwater, common reeds, freshwater fish, and water buffalo. These four factors are closely interrelated and require a relatively stable ecosystem.

Kentish plovers over East Hammar marsh

Our main task as a team was to evaluate the integrity of aquatic ecosystem of the southern marshlands. We established two research stations in East Hammar marsh: (1) a channel marsh that is important for fishing and transportation and has deep tidal water and (2) an open marsh with a vast shallow semi-diurnal tide that becomes nearly dry at ebb tide. The sampling was carried out over six months from March to August 2018, during which time we measured water quality along a number of different parameters and observed and recorded the presence of aquatic plants, phytoplankton, zooplankton, benthos, fish, and birds. And then we compared those findings with observations made under the Iraq Marshlands Restoration Program to determine population changes.

We found a sharp increase in water salinity in the marsh due to a decrease of Tigris and Euphrates discharge and an advancing of Arabian Gulf salt wedge inside the marsh. In August 2018, the salinity reached 16.1 psu, when it was previously around three to four ppt. Our analysis of phytoplankton, zooplankton, benthos, and fish, based on monthly data, indicated the invasion of marine species of different groups and the disappearance or withdrawal of freshwater native species originally inhabiting East Hammar marsh. The fish population of the marsh contained only two native freshwater fish species, while the rest were exotic and marine invaders.



	March	April	May	June	July	August
Manthory	5.1	3.74	4.74	4.9	10.34	16.1
Burgha	5.83	5.25	4.5	6.13	10.55	16.3

Water salinity levels in East Hammar marsh

This increase in water salinity will eventually destroy the livelihood of the Marsh Arabs. Common reeds can tolerate salinity up to 25-35 psu. If the trend continues, the reeds are going to diminish or disappear from the marsh. With no fodder for the buffalo, the present large herds in the marshes will also disappear, as will local dairy production and a major part of their diet. Furthermore, water buffalo need to be immersed in freshwater several times a day, not in the present increasingly saline water.

People in the marshes depend on freshwater fish as daily food. As a result of the increase in salinity, their favorite fish species, *Cyprinidae*, will continue to disappear, replaced by exotic tilapia and small marine fish. Marsh Arabs are already buying fish instead of fishing themselves.

Marsh Arabs are now buying drinking water for their domestic use and their buffaloes' consumption. They are also increasingly buying fodder for their livestock, when there was no need earlier. Some buffalo breeders on the southern banks of Shatt Al-Arab have started to migrate from region. Migration will grow if the East Hammar marsh ecosystem continues to change from freshwater/oligosaline to estuarine/marine.

INSTITUTIONAL SUPPORT

IMRP's efforts to support existing institutions were limited to the Ministry of Water Resources in Baghdad and the University of Basra and focused on interventions that could support the restoration of the southern marshes. In the chaotic atmosphere following the invasion, its activities shared a common goal: to provide immediate assistance for institutions to operate functionally again, rather than tackling endemic and deep rooted problems that grew out of governmental neglect and international isolation.

IMRP used it resources for the U.S. Army Corps of Engineering to develop a dynamic model to predict the impact of dam releases along the Tigris and Euphrates rivers, bolstering the ministry's new mandate to shift from an irrigation entity to one with a broader vision of water resources management. Within that same ministry, IMRP refitted its central soil and water laboratory that was virtually defunct. And it nominally supported a new center's efforts to have the southern marshlands be recognized by an international convention. In Basra, it refitted the water laboratory at the university, which then branded itself as a marshlands ecology laboratory that served faculty and graduate students in the research. It also attempted to establish a fish hatchery center at the university's Marine Science Center, with far less success.

Marshlands ecology laboratory at the University of Basra

In fact, IMRP's efforts were mostly very successful in the short-term. The hydrologic model was used by MOWR as its core planning tool for six years, until it no longer reflected fundamental environmental changes in Iraq. The ten ministry engineers who had been trained repeatedly by USACE either shifted to positions elsewhere or were overwhelmed by the requirements to rework the model. The ambitious and complex model could be used effectively but not upgraded. However, one might argue that for six years the model strengthened the ministry's ability to refashion itself and added to its expertise and credibility in

the long-term.

In contrast, re-equipping MOWR's central laboratories was a long-term success. After more 12 years, they are still in full operation and work on a fee for service basis. This approach has probably enabled them to constantly upgrade their equipment and continue to provide sought-after services in soil and water analysis.

At the University of Basra, the renamed marshlands ecology laboratory was a badly needed facility in an institution that had been racked by widespread theft by locals immediately after the invasion, stripping it of furniture and equipment. By June 2004, the laboratory was an empty room with some of its more valuable equipment hidden in faculty homes for safekeeping. The newly refitted laboratory successfully supported the research of faculty and of nearly two dozen students for advanced degrees. However, over time, the specialized scientific equipment needed to be upgraded or repaired but has not been. The operations of the fish hatchery at the Marine Science Center were disappointing during IMRP and fared no better after its conclusion. It was an investment made with great hope but sub-optimal results.

IMRP was correct to offer targeted assistance, rather than make major institution-building commitments in a ravaged country. It had neither the resources nor the time. Operating in war-like conditions, it traded illusory long-term sustainability for realistic short- and middle-term gains that, even so, lasted upwards of six years. Among its variety of initiatives, the soil and water laboratories in MOWR stand out a successful example of constant improvement and stability. IMRP served the purpose of helping to get the institutions moving again, but for how long depended on those institutions' ability and interest in bringing the resources together to meet longer-term goals.

AGRICULTURAL PRODUCTION

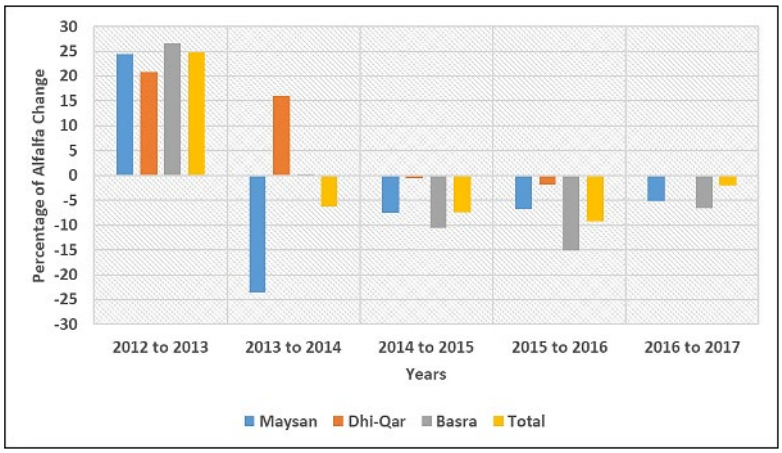
Maysan governorate date palm nursery in 2018 first planted by IMRP in 2005

Plans to develop a central soil-water database to be accessed by the public and private sectors never materialized. The Ministry of Agriculture and the University of Basra, the anticipated major players, never moved beyond the initial meeting stage. This is unfortunate because no single party now has the resources to initiate, maintain, and grow a data bank that can it update and share over time. Our ecosystem monitoring has revealed a relatively rapid shift in the marshlands from freshwater to estuarine habitats. A reversal, or even a limiting, of this trend requires unimpeachable data to elicit government and popular support for action. One of the successes of IMRP was to focus Iraqi scientific attention on the importance of southern marshes. Hundreds of scientific papers M.Sc. theses and PhD dissertations have dealt with various aspects of the marshes since 2006.

In sharp contrast, the demonstration of field crops - notably alfalfa and sorghum and the investment in date palm orchards was among the greatest achievements with the longest lasting impact of IMRP's many initiatives. The area of alfalfa cultivation in the three governorates in which IMRP worked soared from the initial 165 donums in 2004 to slightly more than 400 in summer 2006 to 30,000 donums in the season immediately after the project closed. The area continued to climbed steadily to nearly 40,000 in 2013, until the area fell from then to present 30,000. Alfalfa growing in the marshlands has been exceedingly popular, and one might argue that the current is largely a reflection of constraints. Increased soil and

irrigation water salinity, a rise in temperatures that reach 50° C during summers, and water shortages in some marsh areas account for the drop since 2013. Alfalfa requires a high quantity of water that is not available now in most of the marshes.

One might reasonably argue that if the water quantity and quality had remained constant since 2013, the total area cultivated with alfalfa would have risen higher. However, it appears that the sustainable ceiling for alfalfa cultivation in the three governorates is in the range of 30,000 donums, limited more by recent soil and water conditions than by farmer interest.



Percent of change in alfalfa cultivated area in the three southern governorates

Sorghum, also introduced by IMRP, has not seen a comparably explosive growth, but there has been a relatively stable growing area from 2012 to 2017, given available data, with bursts in 2013 and 2014. Sorghum can tolerate higher levels of salinity, but the water shortage has constrained and decreased overall cultivation.

Alfalfa and sorghum cultivation, introduced by IMRP, parallel increases in livestock birth rate and birth weight, lactation period, and dairy production, as the following chapter on livestock attests. Indeed, IMRP's design and implementation argued that green fodder cultivation would significantly improve animal health and productivity. That has shown to be the case.

IMRP also invested in the installation of eight date palm nurseries in the three governorates with from 500 to 1,000 transplanted trees in each. Planted and maintained by Marsh Arab tribal members, the palms had a survival rate of more than 90 percent by the program's close. However, of the eight nurseries that were supported by IMRP, four did not survive, the victims of intertribal conflict or oil drilling. The four that did survive have thrived and increased in size. All four nurseries have intercropped field and/or high vegetables, and the two in Basra also have plastic greenhouses. The owners of all four nurseries continue to honor an agreement made with IMRP and the directorates of agriculture in 2005 to distribute offshoots free of charge to others. However, the number of offshoots distributed has been too few to enable others to establish new nurseries, which was a longer-term goal of the program.

LIVESTOCK PRODUCTION AND VETERINARY SERVICES

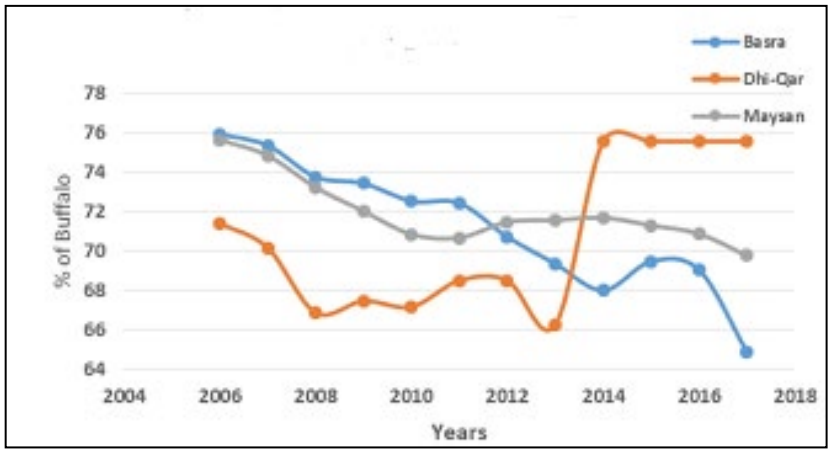
The livestock sector in the marshlands has seen dramatic improvement since IMRP ended in 2006. These changes are across the board: in the absolute number of livestock, in their increasing diversity, in greater birth weight and daily growth rate, in higher daily milk yields, and in longer lactation periods. There have been


Water buffalo at a homestead in the Basra governorate marshlands

accompanying advances in the closely related meat and dairy markets. Live weight and market prices for buffalo and cattle have increased three- to four-fold. And rising daily milk yields sparked the creation of cottage industries to produce dairy products using higher fat buffalo milk. These changes all point to an increasingly healthy and dynamic livestock sector in the marshlands.

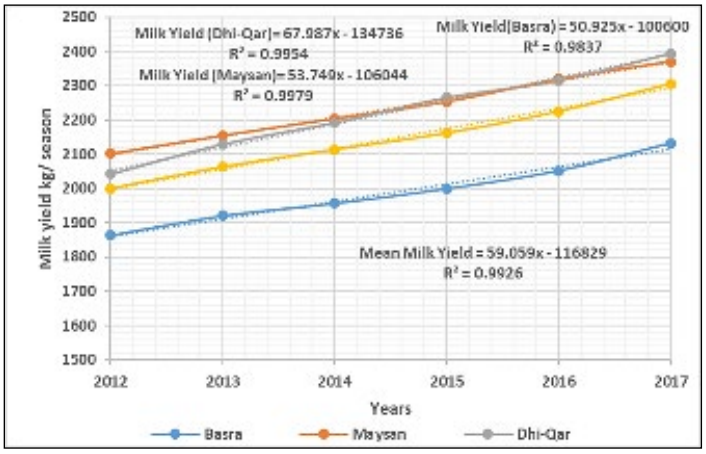
While many factors are undoubtedly at play, we believe that IRMP's introduction of green fodder, high protein crops – alfalfa and sorghum - in 2004 spurred these changes. Alfalfa is now a common part of animal diet, supplementing the increased levels of bran and straw. Estimated daily consumption of alfalfa by buffalo and cattle is three kilograms a head. The improvements in overall animal health and productivity were anticipated by IMRP, based on expert advice, and were among the program's core objectives.

However, other anticipated changes in the marshlands did not meet expectations. In 2006, IMRP predicted a strong shift away from the historical dominance of buffalo ownership to a more diversified pattern of ownership that included the relatively newly introduced cattle and a rapid increase in sheep holdings, making it the dominate animal. Instead, buffalo have continued to be the vastly most numerous animals owned in the marshlands. In 2017, they ranged from 65 to 75 percent of all livestock holdings. Greater access to reflooded marshes by buffalo herders and increased financial earnings realized from meat and dairy production may help to explain the continued reliance on buffalo ownership.



Percent of buffalo in overall livestock in three southern governorates

IMRP's introduction of a veterinary service dedicated to working in the marshlands villages was far less successful but reveals some interesting lessons. During the active period of the program, the veterinary efforts were highly regarded by Marsh Arabs, being the first time that the services were offered in the marshes. And the permanent recruitment of the five IMRP veterinarians by the agricultural directorate in Dhi-Qar governorate when the program ended would appear at first glance to be a sign of both success and sustainability. But it is only minimally so. The veterinarians do not travel to the villages, have no resources, or have their own store of medicine.



Milk yield trends (2012-2017)

Looking back, one might argue that providing free veterinary services to livestock owners was certain to be welcomed and successful but lasting only as long as IMRP did. IMRP initiated a service that was not financially sustainable. It met immediate demands, offering help to address emergency conditions immediately after the fall of the regime. However, the governorates do not have the resources to provide free and extensive services as IMRP did.

CAPTURE FISHING AND FISH FARMING

IMRP's efforts to revive a highly prized native fish species were well-intentioned but ultimately unsuccessful. It released only about four percent of the *bunni* fingerlings (130,000 out of 3,000,000) it had planned to. All of them were freed only into Hammar marsh.

Tilapia trucked from the marshlands to middle Iraq markets

While some were occasionally caught, confirming their viability, their number in fish catches decreased sharply over time. Likely, few if any are still left. The result is that the *bunni* population is nearly decimated. Still highly valued and demanding the highest price in markets, *bunni* are categorized as being "very rare." In current fish catches, they are most likely to be small, often only a year old. Overfished and not allowed to grow to maturity, the future seems increasingly dim. Their current state is perhaps the greatest disappointment to IMRP's legacy.

More generally, fish and fishing systems have gone through dramatic changes since the first Gulf War, nearly thirty years ago. The changes are likely to be permanent and accelerating over time. Native fish are quickly being replaced by exotic species, most especially two species of tilapia and three of carp. Equally troubling is the narrowing of fish diversity in the wild. Of the native species observed in the marshes in 2006, all of them have disappeared or are now rare or very rare, with the exception of freshwater mullet and catfish. Accidently introduced in 2005-2006, Nile and Red belly tilapia have both expanded quickly into the three marshes and are already very common. Trucks regularly transport large loads to markets in middle Iraq.

Over time, capture fishing has become less remunerative and less desirable as an occupation. Many fishermen are leaving to work other jobs. And fish farming is not much more attractive. Only a small fraction of the fish farms that were started in Basra and Maysan governorates are still in operation, the victims of poor water quality and increasing competition with imported fish from Iran, which have flooded the local markets.

Rusted pipes in Al Chebayish

CONSTRUCTED WETLANDS

None of the towns in the marshlands, Al Chebayish being the largest among them, had working and reliable sanitation system in 2006. The situation is no better in 2018. They still do not. Sewage is trapped behind homes in reed crates and not treated, contaminating the piped drinking water that the inhabitants justifiably refuse to drink. More than 12 years ago, IMRP developed detailed designs for a relatively low-cost system to treat household waste and

channel it safely into the marshes. Unfortunately, the program did not have the funding to install the constructed wetland. It was a lost opportunity that could have been a model for other population centers and, in hindsight, might have had a greater impact than some other initiatives by IMRP.

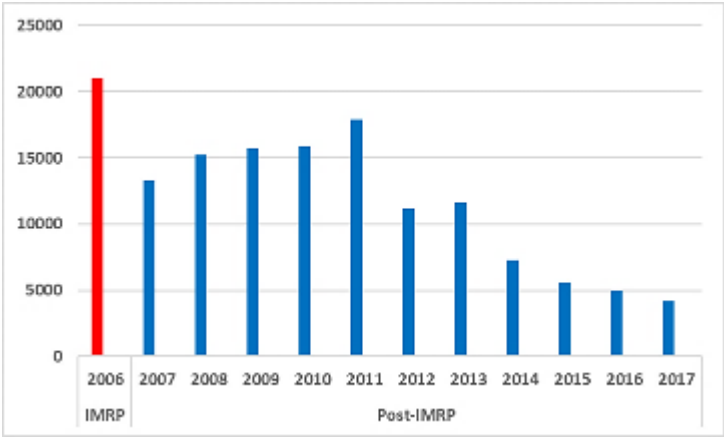
PRIMARY HEALTH CARE

IMPR's plan to provide primary health care to an unserved community, that was desperately in need, seemed well-designed. Rather than acting on its own, IMRP operated through a British non-governmental organization, that had strong ties to Marsh Arabs with its long-standing humanitarian assistance. It chose two existing clinics that could potentially serve large populations, having gained the full support of tribal leaders beforehand. And it appeared to have the approval of the Ministry of Health, although AMAR carried out the independently.

Examination room in a marshlands clinic

AMAR operated under wartime, emergency conditions, working with a population that had few resources and a local government that had been devastated and was in the process of slowly righting itself. At that time, all health services in the two clinics were understandably free of charge. But for a country facing economic ruin, providing free services post-program was unsustainable, as was anything above minimal health care. After 2006, services diminished as costs increased. The 2014 jump in medical fees was a near-fatal blow.

It would be more appropriate to think of IMRP's efforts in public health care as emergency relief rather than as development assistance. The plan never moved beyond the short-term life of the program. There was no a contingency plan for external funding beyond November 2006. And there was no strategy by AMAR to reintegrate its operations in the clinics back into the Ministry of Health's line responsibilities. IMRP's initiative was not sustainable, and its benefits, highly valued by the local population, were sadly short-lived.



Patients' visits to IMRP-assisted clinics during IMRP (2006) and since program closure (2007-2017)

MARSH ARAB WOMEN'S LIVELIHOODS AND ACTIVITIES

Few of the recent examinations of Marsh Arab society and the marshland environment deal with Marsh Arab women other than marginally. The only one serious research effort on Marsh Arab women reached some of the same conclusions that we did. We know that they play a variety of important roles in their

households and in the public arena. And we know that their lives changed significantly with the drainage of the marshes and their forced displacement. And we believe that there may have been a shrinking of women's roles in the public arena, although we have also noted some women are quite active in commercial operations. More research is required to better understand the fullness of their activities, their status, and their contributions.

SO WHAT WAS IMRP'S IMPACT? WHAT WAS SUSTAINABLE? AND WHY?

Looking back after 12 years at IRMP's initiatives, we found encouraging threads but also disappointments. During its contract life, IMRP did much to raise the international profile of Iraq's southern marshlands. For many years previously, the marshlands were the exclusive realm of explorers and travelers who created a mysterious and exotic world. Then came more than a decade of government-led attacks, abuse, and isolation. IMRP brought attention to the reality of a displaced people living in an environmental nightmare. However, that attention did not yield the massive investment expected. IMRP did not have the resources, time, or reach to reduce or reverse the years of massive damage. Funding moved on to the latest crisis.

Initiatives that depended on institutional support were far less successful than those that flourished with individual enterprise. IMRP's investments in government and university laboratories yielded short-term gains. Some of the laboratories were useful and used for a number of years, until the equipment became outdated or broken. At the University of Basra, a newly named marshlands ecology laboratory supported the research of faculty and a score of graduate students for a time, creating a new generation of marshlands experts. The message was more hopeful in Baghdad where the soil and water laboratory in the Ministry of Water Resources' headquarters is still in full operation. Working on a service for fee basis, it has been able to maintain its integrity and effectiveness. The lesson was to find a way that enabled a successful degree of self-sufficiency. Dependency on internal support was a losing strategy.

In the marshlands, IMRP's activities that relied on government support could not outlast the program. Although the hydrologic model was admired and used by the Ministry for planning purposes over six years, it could not be updated and is now a relic. The government lacks the resources and expertise to make it operative again. A hoped for central soil-water database that would be used by government and academia did not materialize, never moving beyond early meetings. Designs for a low-cost constructed wetlands in the marshes' largest town were never translated into action. Al Chebayish was recently fined for continuing to dump raw waste into Central marsh. Population centers in the marshes still lack environmentally safe systems for household sanitation. And two public health clinics upgraded and supported by IMRP saw an explosion of use during the program but now receive a quarter of the patients they saw then.

IMRP's greatest impact was in areas that captured the imagination of the local population, where relatively small interventions were not only sustainable but, in some cases, transformative. Demonstrations of alfalfa and sorghum on a few hundred donums led to their cultivation of a large scale. In the first season after IMRP ended, more than 30,000 donums of alfalfa were planted in the three southern governorates. That level has largely been stable during the past 12 years, rising to 40,000 at one point and then falling to 30,000, suggesting that it a reasonable outer limit, given the current water availability and quality. We believe that the expansion of green fodder had the planned effect on livestock that are in better health and more productive than ever: larger numbers, increasing diversity, greater birth weight and daily growth rate, higher daily milk yields, and longer lactation periods.

There have been parallel improvements in meat and dairy markets. The result is the creation of a cottage industry to produce dairy products improving Marsh Arab incomes and offering greater opportunities for women as rising entrepreneurs. These changes suggest an increasingly healthy and dynamic livestock

sector in the marshlands. They also highlight the difference between sustainability and transformation. Alfalfa and sorghum cultivation are clearly sustainable, but dairy production is transformative.

Efforts by IMRP to revitalize the decimated date palm industry were only partially successful. Of the eight nurseries that IMRP supported through the purchase of the trees, four are still in operation and are thriving, but three fell victim to intertribal disputes, as a way to avenge affronts, and one was destroyed when the government claimed the land for oil drilling. Owners of the four operating nurseries honored their agreements to distribute offshoots to others, but the number was too small to develop new orchards, a longer-term goal of the program. In any event, the area of date palm nurseries has increased in the years since IMRP ended, and would have one done so without its intervention.

IMRP was far less successful in the area of capture fishing. Its goal was to revitalize the population of two highly marketable fish species that were rapidly disappearing from overfishing and changes in the marsh ecology. It was able to reintroduce only one for only about four percent of the anticipated number: 130,0000 fingerlings instead of the planned three million. There were a number of mishaps beyond the program's control, but also the local institution that IMRP chose was clearly inadequate to carry out the work. The dwindling number of this highly prized fish is not the direct responsibility of IMRP, but the program clearly failed to mitigate the dire situation. More broadly, native fish are being aggressively replaced by recent invasive and exotic species. Fish that were common in 2006 are becoming increasing rare or are no longer sighted.

This change in fish population mirrors a fundamental ecological shift in East Hammar marsh from a freshwater to estuarine or marine habitat. The Tigris and Euphrates rivers are no longer feeding the marsh, and there is penetration of Arabian Gulf water through the Shatt Al Arab. The change is reflected in population changes in phytoplankton, zooplankton, and marcobenthic species. Aquatic plants are more resilient and able to tolerate higher levels of salinity. However, two shrimp species and fish that were never observed in the marsh are increasingly common. Different species of tilapia, accidentally introduced in 2006, are now classified as very common in all three marshes. In the fish markets the region, the most available fish are exotic, farmed, or imported in large numbers from Iran daily.

In summary, IMRP's track record on impact and sustainability is mixed. Rapid wins during the program's life did not necessarily lead to long-term gains. Too often, program initiatives were constrained by a changing physical environment and a slow to recover institutional one. They were carried out during a time when the country was going through invasion and internal strife. Some of its activities were designed to address immediate humanitarian needs, such as renewal of public health access. Others sought to bolster national and local government entities in transition. They required long-term external support to succeed. But those activities that met local needs and offered the possibility of a better future were the ones most likely to be adopted and, in some cases, transformed.

1. Introduction

Peter Reiss and Najah A. Hussain

Typha domengensis in Central marsh

During the darkest days of the 2003 invasion of Iraq, members of an U.S. intergovernmental implementation oversight committee, drawn from many departments and agencies, often remarked that the USAID Iraq Marshlands Restoration Program (IMRP) was the single bright spot in a sea of otherwise bleak failures and setbacks across the country. Budgeted at $4 million, the program was a uniquely small initiative that had an outsized impact on the livelihoods and lives of one of the most marginalized and abused populations in pre-invasion Iraq, the Marsh Arabs who were forcibly scattered across and beyond the southern marshlands.

IMRP was carried out between March 2004 and November 2006. The program received widespread international recognition during and after its operation. It was highlighted twice in the New York Times – once on the front page above the fold, and was profiled broadly in the media: BBC, CNN, The Economist, and scores of newspapers worldwide. The initial scientific visit was the basis for an article in *Science*, the journal of American Association for the Advancement of Science, and the program was awarded honors in 2007 by the Environmental Section of the American Anthropological Association after an international competition.

Despite its widely recognized successes, IMRP was not extended, and direct USAID support to the marshlands was curtailed and moved elsewhere. Interest in the marshlands by the U.S government waned, likely because Iraq took a more violent and unstable downward turn. Still, on the ground, progress seemed clear. The program established an ecological monitoring system for capturing changes in marshland restoration through a large team of experts at the University of Basra working closely with the Ministry of Water Resources. Through the U.S. Army Corps of Engineers, it developed a hydrologic model for the Tigris-Euphrates river system to predict the impact of basin-wide releases and trained many staff of the Ministry to use and maintain the model. It introduced new plant varieties, which were quickly adopted by farmers and saw a rapid expansion of cultivation after IMRP ended, and it worked with Marsh Arab tribes to plant date palm orchards that were decimated by the previous regime. It launched a veterinary service that employed recent graduates who provided services in the localities for the first time. IMRP reintroduced fingerlings of a highly marketable fish to revive a battered industry. And it renovated and outfitted two public health clinics in the marshes that served more than 20,000 people during the first year of their renewed operation.

SUSTAINABILITY AND TRANSFORMATION

It is highly unusual for governments, donors, or implementers to look back critically at their efforts years later. There are few examples of post-program impact assessments that use quantifiable measures of long-term program sustainability. Contrary to this usual pattern, DAI decided on IMRP's tenth anniversary to self-finance an impact assessment that explores what happened to the wide range of ostensibly successful interventions that were introduced during the program's three-year life.

Development assistance is inherently unstable. Project-limited funding ends, staffing shifts, national and local priorities change, and international donor interest focuses elsewhere. This report examines years later what happens then. Can and do the benefits and progress engendered by a development program continue? Discussions of project impact usually dwell on the nature of sustainability, as measured by continuity and longevity. This report explores sustainability, but it also examines how the program's initiatives may have transformed in different ways. For example, alfalfa cultivation introduced into the marshlands by IMRP is sustainable. The emergence of a dairy industry started by Marsh Arabs is a transformation.

BACKGROUND

One month after the U.S. invasion of Iraq in April 2003, USAID/ANE the Advancing the Blue Revolution Initiative (ABRI) to prepare a detailed design for a restoration program in the southern marshlands in Iraq. Over the previous decades, the Iraqi government had systematically drained the marshlands and forcibly moved the local population, commonly called Marsh Arabs, out of the area to the arid margins. The then USAID Administrator, Andrew Natsios, had a deeply personal interest in the plight of the people and the environmental devastation of what had been the world's second largest wetland. By the time of the invasion, the marshland was roughly seven percent of its historical area.

The Department of State and USAID approved the initial proposal and authorized an exploratory scientific visit, which I led in June 2003. The team travelled extensively through the marshlands and travelled to Baghdad to make presentations to American and Iraqi officials. Based on that visit and the subsequent report, USAID funded IMRP as a multi-year initiative under ABRI. DAI hired a long-term team working out of Basra, established a permanent office, and moved quickly into on-the-ground operations.

During its three-year implementation, the program was judged to be an unqualified success, both in terms of its technical accomplishments and its security arrangements. Even during the most chaotic and dangerous periods in the south of Iraq, the technical team operated daily, visiting the marshlands and

working with government officials and the local population. Its team remained safe and secure throughout, despite an early explosion in a nearby police station that blew out of the windows of the project office building.

PROGRAM SUSTAINABILITY AND IMPACT OBJECTIVES

The objective of this sustainability study is to determine the continuity and/or discontinuity of the IMRP's efforts and their institutional, social, and economic impact after more than a decade since its conclusion in November 2006, as follows:

- Update our understanding of the current ecology of the Iraq marshlands through description, analysis and documentation
- Determine the long-term effectiveness of institutional support - hydrologic modeling and water/soil laboratory renewals - provided to the government and the local university
- Examine and measure, to the extent possible, the continuity of program interventions in the marshlands between 2006 to 2018 in agricultural and livestock production, reintroduction of native fish species, and primary health care
- Determine if and how the current ecology of the marshlands is a factor that affects the success or failure of IMRP interventions
- Use the ecosystem monitoring results to provide a more nuanced understanding of IMRP sustainability
- Recommend promising opportunities for future donor and government investment in the marshlands

The study is based on field visits and interviews carried out between December 2017 and September 2018 in Baghdad, Basra, and throughout Iraq's southern marshlands.

IMRP OBJECTIVES

IMRP's overall objectives were to:

- Improve the social and economic lives of marsh dwellers
- Assess the success of wetland restoration and help guide government policies and decisions
- Strengthen Iraqi commitment to marshland management
- Reach national and international consensus on long-term restoration strategies

IMRP GUIDELINES

The program was implemented using the following guidelines:

- Work in close implementation with GOI and other donors
- Design and carry out activities using collaborative planning with our Iraqi partners
- Place the views, concerns, and perspectives of the marsh dwellers at the center of the program and ensure that they guide decisions about marsh restoration and economic development
- Adopt integrated economic development and ecosystem management as the framework for the program
- Work to ensure the sustainability of program initiatives
- Develop local capacity in wetland management and improved governance
- Emphasize income generation

IMRP carried out activities in the following areas:

- Hydrologic basin decision-support model for the Ministry of Water Resources
- Water and soil laboratory re-establishment in the Ministry of Water Resources (MOWR) and the University of Basra
- Ecosystem monitoring of the post-invasion inundated marshlands
- Agricultural production and agribusiness
- Livestock and dairy production
- Capture fishing (i.e., restocking valuable native fish)
- Primary health care through direct support to re-establish two local clinics

The impact assessment team is examining the current state of each of these areas of IMRP implementation through numerous field trips throughout the marshes and visits to government officers in the southern governorates and in Baghdad. This report is the product of those field visits and interviews.

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2. Impact Assessment and Ecosystem Monitoring Teams

Najah A. Hussain

Members of the impact assessment team visiting sites in Central marsh

This impact assessment of IMRP was carried out by two in-country teams working in parallel under the direct supervision of Professor Dr. Najah A. Hussain, founder of the Marine Science Centre and professor emeritus of the Department of Ecology, both in the University of Basra. The two teams began at different times, worked separately, made independent field visits to the marshlands, and submitted separate reports that have been integrated into this document.

While conducting the initial phase of the impact assessment, it became apparent that the addition of an ecosystem monitoring component would bring an important new dimension to the activity. When we first developed the proposal, we confined the assessment's focus to the interventions and activities of IMRP that sought to improve livelihoods and health. We soon realized that this approach was too confining and would not permit us to adequately explain why some IMRP activities succeeded and others failed to take hold.

Twelve years after the program ended in 2006, we now see, for example, that water shortages and water salinity are among the most important factors limiting sustainability. Monitoring the marshes is an important contribution to our knowledge, and it also enables us to understand and explain to governments,

donors, and others why different initiatives of IMRP succeeded or failed. In many cases, we believe that the non-sustainability of program activities was far more due to exogenous factors – such as water availability and civil strife – than to issues with IMRP design and implementation. Ecosystem monitoring enables us to argue the case more convincingly with facts than merely posturing suspicions.

Tables 2.1 and 2.2 provide the names, positions, and affiliations of the members of the two teams.

TABLE 2.1: IMPACT ASSESSMENT TEAM

Impact Assessment Team Members	Team Position	Affiliation
Najah A. Hussain	Team Leader and Senior Ecologist	University of Basra
Asaad Y. Ayied	Senior Livestock Expert	University of Basra
Abbas M. Jassim	Agricultural Production Expert	University of Basra
Amjed K. Resen	Fish Ecology Expert	University of Basra
Khalidah S. Al-Niaeem	Fish Diseases Expert	University of Basra
Alaa H. Al-Badran	Institutional Expert	Basra Governorate
Peter Reiss	Activity Manager/Integrator	DAI

IMPACT ASSESSMENT TEAM

The Iraqi members of the assessment team with a Marsh Arab woman in front of a traditional guesthouse (mudhif) made of reeds. Dr. Najah A. Hussain, team leader, is back row center

TABLE 2.2: ECOSYSTEM MONITORING TEAM

Ecosystem Monitoring Team Members	Team Position	Affiliation
Najah A. Hussain	Team Leader and Fish Expert	University of Basra
Haifa A. Hamza	Benthos Expert	University of Basra
Muhana A. Qassim	Ornithologist	University of Basra
Mohammad S. Moyel	Water Quality Expert	University of Basra
Maitham Ghaley Al-Shaheen	Phytoplankton Expert	University of Basra
Adil F. Abbas	Zoologist	University of Basra
Anfas N. Okash	Zooplankton Expert	University of Basra
Peter Reiss	Activity Manager/Integrator	DAI

ECOSYSTEM MONITORING TEAM

The ecosystem monitoring team in the Department of Ecology's laboratory at the University of Basra

3. Field Visits to the Marshes

Najah A. Hussain and Adil F. Abbas

Ecosystem monitoring team member using a bottom dredger to collect benthos in East Hammar marsh

Impact assessment team members examining a date palm orchard in Bahla, funded by IMRP in 2006

Two discrete teams of Iraqi experts carried out the fieldwork upon which this report is based. The impact assessment team made seven field trips to Huwaizah, Hammar, and the Central marshes between the inception of the program in December 2017 and April 2018 (Table 3.1 and Figure 3.1). During each of the visits, the interdisciplinary team of experts explored the current state of agricultural production, date palm orchards, fishing, livestock, and public health, women's activities, and local government efforts. The ecosystem monitoring team made six field trips to the marshlands between April and August 2018. They explored the water quality and the flora and fauna of the area during their site visits.

IMPACT ASSESSMENT TEAM

The impact assessment team chose field sites based on the following:

- Areas adjacent to the marshlands known for agricultural production and livestock breeding
- Specific date palms orchards, public health clinics, and constructed wetlands involved in IMRP implementation
- Prime locations for fishing landing and key local fish markets
- Agriculture offices in different districts to collect data on agricultural and livestock production

TABLE 3.1: SITE VISITS BY THE IMPACT ASSESSMENT TEAM

Trip	Date	Sites Visited
1	12 December 2017	Maysan Governorate / Huwaizah Marsh
2	11 January 2018	Al Mejar District / Qal'at Saleh District, Huwaizah
3	8 February 2018	Al Mejar District / Qal'at Saleh District, Huwaizah
4	22 February 2018	Dhi-Qar Governorate / Al Chebayish / Hammar Marsh
5	22 March 2018	Al Chebayish / Central Marsh
6	29 March 2018	Al Adil Sub-district / Uoda Marsh/ Central Marsh
7	21 April 2018	Qurna / Central Marsh

In addition, the team leader visited the Center for the Restoration of Iraqi Marshes and Wetlands (CRIMW) in Baghdad in June 2018 and water and soil laboratories of the Ministry of Water Resources in Basra and at the University of Basra and the CRIMW branch office in Basra.

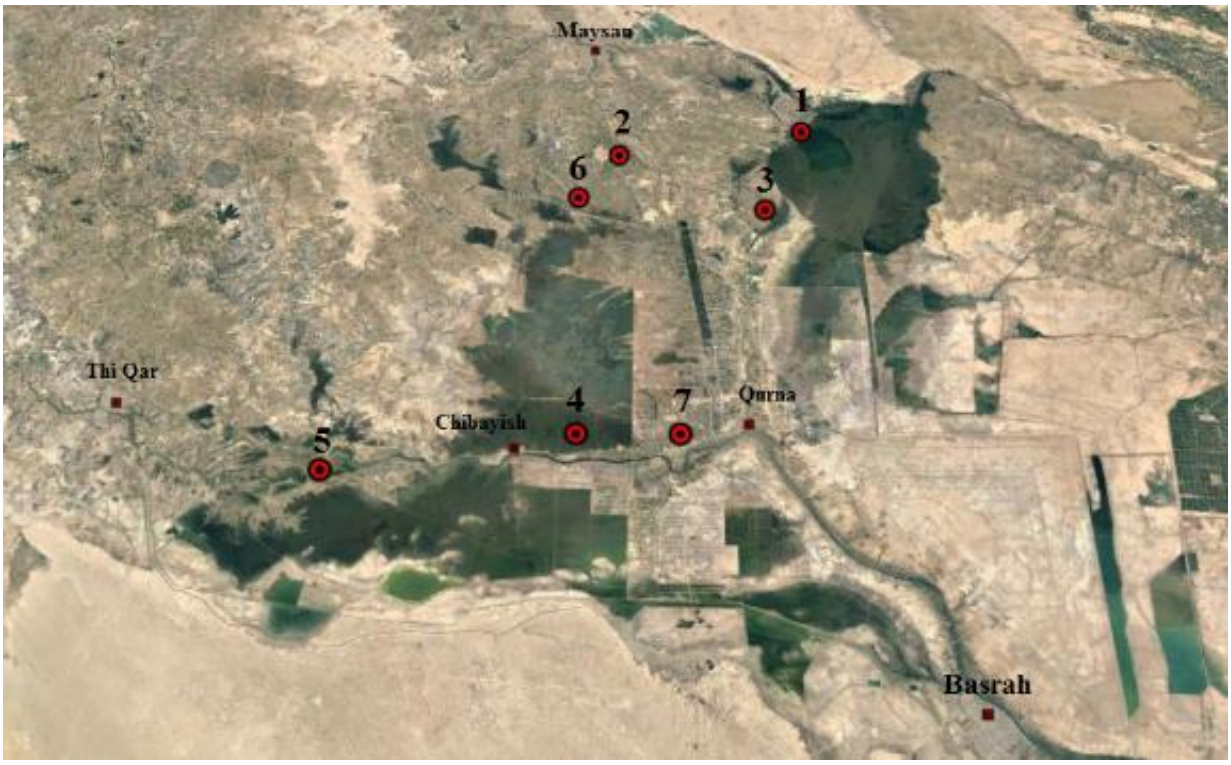
ECOSYSTEM MONITORING TEAM

Unlike the impact assessment team, which travelled widely throughout the three southern marshes, the ecosystem monitoring team's approach was to establish two research stations that they regularly visited between March and August 2018 to examine restoration patterns over a continuous six-month period. The two sites are in East Hammar marsh, a vast wetland that falls in Basra and Dhi-Qar governorates (Figure 3.2). The first station is in Manthori, a channel marsh that is important for fishing and transportation and has deep tidal water. The second station is in Burgha, an open marsh with a vast shallow semi-diurnal tide that becomes nearly dry at ebb tide.

The ecosystem monitoring team chose to establish two stations in East Hammar marsh for a number of reasons:

- ***Ecology:*** It is the most ecologically diverse of the southern marshes, thus providing a wealth of rich data.
- ***Environment:*** It is a semi-diurnal tidal marsh with an oligosaline environment.
- ***Economics:*** It is located in two governorates with large oil fields at its southern edge, giving it political prominence.
- ***Local production:*** The marsh remains an important fishing ground for fish and shrimp, despite a recent history of drainage and diversion in the southern marshes.

FIGURE 3.1: LOCATIONS OF SITE VISITS BY IMPACT ASSESSMENT TEAM



1 Maysan Governorate/Huwaizah Marsh
2 Al Mejir District/Kala Saleh District
3 Al Mejir District/Kala Saleh District
4 Dhi-Qar Governorate/Chebayish town
5 Chebayish town/Hammar Marsh
6 Aladil District
7 Qurna/Central Marsh

FIGURE 3.2: LOCATION OF RESEARCH STATIONS OF THE ECOSYSTEM MONITORING TEAM IN EAST HAMMAR MARSH

East Hamar Research Stations: Station 1 Burgha. Station 2 Manthori

Ecosystem monitoring team ornithologist taking photos of aquatic birds in East Hammar marsh

4. Marsh Ecosystem Monitoring

Najah A. Hussain, Adil F. Abbas, Maitham Ghaley Al-Shaheen, Haifa A. Hamza, Mohammad S. Moyel, and Muhana A. Qassim

Measuring light penetration to calculate water transparency at the Manthori research station

Collecting benthic organisms, such as snails and small crabs, at the Burgha research station

The marshes of southern Iraq are the largest in the Middle East and southwest Asia. Before they were drained to about seven percent of their original size, they looked like a huge oasis surrounded by a vast, dry desert. The marshes are eleventh in size worldwide and are characterized by their biodiversity and cultural wealth. Several species are present only in these marshes. And it is the only marsh in world that was historically, and still is although far less so, occupied by people for millennia, not just on the fringes but deep inside. Playing a major ecological role in the region, the marshes are on the flying route of many migratory birds from the Middle East and Siberia to East Africa, and it is the spawning and nursery ground for marine migratory fish and shrimp from the Arabian Gulf. The marshes were also a major food source, producing 60 percent of the freshwater fish in the Iraqi market, huge amounts of rice grown near the banks, and a rich variety of wild birds that were hunted.

The southern marshlands were targeted by the Saddam regime from the early 1990s until the 2003 invasion. That period was a near fatal blow the region's flora, fauna, and Marsh Arab way of life. After 2003, the marshes were haphazardly inundated with more than half reflooded, witnessing some degree of

restoration. This assessment explores the impact of that reflooding, which has created a very different and still changing ecological balance.

BACKGROUND

IMRP'S Final Report in 2006 stated that the rate of restoration between 2003 and 2006 was remarkable considering that reflooding occurred for such a short period, but that the water supply would not be sufficient to fully restore all the marshes. While some areas were experiencing reduced recovery due to elevated salinity and toxicity, many locations seemed to be functioning at levels close to the natural Huwaizah and even historic levels in some areas. It suggested that restoration of the southern marshlands might be difficult in some localized areas since soil conditions and water quality in the drained and diked (as compared to the reflooded and natural) marshes clearly demonstrated massive shifts in ion chemistry and structure. But it argued that reflooded and drained marsh areas could be restored, but some locations would have excessive salt accumulation problems, toxic elements, and severe water quality degradation with a concomitant loss of native marsh vegetation. It urged that those areas be identified so that the limited water supplies could be used to restore those areas with the most promise for full restoration.

This chapter explores the water quality, flora, and fauna at two research stations in East Hammar marsh to understand the impact of reflooding and assess the current conditions. One research station is at Manthori, a channel marsh that is important for fishing and transportation and has deep tidal water. The second station is in Burgha, an open marsh with a vast shallow semi-diurnal tide that becomes nearly dry at ebb tide.

RESULTS

WATER QUALITY (ADIL F. ABBAS AND MOHAMMAD S. MOYEL)

After more than ten years of deliberate state-led desiccation, Hammar marsh was inundated in 2003, slowly reclaiming about 75 percent of its original area. From 2004 to 2006, IMRP documented the return of a high percentage of its flora and fauna. Before the drainage, East Hammar was supplied by the Tigris and Euphrates rivers. No longer. With decreased freshwater discharge from the Tigris and Euphrates has come increased Gulf water penetration inside the Shatt Al Arab River that reaches to East Hammar marsh, 110 kilometers north of the Arabian Gulf. East Hammar marsh is now the only tidal marsh in southern Iraq, fed largely by the Shatt Al Arab River. Semi-diurnal tides cover vast areas of marsh twice daily. As a result, the marsh faces successive salt fronts from the Gulf that have reshaped the marsh habitat from freshwater to estuarine accompanied by drastic changes in the composition of marsh flora and fauna.

During the monitoring period, the water salinity changed from 3.74 parts per thousand (psu) in the four months from March to June to 5.1 psu in July and August due to the advancing of the salt wedge estuary. At the end of August, water salinity reached 16.1 psu. Salinity at this high level has never been recorded previously in the marsh. Freshwater and oligosaline species are gradually disappearing and marine species have started to invade the marsh and replace them. Aquatic plants were highly affected by saline water, especially submerged species. Only emerged species exist because of their high resistance to saline water. Freshwater fish, phytoplankton, zooplankton, and benthos were drastically affected, and marine species have started to replace them.

Many water characteristics were also affected by the increases in water salinity, they are but still within the acceptable limits (Table 4.1). Only dissolved oxygen concentration was low in marsh water, especially at Manthori station. This might be explained by the release of untreated sewage directly to marsh water.

TABLE 4.1: COMPARISON OF MAJOR WATER CHARACTERISTICS IN EAST HAMMAR MARSH (2006 AND 2018)

Water Characteristics	IMRP in 2006 (monthly ranges)	Present Study in 2018 (monthly ranges)
Salinity (psu)	1.7-2.7	3.74- 16.3
Conductivity (mS/cm)	1.2-1.8	6.2- 25.9
Hydrogen potential (pH)	8.1-8.2	8.4- 9.1
Dissolved oxygen (mg/L)	5.5-12	3.9- 8.7
TN (ugat/No3L)	12-30	3.1-11 ppt
TP (ugat/PO4L)	0.05-0.55	0.78-1.25 ppt
BOD (g/L)	0.25-0.5	1.9-3.9
Turbidity (NTU)	NA	47.2-175
Transparency (cm)	20-60	31-110

Specifically:

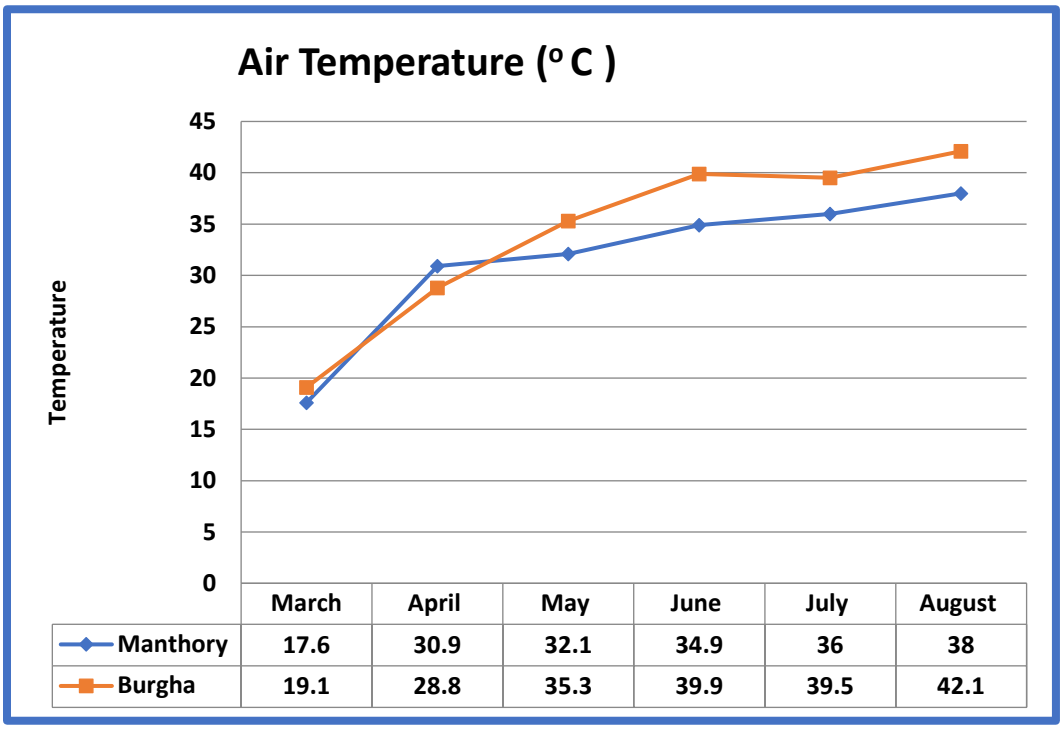
- ***Salinity*:** In 2006, the water in East Hammar was slightly saline. It could be used for drinking for people and livestock. Drinking water salinity is recommended at 0.5 psu in some countries. In Iraq, 1 psu (equal to 1 gram of salt in liter of distilled water) is acceptable. Salinity levels in 2006 are three to more than five times the levels in 2006. Our analysis clearly indicates that estuarine water is not acceptable for human or animal consummation.
- ***Conductivity*:** This is a more accurate indication of salinity, since it is a measurement of all salts dissolved in water. The ranges in 2018 indicate estuarine water with levels about five to 12 times higher than in 2006. Brackish and estuary water's ranges are 0.5 to 17 mS/cm. The highest range of 25.9 mS/cm is below ocean salinity levels, usually considered between 30 and 37, but still multiple times higher than 2006 and at levels that cannot be tolerated by the historical fauna and flora in the marshlands.
- ***Hydrogen potential (pH)*:** pH is a measure of free hydrogen available in water. As water becomes more saline, the pH increases and becomes alkaline. The table values of 2006 and 2018 indicate that East Hammar was and continues to be saline like sea.
- ***Dissolved oxygen (DO)*:** 2006 values were higher than in 2018, meaning there was more dissolved oxygen in water for organisms previously. In 2018, the lower range DO value of 3.9 milligrams per liter (mg/L) is dangerously low, as the lowest acceptable value of DO is 4-5 mg/L.
- ***Total Nitrate (TN) and Total Phosphorus (TP)*:** Both TN and TP values of are low, indicating that nutrients are not available in marsh water.
- ***Biological oxygen demand (BOD)*:** Oxygen used by microorganisms is an indication of pollution. Most pristine rivers have a BOD below 1 mg/L. The 2006 values are low, indicating that little or no pollution existed. In 2018, the BOD range in East Hammar is 1.9 to 3.9, indicating increased, but not severe, pollution levels.
- ***Transparency*:** This indicator measures the amount of light penetrating water depth. As the number increases, it means that the water is clearer and has no suspended organic particles. Marsh freshwater has low transparency. From 2006 to 2018, measurements indicate that transparency is increasing.

For freshwater marshes, an increase in water salinity is a sign of environmental detrition, because it can mean a change in the entire ecosystem from freshwater to marine with different groups of animals and plants. Healthy freshwater marshes can be judged by higher dissolved oxygen concentration and lower biological oxygen demand. The increased salinity during July and August affected other factors, leading to increases in pH and dangerous dissolved oxygen concentrations during the same months. East Hammar's salinity, pH, and dissolved oxygen levels in 2018 indicate and increasing unhealthy marsh. However, the situation could be reversed with a combination of factors: more rain and increased discharges from the Tigris River. Table 4.2 indicates that salinity levels in April and May were bearable, but the latter would require concerted actions by the Ministry of Water Resources.

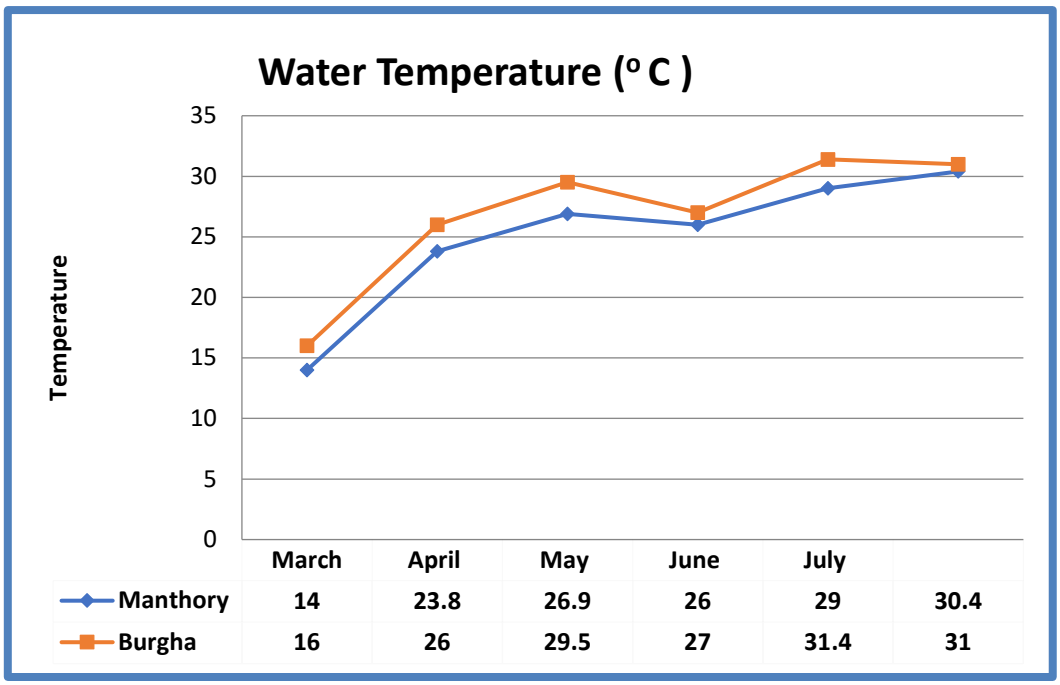
TABLE 4.2: WATER QUALITY AT THE MANTHORI AND BURGHA RESEARCH STATIONS IN EAST HAMMAR MARSH (MARCH-AUGUST 2018)

	Manthori						Burgha					
Water Characteristics	**March**	**April**	**May**	**June**	**July**	**August**	**March**	**April**	**May**	**June**	**July**	**August**
Air temperature (C°)	17.6	30.9	32.1	39.9	36	38	19.1	28.8	35.3	34.9	39.5	42.1
Water temperature (C°)	14	23.8	26.9	27	29	30.4	16	26	29.5	26	31.4	31
pH	8.5	8.56	8.6	8.8	8.44	8.4	8.9	8.78	9.1	8.35	8.72	8.8
Salinity (psu)	5.1	3.74	4.74	4.9	10.3	16.1	5.83	5.25	4.5	6.13	10.6	16.3
Conductivity (mS/cm)	8.4	6.23	7.91	8.16	16.3	25.4	9.5	8.75	7.53	10.1	16.7	25.9
Dissolved oxygen (mg/L)	6.8	7.8	4.2	4.2	3.9	4.5	8.7	6.5	6.1	5.1	7.6	4.4
Turbidity (NTU)	63.2	62	137	144	60.2	47.2	49.6	104	175	94	104	69.4
BOD (mg/L)	2.11	1.58	3.2	2.9	2.1	1.9	3.9	3.8	2.6	2.6	2.3	2.8
Total phosphate (ppt)	0.78	.086	1	0.79	0.79	0.53	1.01	1.1	1.1	1.25	0.83	0.67
Total nitrate (ppt)	7.79	3.1	4.39	2.07	8.6	8.33	9.8	11	7.79	9.3	10.2	10
Transparency (cm)	110	62	31	32	35	38	85	55	22	37	29	33

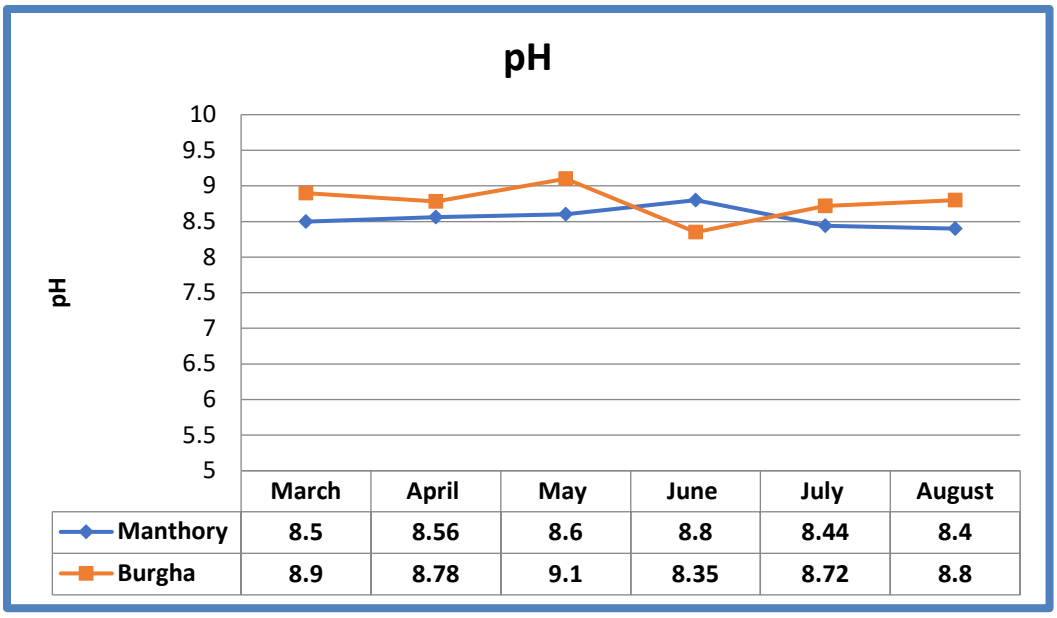
FIGURES 4.1-4.11: WATER CHARACTERISTICS IN THE RESEARCH STATIONS (MARCH-AUGUST 2018)



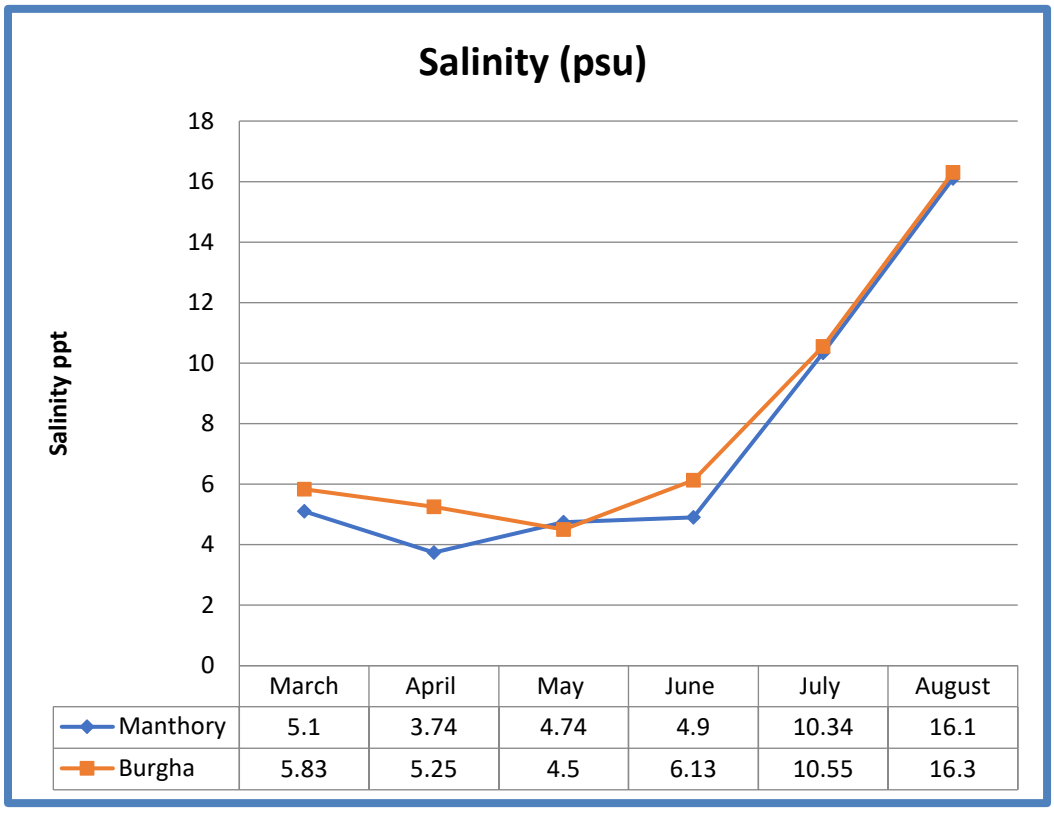
	March	April	May	June	July	August
Manthory	17.6	30.9	32.1	34.9	36	38
Burgha	19.1	28.8	35.3	39.9	39.5	42.1



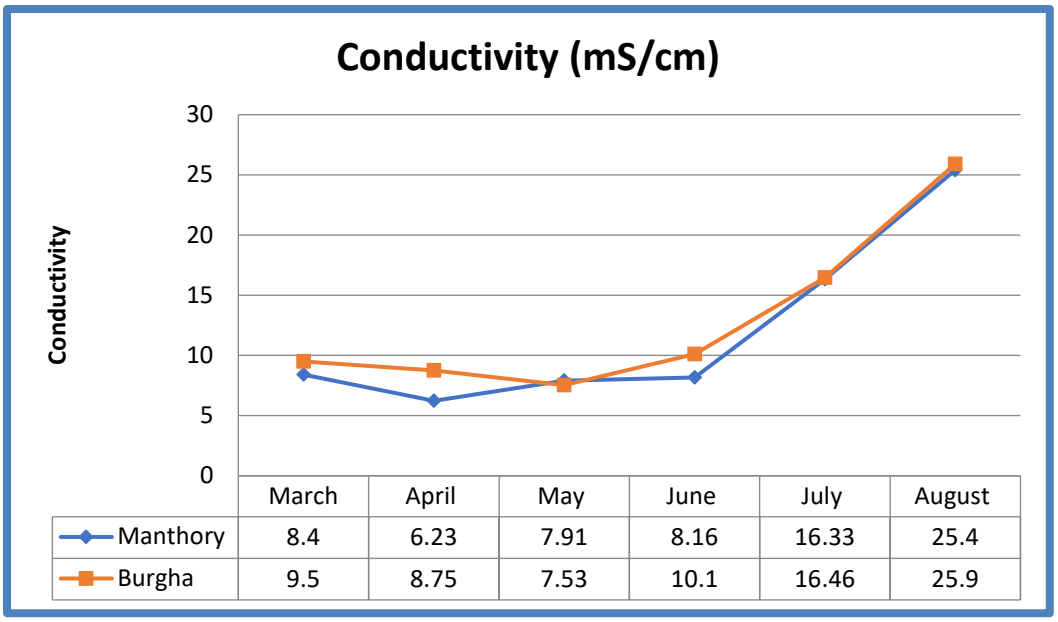
	March	April	May	June	July	
Manthory	14	23.8	26.9	26	29	30.4
Burgha	16	26	29.5	27	31.4	31

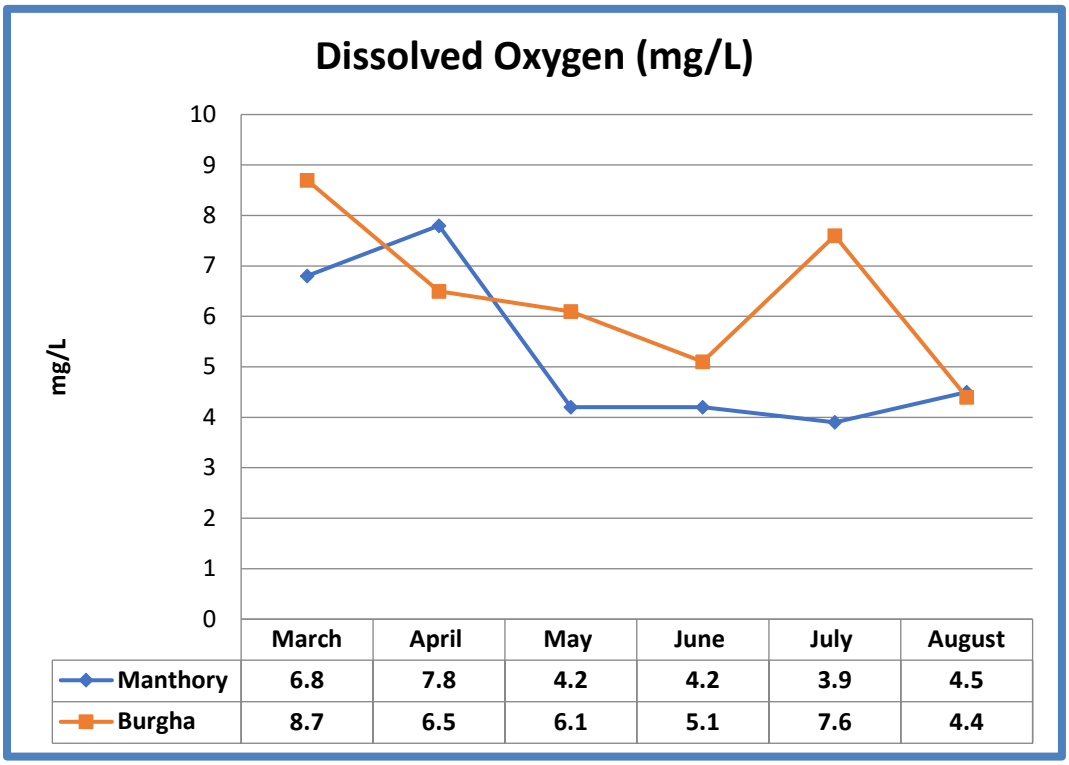


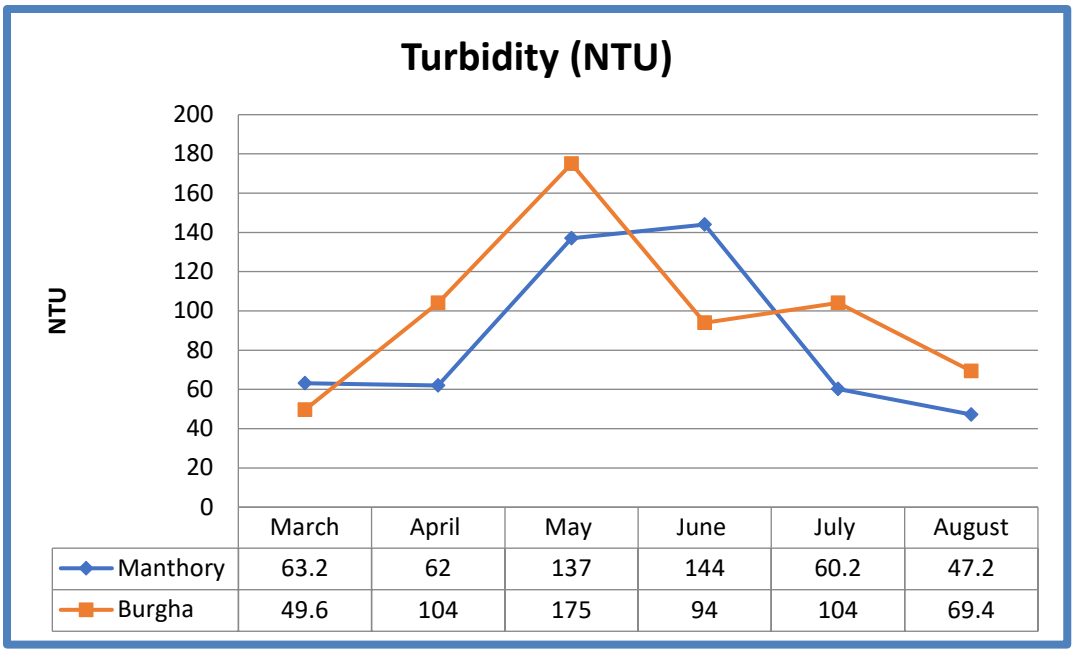
	March	April	May	June	July	August
Manthory	8.5	8.56	8.6	8.8	8.44	8.4
Burgha	8.9	8.78	9.1	8.35	8.72	8.8



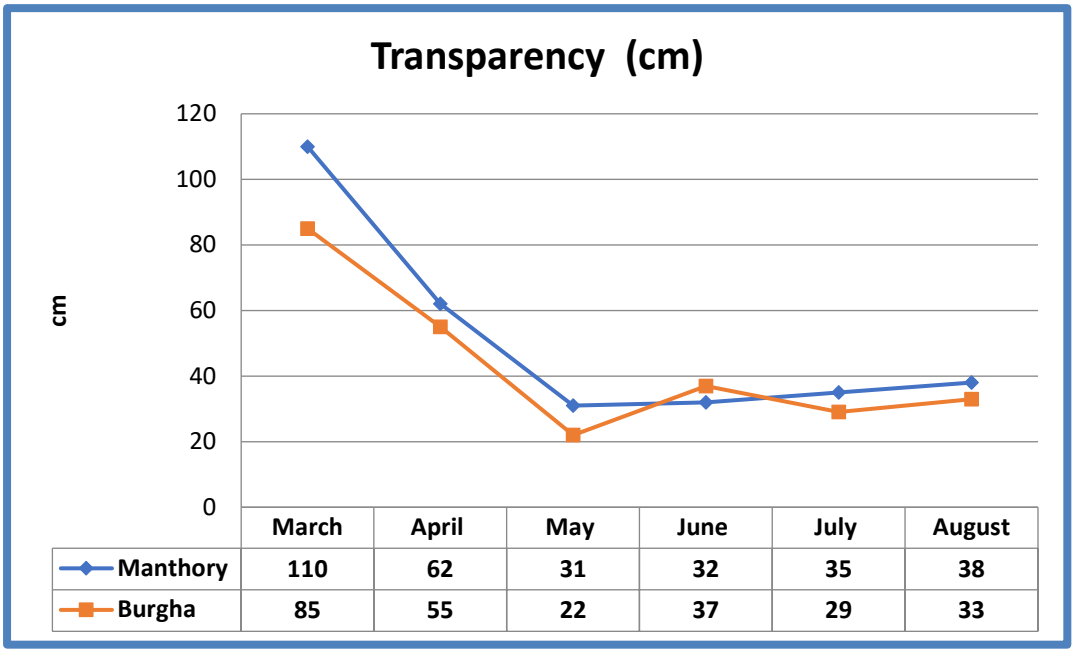
	March	April	May	June	July	August
Manthory	5.1	3.74	4.74	4.9	10.34	16.1
Burgha	5.83	5.25	4.5	6.13	10.55	16.3


Conductivity (mS/cm)
Conductivity
30
25
20
15
10
5
0
March April May June July August
Manthory 8.4 6.23 7.91 8.16 16.33 25.4
Burgha 9.5 8.75 7.53 10.1 16.46 25.9

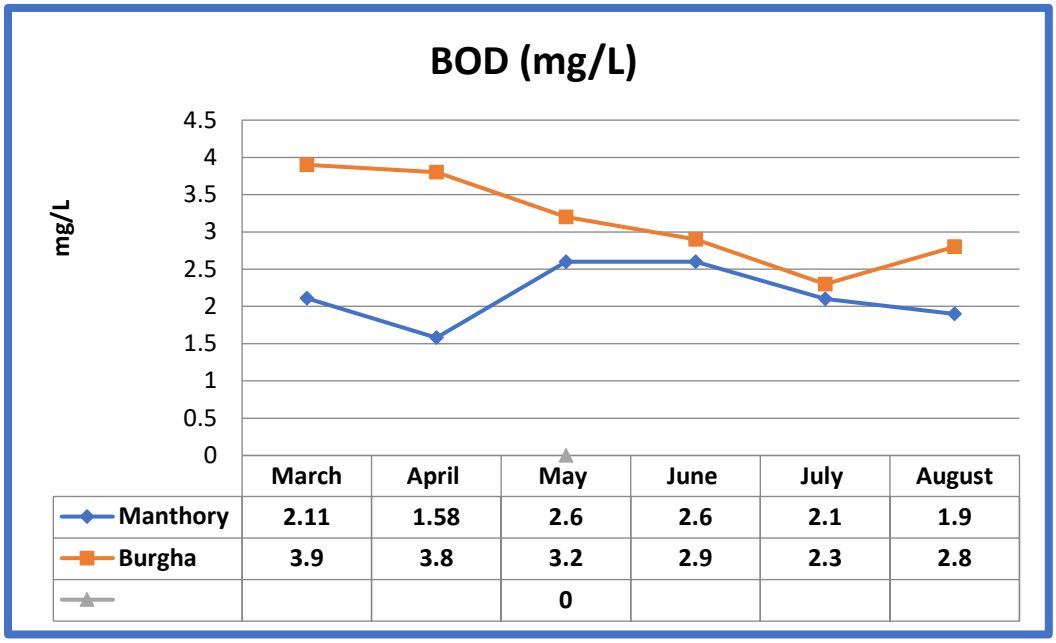

Dissolved Oxygen (mg/L)
mg/L
10
9
8
7
6
5
4
3
2
1
0
March April May June July August
Manthory 6.8 7.8 4.2 4.2 3.9 4.5
Burgha 8.7 6.5 6.1 5.1 7.6 4.4



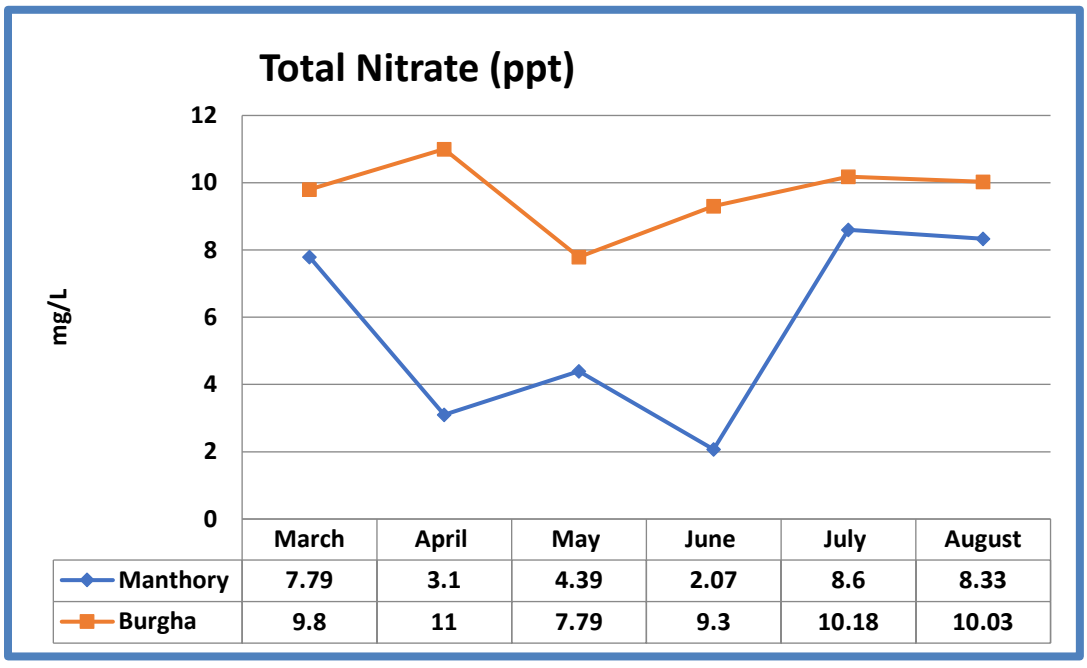
	March	April	May	June	July	August
Manthory	63.2	62	137	144	60.2	47.2
Burgha	49.6	104	175	94	104	69.4



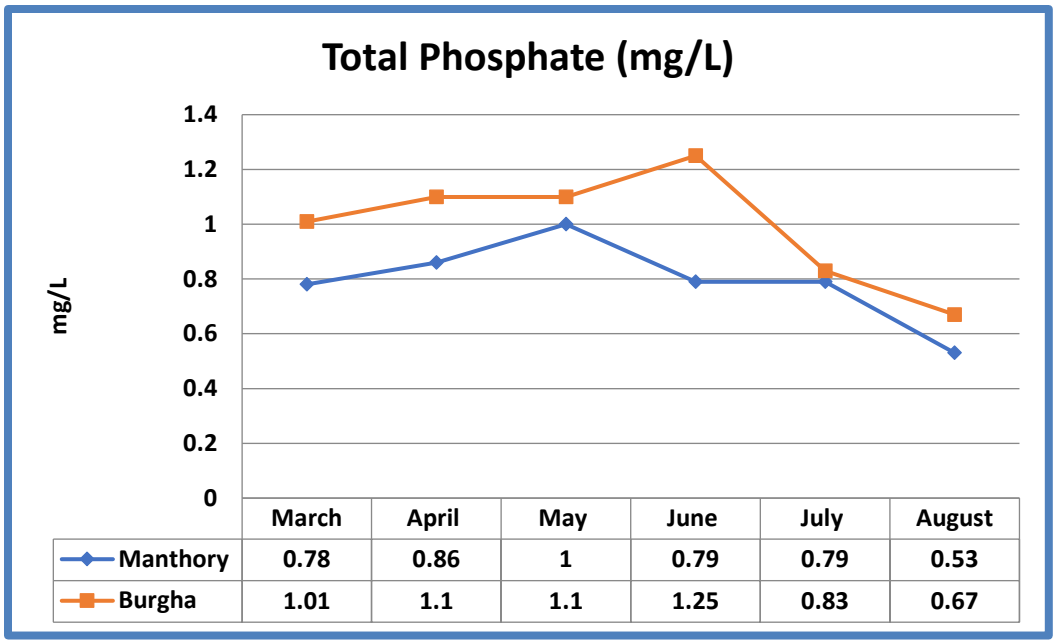
	March	April	May	June	July	August
Manthory	110	62	31	32	35	38
Burgha	85	55	22	37	29	33



	March	April	May	June	July	August
Manthory	2.11	1.58	2.6	2.6	2.1	1.9
Burgha	3.9	3.8	3.2	2.9	2.3	2.8
			0			



	March	April	May	June	July	August
Manthory	7.79	3.1	4.39	2.07	8.6	8.33
Burgha	9.8	11	7.79	9.3	10.18	10.03



Flora and Fauna

The following discussion concerns changes in flora and fauna in East Hammar from 2006 to 2018, as they relate to shifting water quality. An examination of Table 4.3 on the five most common bird, fish, and plant species reveals that plant species have remained stable so far, but that fish and bird species are essentially entirely different.

Aquatic Plants (Adil F. Abbas)

During the monitoring period (March-August), four emerged species were recorded, represented by the most abundant species in the Iraqi southern marshes. Seven submerged plants were recorded, all among the most dominant species. No floating plant species were recorded in the marsh. The number of recorded species during the monitoring period was much lower than previously recorded by IMRP in 2006. The reason for this decline is the sudden increase in water salinity due to the advancing Arabian Gulf salt wedge in the marsh, bearing in mind that all of the aquatic plants species in the marsh were historically freshwater ones.

Another reason for the decrease in the occurrence of aquatic plants is the increase in boat traffic with their outboard motors. The aquatic plants are being destroyed by their propellers, which could explain the difference in the number of submerged species between the two stations. Manthori is characterized by deep water, allowing the boats to move freely. On the contrary, Burgha is a shallow one helping the aquatic plants to thrive. Buffalo herds play major role in diminishing an emerged plants canopy, exacerbated by the harvesting of aquatic plants by Marsh Arabs using chainsaws. These activities have led to a reduction in the density and abundance of the aquatic plant canopy.

An increase in salinity from 3-5 psu in March-June to 16 psu in July-August resulted in the disappearance of floating plants and reduced density of emerged and submerged species, as a result of advancing of a salt wedge from the Gulf as far as the East Hammar marsh. The effect of increased salinity on aquatic plants is shown below.

TABLE 4.3: FIVE MOST COMMON OR ABUNDANT BIRDS, FISH, AND AQUATIC PLANTS SPECIES IN EAST HAMMAR MARSH (2006 AND 2018)

Hammar Marsh (2006)	Manthori (2018)	Burgha (2018)
Aquatic Bird Species		
Egretta garzetta	*Charadrius dubius*	*Charadrius dubius*
Larus ridibundus	Actitis hypoleucos	Sterna caspia
Larus genei	Sterna hirundo	Sterna hirundo
Larus canus	*Circus aeruginosus*	*Circus aeruginosus*
Sterna albifrons	*Sterna albifrons*	*Sterna albifrons*
Fish Species		
Liza abu	*Tenualosa ilisha*	*Silurus triostegus*
Liza carinata	*Oreochromis aureus*	*Oreochromis aureus*
Carassius carassius [a]	Carassius auratus	Carassius auratus
Barbus luteus	Poecilia latipinna	Poecilia latipinna
Alburnus mossulensis	Oreochromis niloticus	Oreochromis niloticus
Aquatic Plant Species		
Ceratophyllum demersum	*Ceratophyllum demersum*	*Ceratophyllum demersum*
Myriophyllum verticillatum	*Potamogeton perfoliatus*	*Myriophyllum verticillatum*
Phragmites australis	*Phragmites australis*	*Phragmites australis*
Schoenoplectus litoralis	*Schoenoplectus litoralis*	*Schoenoplectus litoralis*
Potamogeton pectinatus	*Potamogeton crispus*	*Potamogeton pectinatus*

TABLE 4.4: NUMBERS OF AQUATIC PLANT SPECIES IN EAST HAMMAR MARSH (2006 AND 2018)

Type of Aquatic Plants	IMRP Final Report (2006)	Present Assessment (2018)
Emerged species	4	4
Floating species	0	0
Submerged species	7	7
TOTAL	11	11

TABLE 4.5: AQUATIC NATIVE PLANT SPECIES IN MANTHORI AND BURGHA RESEARCH STATIONS (MARCH TO AUGUST 2018)

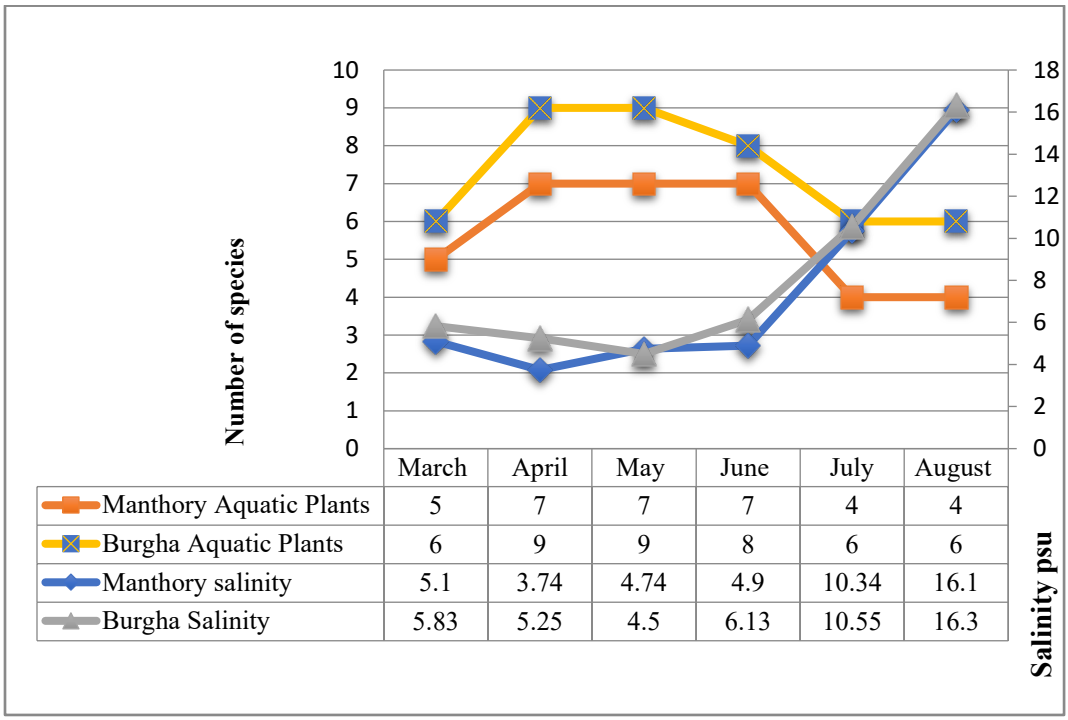
No.	Group	Status	Manthori						Burgha					
			March	April	May	June	July	August	March	April	May	June	July	August
Emerged Plants														
1	Juncus rigidus	N	+	+	+	+	+	+	+	+	+	+	+	+
2	Phragmites australis	N	+	+	+	+	+	+	+	+	+	+	+	+
3	Schoenoplectus sp.	N	+	+	+	+	+	+	+	+	+	+	+	+
4	Typha domengensis	N	+	+	+	+	+	+	+	+	+	+	+	+

No.	Group	Status	Manthori						Burgha					
			March	April	May	June	July	August	March	April	May	June	July	August
Submerged Plants														
5	Ceratophyllum demersum	N	-	+	+	+	-	-	+	+	+	+	+	+
6	Chara sp.	N	-	-	-	-	-	-	-	+	+	+	-	-
7	Myriophyllum spicatum	N	-	-	-	-	-	-	-	+	+	+	+	+
8	Najas marina	N	-	-	-	-	-	-	+	+	+	-	-	-
9	Potamogeton crispus	N	-	+	+	+	-	-	-	-	-	-	-	-
10	Potamogeton pectinatus	N	-	-	-	-	-	-	-	+	+	+	-	-
11	Potamogeton perfoliatus	N	+	+	+	+	-	-	-	-	-	-	-	-
Total number of species			5	7	7	7	4	4	6	9	9	8	6	6

N: Native

Cladophora glomerata, an algal plant cover, at Burgha research station in East Hammar marsh

FIGURE 4.12: EFFECT OF SALINITY ON AQUATIC PLANTS



	March	April	May	June	July	August
Manthory Aquatic Plants	5	7	7	7	4	4
Burgha Aquatic Plants	6	9	9	8	6	6
Manthory salinity	5.1	3.74	4.74	4.9	10.34	16.1
Burgha Salinity	5.83	5.25	4.5	6.13	10.55	16.3

PHYTOPLANKTON (MAITHAM GHALEY AL-SHAHEEN)

Manthori Research Station

Blue green algae, represented by six species and two of them belonging to the genus *Oscillatoria*, occurred in all samples during the six-month period of data collection. The highest number of occurrences was in June, coinciding with increasing water temperature. A sharp increase in salinity led to the disappearance of half of the species in July and August.

Green algae characterized by the occurrence of five species belonging to four different genera, including *Scenedesmus,*was recorded in March and June only. The environmental conditions in June permitted the emergence of more species that quickly disappeared in July and August due to increased water salinity.

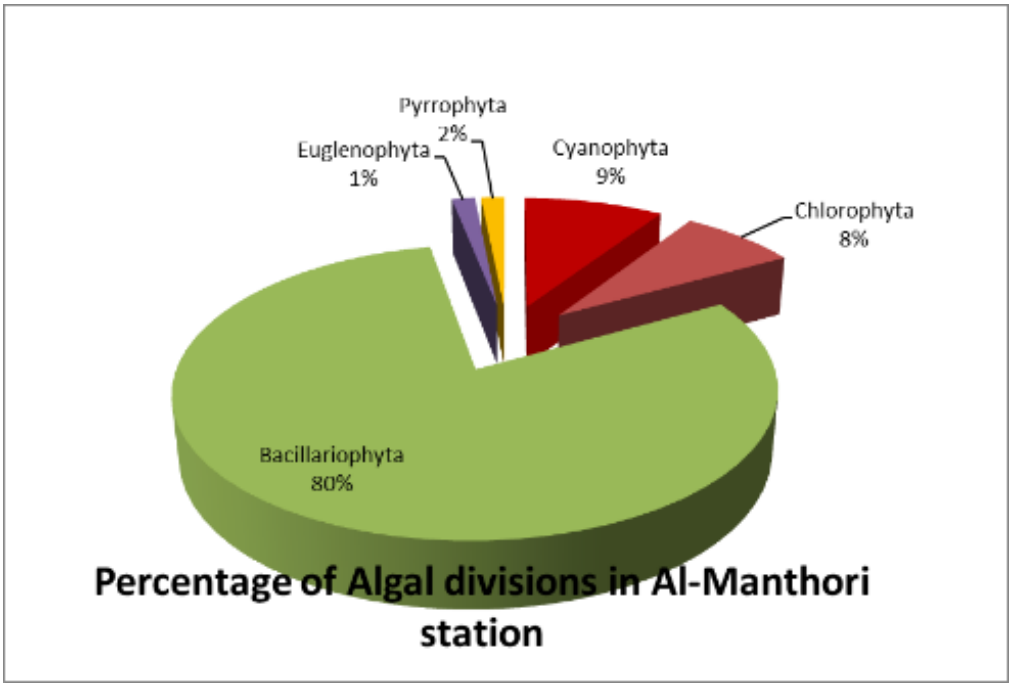
The algal group *Bacillariophyta* forms the bulk of phytoplankton consisting of 52 species. Eight of them occurred during most months of the study period:

Cyclotella meneghiniana	
▪ Entomoneisalata ▪ Gyrosigmaacuminatum ▪ Gyrosigmafasciola ▪ Gyrosigmascalproides	▪ Gyrosigmaattenuatum ▪ Nitzschiabilobata ▪ Nitzschia sigma

Other species occurrences fluctuated during the period, but, in general, the number of species decreased in March, April, and May. June experienced a bloom in the number of species, followed by drastic decrease in July and August. The decrease in the number of species is normal, since *Bacillriophyta* prefer cold temperatures for growth, the opposite of blue green algae, which prefer warm and high temperatures. There was also the negative effect of water salinity on freshwater and oligosaline diatoms.

Marine diatom species, including *Vanheurckia lewsiana, Gyrosignma sinensis, Nitzschia bybrid, and Nitzschia increta* were first recorded in the Shatt Al Arab in 1979 and in the Fao/Shatt Al Arab estuary but not in the marshes (Pankow and Hug 1979, Al Shaheen 2016). However, *Nitzschia increta* appeared in East Hammar in June and July due to the sharp increase in water salinity. *Euglenophyta* and *Pyrrophyta* groups represent by one species for both, occurred in March and April and then disappeared in May to reappear in June and disappear again in July. In general, the highest number of phytoplankton species was recorded in June (39) and the lowest (18) in May.

FIGURE 4.13: PERCENTAGE OF ALGAL DIVISIONS IN AL-MANTHORI STATION



Burgha Research Station

Six blue green species were recorded at the Burgha station, two of them belonging to genus *Oscillatoria*, dominated by number of species especially in July. Five genera of green algae were recorded, their occurrence fluctuating between the six months of data collection, but all appearing in July. Diverse *Bacillariophyta* species were recorded during the study period in this station:

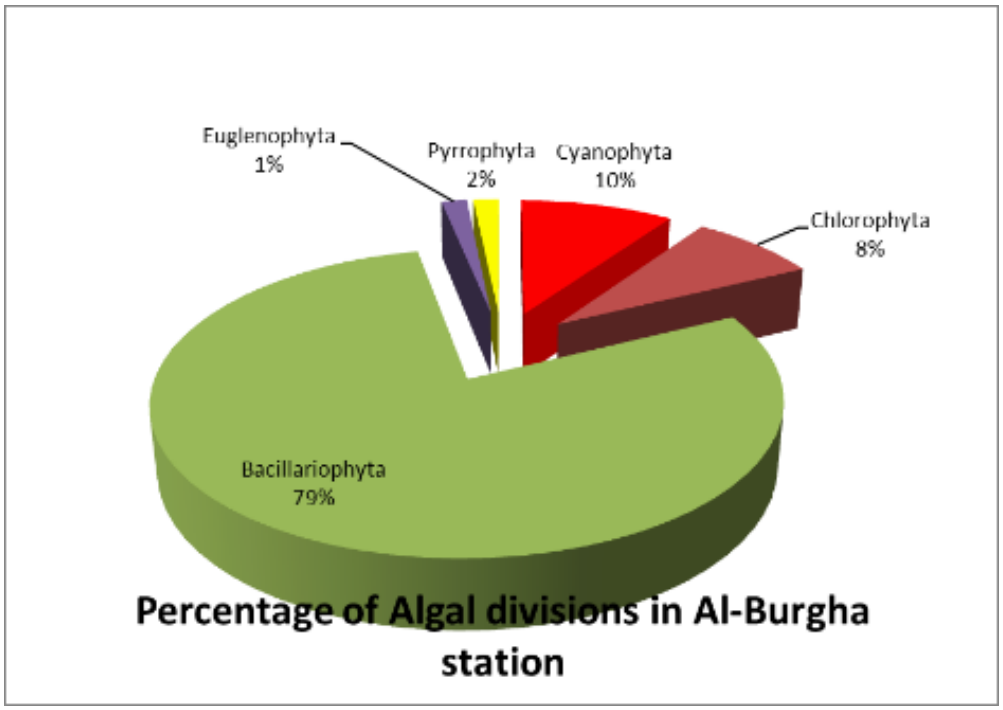
Cyclotellameneghiniana	
▪ Campylodiscus clypeus	▪ Gyrosigmafasciola
▪ Campylodiscus sp.	▪ Gyrosigmascalproides
▪ Entomoneisalata	▪ Gyrosigmasinensis
▪ Gyrosigmaacuminatum	▪ Nitzschia sigma
▪ Gyrosigmaattenuatum	

The number of *Bacillariophyta* species varied from 18 in March to 29 in July. Marine and estuarine species occurred for first time in Burgha station, including *Nitzschiaincreta*, *Nitzschia hybrid,* and *Gyrosigma sinensis*. *Euglenophyta* species were absent from the monthly sample until May and then reoccurred in July and August.

Pyrrophyta algae were represented by single species occurred in five months except July. In general, March was the lowest month for the number of phytoplankton species recorded (23) and July the highest

(40). We observed a close relationship between phytoplankton species occurrence and water temperature, salinity, and turbidity.

FIGURE 4.14: PERCENTAGE OF ALGAL DIVISIONS IN AL-BURGHA STATION



In conclusion, the majority of species recorded during the study period were marine and estuarine, indicating that the freshwater environment of East Hammar marsh is changing to an estuarine or marine environment, if the current hydrological situations prevail. Certainly, the conditions will affect other ecological groups, such as freshwater aquatic plants, zooplankton, invertebrates, fish and birds.

TABLE 4.6: PHYTOPLANKTON SPECIES RECORDED IN EAST HAMMAR MARSH (1992, 2006, AND 2018)

Number of Species	Notes	References
154	Southern part of East Hammar marsh	Al Saadi et al. 1992
64	Six months sampling	IMRP Final Report 2006
71	Six months sampling	Present study 2018

Sampling phytoplankton in East Hammar

TABLE 4.7: PHYTOPLANKTON SPECIES IN MANTHORI AND BURGHA RESEARCH STATIONS (MARCH TO AUGUST 2018)

No.	Group	Habitat	Manthori						Burgha					
			March	April	May	June	July	August	March	April	May	June	July	August
Cyanophyta														
1	*Anabaena sp.*	UN	-	-	-	+	-	-	+	-	-	+	-	-
2	*Chroococcus sp.*	UN	-	-	-	+	-	-	-	+	-	-	+	-
3	*Mersimopedia sp.*	UN	+	-	-	+	-	+	+	-	-	+	+	-
4	*Oscillatoria sp.*	UN	+	+	+	+	+	+	+	-	+	+	+	+
5	*Oscillatoria limnetica*	UN	+	+	-	+	+	+	+	-	+	+	+	+
6	*Spirolina sp.*	UN	+	+	-	-	+	-	-	-	-	-	+	-
Chlorophyta														
7	*Ankistradesmus sp.*	UN	-	-	-	+	-	-	-	-	-	-	-	-
8	*Cladophora glomerata*	UN	-	+	-	-	-	-	-	+	-	-	+	-
9	*Gomphosphaeria aponina*	UN	-	-	-	-	-	-	-	-	-	-	+	-
10	*Green cocci*	UN	-	-	-	+	+	+	-	-	-	+	+	+
11	*Oedogomium sp.*	UN	-	-	-	+	-	-	-	+	-	-	+	-
12	*Scenedesmus quadricauda*	UN	+	-	-	+	-	-	-	-	-	+	+	-
Bacillariophyta														
13	*Achnanthes brevipes* var. *intermedia*	B,M	-	-	+	+	-	-	-	-	-	-	+	-
14	*Amphora mexicana*	F	-	-	-	+	+	-	-	-	-	-	+	-
15	*Amphora ovalis*	F,B	-	-	-	-	-	-	-	-	+	-	-	-
16	*Bacillaria paxillifer*	B,M	+	-	-	-	+	-	-	-	-	-	-	-
17	*Caloneis permagna*	B	-	-	-	-	-	-	+	+	+	-	+	-
18	*Campylodiscus biocostatus*	B	+	+	+	-	-	-	-	+	+	-	-	-
19	*Campylodiscus clypeus*	UN	+	-	-	+	-	+	-	+	+	+	+	+
20	*Campylodiscus sp.*	UN	-	+	+	+	-	-	-	+	+	+	+	+
21	*Cocconies placentula*	F,B	+	-	-	-	+	-	+	-	-	-	+	-
22	*Coscinodiscus sp.*	UN	+	-	-	-	-	-	+	-	-	-	+	-
23	*Cyclotella meneghiniana*	F,B	+	+	+	+	+	+	+	+	+	+	+	+
24	*Entomoneis alata*	B	+	+	+	+	+	+	+	+	+	+	+	+
25	*Entomoneis corrngata*	B	+	+	-	-	-	-	-	+	-	-	-	-
26	*Entomoneis paladosa*	B,M	+	+	-	-	-	-	-	+	-	+	-	-
27	*Entomoneis sp.*	UN	-	-	-	+	-	-	-	-	-	-	-	-
28	*Gyrosigma acuminatum*	F,B	+	+	+	+	+	+	+	+	+	+	+	+
29	*Gyrosigma attenuatum*	F,B	+	+	+	+	+	+	+	+	+	+	+	+
30	*Gyrosigma distortum var. parkeri*	UN	-	-	-	+	-	-	-	-	-	-	-	-
31	*Gyrosigma eximium*	B	-	-	-	-	-	-	-	-	-	-	-	+
32	*Gyrosigma fasciola*	B,M	+	+	+	+	+	-	+	+	+	+	+	+

No.	Group	Habitat	Manthori						Burgha					
			March	April	May	June	July	August	March	April	May	June	July	August
33	*Gyrosigma scaproides*	F	+	+	+	+	+	-	+	+	+	+	+	+
34	*Gyrosigma sinensis*	M	-	+	-	+	+	+	+	+	-	+	+	+
35	*Gyrosigma sp.*	UN	-	+	-	-	-	-	-	+	-	-	-	-
36	*Mastogloia braunii*	B	-	-	+	-	-	-	+	-	-	-	-	-
37	*Navicula salinarum*	F,B	+	-	-	+	-	+	+	-	-	+	+	+
38	*Navicula sp.*	UN	+	+	-	+	+	+	+	+	+	+	+	+
39	*Nitzschia acicularis*	UN	-	+	-	-	-	-	-	+	-	-	-	-
40	*Nitzschia bicapitata*	M	-	-	-	-	+	-	-	-	-	-	-	-
41	*Nitzschia bilobata*	M	+	+	+	+	+	+	-	+	-	+	+	+
42	*Nitzschia clausii*	M,B	-	-	-	-	-	+	+	-	-	-	-	-
43	*Nitzschia dubia*	B,M	-	+	-	-	-	-	-	+	-	-	-	-
44	*Nitzschia filiformis*	B,M	+	-	-	-	-	-	-	-	+	-	-	-
45	*Nitzschia hybrida*	B,M	-	-	+	+	-	+	-	-	+	+	+	-
46	*Nitzschia increta*	M	-	-	-	-	+	+	-	-	-	+	+	+
47	*Nitzschia lorenziana*	B	+	-	-	-	-	-	-	-	-	-	-	-
48	*Nitzschia palea*	F	+	-	-	-	-	-	-	-	-	-	-	-
49	*Nitzschia prolongata*	B,M	+	-	-	-	+	+	+	-	-	-	+	+
50	*Nitzschia sigma*	F,B,M	+	+	+	+	+	-	+	+	+	+	+	-
51	*Nitzschia sp.*	UN	+	-	+	+	+	+	+	+	+	+	+	-
52	*Parlibellus cruticula*	B,M	-	-	-	-	-	-	-	-	-	-	+	-
53	*Plagiotropis lepidoptera*	un	-	-	-	-	-	-	-	-	+	-	+	+
54	*Pleurosigma elongatum*	B	+	-	-	+	-	+	+	-	-	+	+	-
55	*Pleurosigma sp.*	UN	+	+	-	+	+	+	-	+	-	+	+	-
56	*Pleurosira sp.*	UN	-	+	-	-	-	+	-	+	-	-	-	-
57	*Rhopalodia gibba*	F	-	+	-	-	+	+	-	-	+	-	+	-
58	*Sieminskia wohlenbergii*	B	-	-	-	-	-	+	-	-	-	-	-	+
59	*Surirella sp.*	UN	+	-	+	+	-	-	-	-	+	-	-	-
60	*Surirella stratula*	B	-	-	-	+	-	-	-	-	-	-	-	-
61	*Tabularia sp*	UN	-	-	-	-	-	-	-	-	-	-	+	-
62	*Tabularia sp.*	UN	-	+	-	+	+	+	-	+	+	-	-	-
63	*Tryblionella coarcata*	B,M	-	-	-	-	-	+	-	-	-	+	-	+
64	*Tryblionella granulata*	M	-	-	-	-	-	+	-	-	-	-	-	+
65	*Tryblionella littoralis*	B,M	-	-	-	-	-	-	-	-	+	-	-	-
66	*Tryblionella sp.*	UN	-	-	-	+	-	-	-	-	-	+	-	-
67	*Ulnaria sp.*	UN	-	-	-	+	+	-	-	-	+	+	+	-
68	*Ulnaria ulna var. clvicepes*	F	-	-	+	+	-	-	-	-	-	-	-	-
69	*Vanheurckia lewisiana*	B	-	-	-	+	+	-	-	-	-	-	-	-

No.	Group	Habitat	Manthori						Burgha					
			March	April	May	June	July	August	March	April	May	June	July	August
Euglenophyta														
70	*Euglena sp.*	UN	+	+	-	+	-	-	-	-	-	+	+	+
Pyrrophyta														
71	*Peridinium sp.*	UN	+	+	-	+	-	+	+	+	+	+	-	+

F: Freshwater, B: Brackish water, M: Marine, un: Unknown

ZOOPLANKTON (ANFAS N. OKASH)

Both small (meioplankton) and minute (microplankton) zooplankton appear in March, April, May, and June in Manthori and Burgha stations at East Hammar marsh. The dominant group was *Cirripedia* larvae, especially larva of *Apocyclops.* Another group of *Cyclops,* also occurred in high density, especially the genus *Cyclopoida,* abundant in low salinity habitats.

The most abundant and widespread zooplankton groups at both stations were *Cirripedia* larvae with very high density due to water hardness. Freshwater *Copepoda* genus (*Apocyclops, Cyclops, and Eucyclops*) occurred in high densities. During these four months, the group *Cyclopoida* occurred in high density, especially with in the first three months. In May, *Cladocera* appeared in large numbers, especially the genus *Moina*, which prefers a freshwater habitat, accompanied by the appearance of jellyfish. On the other hand, the high salinity in July and August caused the disappearance of the freshwater *Cladocera* group.

In July and August, there was a major change in the quality and quantity of small zooplankton (meioplankton) due to the sudden increase of salinity, leading to the disappearance of many freshwater groups like *Cyclopoida* and *Cladocera* and a decrease in the number of other groups (*Cirripedia* larvae), besides the appearance of marine species previously recorded only in the Arabian Gulf water.

Marine zooplankton occurred in high density, such as *Calanoida* family, especially the genus *Bestiolina* accompanied by the appearance of jellyfish of *Coelenterate*. The larval stages of shrimps, crabs and *Mysida* were abundant during the study period and their numbers did not suffer from an increase in water salinity. The change in salinity could bring new marine zooplankton to the marsh changing the zooplankton composition drastically.

Aquatic plants sampling at Manthori research station marsh

TABLE 4.8: ZOOPLANKTON SPECIES AT THE MANTHORI AND BURGHA RESEARCH STATIONS (MARCH TO AUGUST 2018)

No.	Group	Habitat	Manthori							Burgha				
			March	April	May	June	July	August	March	April	May	June	July	August
Copepoda														
1	*Apocyclops sp.*	F	+	+	+	+	-	-	-	-	-	+	-	-
2	*Bestiolina arabica*	M	-	-	-	-	+	+	-	-	-	-	+	+
3	Copepodite stages		-	-	-	-	-	-	-	-	+	-	-	+
4	Copepodite stages (*Calanoida*)	M	-	-	-	-	+	+	-	+	-	-	+	+
5	Copepodite stages (*Cyclopoida*)	F	-	+	+	+	-	-	-	-	-	-	-	-
6	*Cyclops crassicaudis*	F	+	+	+	-	-	-	+	-	-	-	-	-
7	*Delavalia longifurca*	F	+	+	+	-	-	-	+	-	-	-	-	-
8	*Eucyclops sp.*	F	+	+	+	-	-	-	+	+	+	-	-	-
9	*Harpacticoida*	F	-	-	-	-	-	-	-	-	-	+	-	+
10	*Limnoithona tetraspina*	F	+	+	+	-	-	-	-	-	-	-	-	-
11	*Mesocyclops sp.*	F	+	+	+	+	-	-	-	+	+	-	-	-
12	*Microstella sp.*	F	+	+	+	-	-	-	+	-	-	-	-	-
13	*Nauplii* larvae	F	+	+	-	+	-	-	+	-	-	-	-	+
14	*Oithona*sp.	M	-	-	-	-	+	+	-	-	-	-	+	-
15	*Pseudodiaptomus* sp.	M	-	-	-	-	+	+	-	-	-	-	+	+
Cladocera														
16	*Moina sp.*	F	+	+	+	+	-	-	+	+	+	+	-	-
17	*Simocephalus sp.*	F	+	+	+	-	-	-	-	-	-	-	-	-
Other Groups														
18	Amphipoda		-	-	-	-	-	-	-	-	+	-	+	+
19	Cirripedia larvae	F	+	+	+	+	+	+	+	+	+	+	+	+
20	Coelenterate (Medusa) Jellyfish	M	-	-	-	-	+	+	-	-	-	-	+	+
21	Fish eggs	F	-	+	+	+	-	-	-	+	+	+	-	-
22	Fish larvae	F	-	+	+	+	+	+	-	+	+	+	+	+
23	Foraminifera	F	-	-	-	-	-	-	-	+	+	-	-	-
24	Insect	F	-	-	-	-	-	-	-	-	-	-	+	-
25	Insect larvae	F	-	-	-	-	-	-	-	+	+	+	-	-
26	*Isopoda*	M	-	-	-	-	-	-	-	-	-	-	-	+
27	*Mysidacea*	M	-	-	-	+	+	+	-	-	-	+	+	+
28	*Nematode*	F	-	-	-	-	-	-	-	+	+	-	-	-
29	*Oligochaeta*	F	-	+	+	+	-	-	-	-	-	-	-	-
30	*Ostracoda*	F	-	-	+	+	+	+	+	-	-	+	-	-
31	*Protozoa*	F	+	+	+	-	-	-	-	-	-	+	-	-
32	Rotifer (*Brachionus*)	F	+	+	+	-	-	-	-	-	-	+	-	-

No.	Group	Habitat	Manthori							Burgha				
			March	April	May	June	July	August	March	April	May	June	July	August
33	Shrimp	F M	+	+	+	-	-	-	-	+	+	-	-	+
34	Zoea of crab	F M	-	-	-	+	+	+	-	-	-	+	+	+
Total			14	18	18	12	10	10	8	11	12	12	11	14

F = Freshwater, M = Marine

FISH (NAJAH A. HUSSAIN)

The fish community of East Hammar marsh is now dominated by exotic species and marine migratory fish species from Arabian Gulf. This fish composition, from what had been recorded in 2006, reflects a fundamental change from freshwater to estuarine / marine habitat. Increased marsh water salinity has led to the disappearance of most of the previously abundant native freshwater species recorded previously in East Hammar marsh in 2006, except for two species: *Planiliza abu* (*kishne)* and *Silurus triostegus* (*jurri)*. Their disappearance in July and August from the marsh coincides with the sharp increase in water salinity. The change in East Hammar marsh from a freshwater to marine habitat has encouraged the migration and invasion of marine fish species. For example, the marine bull shark (*Carcharhinus leucas)* was not previously recorded in East Hammar marsh in 2006 during IMRP.

Table 4.9 shows the gradual decrease of native species and increase of marine and exotic species in East Hammar marsh from 2008 to 2018. A comparison of that decade indicates an increased number and percentage of non-native species in East Hammar marsh and decreased number of native species, from half in 2008 and 2009 to 10 percent now.

TABLE 4.9: NATIVE, EXOTIC, MARINE, AND INVADER FISH SPECIES RECORDED IN EAST HAMMAR MARSH (2008 TO 2018)

Year	Native Species	Exotic Species	Marine Species	Invasive Species	Total	Native %	Ref.
2008	15	6	10	-	31	48%	Hussain et al.
2009	16	5	5	-	31	52%	Hussain et al.
2017	9	7	17	1	34	26 %	Hameed
2018	2	7	10	1	20	10%	Recent Study

Invasive small marine fish (Leiognathus bindus beside Thyrssa sp) caught in East Hammar marsh

TABLE 4.10: FISH SPECIES AT MANTHORI AND BURGHA RESEARCH STATIONS (MARCH-AUGUST 2018)

Common Name	Scientific Name	Status	Manthori						Burgha					
			March	April	May	June	July	August	March	April	May	June	July	August
Cypriniformes														
Carp	*Cyprinus carpio*	F E	+	+	+	+	+	-	+	+	+	+	+	+
Prussian carp	*Carassius auratus*	F E	+	+	+	+	+	-	+	+	+	+	+	-
Sharp belly	*Hemiculter leucisculus*	F I	+	+	+	+	+	+	-	-	-	-	-	-
Cyprinodontiformes														
Black molly	*Poecilia sphenops*	F E	-	-	-	-	-	-	-	-	-	-	-	+
Molly	*Poecilia latipinna*	F E	+	+	+	+	+	+	+	+	+	+	+	+
Mugiliformes														
Greenback mullet	*Chelon subviridis*	M Mi	+	+	-	-	+	+	+	+	-	+	-	+
Hishni mullet	*Planiliza abu*	F N	+	+	-	+	-	+	+	+	+	+	-	-
Perciformes														
Blue tilapia	*Oreochromis aureus*	F E	+	+	+	+	+	+	+	+	+	+	+	+
Eastern mudskipper	*Boleophthalmus dussumieri*	M I	-	-	-	+	-	-	-	-	+	+	-	-
Green mudskipper	*Bathygobius fuscus*	M Mi	+	+	+	+	+	+	+	+	-	+	-	+
Nile telapia	*Oreochromis niloticus*	F E	+	+	+	+	+	+	+	+	+	+	+	+
Orangfin ponyfish	*Leiognathus bindus*	M I	+	-	-	-	+	+	+	-	-	-	-	+
Red belly tilapia	*Coptodon zillii*	F E	+	+	+	+	+	+	+	+	+	+	+	+
Silver silage	*Silago sihama*	M Mi	+	-	-	+	+	+	+	-	-	+	+	+
Siluriforme														
Tigris catfish	Silurus triostegus	F N	+	+	+	+	-	-	+	+	+	+	-	-
Clupeiformes														
Hilsa shad	*Tenualosa ilisha*	M Mi	+	+	+	+	+	+	+	+	-	-	-	+
Oblique-jaw thryssa	*Thryssa whiteheadi*	M Mi	+	-	-	+	+	+	+	-	-	-	-	+
Beloniforme														
Needle fish	*Hemiramphus*	M Mi	-	-	-	-	-	+	-	-	-	-	-	+
Pleuronectiforme														
Oriental sole	*Brachirus orientalis*	M Mi	-	-	-	-	-	+	-	-	-	-	-	-
Carcharhiniforme														
Bull shark	*Carcharhinus leucas*	M Mi	-	-	-	-	-	+	-	-	-	-	-	-

Dominant migratory shrimp M. affinis from East Hammar marsh

Casting a net for fish samples in East Hammar marsh

AMPHIBIANS

Only the marsh frog (*Palophylax ridibandus)* was found in abundant number, mostly at the Manthori station. The tree frog (*Hyla savignyi)* that was previously recorded in the marsh was absent.

REPTILES

During March, April, May, and June, several freshwater reptile species were seen in East Hammar marsh, mostly in Manthori. The species were hard shell turtle (*Mauremys caspica)*, smooth shell turtle (*Raftus euphraticus)* and a freshwater snake (*Natrax tessellate).* With the increase of salinity in July and August, most of these reptiles suffer dangerously and in several occasions died. Many turtles of both species left the water to the banks for refugee.

Ecosystem monitoring team's zooogist with a smooth shell turtle

BIRDS (MUHANA A. QASSIM)

Iraq's southern marshes are consider by many ecologists as an important wetland habitat for resident, winter migratory, passing, or visiting bird species. The marshes are situated on the flying routes of many migratory birds from north of the Middle East and Central Asia to Africa. The three southern marshes were also listed by RAMSAR Convention as an important bird habitat for native and migratory bird species. During the monitoring period from March to August 2018, 57 species were recorded belonging to nine orders shown in the Table 4.11.

TABLE 4.11: BIRD ORDERS OBSERVED IN EAST HAMMAR MARSH (MARCH-AUGUST 2018)

Order	Number of Species
Anseriformes	1
Charadriiformes	23
Ciconiiformes	5
Columiformes	2
Coraciiformes	4
Falconiformes	2
Passeriformes	17
Podicipitiformes	1
Ralliformes	2
Total	57

FIGURE 4.15: BIRD SPECIES AS A PERCENT OF THE OVERALL POPULATION

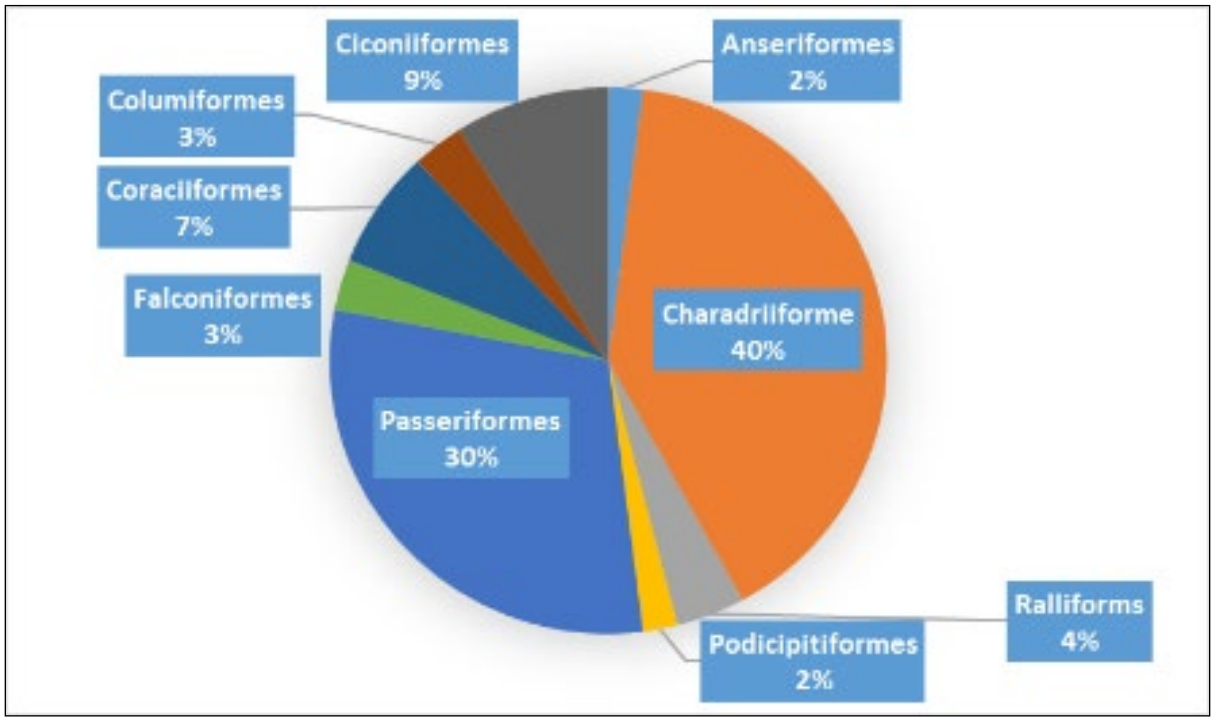


TABLE 4.12: BIRD VARIETIES OBSERVED AT EAST HAMMAR RESEARCH STATIONS (MARCH-AUGUST 2018)

Status	Scientific Name	Common Name	Manthori							Burgha				
			March	April	May	June	July	August	March	April	May	June	July	August
SVB,PM	*Hirundo rustica*	Barn swallow	+	+	+	+	+	+	+	+	+	+	+	+
R,WV,PM	*Haemantopus Haemantopus*	Black winged stilt	+	+	+	+	+	+	+	+	+	+	+	+
SVB,PM	*Merops supercliosus*	Blue-cheeked bee–eater	+	+	+	+	+	-	+	+	+	+	+	-
SV,PM	*Sterna caspia*	Caspian tern	-	+	+	+	+	-	-	-	-	+	+	-
RB	*Streptopelia decaocto*	Collared dove	+	+	+	+	+	+	+	+	+	+	+	+
SVB,PM	*Glareola praticola*	Collared pratincole	+	+	+	+	+	+	+	+	+	+	+	+
RB,WV,PM	*Alcedo cristata*	Common kingfisher	-	-	-	-	-	-	+	+	-	-	-	-
PM	*Phoenicurus phoenicurus*	Common redstart	-	-	-	-	-	-	-	-	-	+	-	-
WV,PM	*Actitis hypoleucos*	Common sand piper	-	-	-	-	-	-	-	+	-	+	+	-
WV,PM	*Gallinago gallinago*	Common snipe	-	-	-	-	+	+	-	-	-	+	+	+
WVB,PM	*Sterna hirundo*	Common tern	+	+	+	+	+	+	+	+	+	+	+	+
WVB,PM	*Fulica atra*	Coot	-	-	-	-	-	-	-	-	-	-	-	+
RB	*Galerida cristata*	Crested lark	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Calidris ferruginea*	Curlew sandpiper	-	-	-	-	-	-	-	-	-	+	-	-
WV,PM	*Calidris alpina*	Dunlin	+	-	-	-	-	-	-	-	-	-	+	-
RB	*Prinia gracilis*	Graceful prinia	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Tringa tetanus*	Greenshank	-	-	+	+	+	+	+	+	-	+	+	+
WV,PM	*Motacilla cinerea*	Grey wagtail	+	-	-	-	-	-	+	-	-	-	-	-
RB	*Corvus corone cornex*	Hooded crow	+	+	+	+	+	+	+	+	+	+	+	+
PM	*Delichon urbica*	House martin	-	-	-	-	-	-	+	+	+	+	+	-
RB	*Passer domesticus*	House sparrow	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Oenanthe isabellina*	Isabelline wheatear	-	-	-	-	-	+	-	-	-	-	-	-
RB,	*Charadrius*	Kentish	+	+	+	+	+	+	+	+	+	+	+	+

Status	Scientific Name	Common Name	Manthori							Burgha				
			March	April	May	June	July	August	March	April	May	June	July	August
WV,PM	*alexandrines*	plover												
RB	*Streptopelia senegalensis*	Laughing (palm) dove	+	+	+	+	+	+	+	+	+	+	+	+
PM	*Lanius minor*	Lesser grey shrike	-	-	-	-	-	-	-	-	-	+	-	-
SVB,PM	*Ixobrychus minutus*	Little bittern	+	+	+	+	-	-	+	+	+	+	-	-
RB,SV,PM	*Egretta garzetta*	Little egret	-	-	+	+	+	+	-	+	+	+	+	+
RB	*Tachybaptus ruficollis*	Little grebe	-	-	-	-	-	-	+	-	+	+	+	-
PM, may B	*Charadrius dubius*	Little ringed plover	+	+	+	+	+	+	+	+	+	+	+	+
SVB,PM	*Sterna albifrons*	Little tern	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Bueto rufinus*	Long-legged buzzard	-	-	-	-	-	-	-	-	-	-	-	+
RB,WV	*Marmaronetta angustirostris*	Marbled teal	-	-	-	-	-	-	-	-	-	-	-	+
RB, WV,PM	*Circus aeruginosus*	Marsh harrier	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Tringa stagnatilis*	Marsh sandpiper	-	+	-	-	-	-	-	-	-	-	-	-
RB, WV,PM	*Gallinulua chloropus*	Moorhen	-	-	-	-	-	-	+	+	+	+	+	-
RB	*Ceryle rudis*	Pied kingfisher	+	+	+	+	+	+	+	+	+	+	+	+
RB,SV,PMt	*Ardea purpurea*	Purple heron	-	+	+	+	+	+	+	-	-	-	-	-
PM	*Lanius collurio*	Red–backed shrike	-	-	-	-	-	-	-	-	-	+	-	-
RB	*Hoplopterus indicus*	Red wattled lapwing	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Philomachus pugnax*	Ruff	-	-	-	+	+	+	-	-	-	+	+	+
SV,PM	*Cercotrichas galactotes*	Rufous-tailed scrub robin	-	-	-	-	-	-	+	-	-	-	-	-
SVB	*Reparia reparia*	Sand martin	-	-	-	-	-	-	+	+	+	+	+	-
RB, WV,PM	*Larus genei*	Slender-billed gull	+	+	+	+	+	+	+	+	+	+	+	+
R,PM	*Vanellus spinosus*	Spur-winged lapwing	-	-	-	-	-	-	+	-	-	-	-	-
RB,SV	*Ardeola*	Squacco	+	+	+	+	+	+	+	+	+	+	+	+

Status	Scientific Name	Common Name	Manthori							Burgha				
			March	April	May	June	July	August	March	April	May	June	July	August
	ralloides	heron												
WV	*Sturnus vulgaris*	Starling	-	-	-	-	+	+	-	-	-	-	-	+
WV,PM	*Arenaria interpres*	Ruddy turnstone	+	-	-	+	-	-	-	-	-	-	-	-
RB,SV,PM	*Bubulcus ibis*	Western cattle egret	-	+	-	-	-	-	-	-	-	-	-	-
WV,PM	*Motacilla flava*	Western yellow wagtail	+	-	-	-	-	-	+	-	-	-	-	-
RB,SV,PM	*Chlidonians hybridus*	Whiskered tern	+	+	+	+	+	+	+	+	+	+	+	+
RB,SV	*Chettusia leucura*	White tailed lapwing	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Matacilla alba*	White wagtail	-	-	-	-	+	+	-	-	-	-	+	+
SV,Pm	*Chlidonia leucopterus*	White-winged black tern	+	+	+	+	+	-	+	+	+	+	+	-
RB	*Halcyon smyrnesis*	White-breasted kingfisher	+	+	+	+	+	+	+	+	+	+	+	+
RB	*Pycnonotus leucogenys*	White-checked bulbul	+	+	+	+	+	+	+	+	+	+	+	+
WV,PM	*Tringa glareola*	Wood sandpiper	-	-	-	+	-	-	-	-	-	-	-	-
Monthly number of species			32	36	39	30	36	32	31	32	32	29	29	29

R: Resident, SV: Summer visitor, WV: Winter Visitor, PM: Passage migrant, B: Breeding

Field results showed that 46 and 39 species were recorded in Manthori and Burgha research stations, respectively. The largest number of species was recorded in Manthori during May, and the lowest was in July with 30 species sighted. In Burgha station, the highest number of species was recorded in April and May (32), and the lowest was recorded in June, July and August (29 species). Most birds were migratory coming as winter or summer visitors or were only passing through. The rest were local or native, usually nesting but also as summer visitors. From field observations, we found that the winter visitors started to return to their home habitat for breeding. Those that were left during spring and summer seasons were non-breeding. The low number of bird species recorded was due to the limited monitoring period covering the spring and summer months (the hottest months of the year) and did not include the autumn and winter seasons which are the best periods for bird observation, especially the migratory ones.

TABLE 4.13: NUMBER OF BIRD SPECIES OBSERVED IN EAST HAMMAR MARSH (1972, 1975, 1979, 2006 AND 2018)

Number of Species	Notes	Reference/Year
73	(Combined 1972, 1975, 1979)	Scott 1995
29	For six months	IMRP 2006
59	For six months	Present survey 2018

Table 4.13 shows that the number of species has not been affected by increased water salinity, although the current number is less than what was recorded by Scott (1995) before the near total dissection of the marshes.

MACROBENTHOS (HAIFA A. HAMZA)

A total of 25 taxa of macrobenthos were collected in both stations in East Hammar marsh during the sampling period. Two species of marine shrimp invaded the marsh that had never been recorded previously. They are usually present in the Shatt Al Arab estuary and the Gulf. These marine shrimp were found in August 2018, coinciding with an increase in water salinity. There was also a noticeable decrease in the number of Mollusca species again coinciding with increased salinity, since these species were a freshwater variety. Differences do occur between species in both stations. The most abundant group was *Crustacea*, followed by Mollusca and then insects. Some species, like freshwater shrimp and two species of Mollusca, were absent from Burgha.

Collecting benthos samples from bottom sediments in East Hammar marsh

BIRDS OBSERVED IN EAST HAMMAR MARSH (MARCH-AUGUST 2018)

Black winged stilts

Little egrets

Collared pratincole

White tailed lapwings

Pied kingfisher in East Hammar marsh

Pied kingfisher in East Hammar marsh

TABLE 4.14: MACROBENTHIC SPECIES OBSERVED IN THE MANTHORI AND BURGHA STATIONS (MARCH TO AUGUST 2018)

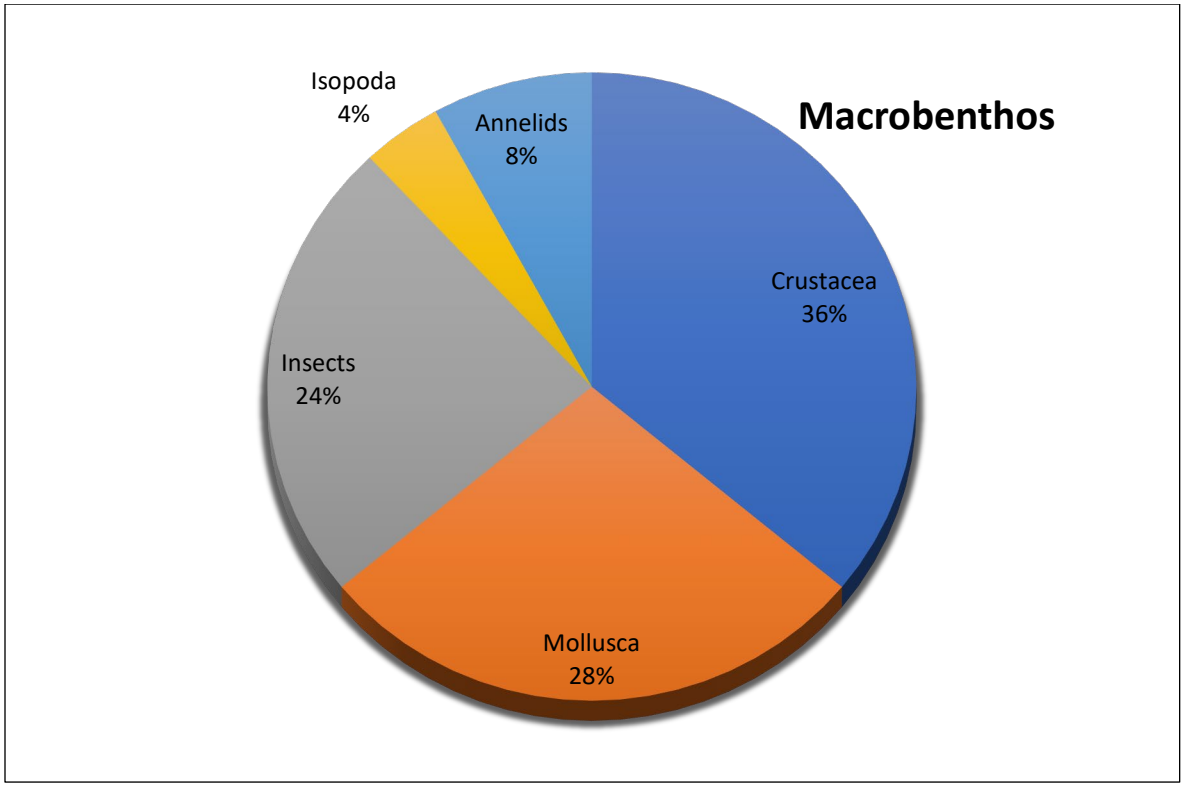
No.	Group	Habitat	Manthori						Burgha					
			March	April	May	June	July	August	March	April	May	June	July	August
Crustacea														
1	*Amphibalanus amphitrite*	M	+	+	+	+	+	+	+	+	+	+	+	+
2	*Atyaephyra desmarestii mesopotamica*	F/N	+	+	+	+	+	+	-	+	-	-	-	+
3	*Caridina babaulti basrensis*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
4	*Elamenopsis kempi*	F/N	-	+	+	+	+	+	+	+	+	+	+	+
5	*Macrobrachium nipponense*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
6	*Metapenaeus affinis*	M/Mi	+	+	+	+	+	+	+	+	+	+	+	+
7	*Parhyale basrensis*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
8	*Exopalaemon styliferus*	M/I	-	-	-	-	-	+	-	-	-	-	-	+
9	*Penaeus semisulcatus*	M/I	-	-	-	-	-	+	-	-	-	-	-	+
Mollusca														
10	*Bellamya bengalensis*	F/N	+	+	+	+	+	-	+	+	+	+	+	-
11	*Carbicula fluminalis*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
12	*Carbicula fluminea*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
13	*Lymnaea auricularia*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
14	*Malanoides tuberculata*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
15	*Melanopsis nodos*	F/N	+	+	+	+	+	-	-	-	-	-	-	-
16	*Physa acuta*	F/N	+	+	+	+	+	-	-	-	-	-	-	-
Insects														
17	*Aeshnidae* nymph	F/N	+	+	+	+	+	+	+	+	+	+	+	+
18	*Gomphidae* nymph	F/N	+	+	+	+	+	+	+	+	+	+	+	+
19	*Libellulidae* nymph	F/N	+	+	+	+	+	+	+	+	+	+	+	+
20	*Zygoptera nymph*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
21	*Chironomide* larvae	F/N	-	-	-	-	-	-	-	-	-	-	-	+
22	*Coleoptera* spp	F/N	-	-	-	-	-	-	-	-	-	-	-	+
Isopoda														
23	*Sphaeroma annanidalie*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
Annelids														
24	*Dendronereides heteropoda*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
25	*Limnodrilus hoffmeisten*	F/N	+	+	+	+	+	+	+	+	+	+	+	+
Monthly number of species			20	21	21	21	21	20	18	19	18	18	18	222

F: Freshwater, M: Marine, N: Native, Mi: Migratory, I: Invader

TABLE 4.15: MACROBENTHOS RECORDED IN EAST HAMMAR MARSH (2006 AND 2018)

Group	IMRP (2006)	Present (2018)	Difference In Taxa
Mollusca (snail)	13	7	-6
Insecta	8	6	-2
Shrimp	3	6	+3
Bivalve	2	0	-2
Spider	2	0	-2
Amphipoda	2	1	-1
Isopoda	2	1	-1
Crab	2	1	-1
Annelid	2	2	0
Cirriped	1	1	0
TOTAL	39	25	-14

FIGURE 4.16: RELATIVE ABUNDANCE OF MACROBENTHOS GROUPS IN EAST HAMMAR



Gastroboda shells in East Hammar marsh after the tidal retreat

CONCLUSION

The Marsh Arabs' livelihood has historically depended, and still depends in large part, on the products of the aquatic ecosystem. The marsh ecosystem even now supplies them with basic resources and physical access used daily and enables them to continue that life style into the future. Their basic requirements are crude freshwater, common reeds, freshwater fish, and water buffalo. These four factors are closely interrelated and require a relatively stable ecosystem.

Our main task as a team was to evaluate the integrity of aquatic ecosystem of the southern marshlands. We established two research stations in East Hammar marsh: (1) a channel marsh that is important for fishing and transportation and has deep tidal water and (2) an open marsh with a vast shallow semi-diurnal tide that becomes nearly dry at ebb tide. The sampling was carried out over six months from March to August 2018, during which time we measured water quality along a number of different parameters and observed and recorded the presence of aquatic plants, phytoplankton, zooplankton, benthos, fish, and birds. And then we compared those findings with observations made under the Iraq Marshlands Restoration Program to determine population changes.

We found a sharp increase in water salinity in the marsh due to a decrease of Tigris and Euphrates discharge and an advancing of Arabian gulf salt wedge inside the marsh. In August 2018, the salinity reached 16.1 psu, when it was previously around three to four ppt. Our analysis of phytoplankton,

zooplankton, benthos, and fish, based on monthly data, indicated the invasion of marine species of different groups and the disappearance or withdrawal of freshwater native species originally inhabiting East Hammar marsh. The fish population of the marsh contained only two native freshwater fish species, while the rest were exotic and marine invaders.

This increase in water salinity will eventually destroy the livelihood of the Marsh Arabs. Common reeds can tolerate salinity up to 25-35 psu. If the trend continues, the reeds are going to disappear from the marsh. With no fodder for the buffalo, the present large herds in the marshes will also disappear, as will local dairy production and a major part of their diet. Furthermore, water buffalo need to be immersed in freshwater several times a day, not in the present increasingly saline water.

People in the marshes depend on freshwater fish as daily food. As a result of the increase in salinity, their favorite fish species, *Cyprinidae*, will continue to disappear, replaced by exotic tilapia and small marine fish. Marsh Arabs are already buying fish instead of fishing themselves.

Marsh Arabs are now buying desalinated drinking water for their domestic use and their buffaloes consumption. They are also increasingly buying fodder for their livestock, when there was earlier need. Some buffalo breeders on the southern banks of Shatt Al-Arab have started to migrate from region. Migration will grow if the East Hammar marsh ecosystem continues to change from freshwater /oligosaline (i.e., low saline) to estuarine / marine.

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BURGHA AND MANTHORI RESEARCH STATIONS IN EAST HAMMAR MARSH

Burgha Research Station

Manthori Research Station

5. Institutional Support

Najah A. Hussain and Alaa H. Al-Badran

Current state of the marshlands ecology laboratory in the University of Basra

In addition to its efforts in the marshes, IMRP worked at an institutional level with the Government of Iraq and the University of Basra. Using its USAID-contracted funds, it financed the activities of the U.S. Army Corps of Engineers (USACE) to jointly develop a decision-support model with the Ministry of Water Resources for water releases in the entire Tigris-Euphrates system and train a number of its staff to operate and maintain the model. It re-equipped the water laboratory in the Ministry of Water Resources headquarters in Baghdad, the marshland ecology laboratory in the College of Agriculture and the fish hatchery laboratory in the Marine Science Center, both at the University of Basra.

MOWR HYDROLOGIC MODEL OF TIGRIS-EUPHRATES BASIN

Background

The Ministry of Water Resources manages the water control infrastructure of the Tigris and Euphrates basins to serve Iraq's national needs. Following the invasion, the U.S. Army Corps of Engineers was quickly established as the lead in Iraq's water sector. Its representative acted as "shadow minister" during the first months after the invasion and signaled a desperate need to develop a hydrologic model of the basins to better inform operations. The objective was to enable the MOWR to regain water management

capability and to update data, modeling, and real-time management systems technology that were lagging behind international standards.

Under a subcontract through IMRP, the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC) in Davis, California constructed the region's first reservoir simulation model for the Tigris and Euphrates river basins. The USACE working with MOWR staff collected the necessary data on the water management system in Iraq, including river flow records, characteristics and functions of flow regulation projects, and water withdrawal requirement. In addition, HEC worked in collaboration with MOWR engineers, training ten engineers in Iraq and hosting two senior engineers at Davis for two months. After more than two years, the USACE and MOWR completed the reservoir model that incorporated major storage structures, diversion projects, and operational criteria as dictated by the MOWR regulation plan for its water management system. The model was refined to serve as a planning-aid tool for performing water budget analyses, and developed into a decision-support tool for real-time operation.

Result

Initially, the hydrologic model was seen to have been useful to the Ministry and worked properly. The General Manager of CRIMW noted that the model was in operation for six years, from 2006 to 2012. However, problems then arose because of both the internal dynamics of the model and because of those who were responsible for its operation. Over time, the Ministry found that it no longer reflected fundamental changes in water resources inputs, rain levels, and rising temperatures.

The program would need to be updated, but the Ministry lacks the staff resources to do it. Many of the engineers trained by USACE have taken leave permits from the Ministry, accepting employment outside the country for significantly higher salaries, and the Ministry did not offer monetary incentives to encourage them to stay in their positions. The program will need to be modernized if it is to be used again, and there has been some mention of updating it as part of a strategic plan through 2035. Some of the original trainees are still working in the MOWR head office or have gone over to CRIMW in Baghdad. Those who were trained by the Army Corps of Engineers during IMRP will need to be retrained if the model is to be reused, and they appears to be some continuing relationship between USACE and the National Iraqi Center for Water Resources and MOWR's Department of Dams.

Therefore, the hydrologic model appears to have served a useful purpose for a limited period of time, but its demise is largely due to staffing issues arising from rigid administrative rules and restricted resources. Enhancing the experience and qualifications of staff, thus making them more attractive for outside hire, is a common institutional development problem, but one which seems not to have been adequately addressed during the period of USACE's assistance.

CENTER FOR RESTORATION OF THE IRAQI MARSHES AND WETLANDS

Background

IMRP played a role in the creation of the Center for the Restoration of the Iraq Marshlands (CRIM) and worked with its staff and other entities to register the marshes as RAMSAR convention sites. CRIM was more recently renamed the Center for the Restoration of the Iraqi Marshes and Wetlands (CRIMW), having been expanded to a general directorate by law to cover all types of wetlands in Iraq . CRIMW has four branches in southern Iraq, in Basra, Maysan, Dhi-Qar and Muthanna. A fifth branch is in Sulaymaniyah in the north of Iraq.

RESULT

After years of preparation, Iraq entered the Ramsar Convention on 17 February 2008. Currently, four sites have been designated as "wetlands of international importance" totally 537,900 hectares, including Huwaizah, Central, and Hammar marshes and the far smaller 500 hectare Sawa Lake in Muthanna governorate. Under the Convention, the contracting parties commit to "(1) work towards the wise use of all their wetlands, (2) designate suitable wetlands for the list of Wetlands of International Importance (the 'Ramsar List') and ensure their effective management, and (3) cooperate internationally on transboundary wetlands, shared wetland systems and shared species."

Although the acquisition of additional funds from USAID and other bilateral and multilateral donors was not an explicit responsibility of IMRP, program management in close collaboration with USAID met, briefed, and worked with a number of donors in anticipation of a flow of funds for expanded support for the marshlands. During the program there were presentation to the British Foreign Office in London, the Canadian International Development Agency (CIDA), in Ottawa the United Nations Environmental Program (UNEP) and the United Nations High Commissioner for Refugees (UNHCR) in Geneva, and the European Commission in Brussels.

Recent interviews with CRIMW have revealed that the Government of Iraq has received no external contributions since the close of IMRP, with the exception of logistical support for a monitoring program from UNEP; a geographical information systems (GIS) project to connect the governorates funded by the Italian government, which is on hold for reasons unclear to CRIMW. In addition, Ramsar awarded two small grants to Nature Iraq in 2014, to improve the management effectiveness by raising awareness of the local communities about the opportunities and challenges of conserving the site and ensuring their participation in key decision making processes. (ramsar.org 29 October 2015).

In all, the level of contributions and investments to the marshes has been very disappointing, as is the ability of CRIMW to fulfill its mandate. CRIMW depends entirely on its limited budget from the national government. When CRIMW was created, it regularly carried out monitoring activities in the marshes, but its field activities are now limited to measuring the level of inlet water. It has not done regular ecosystem monitoring since 2007, just after IMRP ended USAID support for the marshlands ceased. Its monitoring is now based on openly available remote sensing data as they seek to identify and resolve emerging problems. CRIMW does not operate its own laboratory, instead paying the MOWR headquarters laboratory for services. In the past, CRIMW has asked USAID to establish a specialized wetlands laboratory without success. Initially, USAID also supplied instruments to measure water discharge and water quality to 16 monitoring stations operated by CRIMW; another 13 were equipped by the Italian government, but the instruments are no longer working and their warranties have long expired.

MOWR AND UNIVERSITY LABORATORY UPGRADES

BACKGROUND

USAID funding through IMRP was used to renew and re-equip water and soil laboratories in the Ministry of Water Resources and in the University of Basra. Pre-invasion, the scientific laboratories at both institutions had been in fairly good condition, given the preceding years of internationally-imposed economic sanctions. However, with the invasion, the country experienced widespread and massive disorder. With no national military or police force to keep order, Iraq suffered from uninterrupted looting in government offices and on university campuses. IMRP, at the request of the ministry and the university, re-outfitted laboratories in both entities.

RESULT

- **Central Water and Soil Laboratories in the Baghdad headquarters of the Ministry of Water Resources.** IMPR supported the re-establishment of two laboratories in the Ministry of Water Resources. The labs are still operative and offer services, such as water and soil sample analyses, for fees.
- **Marshland Ecology Laboratory in the Department of Fisheries, College of Agriculture, University of Basra.** The Marshland Ecology Laboratory in the Department of Fisheries, College of Agriculture in the University of Basra is still in place and served both undergraduate and postgraduate students. Faculty noted that field instruments supplied by IMRP were of great help to perform the field measurements of many post-graduate students at Department of Fisheries and other College of Agriculture departments.

  However, after more than ten years, most of the equipment is no longer working. It has become old and needs to be maintained. When fully operative, the lab was used by scientists to prepare more than 30 research papers dealing with water quality of southern marshes and the Shatt Al-Arab river. More than 20 Ph.D. and M.Sc. students carried out the research for their degrees in the lab, using the field instruments supplied by IMRP. Most of field surveys on the southern marshes done at the university were supported by the laboratory, using field instruments supplied by IMRP.
- **Aquaculture Fish Hatchery Laboratory in the Marine Science Center, University of Basra.** The Aquaculture Fish Hatchery Laboratory in the Marine Science Center is still in working order under the supervision of qualified staff, including several Ph.D. and M.Sc. faculty and staff of the Marine Science Center. The laboratory depends on local contributions, due to the cessation of government support and international assistance. However, the Center has not been able to continue its efforts with IMRP to reintroduce native fingerlings into the marshes to support local fish stock. This stoppage had a serious negative impact on the local fish stock, including the highly prized *bunni*, which was major focus of work under IMRP.

CONCLUSIONS

IMRP's efforts to support existing institutions were limited to the Ministry of Water Resources in Baghdad and the University of Basra and focused on interventions that would support the restoration of the southern marshes. In the chaotic atmosphere following the invasion, its activities shared a common goal: to provide immediate assistance for institutions to operate functionally again, rather than tackling endemic and deep rooted problems that grew out of governmental neglect and international isolation.

IMRP used it resources for the U.S. Army Corps of Engineering to develop a dynamic model to predict the impact of damn releases along the Tigris and Euphrates rivers, bolstering the ministry's new mandate to shift from an irrigation entity to one with a broader vision of water resources management. Within that same ministry, IMRP refitted its central soil and water laboratory that was virtually defunct. And it nominally supported a new center's efforts to have the southern marshlands be recognized by an international convention. In Basra, it refitted the water laboratory at the university, which then branded itself as a marshlands ecology laboratory that served faculty and graduate students in the research. It also attempted to establish a fish hatchery center at the university's Marine Science Center, with far less success.

In fact, IMRP's efforts were mostly very successful in the short-term. The hydrologic model was used by MOWR as its core planning tool for six years, until it no longer reflected fundamental environmental changes in Iraq. The ten ministry engineers who had been trained repeatedly by USACE had either shifted to positions elsewhere or were overwhelmed by the requirements of reworking the model. The ambitious and complex model could be used effectively but not upgraded. However, one might argue that for six

years the model strengthened the ministry's ability to refashion itself and added to its expertise and credibility in the long-term.

In contrast, the re-equipping MOWR's central laboratories are an unqualified long-term success. After more 12 years, they are still in full operation and work on a fee for service basis. This approach has probably enabled them to constantly upgrade their equipment and continue to provide sought-after services in soil and water analysis.

At the University of Basra, the renamed marshlands ecology laboratory was a badly needed facility in an institution that had been racked by widespread theft by locals immediately after the invasion, stripping it of furniture and equipment. By June 2004, the laboratory was an empty room with some of its more valuable equipment hidden in faculty homes for safekeeping. The newly refitted laboratory successfully supported the research of faculty and of nearly two dozen students for advanced degrees. However, over time, the specialized scientific equipment needed to be upgraded or repaired but has not been. The operations of the fish hatchery at the Marine Science Center were disappointing during IMRP and fared no better after its conclusion. It was an investment made with great hopes but sub-optimal results.

IMRP was correct to offer targeted assistance, rather than make major institution-building commitments in a ravaged country. It had neither the resources nor the time. Operating in war-like conditions, it traded illusory long-term sustainability for realistic middle-term gains that, even so, lasted upwards of six years. Among its variety of initiatives, the soil and water laboratories in MOWR stand out a successful example of constant improvement and stability. IMRP served the purpose of helping to get the institutions moving again, but for how long depended on their ability and interest in bringing the resources together to meet a long-term goal.

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6. Agricultural Production

Abbas M. Jassim

Al Tar district, Maysan governorate date palm orchard in 2018, initially planted by IMRP in 2006

Prior to draining the southern marshes, the local economy was based on the area's biological diversity: livestock, fishing, hunting, and mat-making from the ubiquitous reeds. Agriculture was seldom carried out in the marshes. Desiccation of the marshes forced many marsh dwellers into agriculture. At the time of the invasion in 2003, little besides wheat was grown in the area that had been marshes. And large areas that had once been covered by water were converted to complex irrigation and drainage systems, leading to disastrously high soil salinity on a massive scale.

With marsh drainage and forcible displacement, many of the marsh dwellers came to view themselves as agriculturalists, as most of their income derived from growing and selling crops. Yet, agriculture in these areas was poor, even in areas where former marsh dwellers had been cultivating for more than a decade. The transition from marsh to drained land has not been easy for the former marsh dwellers. Faced with challenges particular to their land and water conditions, the former marsh dwellers eked out a difficult existence.

To offer a viable set of opportunities to the former marsh dwellers, IMRP focused on carrying out three interventions in agriculture: developing a soil-water database to improve land and irrigation planning, carrying out large-scale crop demonstrations for field crops and horticulture, and establishing date palm nurseries for growing and distributing off-shoots. Implementation was contingent on the absence of

reflooding of former marshlands. They were designed to stabilize and improve the living conditions of former marsh dwellers who had become farmers and who wished to remain farmers.

CENTRAL SOIL-WATER DATABASE

BACKGROUND

In March 2004, IMRP with local representatives of the Ministry of Agriculture conducted a soil and water survey at 70 different locations in the Hammar, Huwaizah, and the Central marshes. The aim of the effort is to determine the extent to which soil and water resources were limited agricultural production at the farm and village levels in the drained and reflooded marshlands. It also developed a set of practical soil and water indicators to help local government officers and growers identify signs of soil and water degradation and to adopt practices to reverse it, thereby increasing agricultural productivity and sustainability.

IRMP and its partners identified indicators of productivity and soil and water health and cataloged the results in an electronic database for access by the GOI, farmers, and university staff. Along with the results, IMRP provided training on how the indicator data ought to be interpreted and potential management options to overcome the problems identified. They were used, among other factors, to select the type of crop to be cultivated in a particular farm. Date palms, alfalfa and sorghum were selected for their market value and their ability to tolerate a considerable amount of salinity and potential water shortages.

The longer term objective was to create a useable and sustainable central database for marsh soil and water data that could be easily accessed by the public and private sector, improve crop selection and production by providing farmers with useful and accurate information on soil and water characteristics, and build capacity in the GOI ministries and the University of Basra through workshops and training sessions on the soil and water testing methods, use of modern laboratory equipment, and soil and water management options

RESULT

Following the close of IMRP, there was no further action on the part of the Ministry of Agriculture and the University of Basra to continue to develop and maintain a central soil-water database. After 12 years, it appears that neither side even knows where the IMRP data are. There continue to be interactions between the two institutions on many levels, but not in this area inspired by IMRP.

FIELD CROP DEMONSTRATIONS

BACKGROUND

IMRP's objectives in its agriculture component were to increase household incomes from agriculture and livestock herding by introducing higher-value crops to broaden the range grown by the marsh dwellers, improve farm management, and stimulate regional markets through an influx of locally-produced goods.

Livestock production in the marshes was low because of poor nutrition from underfeeding. Marsh Arabs did not cultivate forage crops, and herders did not have the resources to purchase feed. Livestock production from natural pastures is generally low, and roughages have low nutritive value, but the value can be improved by supplementing natural pastures with forage legumes. To address this problem, IMRP introduced alfalfa cultivation in April 2004 on 35 donums in Hammar marsh. In September 2004, another 130 donums were planted in the three governorates that contain marshlands. From 2004 through the close

of IMRP, there was a steady increase in the area cultivated in alfalfa. By summer 2006, the area had increased from the original 165 donums to 420 donums. It mushroomed to 30,000 donums during the first growing season after the program ended in November 2006.

IRMP also demonstrated sorghum on twenty hectares in Maysan governorate and ten hectares in both Basra and Dhi-Qar governorates. Sorghum yields were about 180 percent (2,800 kilogram per hectare) higher than in previous years due to the purchase of high-quality sorghum seeds, the introduction of fertilizers and pesticides, which farmers usually could not afford to purchase, and improved methods of preparation and planting.

Other demonstrations included fifteen hectares of wheat, five hectares of barley, and five hectares of broad beans in each of the three southern governorates. Each participating marsh dweller received IMRP support to grow 1.25 hectares of wheat or barley.

RESULT

Alfalfa cultivation in the three governorates in which IMRP operated expanded dramatically from 165 donums during the initial planting seasons in 2004 to 30,000 donums during the growing season immediately after the program ended in 2006.

Alfalfa field in Al Tar District

The figures for years 2007 through 2011 are not accessible, but agriculture directorate staff in the three governorates indicated that the cultivated area was in the 2006 range during those years. The total area planted with alfalfa in the three governorates has not fluctuated greatly since 2006, having remained above 30,000 donums during the past 11 years. In 2017, the total area was 30,567 donums. (The total for 2018 is not yet available and the directorates do not collect data on yields.) Alfalfa cultivation peaked in 2013, but increased soil and irrigation water salinity, a rise in temperatures that reach 50° C during summers, and water shortages in some marsh areas account for the drop since then. Alfalfa requires a large quantity of water that is not available now in most of the marshes.

At the level of each governorate, the trends become clearer (Table 6.1). Dhi-Qar with the best water conditions shows increases throughout the post-IMRP period, with a 21 percent increase in 2013 and a 16 percent increase in 2014. Conversely, Maysan saw a 31 percent decrease in alfalfa cultivation in 2014 after a 25 percent increase in 2013. Alfalfa cultivation in Basra decreased by 11 percent in 2015 following on a 27 percent increase in 2013. One might reasonably argue that if the water quantity and quality had remained constant since 2013, the total area cultivated with alfalfa would have risen higher. However, it appears that the sustainable ceiling for alfalfa cultivation in the three governorates is in the range of 30,000 donums, limited more by recent soil and water conditions than by farmer interest.

Marsh Arabs who have taken up farming say that feeding alfalfa to their buffalo and cattle improves the quality and quantity of milk and other dairy products and fattens male calves for meat production. Interestingly, very few animal owners cultivate alfalfa or sorghum themselves. These crops are grown by others. But animal owners who do grow alfalfa are more likely to own cattle and, less frequently, sheep. Market prices for alfalfa and sorghum have largely remained stable, as their cultivation has waxed and waned over the past 12 years.

Alfalfa planted near an oil rig in Huwaizah marsh operated by a Chinese company

Alfalfa growing in the remaining IMRP-funded date palm orchard in Maysan governorate

TABLE 6.1: AREA OF ALFALFA CULTIVATION DURING AND AFTER IMRP IN THREE GOVERNORATES* (DONUM)

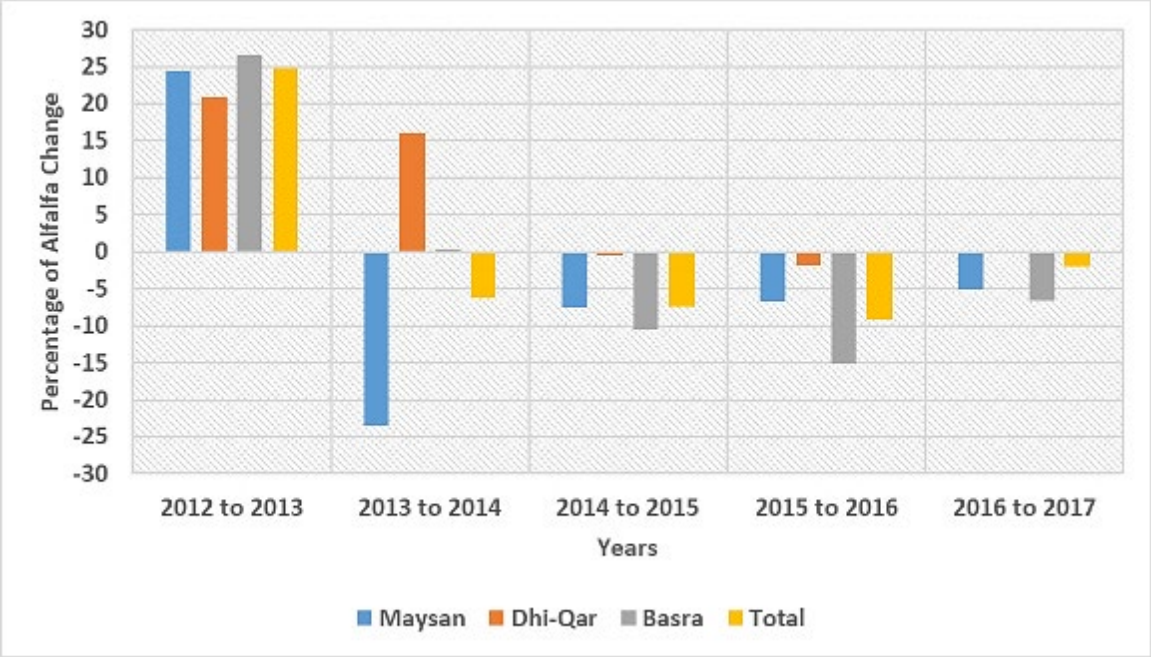
	IRMP	Post-IRMP						
Governorate	**2004**	**2006**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Maysan	40	12000	12469	15522	11850	10946	10191	9665
Dhi-Qar	40	5500	5848	7064	8200	8163	8039	8019
Basra	85	12500	13461	17048	17100	15287	12968	12883
Total	165	30,000	31,778	39,634	37,150	34,396	31,198	30,567

*Data provided by the governorates' agricultural directorates

TABLE 6.2: PERCENTAGE OF CHANGE IN AREA OF ALFALFA CULTIVATION FROM 2012 TO 2017

Governorate	2012/ 2013	2013/ 2014	2014/2015	2015/ 2016	2016/ 2017
Maysan	+24.5	-23.6	-7.6	-6.8	-5.2
Dhi-Qar	+20.8	+16.1	-.46	-1.8	-.25
Basra	+26.6	+. 31	-10.6	-15.2	-6.6
Total	+24.7	-6.3	-7.4	-9.3	-2.0

FIGURE 6.1: PERCENTAGE OF CHANGE IN AREA OF ALFALFA CULTIVATION FROM 2012 TO 2017



Sorghum cultivation appears also to have taken hold, although not to the extent that alfalfa has. We were only able to obtain the figures for the districts in Maysan where IMRP held demonstrations (Table 6.3). They suggest a relatively stable growing area from 2012 to 2017, with bursts in 2013 and 2014. Sorghum can tolerate higher levels of salinity, but the water shortage has constrained and decreases overall cultivation.

TABLE 6.3: SORGHUM CULTIVATION AFTER IMRP (2012-2017) (DONUM)

Governorate	2012	2013	2014	2015	2016	2017
Maysan	3315	4127	3150	2910	2709	2569
Dhi-Qar	1372	1658	1924	1915	1886	1881
Basra	2757	3492	3503	3131	2656	2639
Total	7444	9277	8577	7956	7251	7089

Corn cultivation has expanded in the governorates. It is a new crop for marsh people, used as fodder for their water buffaloes. Barley is also grown in the marshlands. However, most farmers prefer to grow wheat because the government buys it at a good price. In addition, some farmers grow tomatoes, cucumbers, broad beans, and cowpeas. Marsh farmers said they would like to expand their alfalfa and barley cultivation. However, they constrained by a water shortage of water and a government resolved to encourage wheat growing.

TABLE 6.4: AREA CULTIVATED IN CORN AND BARLEY DURING THE PAST DECADE IN MAYSAN DISTRICTS WHERE IMRP OPERATED (DONUM)

Year	Corn	Barley
2006	5000	22500
2007	7000	24650
2008	5445	19224
2009	5443	21800
2010	7474	24670
2011	8016	28405
2012	16947	25898
2013	8387	22905
2014	15307	36930
2015	5825	12899
2016	7784	7005

DATE PALM NURSERIES

BACKGROUND

During the turmoil following the 1991 Gulf War and the failed Shi'a insurrection, the southern marshlands and the date palm orchards fell victim to a state-led strategy to punish the rebellious farmers by destroying their livelihood. The number of date palms decreased by 50 percent from cutting down trees and draining the marshes. Planting date palms was a central part of IMRP's strategy to introduce profitable and sustainable agricultural opportunities to the region because of their high market value and their native presence.

The objectives were to establish eight date palm nurseries, five in Hammar marsh and three in Huwaizah, train local farmers on new techniques for the establishment of nurseries and care cultured offshoots, distribute offshoots from nurseries to farmers thereby increasing date palm production in southern Iraq, and create income-generating opportunities for local villagers.

Implementation reflected a partnership among four key stakeholders: the program, tribal leaders, nursery landowners, and the Ministry of Agriculture. IMRP purchased date palms for eight nurseries, 4,500 trees in all. Tribal leaders organized the labor force from the local district. Nursery owners pledged to distribute

offshoots freely to other farmers. And the ministry committed to provide farming extension support carry out workshops and field days for farmers in the area. Given continuing conflicts between the tribes, IMRP often acted as a neutral mediator advocating non-violent solutions that benefited the parties in dispute. Most often, the disputes centered on the selection of a tribe for a nursery, the timing of planting the date palms, and the scheduling of offshoot distribution to another tribe.

During the planting in 2004, IMRP established eight date palm nurseries—the first containing 1,000 palms, the rest with 500 palms with 21 date palm varieties. The IMRP team provided regular supervision, which resulted in an average survivability of more than 90 percent for offshoots. The most valuable *barhi* offshoots survival rate was nearly 100 percent, due to root hormone applications and other treatments that helped the offshoots to survive until producing their own strong root systems. A 50 to 80 percent survival rate for date palm offshoots is considered normal.

RESULT

Four of the eight original nurseries that were established under IMRP are still in active operation. Two in Maysan and one in Dhi-Qar were destroyed due to tribal conflicts. The disputes between tribes appear have started for personal reasons leading to the death of a tribesman. As a result, the tribe that suffered the loss destroyed the nursery of the other tribe as part of its revenge measures. In Basra, one nursery was destroyed because an oil field was discovered to underlie the same area. The Ministry of Oil recompensed the nursery owner, as it was over ten years old. The remaining four nurseries are in good condition, especially in Basra governorate. One Basra nursery in Nahar Saleh has 1000 offshoots and is thriving.

In keeping with the agreement made among the agricultural directorates, the nursery owners, and IMRP 13 years so, all nursery owners have donated offshoots to other farmers. Offshoots have been given to other farmers who are commonly relatives from the same tribe, neighbors, and friends in the same area. Offshoots have been given for free, and no agreement was made between the owner and the offshoot recipient. The offshoots that they distributed to other farmers were in small numbers - from one to ten offshoots. As a result, no knew nurseries have been established. The offshoots have been planted in existing orchards or in gardens.

Figures 6.1 and 6.2 indicate the date palm nursery area and number of date palm trees from 2006 to 2012 in the Maysan governorate's districts in which IMRP operated. They show a slow but steady increase from 2006 to 2012 with a leveling off from 2013 to 2016. One point worth noting is that in 2004, IMRP was told that the date palm sector had been decimated between 1991 and the 2004 invasion. In 2006, the number of palms in the districts exceeded 67,000. The total increase after the succeeding ten years was 20.5 percent in nursery area and a 25.8 percent increase in number of date palms.

TABLE 6.5: CURRENT STATUS OF IMRP-FUNDED DATE PALM NURSERIES

Current Status	Basra	Maysan	Dhi-Qar	Total
Nurseries planted under IMRP in 2004	3	3	2	8
Nurseries still in operation in 2018	2	1	1	4
Nurseries destroyed by tribal conflicts	0	2	1	3
Nurseries destroyed by oil drilling	1	0	0	1

Date palm orchard in Qal'at Saleh district, Maysan governorate no longer in operation due to tribal conflicts

TABLE 6.6: DATE PALM NURSERIES FIRST DEVELOPED BY IMRP AND STILL IN OPERATION

Orchard (Governorate)	Date Palms Planted by IMRP (2004-06)	Date Palms (2018)	Main Varieties	Current Condition	Sold at Market or Home	Offshoots Replanted	Interplanted Crops
Al MeJar, Ommara (Maysan)	500	610	Barhi, Khodrawi, Chebchab, Braim, Sayer, Syer, Hillawi, Guntar	Very good	Both	110	Alfalfa
Al Tar, Chebayish (Dhi-Qar)	500	560	Barhi, Khodrawi, Sayer, Um-Aldehin, Aahdi, Hadal Chebchab, Hillawi, Guntar	Very good	Both	60	Alfalfa Corn
Nahar Saleh, Al Midaina (Basra)	1000	1200	Barhi, Chebchab, Sayer, Um-Aldehin, Hadal, Makktom, Hillawi, Khodrawi, Braim, Zahdi	Excellent	Both	200	Alfalfa Tomato Cucumber Eggplant Pepper
Al Header-Bahla (Basra)	500	750	Barhi, Chebchab, Sayer, Um-Aldehin, Zahdi, Makktom, Hillawi, Khodrawi, Braim, Guntar	Excellent	Both	250	Alfalfa Tomato Cucumber

FIGURE 6.2: AREA OF DATE PALM NURSERIES IN IMRP DISTRICTS IN MAYSAN GOVERNORATE (2006-20016)

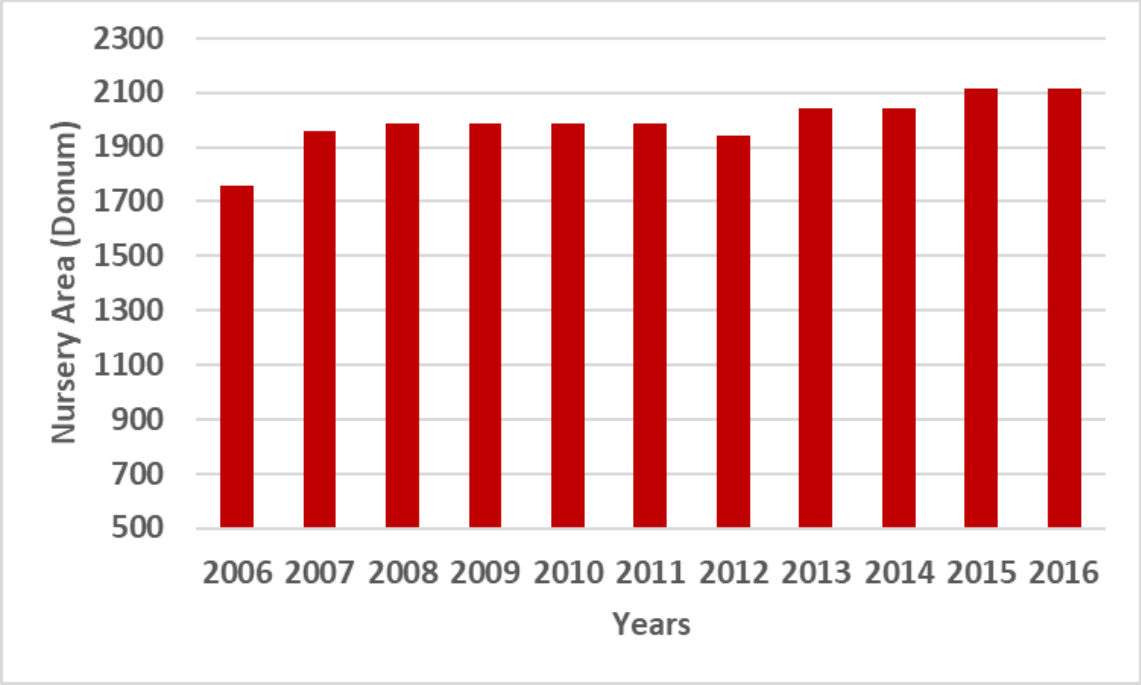
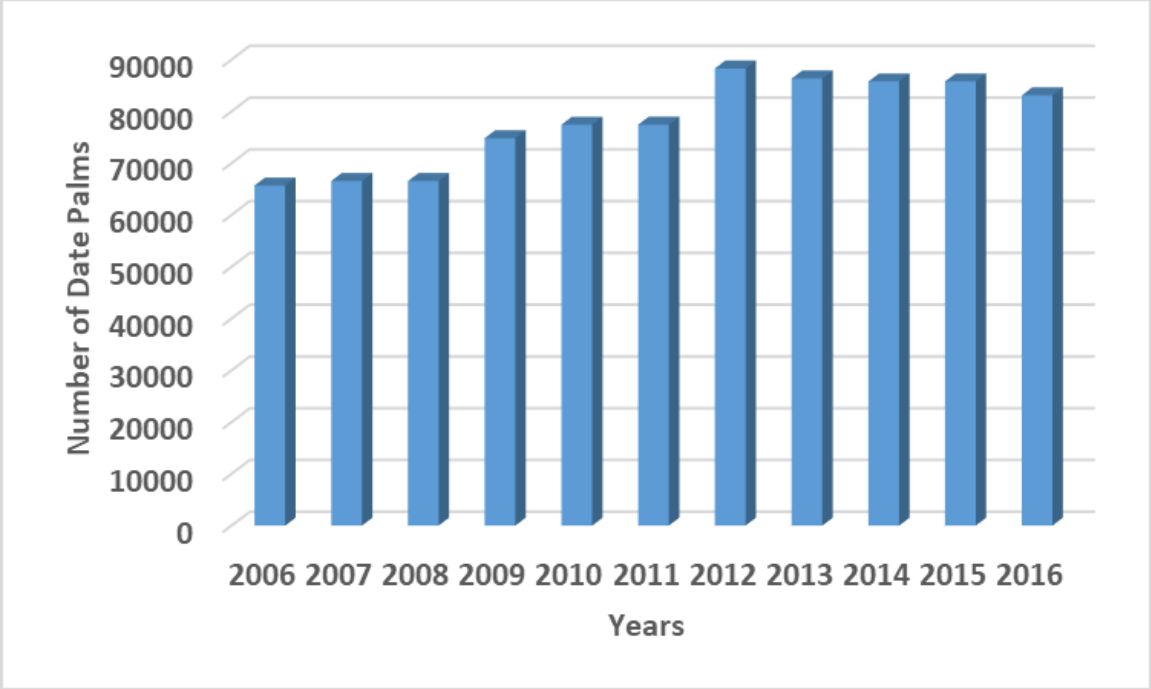


FIGURE 6.3: NUMBER OF DATE PALMS IN IMRP DISTRICTS IN MAYSAN GOVERNORATE (2006-2016)



A very interesting and promising development is the recent installation of greenhouses in the orchards for going high value vegetables, including tomato, cucumber, eggplant, and sweet pepper. The greenhouses were distributed by the agricultural directorate in Basra governorate. The two IMRP-funded nurseries in Basra, in Nahar Saleh and in Al Header, now have successful greenhouse operations.

Plastic greenhouses for high value vegetables scattered among an IMRP-funded date palm nursery in Nahar Saleh, Basra governorate

Unfortunately, there are no accurate data available about date production in the four nurseries and how much is sold. However, the average date palm produces about 40 to 50 kilograms. The retail price for *barhi* dates is USD 3.00 per kilogram, and for other varieties about USD 0.75. The wholesale sale for dates is 20 to 25 percent less than the retail price.

CONCLUSIONS

Plans to develop a central soil-water database to be accessed by the public and private sectors never materialized. The Ministry of Agriculture and the University of Basra, the anticipated major players, never moved beyond the initial meeting stage. This is unfortunate because no single party now has the resources to initiate, maintain, and grow a data bank that can it update and share over time. Our ecosystem monitoring has revealed a relatively rapid shift in the marshlands from freshwater to estuarine habitats. A reversal, or even a limiting, of this trend requires unimpeachable data to elicit government and popular support for action.

In sharp contrast, the demonstration of field crops - notably alfalfa and sorghum - and the investment in date palm orchards were among the program's greatest achievements with the longest lasting impact of IMRP's many initiatives. The area of alfalfa cultivation in the three governorates in which IMRP worked soared from the initial 165 donums in 2004 to slightly more than 400 in summer 2006 to 30,000 donums in the season immediately after the project closed. The area continued to climb steadily to nearly 40,000 donums in 2013, until the area fell from then to present 30,000. Alfalfa growing in the marshlands has been exceedingly popular, and one might argue that the current is largely a reflection of constraints. Increased soil and irrigation water salinity, a rise in temperatures that reach 50° C during summers, and water shortages in some marsh areas account for the drop since 2013. Alfalfa requires a quantity of water that is not available now in most of the marshes.

One might reasonably argue that if the water quantity and quality had remained constant since 2013, the total area cultivated with alfalfa would have risen higher. However, it appears that the sustainable ceiling for alfalfa cultivation in the three governorates is in the range of 30,000 donums, limited more by recent soil and water conditions than by farmer interest.

Sorghum, also introduced by IMRP, has not seen a comparably explosive growth, but there has been a relatively stable growing area from 2012 to 2017, given available data, with bursts in 2013 and 2014. Sorghum can tolerate higher levels of salinity, but the water shortage has constrained and decreased overall cultivation.

Alfalfa and sorghum cultivation, introduced by IMRP, parallels increases in livestock birth rate and birth weight, lactation period, and dairy production, as the following chapter on livestock attests. Indeed, IMRP's design and implementation argued that green fodder cultivation would significantly improve animal health and productivity. That has shown to be the case.

IMRP also invested in the installation of eight date palm nurseries in the three governorates with from 500 to 1,000 trees in each. Planted and maintained by Marsh Arab tribal members, the palms had a survival rate of more than 90 percent by the program's close. However, of the eight nurseries that were supported by IMRP, four did not survive, the victims of intertribal conflict or oil drilling. The four that did survive have thrived and increased in size. All four nurseries have intercropped field and/or high vegetables, and the two in Basra also have plastic greenhouses. The owners of all four nurseries continue to honor an agreement made with IMRP and the directorates of agriculture in 2005 to distribute offshoots free of charge to others. However, the number of offshoots distributed has been too few to enable others to establish new nurseries, which was a longer-term goal of the program.

7. Livestock Production and Veterinary Services

Asaad Y. Ayied

Water buffalo grazing in Central marsh

Far more than agriculture, animal husbandry was the historical mainstay of the Marsh Arab economy before the drainage of the marshes. Water buffalo provided the major source of protein to the people, primarily in butter and cheese, although milk was also consumed fresh. These products were sold outside the marshes, and some have estimated that 60 to 65 percent of the dairy products in Iraq originated in the marshlands.

The impact assessment team livestock expert examining water buffalo in a marsh village

With the drainage of the area, this traditional means of production was eroded and disrupted. IMRP found that

production, animal health, dairy processing, and marketing were all poor, as the people adjusted to their newly imposed conditions. The main reasons for the poor performance of the livestock sector were inadequate food supply for the animals, unreliable and/or inaccessible veterinary services, poor animal stock, poor or nonexistent collection and processing services, and inaccessible market infrastructure.

IMRP's assessment of the sector determined that livestock and dairy production required immediate attention and improvement. Issues related to processing and marketing could be addressed once production levels increased. IMRP attempted to revitalize livestock and dairy production in the marshlands by focusing on two of the most promising initiatives: (1) introducing and encouraging the cultivation of alfalfa and sorghum to improve animal health and nutrition and increase birth rates and (2) initiating a veterinary service for new graduates to improve access to veterinary services and provide meaningful employment to unemployed and under-utilized young professionals in the livestock sector.

Sheep in Qal'at Saleh, Maysan governorate

LIVESTOCK PRODUCTION

BACKGROUND

Between 1990 and 1995, the livestock population went into a tailspin in Iraq. Cattle declined by 34 percent, buffalo by 46 percent, sheep by 42 percent, and goats by 81 percent according to www.faostat.fao.org/faostat. In the marshes, the reductions were even more dramatic. For example, the loss of cattle and buffalo were about two to three times more than the rest of Iraq. The main causes of the nationwide decline were directly related to the embargo, which resulted in shortages of equipment, feed, veterinary services, and vaccinations. In addition, the marsh herders and their animals were relentlessly targeted by the Saddam regime and forcibly and repeatedly moved from location to location over many years.

In 2006, IMRP identified what it called a "dramatic shift" in livestock populations in the marshes from water buffalo to sheep herding, which largely coincided with the drainage of the marshes. It found that with the displacement of most of the indigenous people into drained areas between 1980 and 1992, animal owners could not care for their buffalo. Water buffalo numbers decreased to low levels throughout the area, with the exception of inside Hammar Marsh, beyond Garmit Beni Said, where small communities of Marsh Arabs lived traditionally on islands and are said to have thousands of water buffalo.

Interviews with marsh dwellers suggested that about half of the families in Huwaizah and Hammar marshes and two-thirds of those in Nahr Al Aaz own buffalo, but the numbers owned are small. Families with water buffalo generally have four in Nahr Al Aaz, two in Huwaizah, and one in Hammar. Otherwise, animals of preference were *arabi* breed sheep and cattle, which were a cross between Friesian and *al jenoubi* (literally, "southern") breeds that were better adapted to the local climate with higher milk production.

RESULT

The assessment team was able to obtain data about animal holdings in the marshlands in the three governorates of Basra, Dhi-Qar, and Maysan. In November 2006, IMRP predicted a strong shift away from the historical dominance of buffalo ownership to a more diversified pattern of ownership that

included the relatively newly introduced cattle, which did not require access to wetlands and a rapid increase in sheep holdings, making it the dominate animal. However, the livestock ownership records that the team acquired from the three provincial directorates of agriculture tell quite a different story. Cattle are not dominant, but their numbers have steadily increased since 2006.

Livestock Diversity

Buffalo continue to be the vastly more numerous animal owned in the marshlands in all three governorates. In 2017, they ranged from 65 to 75 percent of all animal holdings. And while those percentages have somewhat decreased since 2006, the actual number of buffalo has increased by as much as 17,000 head. In fact, the number of all animals, including cattle, sheep, and goats, has increased.

Table 7.1 displays the number of each livestock in marshland areas in Basra governorate. It shows a steady increase in all of the animals. It also confirms the continued dominance of water buffalo ownership by the local inhabitants.

TABLE 7.1: LIVESTOCK IN THE MARSHLANDS OF BASRA GOVERNORATE

Year	Number of Livestock Owned					Buffalo as Part of Total
	Buffalo	Cattle	Sheep	Goats	Total	
2006	41200	11650	1200	195	54245	76%
2007	42000	12000	1500	220	55720	75%
2008	42350	12500	2200	350	57400	74%
2009	43982	13000	2600	300	59882	73%
2010	44310	13800	2610	350	61070	73%
2011	46400	14300	3000	350	64050	72%
2012	46870	15000	4000	390	66260	71%
2013	47462	15900	4651	400	68413	69%
2014	48579	16280	6000	560	71419	68%
2015	49762	17450	4000	400	71612	69%
2016	50000	18000	4000	400	72400	69%
2017	51199	18528	8484	666	78877	65%

However, the percentage of buffalo in Basra has decreased from 2016 to 2017, although their total number increased by roughly 10,000. There has been a decided shift to cattle ownership. Both buffalo and cattle consume the same feed and in roughly similar quantity, but cattle do not need period of time in the water, as buffalo do and produce more milk,

Water buffalo at a homestead in the Basra governorate marshlandse

Buffalo in Hawaizah marsh, Basra governorate

FIGURE 7.1: PERCENT OF BUFFALO AMONG ALL LIVESTOCK IN BASRA MARSHLANDS

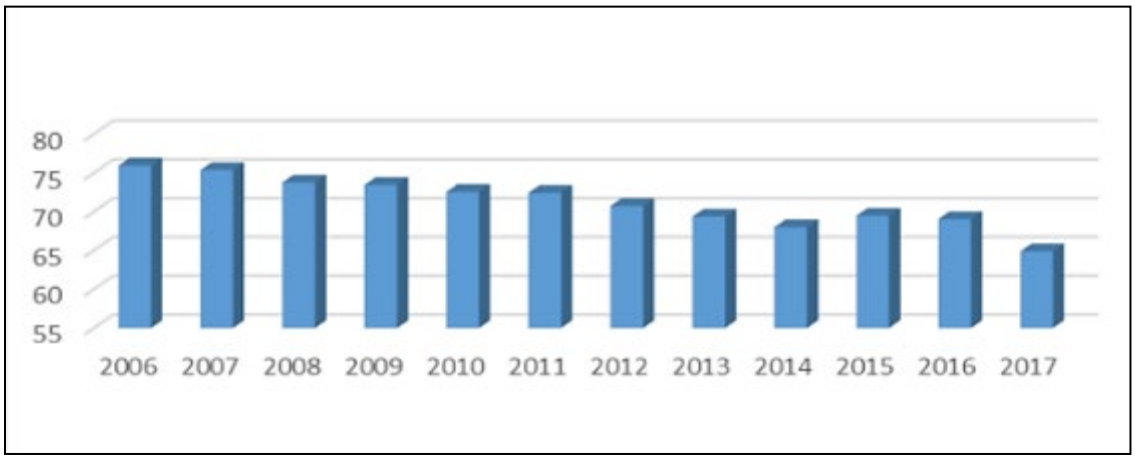


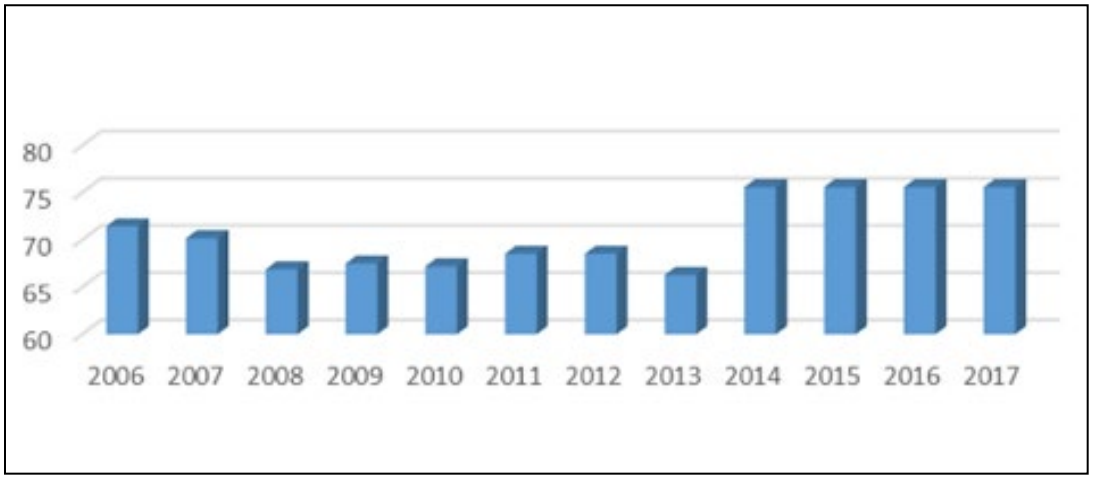
Table 7.2 shows the number of livestock in the Dhi-Qar governorate marshlands over more than a decade. Buffaloes had the largest percentage of the total population, which fluctuated from 66 percent in 2013 to 76 pecent from 2014 to 2017. There was a sharp increase in buffalo holdings from 2014. It is likely related to the good water availability in the marshes of that governorate.

TABLE 7.2: LIVESTOCK IN THE MARSHLANDS OF DHI-QAR GOVERNORATE

Year	Number of Livestock Owned				Total	Buffalo as Part of Total
	Buffalo	Cattle	Sheep	Goats		
2006	8000	2000	1000	200	11200	71%
2007	10000	2500	1500	250	14250	70%
2008	10300	2800	2000	300	15400	67%
2009	11000	3000	2000	300	16300	68%
2010	13000	3500	2500	350	19350	67%
2011	16000	4000	3000	350	23350	69%
2012	16000	4000	3000	350	23350	69%
2013	16500	4500	3500	400	24900	66%
2014	26000	4000	4000	400	34400	76%
2015	26000	4000	4000	400	34400	76%
2016	26000	4000	4000	400	34400	76%
2017	26000	4000	4000	400	34400	76%

In Central marsh, near Al Chebayish, Dhi-Qar governorate

FIGURE 7.2: PERCENTAGE OF BUFFALO AMONG ALL LIVESTOCK IN DHI-QAR GOVERNORATE MARSHANDS



A number of different livestock in Maysan governorate are shown in the Table 7.3. Here, the total number of livestock increased by 113 percent from 2006 to 2017, and buffalo ownership roughy doubled as well.

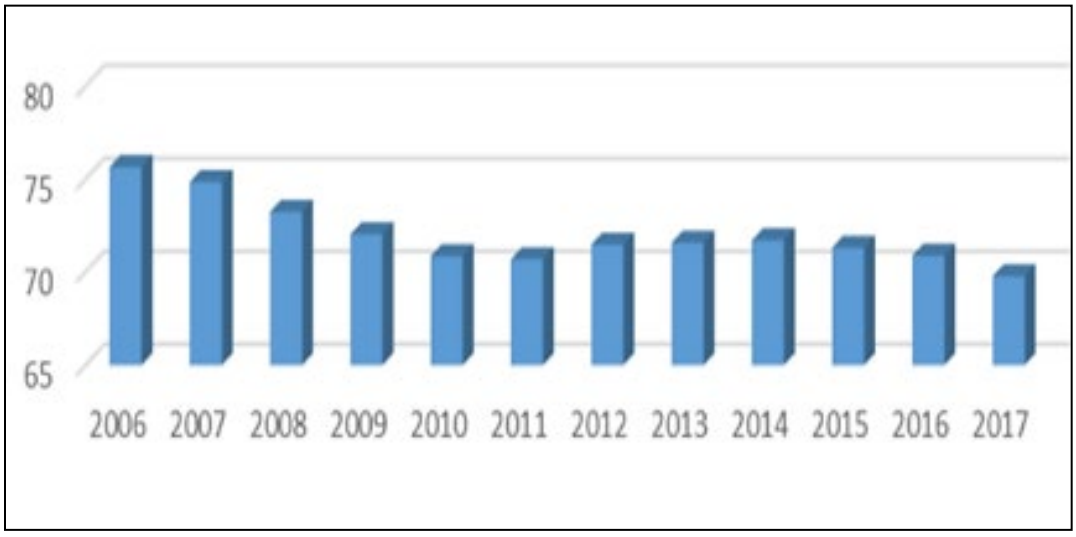
TABLE 7.3; LIVESTOCK IN THE MARSHLANDS OF MAYSAN GOVERNORATE

Year	Number of Livestock Owned				Total	Buffalo as Portion of Total
	Buffalo	Cattle	Sheep	Goats		
2006	17500	2200	1123	300	23129	76%
2007	18750	2589	1350	350	25046	75%
2008	20100	2983	1900	450	27441	73%
2009	21800	4000	2000	450	30259	72%
2010	23200	4500	2478	550	32738	71%
2011	25720	5000	3000	650	36381	71%
2012	26736	5000	3000	650	37398	71%
2013	28500	5500	3100	700	39813	72%
2014	30000	6000	3120	700	41834	72%
2015	31988	6500	3600	750	44853	71%
2016	33651	7000	4000	800	47467	71%
2017	34320	7591	4432	820	49180	70%

Holstein cattle near Al Midaina in Basra governorate

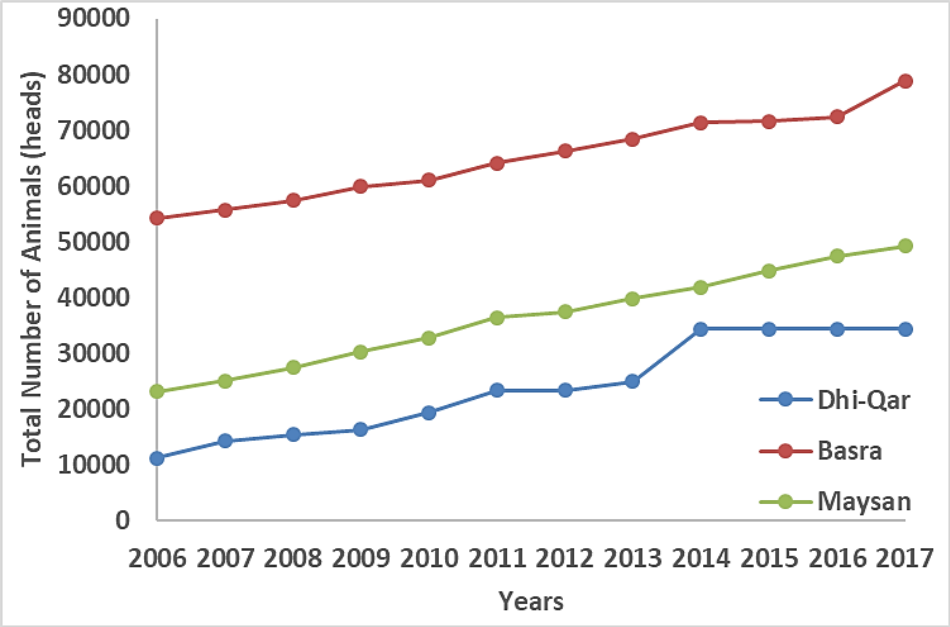
Sheep pen in Qal'at Saleh, Maysan governorate

FIGURE 7.3: PERCENT OF BUFFALO AMONG ALL LIVESTOCK IN MAYSAN GOVERNORATE MARSHLANDS



Among the three governorates that have marshlands, Basra has a larger number of animals than Dhi-Qar and Maysan. A total number of livestock in Basra was nearly 79,000 head in 2017, and in Dhi-Qar and Maysan 40,000 and 25,000, respectively. We were surprised to learn that the number of buffalo has remained so large in the marshlands, despite water quality and water quantity issues. In 2006, we did not expect that it would be the case

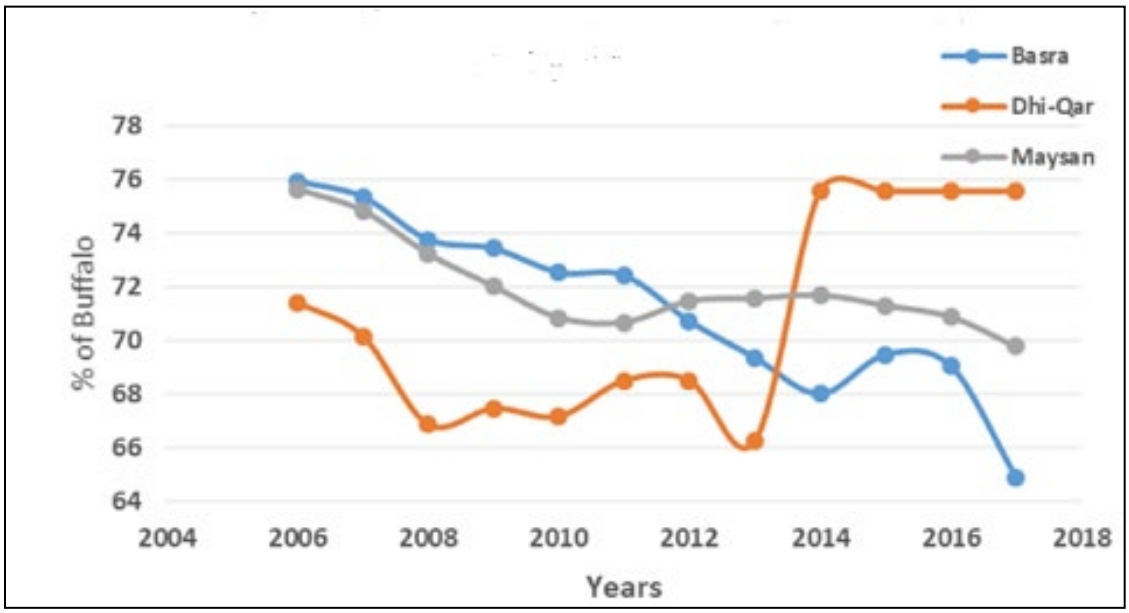
FIGURE 7.4: TOTAL NUMBER OF ANIMALS IN THREE GOVERNORATES



The percentage of buffalo in the three governorates is shown in Figure 7.5. Both Basra and Maysan had a decline in buffalo percentage from 2006 to 2017. In comparison, Dhi-Qar shows a sharp increase in 2014 that held steady through 2017. The main reason is likely the quantity and quality of water in Dhi-Qar marshes in comparison with marshes in Basra and Maysan.

Water buffalo herds in the drained Central marsh near Al Chebayish

FIGURE 7.5: PERCENT OF BUFFALO IN DIFFERENT GOVERNORATES



Floating island near Al Chebayish in Central marsh, Dhi-Qar governorate

At Qal'at Saleh in Maysan governorate

Reproduction and Calf Performance

Considerable research has confirmed the relationship between protein nutrition on one hand and the reproduction, pregnancy and lactation of livestock on the other, particularly consuming high protein legumes like alfalfa. A higher protein diets stimulates the live weight gain or reduces live weight loss (Lindsay *et al.* 1982), improves ovulation rates (Waghorn *et al*. 1990), improves placental size (Hinch *et al.* 1986), improves birth weight (Stephenson *et al.* 1981) and increases survival (Lynch *et al.* 1990). Because the increased birth weight possibly lowers the incidence of retained placenta, it also increases milk yield and efficiencies of milk production (Saadullah 1984). Protein deficiency in early life also prevents the stunting of final body size in adulthood (Preston and Leng 1987).

In general, the number of calves during the lifetime of a buffalo in the marshlands has increased with improvements in livestock diet tied to alfalfa and sorghum cultivation.

The calving interval for buffalo, which has been historically high at 450 days, is shorter despite the harsh environment, poor feed supply, high temperatures, and degraded water quality. There has also been an increase in the health and growth rate of calves, especially during their first months from the increased volume of milk that the calf can suckle.

A comparison of livestock birth weight, daily growth rate, and meat prices in 2006 with 2018 (Tables 7.4 with Table 7.5) reveals that nearly all of these key indicators of the livestock sector have increased significantly over the 12 years. Alfalfa has become a common staple of the diet and even bran and straw have increased, stimulating greater birth weight and higher daily growth.

TABLE 7.4: LIVESTOCK LIVE WEIGHT, GROWTH RATE, AND MEAT PRICES IN 2006 (KILOGRAM / IRAQI DINAR)

Animal	Birth Weight (kg)	Daily Growth Rate (kg)	Daily Feed Consumption (kg)		Market Weight (kg)	Price of Live Weight (kg)	Meat Price (ID/kg)
			Bran	Straw			
Buffalo	40	0.3	2	4	149.5	2000	4000
Cattle	25	0.2	1.5	3	98.0	2000	4000
Sheep	3.5	0.1	1.5	1.51	24.5	3250	7000

The net profit realized from a kilogram of live weight were ID 1,275 (USD 0.87), for buffalo, ID 1,166 (USD 0.79) for cattle and sheep are and ID 1,674 (USD 1.10) for sheep.

TABLE 7.5: LIVESTOCK LIVE WEIGHT, GROWTH RATE, AND MEAT PRICES IN 2018 (KILOGRAM / IRAQI DINAR)

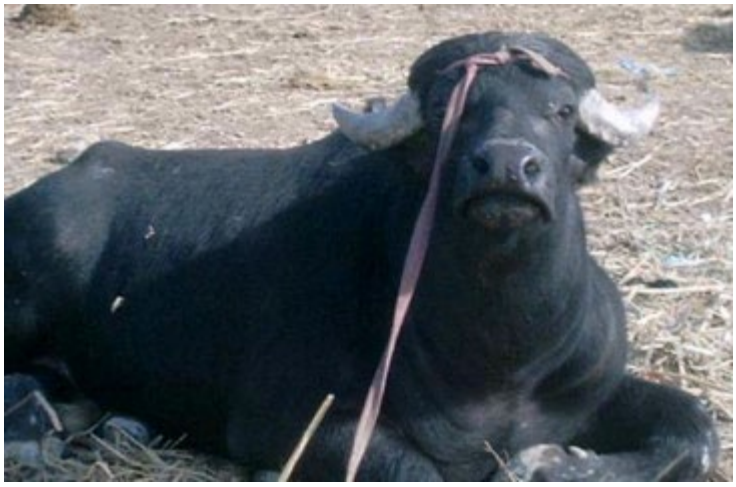
Animal	Birth Weight (kg)	Daily Growth Rate (kg)	Daily Feed Consumption (kg)			Market Weight (kg)	Price of Live Weight (ID/kg)	Meat Price (ID/kg)
			Alfalfa	Bran	Straw			
Buffalo	45.6	1-1.25	3	3	5	450	8,000	14,000
Cattle	41.5	0.535-0.750	3	3	4	400	8,000	14,000
Sheep	3.5	0.120-0.150	1	0.5	1.5	26.2	9,000	16,000

Daily Milk Yields

IMRP found that daily milk yields for buffalo varied within the marshlands. Yields in 2004 ranged from about seven kilograms in Huwaizah and five in Hammar and Al Chebayish/Central marsh, to ten in Nahr Al Aaz, The difference was likely because the forage and feed for buffalo were greater in Nahr Al Aaz than elsewhere. In the marshes, where the daily yields were low, and with only 150 lactation days per year, the annual yield was between 750 and 1070 kilograms. This compares negatively with the annual milk yield of 1342 kilograms recorded in Iraq outside the marshlands (Högberg and Lind 2003). The average annual milk yield was 32 to 46 percent higher than what IMRP had found in the marshes at essentially the same time.

Buffalo milk yields in the marshlands have improved since then. Daily milk yields are roughly the same in Maysan, Dhi-Qar, and Basra where IMRP worked. And all three show a similar, steady increase of almost two percent from 2012 to 2017. This increase is an important development, as milk yields are complicated, influenced by a wide range of environmental and genetic factors. These yields would place the buffalo daily milk production in the marshes highly ranked in the world, but still well below Italian buffalo that produce 18 kilograms of milk daily.

Interestingly and unfortunately, Nahr Al Aaz, which was recorded with the highest daily milk production in 2004, is suffering from a severe water shortage. Many of its inhabitants have left the area and moved to the vicinity of Al Chebayish on the edge of Central marsh in Dhi-Qar governorate where water is more plentiful. Previously, Nahr Al Aaz was heavily populated by marsh dwellers, who owned large herds.



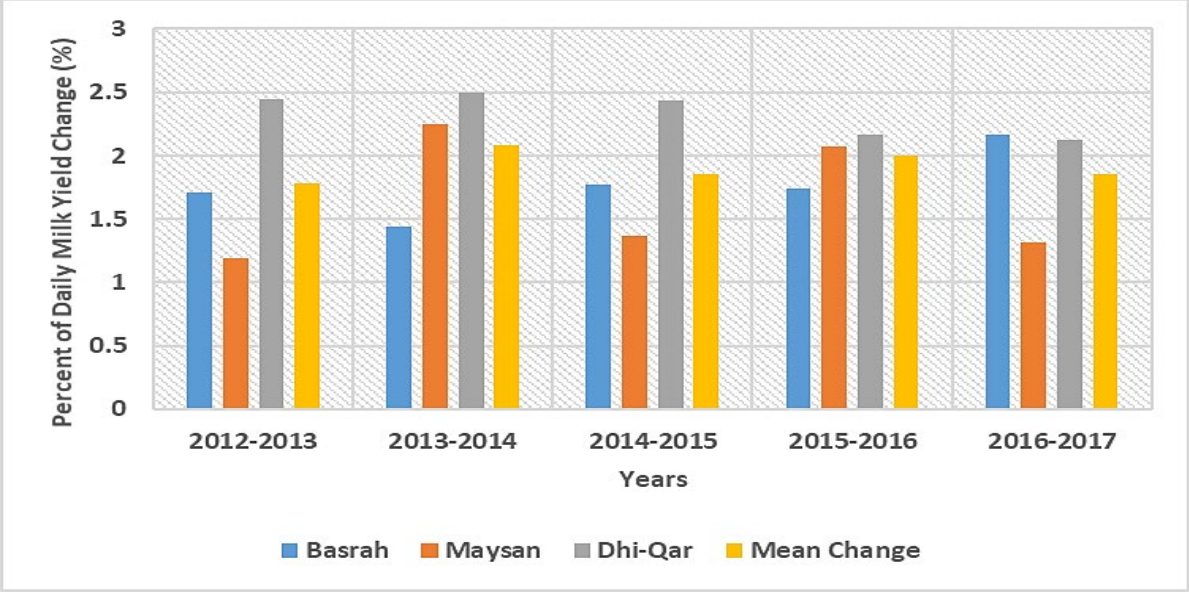
Water buffalo at a homestead in Basra governorate

The data presented in Table 7.4 and Figure 7.6 were provided by the agricultural offices in the three governorates and in interviews conducted by staff of the College of Agriculture in the University of Basra between 2012 and 2017. These research sites included areas in or near the marshes where alfalfa and sorghum were demonstrated by IMRP in 2004, such as Al Adil in Maysan governorate, which has a high concentration of the two crops.

TABLE 7.6: DAILY MILK YIELD OF BUFFALO FROM MARSH IN DIFFERENT PROVINCES (KILOGRAM)

Governorate	2012	2013	2014	2015	2016	2017
Basra	8.21	8.35	8.47	8.62	8.77	8.96
Maysan	9.22	9.33	9.54	9.67	9.87	10.00
Dhi-Qar	9.00	9.22	9.45	9.68	9.89	10.10
Mean	8.81	8.97	9.15	9.32	9.51	9.69

FIGURE 7.6: DAILY BUFFALO MILK YIELD CHANGE IN THE SOUTHERN GOVERNORATES (PERCENT OF KILOGRAM CHANGE)



Lactation or Milking Period

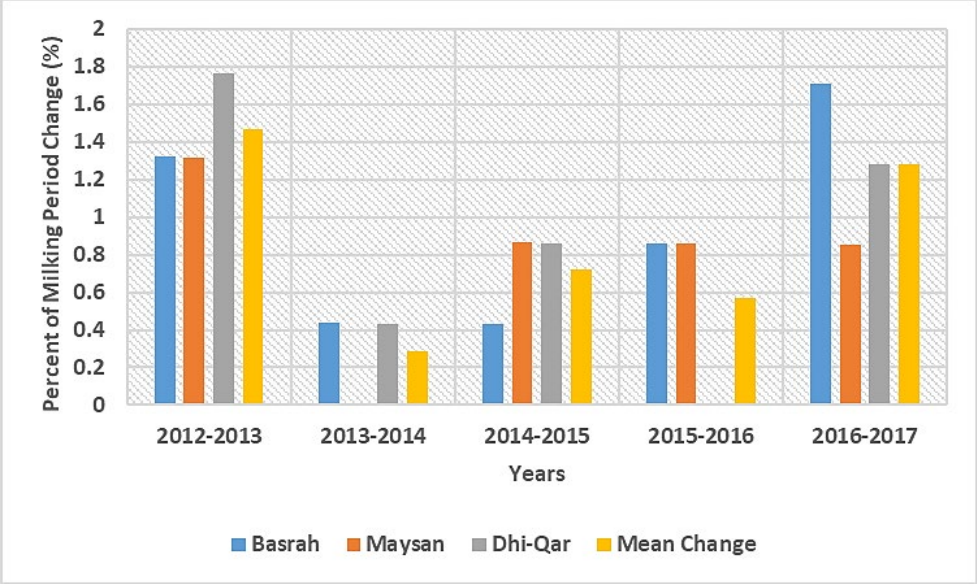
In 2006, IMRP found that the lactation or milking period for water buffalo in the marshlands was 150 days. This compares unfavorably with the lactation period of 255 days recorded in Iraq outside the marshlands (Högberg and Lind, 2003). The lactation period elsewhere in Iraq was 255 days or 70 percent higher than what IMRP had found in the marshes at essentially the same time.

In 2018, the annual lactation period for water buffalo in the three southern governorates is 237 or 238 days, an increase of 58 percent during the past 12 years. Table 7.5 indicates that this increase has been incremental, with small but steady increases of one to four days from year to year between 2012 and 2017. This would mean a roughly 90 kilogram increase in milk production per lactation period for each buffalo. As the length of the lactation period is closely tied to the quality of feed and health of the animal, we think it is fair to conclude that the expansion of alfalfa and sorghum cultivation in the marshlands is at least partly, if not greatly, responsible, for the change.

TABLE 7.7: LACTATION PERIOD OF MARSHLAND BUFFALO IN THE SOUTHERN GOVERNORATES (DAY)

Governorate	2006	2012	2013	2014	2015	2016	2017
Basra		227	230	231	232	234	238
Maysan		228	231	231	233	235	237
Dhi-Qar		227	231	232	234	234	237
Mean	150	227	230	231	232	234	238

FIGURE 7.7: PERCENTAGE OF LACTATION PERIOD CHANGE FOR WATER BUFFALO



Total Annual Milk Yield

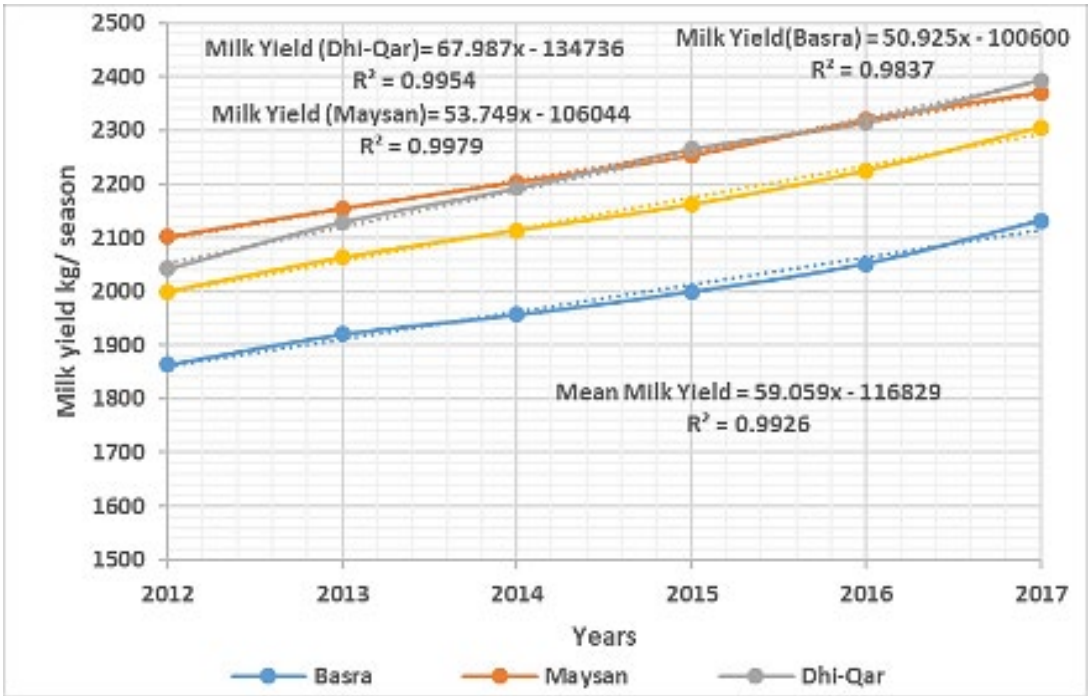
When calculating milk yields over the lactation period, we found a linear improvement from 2012 to 2017. Regression analysis was used to determine the association of yield and time. Our data showed a very accurate predictive rate of 99 percent, which can be used to evaluate different plans to improve buffalo milk production.

The three governorates all experienced a linear increase in milk yield over the period: 50.9 kilograms in Basra, 53.7 kilograms in Maysan, and 67.98 kilograms in Dhi-Qar. The overall average increase in milk yield was 59.05 kilograms. This increase suggests a dynamic improvement in milk yields in the marshlands, which we believe can be attributed in part to IMRP's initiatives 12 to 14 years earlier when alfalfa and sorghum were first introduced into the area.

TABLE 7.8: ANNUAL MILK YIELDS OF BUFFALO IN SOUTHERN GOVERNORATES (KILOGRAM)

Governorate	2012	2013	2014	2015	2016	2017
Basra	1863.67	1920.50	1956.57	1999.84	2052.18	2132.48
Maysan	2102.16	2155.23	2203.74	2253.11	2319.45	2370.00
Dhi-Qar	2043.00	2129.82	2192.40	2265.12	2314.26	2393.70
Mean	1999.87	2063.10	2113.65	2162.24	2225.34	2306.22

FIGURE 7.9: MILK YIELD TRENDS DURING 2012-2017 (KILOGRAM)



Financial Benefits

In calculating the monetary benefit of milk production improvement, the price of one kilogram of raw milk is about USD 1.25. The net profit from selling of each buffalo every year is about USD74 (59.05 kilogram x USD 1.25= USD 73.82). The total profit will depend on the number of buffalo kept by each breeder. That herd number has also improved dramatically since IMRP closed in 2006.

DAIRY PRODUCTION

BACKGROUND

In 2006, there were only informal places within the marshes for milk collection and sale. Small, open-back, unrefrigerated pick-up trucks traveled through the settlements on the roads along the canals at collection points. Residents, effectively women and girls, carried milk in metal containers to these points. In general, females were responsible for livestock and dairy production.

The major markets for milk in the marshes were in the large towns and cities where women spent three to four hours selling milk, cheese, and cream. No organized, regular markets for milk existed in the marshes. The markets were characterized by poor standards of cleanliness, a lack of support services including cooling and weighing equipment, low quantities for sale that did not meet the local demand, and an absence of market information about pricing and market movement.

RESULT

One outcome of increased milk yields is the recent blossoming of a small-scale commercial dairy industry on the margins of the marshes in Bayt Wafi. The owners and workers are Marsh Arabs. Most own buffalo, and they have been able to enter the food production arena because of the increase in both the size of their herds and the milk yield of their buffalo. However, demand exceeds their in-house supply, so the dairy producers travel within a restricted area in the marshes to buy more milk. Destinations for purchasing raw milk tend to be within 45 minutes to an hour away.

Throughout the business process, there are gender overlaps. Both men and women may be own dairy shops, hiring and supervising employees or operate at a smaller scale selling in outdoor markets. And both men and woman travel in the area to buy milk from outside animal owners. However, women are mostly the producers, responsible for processing the milk and making the dairy products in their homes. Men are mostly responsible for selling the products in the shops.

The dairy products are milk, cream, yogurt, and cheese, which are made exclusively from buffalo milk and prepared at home in large bowls heated by gas bottles. It is the first step in making all dairy products. The top layer of some of the milk is used to make cream (milk fat mixed with little milk). The rest is used for yoghurt with no fat. Other milk used for making full-fat yoghurt or cheese in a multi-step process.

Cow's milk treated similarly to buffalo milk, but it has a lower fat content of three to four percent and is mostly used for yoghurt and cheese by cattle owning families themselves, rather than used commercially locally. Most of the cattle in the marshes are high-producing Friesians with three percent fat content. Sheep's milk is mostly suckled by their lambs, and the remainder used by the family owners. Most people in the marshes keep very few sheep, usually fewer than ten head. Larger numbers of sheep are herded by nomads who come in hot summer to the marshes for pasture and water. They produce some dairy products because of high quantity of the milk. Overall, milk production from sheep is very low, hardly enough for new lambs.

Bayt Wafi, between Qurna and Al Deir in Basra governorate, is a center of the dairy industry with more than ten sales shops, housed in small one-room whitewashed buildings lining the road. The shops are air-conditioned and use modern refrigerator cooling systems to avoid spoilage. The shops are notable for their cool and clean environments selling reliably safe, sterile products.

Bayt Wafi is unique. There are no similar dairy shops elsewhere in the southern marshlands. But itinerant dairy middlemen buy cream, yoghurt, and cheese from shopkeepers there and sell the products elsewhere in the marshes and beyond to towns and cities, including Baghdad.

In one dairy production site owned by Om Haider, we found 25-30 large bowls filled with milk. Each bowl holds 25 kilograms of milk. Every day, this business processes between 525 and 750 kilograms of milk (25-30 bowls x 25 kilograms). It takes eight kilograms of milk to produce one kilogram of cheese, and nearly one kilogram of milk to produce one kilogram of full-fat yoghurt. Producers in Bayt Wafi estimated that they use half the milk for cheese and half for yoghurt.

Based on the maximum of 30 bowls of milk for 750 kilograms, about 375 kilograms will be used to make almost 47 kilograms of cheese. In the case we observed, the other 375 kilograms of milk made 364 kilograms of yogurt (200 full fat and 164 no fat) and 10.5 kilograms of cream (5-6 percent milk fat). All of the locally-made dairy products are very high demand.

Table 7.9 calculates Om Haider's daily gross income of USD 1,140 from dairy products using 750 kilograms of raw milk. She estimated that her production costs, including producing her own milk or buying it from others, transportation, labor, shop, equipment and running costs, are about USD 900. That leaves about USD 240 net profit.

TABLE 7.9: ESTIMATED DAILY GROSS INCOME, COSTS, AND NET PROFITS FROM DAIRY PRODUCTION

Dairy Product	Quantity (kg)	Unit Price (USD)	Income and Costs (USD)
Cheese	47.0	5.6	263.20
Yoghurt	364.0	2.0	728.00
Cream	10.5	11.2	117.60
Milk	25.0	1.25	31.25
Daily gross income based on 750 kilograms of milk			USD 1,140
Estimated daily costs			USD 900
Estimated net profit			USD 240

Dairy production in Bayt Wafi using buffalo milk

Interview with a Bayt Wafi Commercial Cheese and Yoghurt Maker

- Om Haider inherited the dairy production and sales business from her mother in 2007-2008. Her mother made and sold dairy products, but it was Om Haider who built the shop. She considers it to be a medium-scale operation. The staff includes her two sons and three woman and two men. They all make cream, yoghurt, and cheese in Om Haider's home, and they all sell them in the shop. Her husband is no longer alive.
- Taking over her mother's operation, she soon realized that there was a good potential market with plenty of available milk and Marsh Arab buyers, but not good products. Back then, raw milk was sold at a low price, and most of it was spoiled with no cooling and refrigeration. Milk cannot be stored for long periods of time in the extremely high outside temperatures during most of the year.
- She said that the business has changed her life and the lives of many other families in the Bayt Wafi area. She estimated that there are seven families producing dairy products, each with five to six persons. All families have been very satisfied with their earnings. But she also emphasized that this work is very time consuming and hard. She and her family members must work almost continuously day and night. Every day, she or someone else in her business travels out to buy buffalo milk.
- According to Om Haider, Marsh Arabs are generally interested in the dairy business. Some appear to have access to the funds for an initial investment and can begin by using their own milk on a smaller scale. Others are very happy to sell her their excess milk, as "they have plenty of it." Om Haider added that her own business could be further developed with by some financial support and better all day electricity. With these, she could develop new products.

White cheese for sale at Om Haider's shop

Yoghurt and cheese under refrigeration

Dairy shop on the road in Bayt Wafi selling yoghurt and cheesemade with buffalo milk from the marshes

Customers at Um Haider's dairy shop in Bayt Wafi

VETERINARY SERVICES

BACKGROUND

Veterinary services in marshland villages were virtually non-existent prior to IMRP. In want of veterinarians, herders would have to transport their animals to larger towns in and around the marshes for medical assistance. However, in actually, they rarely used veterinary services. When IMRP learned that there were many unemployed veterinarians in the region in need of work, it recruited and paid the costs of five graduates to work in the villages. During the program, the veterinarians regularly visited 33 villages, 16 in Central marsh and 17 in Hammar marsh, covering 488 livestock-owning families. They treated just short of 10,000 animals for infectious diseases and parasites, including vaccinations against foot and mouth disease: roughly 5500 buffalo, 1800 cattle, and 2600 sheep.

IMPR funds covered the veterinary services in their entirety, including the salaries of the five veterinaries who essentially became program team members; all medicine; and instruments, tools, and equipment for their work. These costs included vaccines, surgical requirements, and materials for sores and wounds. IMRP also paid for the transportation for the visit the villages in Central and Hammar marshes. Essentially, the five veterinarians acted independently of the agricultural departments in the two governorates, although government staff were kept abreast of their activities and observed their work in the field.

Interview with a Former IMRP Veterinarian

Wesam Al Assady is a principal in the veterinary clinic in Al Chebayish. He graduated from the College of Veterinary Medicine at the University of Basra. He also earned a higher diploma from the same college. He lives in Al Chebayish. He was hired by IMRP as one of the five program sponsored veterinarians in 2005 and was very happy to work with IMRP, as were his four other colleagues. IMRP helped him to practice and test all of the theories and knowledge he learned in his academic training.

He began by gaining the trust of Marsh Arabs. They let him and other veterinaries test and treat their animals freely. Because the IMRP budget allowed, all medicine and other facilities were from reliable, international pharmaceutical companies, especially vaccines of very dangerous diseases and infections as foot-and-mouth disease. These practices had a positive affect on the number, health, and production of all livestock in the marshes.

Wesam said that IMRP also changed the veterinarians' lives, by providing them with a good income for the first time. By the time IMRP closed, all five veterinarians had gained good practical knowledge and experience by practicing every day in very different places with a wide range of cases. This experience permitted them to be quickly accepted for work by the government. Wesam became the principal veterinarian of Al Chebayish, the largest town in the marshes. All of the IMRP veterinarians have received fast promotions and have ained the respect of their managers.

Wesam added that IRMP gave them the encouragement and confidence to accept responsibility for dealing with livestock and so were able to treat the animals for anything from minor infections to epidemic diseases.

RESULT

All five IMRP veterinary graduates have been fully employed by the government since 2006, which would appear to indicate a smooth transition from time-limited, program-based work to permanent government employment. When IMRP ended, we hoped that the local government departments would hire the veterinarians as staff, but it was in no way certain. All of them live and work in Al Chebayish in Dhi-Qar governorate and service animal owners in and outside the marshlands.

However, the reality is more complicated. As government staff, none of the veterinarians travels to the villages. They work exclusively in the government offices. Animal breeders must visit the veterinary clinic with their animals. If medicine is needed, the veterinary will write a prescription, and the animal owner must find the medicine himself. Medicine is expensive and hard to find in the localities. Owners must then go to the city centers to find it. All transportation costs are coverd by the animal owners.

Both the private sector and the government offer veterinary services. Veterinarians and animals owners agreed that the current level of service is no match for the services offered earlier by IMRP. They said that both public and private veterinary services need to be improved, particularly those offered by the government.

No additional veterinarians have been hired by the Dhi-Qar department of agriculture, and the comparable offices in Basra and Maysan do not have veterinarians on staff. The governorate departments of agriculture have not created village veterinary services and have no resources to do so.

Despite the issues and limitations of the current services, general health of the animals is good and far better than what it was in 2004 when IMRP began. There are occasional outbreaks, such as foot and mouth disease, which spread in 2004 and 2005, but it was contained and eventually eradicated by 2015 at a very high cost to the owners.

CONCLUSIONS

The livestock sector in the marshlands has seen dramatic improvement since IMRP ended in 2006. These changes are across the board: in the absolute number of livestock, in their increasing diversity, in greater birth weight and daily growth rate, in higher daily milk yields, and in longer lactation periods. There have been accompanying advances in the closely related meat and dairy markets. Live weight and market prices for buffalo and cattle have increased three- to four-fold. And rising daily milk yields sparked the creation of cottage industries to produce dairy products using higher fat buffalo milk. These changes all point to an increasingly healthy and dynamic livestock sector in the marshlands.

While many factors are undoubtedly at play, we believe that IRMP's introduction of green fodder, high protein crops – alfalfa and sorghum – in 2004 spurred the changes. Alfalfa is now a common part of animal diet, supplementing the increased levels of bran and straw. Estimated daily consumption of alfalfa by buffalo and cattle is three kilograms a head. The improvements in overall animal health and productivity were anticipated by IMRP, based on expert advice, and were among the program's core objectives.

However, other anticipated changes in the marshlands did not meet expectations. In 2006, IMRP predicted a strong shift away from the historical dominance of buffalo ownership to a more diversified pattern of ownership that included the relatively newly introduced cattle and a rapid increase in sheep holdings, making it the dominate animal. Instead, buffalo have continued to be the vastly most numerous animal owned in the marshlands. In 2017, they ranged from 65 to 75 percent of all livestock holdings. Greater access to reflooded marshes by buffalo herders and increased financial earnings realized from meat and dairy production may help to explain the continued reliance on buffalo ownership.

IMRP's introduction of a veterinary service dedicated to working in the marshlands villages was far less successful but reveals some interesting lessons. During the active period of the program, the veterinary efforts were highly regarded by Marsh Arabs, being the first time that the services were offered in the marshes. And the permanent recruitment of the five IMRP veterinarians by the agricultural directorate in Dhi-Qar governorate when the program ended would appear at first glance to be a sign of both success and sustainability. But it is only minimally so. The veterinarians do not travel to the villages, have no resources, or have their own store of medicine.

Looking back, one might argue that providing free services to livestock owners was certain to be welcomed and successful. But IMRP initiated a service that was not financially sustainable. It met immediate demands, offering help to address emergency conditions immediately after the fall of the regime. However, the governorates do not have the resources to provide free and extensive services as IMRP did.

VETERINARIANS AT WORK IN THE MARSHES DURING IMRP IN 2006

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8. Capture Fishing and Fish Farming

Amjed K. Resen

Tilapia, an invasive species, caught in Central marsh and trucked from Al Chebayish to governorates in middle Iraq

Fishing played an increasingly important part of Marsh Arab economy for the past half century, although water buffalo continued to be the most important source of wealth and income. A combination of factors, including the Iran-Iraq War in the mid-1980s and the building of the drainage system in the 1990s, diminished the flow of nutrients to the marshlands and its fish and led to a precipitous fall in catches. The situation worsened with the massive displacement of the local population and restrictions on access to those marshes still under water.

In 1990, the FAO estimated that the total inland catch of fish in Iraq was 23,600 tons, with over 60 percent of this amount coming from the Mesopotamian marshes (UNEP 2001, Abdul Razzak et. al. 2008, Jawad 2012). In Al Chebayish, the largest town in the marshes, Marsh Arabs estimated that until 1991, four truckloads of fish were sent daily to cities to the north. Fish were originally caught with tridents, but dwellers also used nets, although the size of the holes decreased as the catches decreased. As the marshes were drained after 1991, some people used mesh or cloth from which nothing escaped; others used poisons to take the final fish remaining in the drying ponds.

WILD FISH POPULATION

BACKGROUND

In the 1960s, the most common fish in marshlands catches, in order of importance, were *bunni* (*Barbus sharpeyi*), *khatan* (*B. xanthopterus*), *hemri* (*B. luteus*), and *shabut* (*B. grypus*). Of these four culturally important Barbus species, the largest, *shabut* and *khatan,* are both migratory whitefish, while the two smaller species, *bunni* and *hemri*, are more floodplain greyfish or blackfish species. The two migratory Cyprinids were captured both in the marshes and in heavy fisheries, especially around Baghdad, and were used for the traditional Iraqi specialty, *masgouff,* fish roasted on open fires in restaurants along the banks of the Tigris.

Bunni is the only fish species found in the marshes that is endemic to the Tigris and Euphrates rivers (UNEP 2001). Two other Iraqi Cyprinids - *Caecocypris basimi* and *Typhlogarra widdowsoni* - are also endemic, but they are only found in the upstream river reaches. The fourth Barbus species, *B. luteus or hemri*, is smaller and less favored than the three larger species. By 2006, it was the only species still common in the marshes. Small catches of *bunni* were seen in small numbers, particularly in the western marshes.

In the marshes, catch composition changed radically in recent decades due

to the negative effects of marsh drainage, especially on the whitefish species, and to the human introduction of exotic, competitive carp species. By the time of the invasion, fish stocks were dominated by only three species: two carp and one catfish, specifically the Mesopotamian catfish or *juri* (*Silurus triostegus)*, and two introduced carp species, Prussian carp (*Carassius carassius)* and common carp (*Cyprinus carpio)*. Fishermen in Huwaizah and eastern Central (in Qurna) marshes said their catches were over 60 percent *juri*. In the western Central marshes, the introduced carps were about 80 percent of the catches, while *juri* was 15 to 30 percent. Previously highly valued fish, including *bunni* and *shabut*, were rarely in the catch (Abdul Razzak 2014).

Of the non-native species, the common carp (*Cyprinus carpio)* was introduced to promote fish farming in 1968. It spread widely into the field, out-competing the natural fauna with its fast growth and abundant spawning. Crucian carps arrived accidentally, being first observed in the Shatt al Arab in 1995. Two other carp species – the silver carp (*Hypophthalmichthus molitrix*) and the grass carp, *Ctenopharyngodon idella* – were also introduced for culture fisheries in 1985. Both silver and grass carp require a strong flood pulse to stimulate their synchronous spawning behavior, and have not recruited significantly into the wild marsh stocks. Mesopotamian catfish are native (IUCN 2013).

The environmental impact of marsh drainage and exotic fish introduction was a great reduction in fish diversity, particularly in the decimation of many native species. Many became extremely rare, while others disappeared entirely. Given the negative impact of the previous introductions, IMRP firmly decided against further introductions of new fish species. IMRP instead promoted the restoration of wild marshland stocks with the locally preferred Barbus species, common in the marshes pre-drainage. In the 1960s, most the common fish in the catches, in order of importance, were *bunni* (*Barbus sharpeyi*), *khatan* (*B. xanthopterus*), *hemri* (*B. luteus*), and *shabut* (*B. grypus*). Of these four culturally important Barbus species, the largest *shabut* and *khatan* are both migratory whitefish, while the two smaller species, *bunni* and *hemri* are more floodplain greyfish or blackfish species. The two migratory cyprinids were captured both in the marshes and also in heavy fisheries especially around Baghdad, as the basis of the traditional Iraqi *masgouff* specialty, whole fish roasted on open fires in restaurants along the bank of the Euphrates.

RESULT

A comparison of the commercial or marketed fish population in the three southern marshes in 2018 with those in 2006 reveals a number of differences. Key reasons for the change include the introduction and spread of exotic species, deterioration in water quality and quantity, and use of illegal fishing methods.

Many native fish are now rare or very rare, while others were not seen, although they had been observed in 2006 (Table 8.1). Some fish species are dangerously dwindling in number, and others have disappeared. In Huwaizah marsh, three species seen in 2006 were not seen in 2018, in East Hammar it was seven of 19, and in Central 6 of 15 were not seen again. There have not been any attempts to restock native, valuable fish species in the marshes, other than IMRP's to restock *bunni* and establish a fish hatchery in the University of Basra in 2006.

Perhaps the other great ecological change is the sudden appearance and rapid spread of exotic species between 2006 and 2018. The fish catch in all three marshes is now dominated by exotic species, most of all Nile and red belly tilapia, which were "accidentally" introduced in 2005-2006. These exotic species can better tolerate the marshes' harsh environment than the native species. Their spread has been rapid and extensive. They are now a key component of commercial fishing in the marshlands, as the photograph at the beginning of this chapter can attest.

A key factor affecting wild fish population in the marshlands is the deterioration of water quality and quantity in marshes, which has reduced biological productivity of basic food items for fish. Increased water salinity has also changed the fish population, killing native species and introducing other migratory species. This is particularly true of East Hammar marsh where there are four migratory species that were not seen in 2006 are now common or very common: estuarine mullet (now very common), hilsa shad (now common), yellowfin snapper (now common), and migratory shrimp (now very common).

Another is the use of illegal fishing methods which is pervasive, encouraged by the absence of governmental control. The most common tool is fine-mesh netting, which traps even the smallest and most immature fish, so they cannot grow to full size. Another is electrical fishing that uses small batteries that can jolt the water with six thousand volts in the area of a square meter. This dangerous method has proved lethal to fish and to fishermen. Many fishermen have killed themselves through mistaken use.

Tilapia, an exotic and now common species introduced to the Euphrates a few years ago, for sale at a local market

The third most commonly used illegal method is pesticide use. These toxic materials are imported from Iran and are intended to combat pests that attack cotton plants, although cotton growing is scare in the southern governorates. Fishermen use large quantities in two ways: mixing it with wheat grain or water dissolving in water. So effective, within minutes, it can kill all of the organisms in the water in an estimated area of one square kilometer. But its impact goes beyond the fish. Pesticide use has also led to the deaths of large numbers of buffaloes and cattle after drinking the contaminated marsh water.

In Huwaizah marsh (Table 8.2), of the 11 different native and exotic fish species observed, six were recorded in both 2006 and 2018. Of those six, five are still commonly found. However, the most important fish commercially in the marshlands –

bunni (Barbus sharpeyi) - has gone from rare to very rare in 12 years. Historically,

TABLE 8.1: FISH AND SHRIMP OBSERVED IN THREE MARSHES IN 2018

Marsh	Seen in 2006 and 2018	Sightings of Different Fish and Shrimp Species in 2018					
		Seen in 2006 but not in 2018	Very Rare	Rare	Common	Very Common	Total
Huwaizah	6 of 11	0	1	2	6	2	11
East Hammar	7 of 19	6	1	2	4	6	19
Central	6 of 15	6	1	3	3	2	15

Huwaizah marsh was an important source of freshwater fish, but current fish catches contain only fingerlings or young of the year. No large or moderately sized fish were seen, most likely due the sharp reduction in water level and commonly used illegal fishing methods.

In East Hammar marsh (Table 8.3), an increase in water salinity encouraged the migration of estuarine fish and shrimp. Marine fish and shrimp occurred only in this marsh. Exotic and marine fish dominate the fish catch.

Central marsh (Table 8.4), observed at Al Chebayish, was an important supplier of freshwater fish to Bagdad and middle Iraq governorates before the marsh drainage. In 2018, only small fish were seen, as in Huwaizah marsh and presumably for the same reasons related to water level and fishing methods.

CAPTURE FISHING

BACKGROUND

IMRP found no strong evidence of overfishing prior to drainage, but the low levels of production post-invasion reflected the gross extraction of fish during the drying phase and a number of ecological factors: deterioration of the hydraulic regime, reduction of nutrients flowing into the system, decrease in water quality, reduction in longitudinal and lateral, connectivity of the river system, absence of natural spawning, feeding, nursery and sheltering habitats in new drainage canal structures.

Given the negative impact of the previous introductions, IMRP decided against the introduction of new fish species. The objectives of IMRP's fishing systems component instead were to (1) promote the restoration of wild marshland stocks with the three highest values: the locally preferred, Barbus species, once common in the marshes, silver carp, and grass carp and (2) encourage the sustainable management of the recovering fish stocks.

IMRP worked closely with the Marine Science Center at the University of Basra, which was responsible for fertilizing yellow barbel or *bunni*. Initially, IMRP's target was to reintroduce three to five million fingerlings of *bunni* into the marshes. However, the program was able to restock only about 130,000 fingerlings in early August 2005 in East Hammar marsh because of many operational problems and environmental issues.

RESULT

In general, there has been a drastic change in fish catch qualitatively and quantitatively. Earlier catchers were native species. Now, catches are largely exotic species that attract lower market prices. The increase in water salinity may be an important factor in the reduction of the native species.

The impact assessment team visited Central marsh's Al Taweela fishing area near Al Chebayish. The catch, caught in roughly six to seven hours of active fishing time using a fixed gill net, weighed about 25 kilograms. The day's catch was predominately exotic species: *Oreochromis aureus*, *Oreochromis miotricus*, *Coptodon zillii, Carassius carassius* , and *Cyprinus carpio,* that is to say, largely carp and tilapia. There were very few native species: about two kilograms of *Liza abu, which had* previously been the dominant fish species in the marshes, only one *Aspius vorax* , and only one *Barbus sharpeyi*.

In Huwaizah marsh, the total catch was 60 kilograms, captured during a 24 hour period. The mixed catch was both native and exotic species, all small averaging about a year old. Less diverse than in Central, the fish catch included *Aspius vorax*, *Liza abu, and Barbus luteus.* Visits to the local fish markets in towns in the area revealed that that most fish for sale were either brought in from elsewhere in Iraq or were imported from outside the country. Few fish for sale were local.

East Hammar is unique among the marshes for its shrimp population, which reflect its greater water salinity.

Table 8.5 shows the annual catch for each commercial fish species in Basra city. Note the steady increase in tilapia over the six years from 69 to 381 kilograms, a 452 percent increase. Common carp increased from 2011to 2015, but there was a drop in the two succeeding years. The annual catches of the other have held mostly even, with small annual fluctuations.

Shrimp and small tilapia caught in East Hammar marsh

TABLE 8.5: FRESHWATER FISH CATCH IN BASRA CITY (2011-2017) (KILOGRAM)

Fish Species	Year						
	2011	2012	2013	2014	2015	2016	2017
Bunni	13.87	10.812	28.033	40.2	70.8	36.554	22.512
Hamri	30	15.782	70.04	65.245	103.65	99.19	54.11
Samty	189.03	239.958	477.24	435.245	510.76	458.844	322.321
Qishni	133.72	97.3	331.74	295.13	393.975	367.1	224.45
Shalk	72.09	38.27	213.34	213.34	220.55	107.31	107.31
Shank shatt	27	18.5	53.44	48.67	23.77	23.94	20.34
Qattan	9.82	0.656	54.89	21.86	28.985	26.38	10.11
Tilapia	69.1	85.83	-	272.060	297.785	329.220	380.840
Bayat	111.27	26	236.26	61.735	129.65	125.195	125.195
Dwarf	7.65	14.25	96.42	96.9	98.7	83.1	52.26
Shabot	0.175	-	1.00	10.250	6.750	0.100	0.100
Shank	57.550	-	3.60	-	-	29.500	18.410
Sbour	-	-	-	-	-	7.235	4.221
Other	-	12.575	-	64.15	89.020	128.700	-

Data source: Agriculture Directorate, Basra governorat

Itinerant truckers from the city buying fish caught in the marshes

TABLE 8.2: COMMERCIAL FISH SPECIES OBSERVED IN HUWAIZAH MARSH IN 2006 AND 2018

Family	Name			Origin	Maximum Size (cm)	Seen in May 2006	Seen in 2018	Ecological Status 2018	Feeding Behavior
	Scientific	Common	Iraqi Arabic						
Cyprinidae	*Barbus luteus*	Yellow barbel	*Hemri*	Native	30	•	•	Common	Omnivore
Cyprinidae	*Barbus sharpeyi*	Yellow barbel	*Bunni*	Native	60	•	•	Very rare	Herbivore
Cyprinidae	*Aspius vorax*	Tigris asp	*Shiliq*	Native	55	•	•	Common	Carnivore
Cyprinidae	*Carassius carassius*	Prussian carp	*Buj buj*	Exotic introduced in 1995	20	•	•	Common	Omnivore
Cyprinidae	*Ctenopharyngodon idella*	Grass carp	*Ushby*	Exotic Introduced in 1985	70	•		Not seen Rare	Herbivore
Cyprinidae	*Cyprinus carpio*	Common carp	*Carp or Samty*	Exotic Introduced in 1968	70	•	•	Common	Omnivore
Cyprinodontidae	*Aphanius dispar*	Pupfish	*Batreikh*	Native	5	•		Not seen Rare	Carnivore
Mugilidae	*Liza abu*	Freshwater mullet	*Qishni*	Native	15	•	•	Common	Herbivore
Siluridae	*Silurus triostegus*	Mesopotamian catfish	*Juri*	Native	70	•		Not seen Common	Carnivore
Cichlidae	*Oreochromis niloticus*	Nile tilapia	*Shank shatt*	Exotic accidently introduced 2005-2006	23		•	Very common	Herbivore
Cichlidae	*Coptodon zillii*	Redbelly tilipia	*Baltic*	Exotic accidently introduced 2005-2006	18		•	Very common	Herbivore

TABLE 8.3: COMMERCIAL FISH AND SHRIMP SPECIES OBSERVED IN EAST HAMMAR MARSH IN 2006 AND 2018

Family	Name			Origin	Maximum Size (cm)	Seen in May 2006	Seen in 2018	Ecological Status 2018	Feeding Behavior
	Scientific	Common	Iraqi Arabic						
Cyprinidae	*Alburnus sellal*	Sellal bleak	*Samnan*	Native	15	•		Not seen	Omnivore
Cyprinidae	*Alburnus caeruleus*	Tigris bleak	*Samnan*	Native	15	•		Not seen	Omnivore
Cyprinidae	*Aspius vorax*	Tigris asp	*Shilig*	Native	60	•	•	Rare	Carnivore
Cyprinidae	*Barbus grypus*	Shabout	*Shabot*	Native	90	•		Nots seen Rare 2006	Omnivore
Cyprinidae	*Barbus luteus*	Yellow barbel	*Hemri*	Native	30	•	•	Rare	Omnivore
Cyprinidae	*Barbus sharpeyi*	Yellow barbel	*Bunni*	Native	60	•	•	Very rare	Herbivore
Cyprinidae	*Barbus xanthopterus*	Yellowfin barbel	*Qattan*	Native	90	•		Not seen Very rare in 2006	Carnivore
Cyprinidae	*Carassius carassius*	Prussian carp	*Buj buj*	Exotic Accidentally introduced in 1995	20	•	•	Common	Omnivore
Cyprinidae	*Ctenopharyngodon idella*	Grass carp	*Ushby*	Introduced in 1985	70	•		Not seen Rare in 2006	Herbivore
Cyprinidae	*Cyprinus carpio*	Common carp	*Carp or Samty*	Introduced in1968	70	•	•	Common	Omnivore
Cyprinodontidae	*Aphanius dispar*	Pupfish	*Batreikh*	Native	5			Not seen in 2006	Carnivore
Mugilidae	*Planiliza abu*	Freshwater mullet	*Qishni*	Native	15	•	•	Common	Herbivore
Siluridae	*Silurus triostegus*	Mesopotamian catfish	*Juri*	Native	70	•	•	Common	Carnivore
Cichlidae	*Oreochromis niloticus*	Nile tilapia	*Shank shatt*	Exotic	23		•	Very common	Herbivore
Cichlidae	*Oreochromis niloticus*	Nile tilapia	*Shank shatt*	Exotic accidently introduced 2005-2006	23		•	Very common	Herbivore

Family	Name			Origin	Maximum	Seen in	Seen in	Ecological	Feeding
Cichlidae	*Coptodon zillii*	Redbelly tilipia	*Baltic*	Exotic accidently introduced 2005-2006	18		•	Very common	Herbivore
Cichlidae	*Coptodon zillii*	Redbelly tilipia	*Baltic*	Exotic	18		•	Very common	Herbivore
Mugilidae	*Liza subviridis*	Estuarine Mullets	*Byeah bahree*	Migratory	22		•	Very common	Detritivore
Clupeidee	*Tenualosa ilisha*	Hilsa shad	*Sbour*	Migratory	35		•	Common	Omnivore
Sparidae	*Acanthopagrus arabica*	Yellowfin snapper	*Shank*	Migratory	30		•	Common	Carnivore
Penaeidae	*Metapeanus affinis*	Migratory shrimp	*Abu nearra*	Migratory	10		•	Very common	Omnivore

TABLE 8.4: COMMERCIAL FISH SPECIES OBSERVED IN CENTRAL MARSH (AL CHEBAYISH) IN 2006 AND 2018

Family	Name			Origin	Maximum Size (cm)	Seen in May 2006	Seen in 2018	Ecological Status 2018	Feeding Behavior
	Scientific	Common	Iraqi Arabic						
Cyprinidae	*Alburnus sellal*	Sellal bleak	*Samnan*	Native	15	•		Common in 2006	Omnivore
Cyprinidae	*Alburnus caeruleus*	Tigris bleak	*Samnan*	Native	15	•		Common in 2006	Omnivore
Cyprinidae	*Aspius vorax*	Tigris asp	*Shiliq*	Native	60	•	•	Rare	carnivore
Cyprinidae	*Barbus grypus*	Shabout	*Shabot*	Native	90	•		Rare in 2006	Omnivore
Cyprinidae	*Barbus luteus*	Yellow barbel	*Hemri*	Native	30	•	•	Rare	Omnivore
Cyprinidae	*Barbus sharpeyi*	Yellow barbel	*Bunni*	Native	60	•	•	Very rare	Herbivore
Cyprinidae	*Barbus xanthopterus*	Yellowfin barbel	*Qattan*	Native	90	•		Very rare in 2006	Carnivore
Cyprinidae	*Carassius carassius*	Prussian carp	*Buj buj*	Accidentally introduced in 1995	20	•	•	Common	Omnivore
Cyprinidae	*Ctenopharyngodon idella*	Grass carp	*Ushby*	Introduced in 1985	70	•		Rare in 2006	Herbivore
Cyprinidae	*Cyprinus carpio*	Common carp	*Carp or Samty*	Introduced in 1968	70	•	•	Common	Omnivore
Cyprinodontidae	*Aphanius dispar*	Pupfish	*Batreikh*	Native	5	•		Not seen Rare	Carnivore
Mugilidae	*Liza abu*	Freshwater mullet	*Qishni*	Native	15	•	•	Common	detriteivore
Siluridae	*Silurus triostegus*	Mesopotamian catfish	*Juri*	Native	70	•	•	Common	Carnivore
Cichlidae	*Oreochromis niloticus*	Nile tilapia	*Shank shatt*	Exotic accidently introduced 2005-2006	23		•	Very common	Herbivore
Cichlidae	*Coptodon zillii*	Redbelly tilipia	*Baltic*	Exotic accidently introduced 2005-2006	18		•	Very common	Herbivore

IMPR's release of 130,000 *bunni* fingerlings, rather than the planned three million, into only one marsh was a major disappointment for the program. From time to time, over the next five or six years, fisherman occasionally caught a tagged fish, but those chance catches have dwindled to zero. IMRP's intensive efforts to establish a fish hatchery the Marine Science Center also failed and with it the possibility of restoring the *bunni* population to a self-sustainable level. IMRP's intensive efforts to establish a fish hatchery the Marine Science Center also failed and with it the possibility of restoring the *bunni* population to a self-sustainable level (Nasir and Khalid 2017).

FISH FARMING

BACKGROUND

Before the first Gulf War the peak freshwater aquaculture area in Iraq was estimated to be 7,500 hectares. Farmed carp production peaked at approximately 14,000 tons per annum. In 2006, anecdotal information indicates that production was far below the peak. Virtually no fish were farmed during the second Gulf War, and production was just restarting after the invasion. Iraqi silver and grass carp were just beginning to reach the Basra marketplace, and there were only a few hectares of extensive culture of Chinese carps near Basra.

RESULT

The freshwater aquaculture of tilapia (*Oreochromis niloticus* or *Oreochromis spilurus*) has not been introduced into the marshlands or in the aquaculture regions of Iraq. The primary species cultured is common carp due to the ready availability of fingerlings, and to a lesser extent the grass and silver carp. Since 2006, there was a rapid expansion of fish farms in the south. In Basra governorate, there were 424 farms in operation. However, most have shut down. Only 78 or about 18 percent of the total number are still in production, the vast majority using floating cages (Table 8.6). Most of fish farms in the southern marshes are dry due to water shortages, except for a few near the Tigris River in Qal'at Salah district in Maysan. The importation of large amounts of fish from Iran has also contributed to the closing of fish farms. The price for one kilogram of Iranian fish is less than domestically farmed fish that cost about two dollars a kilogram in wholesale markets.

There are a still a number of fish farms using floating cages in Hawaizah marsh and five farms in the area around Al Chebayish The production rate of single cages measuring three meters by three meters by four meters is about 650 kilograms of farmed fish each year.

TABLE 8.6: ACTIVE AND INACTIVE FISH FARMS USING FLOATING CAGES AND POOLS IN BASRA GOVERNORATE (2018)

Fish Farms in Basra Governorate	Active	Inactive	Fish Farmed
Floating Cages	75 (17.7%)	305 (71.9%)	Common Carp
Pools	3 (0.7%)	41 (9.7%)	Common carp Grass carp Sliver carp

In general, the fish farming industry is suffering from stiff competition with imported fish, poor farming practices leading to low production, an increase in the cost of fish pellets, and the poor quality of the locally produced pellets. Poor water quality in the pools and caged areas has slowed the growth of farmed fish.

Fish culture cages in the river at Al Tar and Hammar districts

FISH MARKETING

BACKGROUND

In 2006, the Basra fish market had the largest selection of fish, as would be expected. More than half of the fish in the Basra market were silver carp, common carp and Prussian carp. Most silver, grass and common carp were imported from farms in Iran. A small percentage, perhaps 10-20 percent, came from Iraqi fish farms south of Baghdad. Fish yield from the Shatt Al-Basra and Shatt Al Arab are low and considered "rare".

Most domestic fish yield represented in the market came from the Qarmat Ali River (East Hammar marsh) and the Tigris/Euphrates rivers in the Al-Qurna area. The Silurid catfish are rarely marketed in the south because Shi'as will not eat them, as they have no scales. They are utilized for fishmeal, or in the case of larger sizes, transported to Baghdad and sold there, where some people consume them. The primary source of the high value *bunni*, especially the large size fish, was from Tharthar Lake north of Baghdad. A secondary source was from the river systems near Al-Amara. A few marine migratory species are caught in the Shatt al-Arab river and the Shatt Al-Basra canal, and were "rare" in the marketplace. These include the *Sbour* (hilsa shad, *Tenualosa ilisha*), *beiah* (estuarine mullet *Liza subviridis*) and *Shanag* (yellow fin sea bream, *Acanthopagrus latus*).

Most of the fish in the Basra market are grass carp and common carp. Other species are available, but most are sold in small numbers. A ranking of the fish in the market indicates that currently grass carp, common carp, silver carp, and mullets are the most in volume for sale. Common carp imported daily from Iran is tied with silver carp for third. Freshwater mullet, once the most numerous fish in the marshlands, is now the least available in the market. Of the 14 species of fish for sale, seven are exotic, six are native, and one is imported. However, three of the exotic species vastly outnumber the others.

RESULT

In the marshes, there is a landing where both wild caught and farmed fish are sold by auction to truckers in small pick-ups. Those participating in an auction rarely exceed five buyers. Buyers are outsiders coming from nearby towns and cities. Few Marsh Arabs are commercial traders because they do not have the resources.

From there, the fish are transported to markets in Basra, Al Amarah, and Al Nasariyah.

In the landing area, fish are organized by species and size. Large fish, such as carp and *Tigris aspius* (*shiliq*), are laid on the ground. Large fish and local varieties are the most desirable and are purchased.

Wild captured carp have a flavor that is highly prized by buyers, because of their lower fat content when compared with farmed and Iran-imported carp. However, the price of wild captured is often less because their size is smaller, due to water quality, increased levels of pollution, and lack of wild carp fish stock.

Crates hold small fish that sell for less than one dollar a kilogram. Within the marshes, there are not markets for selling fish. Local people buy directly from fishermen, and the smaller, cheaper varieties are often given to relatives.

Small captured fish for sale in the marshes

Table 8.7 compares fish for sale in Basra market at three points during a 14 year time span. It shows that one species, shaboot (*(B. grypus)*, appears to have disappeared from the market. It was already very rare in 2006. Two *Barbus* species, yellow barbell and yellow fin barbell, are among the most favored fish for eating.

TABLE 8.7: A COMPARISON OF FISH FOR SALE IN THE BASRA MARKET (FEBRUARY 2004, MAY 2006, AND OCTOBER 2018)

Common / Arabic Name	Scientific name	Length (cm)	Price (ID/kg)	Length (cm)	Price (ID/kg)	Length (cm)	Price (ID/kg)	Rank and Status
		February 2004		May 2006		September 2018		
Silver carp	*Hypophthalmychthys molitrix*	25-40	1500-2000	25-60	2500-3000	20-40	3500-4000	3, Exotic Farmed
Grass carp / *Ushby*	*Ctenopharyngodon idella*	30-50	3500	30-60	3500-4000	20-50	4000-5000	1, Exotic Farmed
Common carp / *Samty* (Locally caught)	*Cyprinus carpio*	10-40	2500	10-50	3000-3500	20 -45	4000-5000	2, Exotic Farmed
Yellow barbel / *Bunni*	*Barbus sharpeyi*	20-35	6000	20-55	6000-6500	18-30	7000-9000	5 Native
Shabout / *Shabot*	*Barbus grypus*	30-60	2000	30-60	2000-3000	-	-	-
Yellowfin barbel / *Qattan*	*Barbus xanthopterus*	20-60	6500	20-60	6500-7000	20-35	8000-10000	4 Native
Yellow barbel / *Himri*	*Barbus luteus*	5-15	1000	5-15	1500-2000	15-25	4000	6 Native
Tigris asp / *Shiliq*	*Aspius vorax*	15-45	1500-2000	20-50	2000-2500	15-35	2500-3000	4 Native
Freshwater mullet / *Qishni*	*Liza abu*	10-15	500	10-15	500-1000	10-20	2500	8 Native
Mesopotamian catfish / *Juri*	*Silurus triostegus*	20-60	500	20-60	500-1000	20-45	3000	2 Native
Red belly tilapia / *Zili*	*Coptodon zillii*	-	-	10 - 20	1500	10 - 20	2000	8 Exotic

Common / Arabic Name	Scientific name	Length (cm)	Price (ID/kg)	Length (cm)	Price (ID/kg)	Length (cm)	Price (ID/kg)	Rank and Status
		February 2004		May 2006		September 2018		
Blue tilapia	*Oreochromis aureus*	-	-	-	-	10 -23	3000	7 Exotic
Nile tilapia	*Oreochromis niloticus*	-	-	-	-	10 -23	3000	7 Exotic
Common carp/ *Santy* (Imported Iran)	*Cyprinus carpio*	-	-	20 -40	2500	20 -40	4000	3, Imported

Common carp and grass carp, most likely imported from Iran, for sale at the Basra market in October 2018

CONCLUSIONS

IMRP's efforts to revive a highly prized native fish species were well-intentioned but ultimately unsuccessful. It released only about four percent of the *bunni* fingerlings (130,000 out of 3,000,000) it had planned to. All of them were freed only into Hammar marsh. While some were occasionally caught, confirming their viability, their number in fish catches decreased sharply over time. Likely, few if any are left. The result is that the *bunni* population is nearly decimated. Still highly valued and demanding the highest price in markets, *bunni* are now categorized as being "very rare." In current fish catches, they are most likely to be small, often only a year old. Overfished and not allowed to grow to maturity, the future seems increasingly dim. Their current state is perhaps the greatest disappointment to IMRP's legacy.

More generally, fish and fishing systems have gone through dramatic changes since the first Gulf War, nearly thirty years ago. The changes are likely to be permanent and accelerating over time. Native fish are quickly being replaced by exotic species, most especially two species of tilapia and three of carp. Equally troubling is the narrowing of fish diversity in the wild. Of the native species observed in the marshes in

2006, all of them have disappeared or are now rare or very rare, with the exception of mullet and catfish. Accidently introduced in 2005-2006, Nile and Red belly tilapia have both expanded quickly into the three marshes and are already very common. Trucks regularly transport large loads to markets in middle Iraq. market, as well.

Over time, capture fishing has become less remunerative and less desirable as an occupation. Many fishermen are leaving to work other jobs. And fish farming is not more attractive. Only a small fraction of the fish farms that were started in Basra and Maysan governorates are still in operation, the victims of poor water quality and increasing competition with imported fish from Iran, which have flooded the local markets.

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9. Constructed Wetlands

Peter Reiss and Najah A. Hussain

Rusted sanitation pipes in Al Chebayish town, Dhi-Qar governorate

BACKGROUND

Constructed wetland treatment systems are engineered systems that are designed and built to use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to treat wastewater. They take advantage of many of the processes that occur in natural wetlands, but within a more controlled environment. They offer a cost-effective solution for pollution removal from wastewater and consequent reduction of pollution of receiving water bodies as rivers or marshlands. Constructed wetlands do not require highly skilled personnel and the operation and maintenance requirements are very low.

IMRP found that towns and villages in the marshlands lacked wastewater treatment facilities. After visits to several towns and villages, IMRP selected Al-Chebayish as a good location for the first demonstration system. In Al-Chebayish with a population of roughly 18,000, people had small outdoor toilets with pipes that directly went into cesspools or covered pits adjacent to the houses. During periods of rain or high use, the pits backed up and sewage could enter the house. Cesspools offered little better advantage since they are filled with raw sewage. The small ponds were filled with common reeds (*Phragmites australis*), which were predominantly used as fodder for animals. These

ponds received high amounts of wastes produced in the village through runoff. Municipal water supply pipes carrying drinking water ran directly through the pools. There were many instances of leaks, and people complained of diarrhea and other illnesses. Flies and mosquitoes were endemic. People did not drink the water supplied by the municipality, since treatment was unreliable; machinery was broken and chemicals were not available. The piped water was used for washing. People drank water which was trucked in privately.

In response, IMPR developed an activity to survey, design, and build a constructed wetland in Al-Chebayish. After a number of visits, IMRP decided in conjunction with local town council, town elders, and local ministries of public works and water resources that a five-hectare area, located outside the town, was a suitable location for the constructed wetlands treatment demonstration. The technical team also identified a densely populated part of the town that would be serviced. IMRP contracted an Iraqi surveying company, Sabah Hazbar, to carry out the topographical surveying for both the served and disposal areas, under the supervision of the IMRP team. After the completion of the survey, a local engineering company, Arabic Engineer, was hired to design a sewerage network of the town.

After completing the survey and the design, IMRP's attempts to start the construction failed. The deteriorated security situation in the region and the rapid inflation in the costs had escalated beyond the available budget. One year later, all the documents were delivered to the USAID Agriculture Reconstruction and Development Program in Iraq (ARDI) as the program had indicated its interest in paying for the construction. However, ARDI also put the work on hold.

RESULT

Over the intervening years, there has been no further attempt to build the constructed wetlands in Al-Chebayish or elsewhere in the marshlands. The sanitation problems that were so prevalent 12 years ago are no better. The environment departments in Dhi-Qar and Basra governorates recently cited five municipalities, including Al Chebayish, for illegally dumping their untreated wastewater directly into marshes.

CONCLUSIONS

None of the towns in the marshlands, Al Chebayish being the largest among them, had working and reliable sanitation system in 2006. The situation is no better in 2018. They still do not. Sewage is trapped behind homes in reed crates and not treated, contaminating the piped drinking paper that the inhabitants justifiably refuse to drink. More than 12 years ago, IMRP developed detailed designs for a relatively low-cost system to treat household waste and channel it safely into the marshes. Unfortunately, the program did not have the funding to install the constructed wetland. It was a lost opportunity that could have been a model for other population centers.

10. Primary Health Care

Khalidah S. Al-Niaeem and Amjel K. Resen

Examination room in the Abu Khassaf clinic in 2018

The marshlands have always been one of the most remote and marginal areas in Iraq, historically outside the general control of the government and with a record of having the fewest and least developed services. During the 1990s, medical services were virtually non-existent in the marshes, largely the consequence of a deliberate national policy to persecute the local population. Throughout the area, the situation did not dramatically improve during the course of IMRP's lifetime. Medical services were very limited, with only a few hospitals in the surrounding area and clinics offering no more than the most basic health care. Demanding cases required treatment in the cities. In 2006, most clinic buildings were abandoned or in a state of bad disrepair. Only a few clinics in the marshes were still operational, and they provided only the most basic medicines and with few qualified personnel. Most had only a doctor's assistant.

BACKGROUND

During the years following the Gulf War, the vast majority of Marsh Arabs was displaced to the dried margins of the margins or sought refuge across the border into Iran. The AMAR International Charitable Foundation, a London-based non-governmental organization, was virtually the only entity to provide humanitarian assistance, focusing its efforts on public health and primary education for displaced Marsh

Arabs in Iran. Immediately after the invasion, AMAR launched a program in the marshes on the Iraq side of the border, refurbishing and re-establishing two clinics in June 2003 near Huwaizah and Hammar marshes.

The clinics were staffed with a variety of medical specialists, including doctors, nurses, midwives, and assistants, but both had problems securing medicine. The facilities were supplied from government warehouses, finding the medicine from private sources proved to be too costly, and they lacked the medicine most in demand: antibiotics.

IMRP partnered with AMAR to provide primary health care in two areas with sizable Marsh Arab concentration: Al Khair, situated along Prosperity River, and Abu Khassaf, close to the western edge of Huwaizah marsh. At the time, Al Khair clinic was a recently constructed facility in excellent physical condition, but it had no equipment and only a few desks, chairs, and two air conditioners. Abu Khassaf's clinic was virtually non-functioning. The center had poor staffing and supplies, no electricity, and was located in a large, unserved village. The nearest alternative source of care was more than 20 kilometers away.

Previous studies, undertaken by AMAR indicated that Marsh Arabs suffered from widespread poor health. This was particularly so in the case of children. High infant mortality was reported, and the principal killer was diarrhea. The incidence of infectious diseases was also very high. IMRP, through AMAR sought to provide essential, targeted health care services to this population on a trial basis.

The objectives were to: initiate sustainable healthcare services in collaboration with the Ministry of Health, local health authorities, and the local population; provide immediate curative and preventive care for the most unserved or underserved population groups; initiate health education activities; and monitor the impact of re-flooding on the health of the local population, particularly with respect to the possibility of re-emerging diseases such as malaria and schistosomiasis.

Services began in both clinics on 1 December 2005. Table 10.1 shows the medical training and health education activities. Table 10.2 shows that the number of patients who were provided health services in the two clinics by May 2006 totalled 21,056.

RESULT

The two health clinics in Al Khair and Abu Khassaf that were res-established in the marshlands IMRP in 2005 are still in reasonable physical condition and continue to provide basic, limited services to local residents in 2018. There was no further international donor assistance after IMRP ended, and AMAR did not have the resources to support the clinics independently. Since then, the government has supported clinic operations, but this support covers less than 40 percent of their needs.

IMRP supplied the clinics with medicine for chronic diseases, but no longer. The two clinics now act as the entry points for medical support, limiting dispensed medicine to antibiotics, inflammatory syrup for children, headache pills, bandages, and children vaccinations. The clinics do not dispense prescription medicine for chronic diseases because they are not supplied by the Ministry of Health. Services provided by health clinics include therapeutic and health services, maternity and childhood care, laboratory analyses, and health awareness. Any more complicated treatments are consigned to hospitals.

The level of medical assistance is low, as shown in Table 10.1. While the total number of staff at Al Khair has only decreased by four positions, the clinic has actually lost more of its professional staff. The clinic has lost three doctors, one dentist, and two midwives. Al Khassaf has suffered even more. Now with four staff, it has only a nurse, a clerk, and a driver. It is a shell of what it was 12 year ago.

TABLE 10.1: PAST AND CURRENT STAFF IN THE TWO IMRP-ASSISTED CLINICS

	Al Khair		Abu Khassaf	
Clinic Staff	2006	2018	2006	2018
Doctor	2	1	2	0-
Dentist	0	1	0	0-
Gynecologist	1	0	0	0
Assistant doctor	3	2	1	0
Nurse	2	3	2	2
M.C.H.	3	0	1	0
Midwife	2	0	1	0
Laboratory assistant	2	1	1	0
Administrative/Clerk	2	1	1	1
Driver	0	3	0	0-
Service Officer/Preventive asst.	1	1	1	0
Ambulance driver	0	1	0	1-
Total	18	14	10	4

Table 10.2 shows how many combined patients used health services at the two clinics over the 11 years since IMRP ended. In 2006, the clinics had 21,056 patients. The number decreased in IMRP's aftermath in 2007 by 37 percent and then resurged somewhat from 2008 to 2010. The numbers fell again in 2011, but they plummeted in 2014, falling each year to the 2017. The clinics lost 80 percent of their patients from 2006 to 2017.

The loss of staff and the limited services certainly took their toll on the two clinics, but the sharp decrease may have been even more a result of Iraq's economic crisis. The entry ticket for clinics before 2014 was 500 Iraqi dinars, including medication and laboratory treatment. After 2014, the price increased to 2,000 Iraqi dinars, plus 1,000 Iraqi dinars for each laboratory test. Marsh Arabs said the cost was more than they could comfortably afford.

In general, the health situation in the marshlands is not good. There has been an increase in the number of malnutrition cases. They lack of infrastructure and electrical appliances, especially refrigerators, has led to numerous cases of food poisoning. In the area of Al Khair, as a result of the low water levels in the Tigris River and its branches, there was a spread of many diseases, especially scabies.

In Abu Khassaf, the many oil extraction facilities caused a spike in cancer cases, which the region had not previously known.

Pharmacy at Al Khair Clinic

TABLE 10.2: NUMBER OF PATIENTS SERVED BY THE TWO IMRP-ASSISTED CLINICS (2006-2017)

Activity	IMRP 2006	Post-IMRP											
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Curative care	13209	7250	8250	5000	8300	7850	7500	8300	5000	3900	3250	2800	71100
Laboratory test	1878	0	0	0	0	0	0	0	0	0	0	0	0
Vaccination	4533	14	15	15	17	20	19	23	26	31	30	31	241
Maternal care	546	320	283	284	291	201	255	167	145	147	133	123	2448
Child care	845	5600	6500	6550	7100	9540	3250	3070	2070	1500	1520	1200	47900
Medical training	23	110	126	139	166	182	138	96	50	47	40	31	1125
Health education	22	20	14	22	23	28	14	13	10	9	4	4	151
Total	**21056**	13314	15188	15710	15897	17921	11176	11669	7301	5634	4976	4189	

CONCLUSIONS

IMPR's plan to provide primary health care to an unserved community, that was desperately in need, seemed well-designed. Rather than acting on its own, IMRP operated through a British non-governmental organization, that had strong ties to Marsh Arabs with its long-standing humanitarian assistance. It chose two existing clinics that could potentially serve large populations, having gained the full support of tribal leaders beforehand. And it appeared to have the approval of the Ministry of Health, although AMAR carried out the independently.

AMAR operated under wartime, emergency conditions, working with a population that had few resources and a local government that had been devastated and was in the slow process of righting itself. At that time, all health services in the two clinics were understandably free of charge. But for a country facing economic ruin, providing free services post-program was unsustainable, as were anything above minimal health care. After 2006, services diminished as costs increased. The 2014 jump was a near-fatal blow.

It would be more appropriate to think of IMRP's efforts in public health care as emergency relief rather than as development assistance. The plan never moved beyond the short-term life of the program. IMRP and AMAR never developed a contingency plan for external funding beyond November 2006. And there was no strategy by AMAR to reintegrate its operations in the clinics back into the Ministry of Health's line responsibilities. IMRP's initiative was not sustainable, and its benefits were at best short-lived.

11. Marsh Arab Women's Livelihoods and Activities

Khalidah S. Al-Niaeem

Young girl living on a floating island inside the marshes 2004

The Iraq Marshlands Restoration Program did not include initiatives that were solely dedicated to improve the lives of Marsh Arab women and female children. Instead, it believed that the broad based program would support and improve the lives of women and girls, as they played a wide range of essential roles in household life and family welfare. IMRP activities in agriculture, livestock, constructed wetlands, and public health would necessarily affect their daily lives positively. They were also expected to be major recipients of care in public health clinics, which were to provide better and more reliable services in childbirth, maternal care, childcare, and vaccinations.

BACKGROUND

IMRP found that women were the primary tenders of cattle, sheep, and goats. Men were more likely to care for buffalo, as that care often required moving them at some distance to enable the buffalo to enter the wet marshes. Women also played key roles in dairy sales and production and in food preparation for the family and for the wider public. For example, a small truck plying the paths around settlements along Prosperity River stopped frequently to buy raw milk from cattle owners. The collector was a local woman

who had a small business. Women were also most likely to sell homemade dairy products – cheese and yoghurt – in the local markets some kilometers away from home. We conjectured in 2006 that this work by women in the public arena might well be explained by the frequency and consequences of the pervasive intertribal feuds among Marsh Arabs. Women were the safest members of a family to be in a potentially dangerous and alien setting.

Marsh Arab Women Performing Household and Public Arena Jobs in 2004

Feeding cattle on a floating island

Herding sheep along Prosperity River

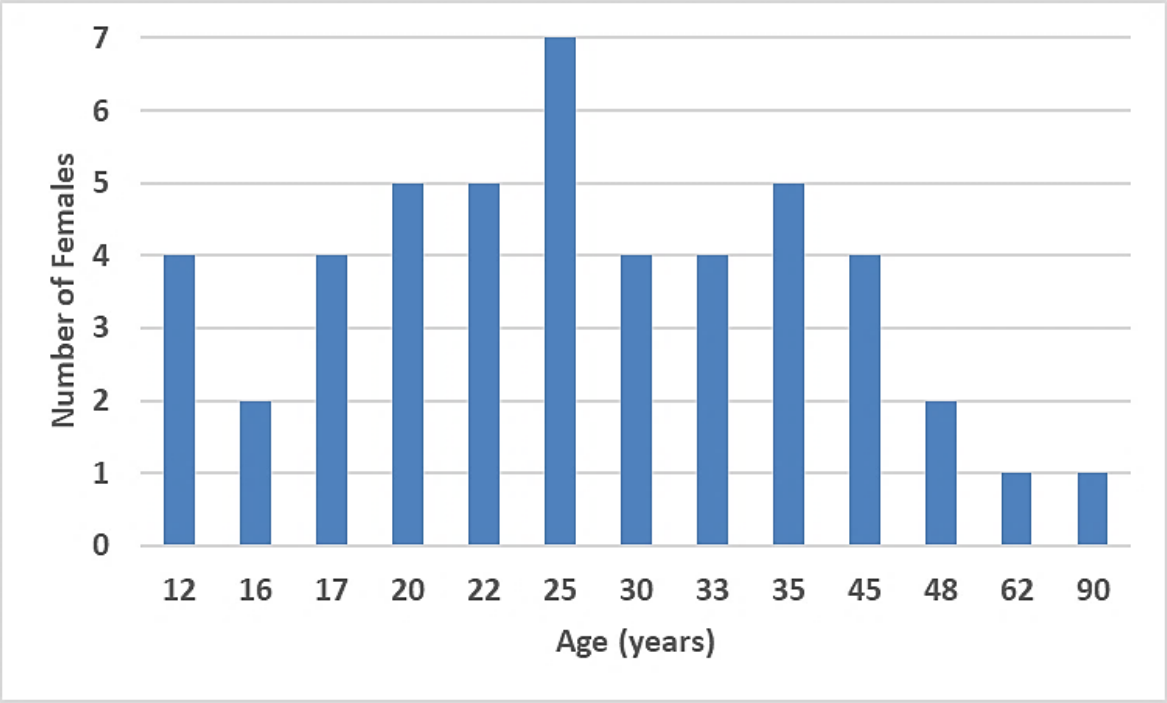
Buying milk from cattle owners along Prosperity River

Selling homemade cheese at a local market

RESULT

The impact assessment team interviewed 48 Marsh Arab women and young girls in the areas of Huwaizah, Hammar, and Central marshes. Figure 11.1 provides the age distribution of the interviewees. This chapter is based in part on those interviews.

FIGURE 11.1: AGE DISTRIBUTION OF MARSH ARAB FEMALES INTERVIEWED IN HUWAIZEH, HAMMAR, AND CENTRAL MARSHES



Women continue to play essential roles in Marsh Arab society. They are active participants in agricultural activities, including post-harvest work and mat making. Many women are involved in food production, the most common being dairy products for the home, but also some are playing commercial and even management roles, selling products to the public. Chapter 7: Livestock Production and Veterinary Services discusses a successful woman business owner who buys milk from buffalo herders in the region, makes cheese and yoghurt on a relatively large basis in her own factory, and sells the products in her own shop and to traders who transport them as far away as Baghdad. Other women sell on a smaller scale in local markets.

Women continue to be livestock tenders, caring for herds of cattle, sheep, and goats. They will care for buffalo if water is they can do it in the immediate vicinity, for example, those relatively few who live on the floating islands. But there is little evidence that they take the buffalo to greater distances across dry marshes to wet areas. Women also sell fish in the local markets.

More recently, Nature Iraq opened a handicrafts center in Al Chebayish where Marsh Arab women make small rugs, bags, and other items. This appears to be a renewal of traditional crafts work and a good source of outside income.

Members of a farming family at one of the IMRP-supported data palm nurseries

Women tending livestock on a floating island near Al Chebayish in Central marsh

Marsh Arab woman entrepreneur in dairy industry who owns and manages the operation

Selling two species of tilapia in the Basra market

While the two public clinics supported by IMRP did provide useful services much in demand, medical care has been more restricted post-program. There were nearly 550 visits for material care in 2006 but only about 2,500 during the next 11 years, averaging about half per year since 2006. However, childcare has more than quadrupled from about 850 in 2006 to about 4,350 per years since then.

Educational opportunities for Marsh Arabs were rare at the time of the invasion. Government schools had been closed for some time. In the succeeding years, schools in the marshlands opened, and some girls are now attending them. At first glance, this seems to be promising. However, at the primary school in Abu Khassaf village, there were 55 children in the first grade but only 10 in the sixth grade. The school was clean and tidy, but the toilets were not working. When that happens, girls often stop going to school. The teaching staff clean and maintain the school themselves because there is no governorate budget. Most of the students, male and female, suffer from malnutrition.

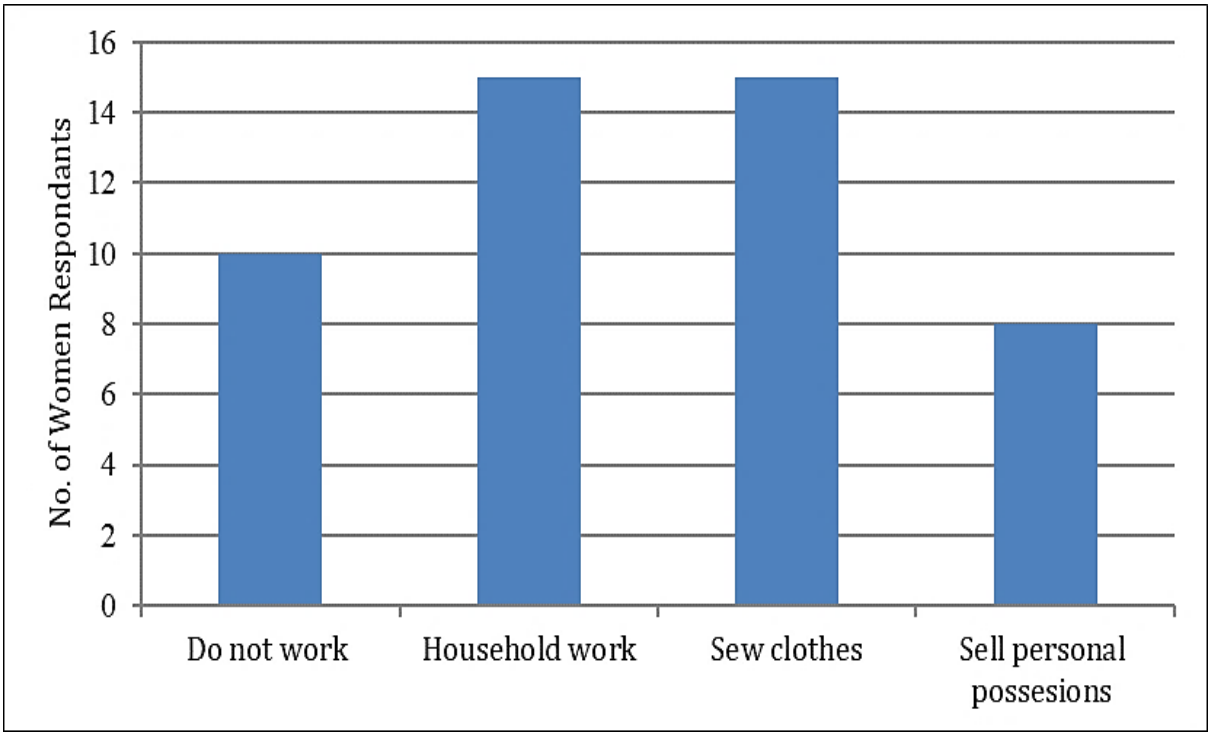
One of the very few research efforts on Marsh Arab women (Fawzi et. al. 2016) has somewhat similar findings as ours. In what they called their preliminary research, they found that the drainage of the marshes drastically changed their activities, limiting their external interactions to domestic efforts. They argue that:

> *"…today most families have little opportunity to utilize their womenfolk's ability to generate income. Furthermore, because women no longer use these skills, their daughters are not learning the skills necessary to live off the marsh ecosystem, and this valuable cultural knowledge is being lost."*

Handicrafts made at the Nature Iraq workshop in Al Chebayish

In our investigation of women's roles, we also found a shrinking of women's activities in the public arena, although a few are moving along new paths, particularly commercial dairy production. We do not yet know if this new direction is common or simply anomalous. Figure 11.2 indicates the main activities as noted by women in interviews.

FIGURE 11.2: MARSH ARAB WOMEN'S ACTIVITIES



Sixth grade students at an elementary school in the marshlands

CONCLUSION

This chapter is only a prelimiary examination of Marsh Arab woman. Few of the recent examinations of Marsh Arab society and the marshland environment (France 2011, Kubba 2011, Ochsenschlager 2004) deal with them other than marginally. The only one serious research effort on Marsh Arab women (Fawzi 2016) reached some of the same conclusions as we did. We know that they play a variety of roles in their households and in the public arena. And we know that their lives changed significantly with the drainage of the marshes and their forced displacement. More research is required to better understand the fullness of their activities, their status, and their contributions.

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Impact assessment team member conducting an interview in the marshlands

12. What Was IMRP's Impact? What Was Sustainable? And Why?

Peter Reiss and Najah A. Hussain

Looking back at IRMP's initiatives after 12 years, we found encouraging threads but also disappointments. During its contract life, IMRP did much to raise the international profile of Iraq's southern marshlands. For many years previously, the marshlands were the exclusive realm of explorers and travelers who created a mysterious and exotic world. Then came more than a decade of government-led attacks, abuse, and isolation. IMRP brought attention to the reality of a displaced people living in an environmental nightmare. However, that attention did not yield the massive investment expected. IMRP did not have the resources, time, or reach to reduce or reverse the years of massive damage. Funding moved on to the latest crisis.

Initiatives that depended on institutional support were far less successful than those that flourished with individual enterprise. IMRP's investments in government and university laboratories yielded short-term gains. Some of the laboratories were useful and used for a number of years, until the equipment became outdated or broken. At the University of Basra, a newly named marshlands ecology laboratory supported the research of faculty and a score of graduate students for a time, creating a new generation of marshlands experts. The message was more hopeful in Baghdad where the soil and water laboratory in the Ministry of Water Resources' headquarters is still in full operation. Working on a service for fee basis, it has been able to maintain its integrity and effectiveness. The lesson was to find a way that enabled a successful degree of self-sufficiency. Dependency on internal support was a losing strategy.

In the marshlands, IMRP's activities that relied on government support could not outlast the program. Although the hydrologic model was admired and used by the Ministry for planning purposes over six years, it could not be updated and is now a relic. The government lacks the resources and expertise to make it operative again. A hoped for central soil-water database that would be used by government and academia did not materialize, never moving beyond early meetings. Designs for a low-cost constructed wetlands in the marshes' largest town were never translated into action. Al Chebayish was recently fined for continuing to dump raw waste into Central marsh. Population centers in the marshes still lack environmentally safe systems for household sanitation. And two public health clinics upgraded and supported by IMRP saw an explosion of use during the program but now receive a quarter of the patients they saw then.

IMRP's greatest impact was in areas that captured the imagination of the local population, where relatively small interventions were not only sustainable but, in some cases, transformative. Demonstrations of alfalfa and sorghum on a few hundred donums led to their cultivation of a large scale. In the first season after IMRP ended, more than 30,000 donums of alfalfa were planted in the three southern governorates. That level has largely been stable during the past 12 years, rising to 40,000 at one point and then falling to 30,000, suggesting that it a reasonable outer limit, given the current water availability and quality. We believe that the expansion of green fodder had the planned effect on livestock that are in better health and more productive than ever: larger numbers, increasing diversity, greater birth weight and daily growth rate, higher daily milk yields, and longer lactation periods.

There have been parallel improvements in meat and dairy markets. The result is the creation of a cottage industry to produce dairy products improving Marsh Arab incomes and offering greater opportunities for women as rising entrepreneurs. These changes suggest an increasingly healthy and dynamic livestock sector in the marshlands. They also highlight the difference between sustainability and transformation. Alfalfa and sorghum cultivation are clearly sustainable, but dairy production is transformative.

Efforts by IMRP to revitalize the decimated date palm industry were only partially successful. Of the eight nurseries that IMRP supported through the purchase of the trees, four are still in operation and are thriving, but three fell victim to intertribal disputes, as a way to avenge affronts, and one was destroyed when the government claimed the land for oil drilling. Owners of the four operating nurseries honored their agreements to distribute offshoots to others, but the number was too small to develop new orchards, a longer-term goal of the program. In any event, the area of date palm nurseries has increased in the years since IMRP ended, and would have one done so without its intervention.

IMRP was far less successful in the area of capture fishing. Its goal was to revitalize the population of two highly marketable fish species that were rapidly disappearing from overfishing and changes in the marsh ecology. It was able to reintroduce only one for only about four percent of the anticipated number: 130,0000 fingerlings instead of the planned three million. There were a number of mishaps beyond the program's control, but also the local institution that IMRP chose was clearly inadequate to carry out the work. The dwindling number of this highly prized fish is not the direct responsibility of IMRP, but the program clearly failed to mitigate the dire situation. More broadly, native fish are being aggressively replaced by recent invasive and exotic species. Fish that were common in 2006 are becoming increasing rare or are no longer sighted.

This change in fish population mirrors a fundamental ecological shift in East Hammar marsh from a freshwater to estuarine or marine habitat. The Tigris and Euphrates rivers are no longer feeding the marsh, and there is penetration of Arabian Gulf water through the Shatt Al Arab. The change is reflected in population changes in phytoplankton, zooplankton, and marcobenthic species. Aquatic plants are more resilient and able to tolerate higher levels of salinity. However, two shrimp species and fish that were never observed in the marsh are increasingly common. Different species of tilapia, accidentally introduced in 2006, are now classified as very common in all three marshes. In the fish markets the region, the most available fish are exotic, farmed, or imported in large numbers from Iran daily.

In summary, IMRP's track record on impact and sustainability is mixed. Rapid wins during the program's life did not necessarily lead to long-term gains. Too often, program initiatives were constrained by a changing physical environment and a slow to recover institutional one. They were carried out during a time when the country was going through invasion and internal strife. Some of its activities were designed to address immediate humanitarian needs, such as renewal of public health access. Others sought to bolster national and local government entities in transition. They required long-term external support to succeed. But those activities that met local needs and offered the possibility of a better future were the ones most likely to be adopted and, in some cases, transformed.

Annex: Biographical Sketches of Team Members

Adil Fadhil Abbas has a B.Sc. in biology (1994) and an M.Sc. in animal/mammal ecology (2013) from the University of Basra. Since 2009, he has worked with the Scientific Advisory Bureau in the College of Science at the university. He has taught many courses in general ecology, wetland ecology, animal ecology, animal classification, biodiversity and photography. He has supervised many undergraduate and graduate students who are studying the diversity of fauna, including mammals, reptiles, insects, and fish. Mr. Abbas has participated on many project environmental impact assessments in southern Iraq. He is coordinator for ecological research projects at the University of Basra. He is also an accomplished wildlife photographer, as the photographs in the ecosystem monitoring chapter in this report can attest.

Alaa Hashim Salem Hassan Al Badran is the only Iraqi member of the team not to be faulty or staff at the University of Basra and has brought a unique and important local institutional perspective to the assessment. He is secretary of the Committee to Revive the Marshes, operating under the Basra Governorate Council, and chair of the Agricultural Engineers Syndicate in Basra. He also heads the Agricultural Advisory Office in Basra. Mr. Al Badran has a Bachelor of Agricultural Science / Soil Sciences and Water Resources (1989-1989) and Bachelor of Arts in the English language from the Faculty of Arts (2000-2001), both from the University of Basra. He has professional certificates in Computer Systems Programming (Intensive Program Preparation), for the number of development and rehabilitation courses in agriculture and the marshes, in training of trainers for human resource development, and from the United Nations in community rehabilitation. He is editor-in-chief of the Basra Oasis newspaper. Among his many positions, he is chair of the Agricultural Cooperative Engineers Housing Society and chairman of the Shatt al Arab Salvation Society (under construction). He was agricultural advisor to the Committee on Agriculture and Water Resources for the Basra Governorate Council (2009-2013) and Executive Secretary of the Basra Advisory Council (2003-2004). In general, Mr. Al Badran has participated in the preparation of most of the projects in agriculture and the marshes since 2004 and has designed and participated in research efforts on the environment and marshes since 2003. He also served on preparatory committees for and participated in nearly 30 conferences dealing with the marshes, environment, and reconstruction since 2003.

Khalidah S. Al-Niaeem is Assistant Professor in Fish Diseases in the Department of Fisheries and Marine Resources, College of Agriculture, University of Basra. She obtained her B. Sc. in biology in 1991 from the College of Education, M.Sc. in fish parasites and diseases in 1999 from the College of Agriculture, and Ph.D. in fish diseases in 2006 from the College of Agriculture, all from the University of Basra. She has been Assistant Lecturer in the Department of Fisheries and Marine Resources at the University of Basra since 1999, became Lecturer in 2002, and Assistant Professor in 2010. She has taught undergraduate students courses in fish diseases and parasites, invertebrates, microbiology, computer science, zoology, English language and applied activities and for graduate students courses in biochemistry, fish diseases, fish technology, fish health, fish treatment, and protozoology. Dr. Al-Niaeem participated in scientific conferences and workshops in and outside Iraq. She has supervised five M.Sc. theses and two Ph.D. dissertations and has published 40 research papers in different scientific journals, as well as three additional articles, which have been accepted for publication. For this assessment, she played a number of different roles, investigating capture fishing, educational conditions, public health, and the status of Marsh Arab women and girls. In doing so, she conducted scores of interviews on gender issues in all three marshes.

Maitham Abdullah Ghaley Al-Shaheen has a B.Sc. in biology (1999), M.Sc. in toxic freshwater algae (2002), and Ph.D. in ecology and taxonomy of diatoms (2016) from University of Basra. Since 2003, he has taught many courses in general ecology, ecology and taxonomy of algae, aquatic environment, plankton and productivity, and environmental awareness. He has supervised many undergraduate students who are studying the ecology, taxonomy, bioindicator, and the biodiversity of diatoms and other algal species. Dr. Al-Shaheen has participated in many project environmental impact assessments in southern

Iraq. He has contributed to training course on the ecology of the marshlands of Iraq (Canada-Iraq Marshland Initiative) and training course of ecology (University of Basra, UNESCO/Iraq office). He is currently Lecturer in the Department of Ecology in the College of Science at the University of Basra.

Asaad Yheia Ayied was deputy director of and team leader for livestock and dairy on the USAID Iraq Marshlands Restoration Program from 2004-2006. He is the lead writer/researcher of the livestock production chapter in the assessment effort. Dr. Ayied has been a permanent staff member of Animal Production Department in the College of Agriculture at the University of Basra since 1983, where he is currently Professor of Animal Breeding and Genetics. He has supervised 15 Ph.D. dissertations and 10 M.Sc. theses of graduate students. Their major focus is the association of genetic polymorphisms and production traits, such as milk yield and meat of different livestock species, including buffalo, cattle, sheep, goats, and camels. He has participated in a number of conferences, workshops, and other academic activities dealing with animal breeding and management in Iraq and internationally. Dr. Ayied has published more than 50 papers dealing with animal breeding, genetics, nutrition, and meat sciences. He has a master's degree in dairy cattle breeding from the University of Melbourne, Australia and a Ph.D. in animal breeding and genetics from the University of Basra, and he did graduate studies in agriculture at the University of Basra.

Haifa Ali Hamza is one of the pioneers in the study of shrimp in Iraq, having successfully identified a new native shrimp species in the Shatt Al Arab River. Dr. Hamza is Assistant Professor in Department of Ecology, teaching undergraduate and graduate students in several departments, including fisheries and marine resources, biology and ecology. She has supervised nine M.Sc. and Ph.D. students and participated many examinations for M.Sc. theses and Ph.D. dissertations. Dr. Hamza has published 16 scientific papers and reports in international and local scientific journals and contributed to many scientific conferences, both locally and regionally. She participated in many ecological surveys in southern marshes and Arabian Gulf. Dr Hamza graduated with a B.Sc. from the Department of Fisheries in the College of Agriculture and with an M.Sc. and Ph.D. from Department of Biology in the College of Science at the University of Basra.

Muhana Kassim Habeeb has a B.Sc. in biology (2004) and an M.Sc. in bird ecology (2009) from the Department of Biology at the University of Basra. He is currently a graduate student working toward his PhD. degree. He has been an assistant lecturer in the Department of Biology and was a manager of the Museum of Natural History at the University of Basra from 2009 to 2012. In April 2009, he took a course that surveyed birds in Sulaymaniyah governorate in northern Iraq under the supervision of Richard Porter, an ornithologist and consultant to Bird Life international. He also carried out many surveys of the birds in southern Iraq. In 2012, Mr. Habeeb transferred to the Department of Ecology, which has been established recently in the same college. In 2013, he was promoted to the rank of lecturer. He has published several papers in local Journals and has taught undergraduate students in biodiversity, ecology of wetlands, classification of animal, and general biology

Najah Aboud Hussain was Team Leader of the impact assessment team and the ecosystem monitoring team for the assessment and was also its Senior Ecologist. On the USAID Iraq Marshlands Restoration Program from 2004 to 2006, he was Team Leader of the Marsh Ecosystem Monitoring component supervising 25 experts. Dr. Hussain founded the Marine Science Center at the University of Basra and was its General Manager for about fifteen years. He has served as a member of the University of Basra's Senate and was a member of the Iraqi Supreme Ecological Committee, Iraq's representative to the IOC/UNESCO Assembly, and the ecological member of Iraqi ministerial team at ROPME meeting. He has taught undergraduate and postgraduate students in several departments of the University of Basra, including biology, ecology, and fisheries and marine resources. He supervised 39 M.Sc. theses and Ph.D. dissertations and published more than 130 scientific papers in international journals and five books dealing with the aquatic ecology of the Shatt Al Arab River, the Iraq marshes, and the Arabian Gulf. He was the editor and a member of editorial boards of local scientific journals. His scientific focus is aquatic ecology, animal biodiversity and water quality. He has participated in a number of regional and

international conferences, workshops, and other academic activities dealing with aquatic ecology and animal biodiversity. Starting in 2003, he played a key role on a number of a major development projects operating in the southern marshlands, including IMRP for three years, ARDI for two years, and leading the fish ecology team for CIMI/ Canadian International Development Agency. Dr. Hussain graduated from the Department of Zoology at the University of Basra with a B.Sc., and has an M.Sc. from Department of Oceanography at Southampton University, and a Ph.D. from the University of Wales. He is currently Emeritus Professor in the Department of Ecology at the University of Basra.

Abbas M. Jasim is Professor of Horticulture at the University of Basra. He is the lead writer/researcher of the agricultural production chapter. His Ph.D. in horticulture from Kansas State University was awarded in 1988. In addition to his academic career, he has also played key roles on a number of international and national development efforts. He was a team leader for establishing date palm nurseries in the marshlands under the USAID Iraq Marshlands Restoration Program in 2004. From 2005 to 2006, he was Grants Manager of the USAID Agriculture Reconstruction and Development Program in Basra. He is a member of National Date Palm Improvement Program and has supervised more than 40 graduate students for their M.Sc. and Ph.D. degrees. He served as the Director of Date Palm Research Center from 1998 to 2005. Dr. Jasim has authored more than 50 research papers published in local and international scientific journals. His research areas include date palm physiology and production, plant tissue culture, stress physiology, and postharvest physiology. Dr. Jasim currently chairs the Department of Horticulture in the College of Agriculture at the University of Basra.

Mohammad Salim Moyel has a B.Sc. in biology (2004). For his M.Sc. from the University of Basra, he conducted a water quality assessment of the northern part of the Shatt al Arab River in 2011, using a water quality index (Canadian Version). He has taught many courses in general ecology, environmental chemistry, fresh water environment, and limnology. He has supervised many undergraduate students who studied water quality and water quality assessment. Mr. Moyel has participated on many project environmental impact assessments in southern Iraq. He worked in many projects with national and international companies and institutions in environmental impact assessments and the monitoring of water quality. He has many published articles on monitoring of water quality of rivers and groundwater. He is currently Lecturer in the Department of Ecology in the College of Science at the University of Basra.

Anfas N. Okash has been a scientist in the Zooplankton Laboratory in the Marine Science Center since 1996. She participated in a survey project on Iraq's southern marshes as a coordinator between Basra University and the University of Waterloo in Canada, and she was involved in an ecological survey of the Shatt al Arab from 2008 to 2010. Ms. Okash has a B.Sc. in biological science and an M.Sc. in invertebrate ecology (2013), and she currently is a lecturer in the Department of Ecology teaching several subjects, including marine science and zoology. She has published research on a newly recorded crab (*Halimede tyche*) found on the Iraqi coast.

Peter Reiss led the first international scientific team in the Iraq marshlands in June 2003 and directed the USAID Iraq Marshlands Restoration Program from 2004 to 2006. He was a permanent development staff member of DAI from 1980 to 2014, where he was director of the Agriculture and the Environment Group, leader of the Water Team, and chief of party of a number of USAID projects in the Middle East, Asia, and Africa, including the Souss-Massa Integrated Water Management Project (SIWM) in Morocco, the Water Policy Project in Lebanon, Fostering the Resolution of Water Resources Disputes (FORWARD), Advancing the Blue Revolution Initiative (ABRI), and Further Advancing the Blue Revolution Initiative (FABRI). He has worked extensively in irrigation with water user associations, water supply and sanitation, utility management, water policy, and water management. Dr. Reiss' areas of expertise are policy development, social analysis, program and research design and management, institutional strengthening, collaborative planning and problem solving, and strategic and business planning. He is co-author of the article, The Restoration Potential of the Mesopotamian Marshes of Iraq, which appeared in *Science* in 2005. He has a master's degree in anthropology from the University of Pennsylvania (1974) and a Ph.D. in social anthropology from the University of Rochester (1980) and did graduate studies in

international agriculture and development at Cornell University. He was Activity Manager and Editor of this assessment report.

Amjed Kadhum Resen is Professor in Fish Ecology and Biology in the Department of Fisheries and Marine Resources, College of Agriculture at the University of Basra. He was the researcher and writer of the capture fishing and fish farming and the public health chapter in this assessment. Dr. Resen has been on the faculty since 1995. He has an M.Sc. (2001) and a Ph.D. (2007) in fish ecology and biology from Department of Fisheries and Marine Resources at the University of Basra. He has 14 academic publications and has attended 30 professional conferences. He has taught undergraduate courses in microbiology, aquatic environmental pollution, fish technology, aquatic ecology, commercial fisheries, fish culture, marine biology and marine ecology and estuaries. He has taught postgraduate courses in fish technology, fish ecology, marine ecology and estuary ecology. He has been a member of the Ecological Monitoring Team for the Southern Iraq Restoration Program since June 2004. He submitted water quality reports at the First Iraqi Marshes Restoration Meeting in Amman, Jordan on 6-11th October 2004; at the Second Iraqi Marshes Restoration Meeting in Aqaba, Jordan on 7-16th March 2005; at the Marine Science Centre on 11-12 June 2005; at the Basra provincial Centre on12-13 August 2005; at the First Iraqi Marshes Restoration Conference in Montreal, Canada on 18-22 November 2005; and at the Fourth Iraqi Marshes Restoration Meeting in Arbil on 26-27 April 2006.