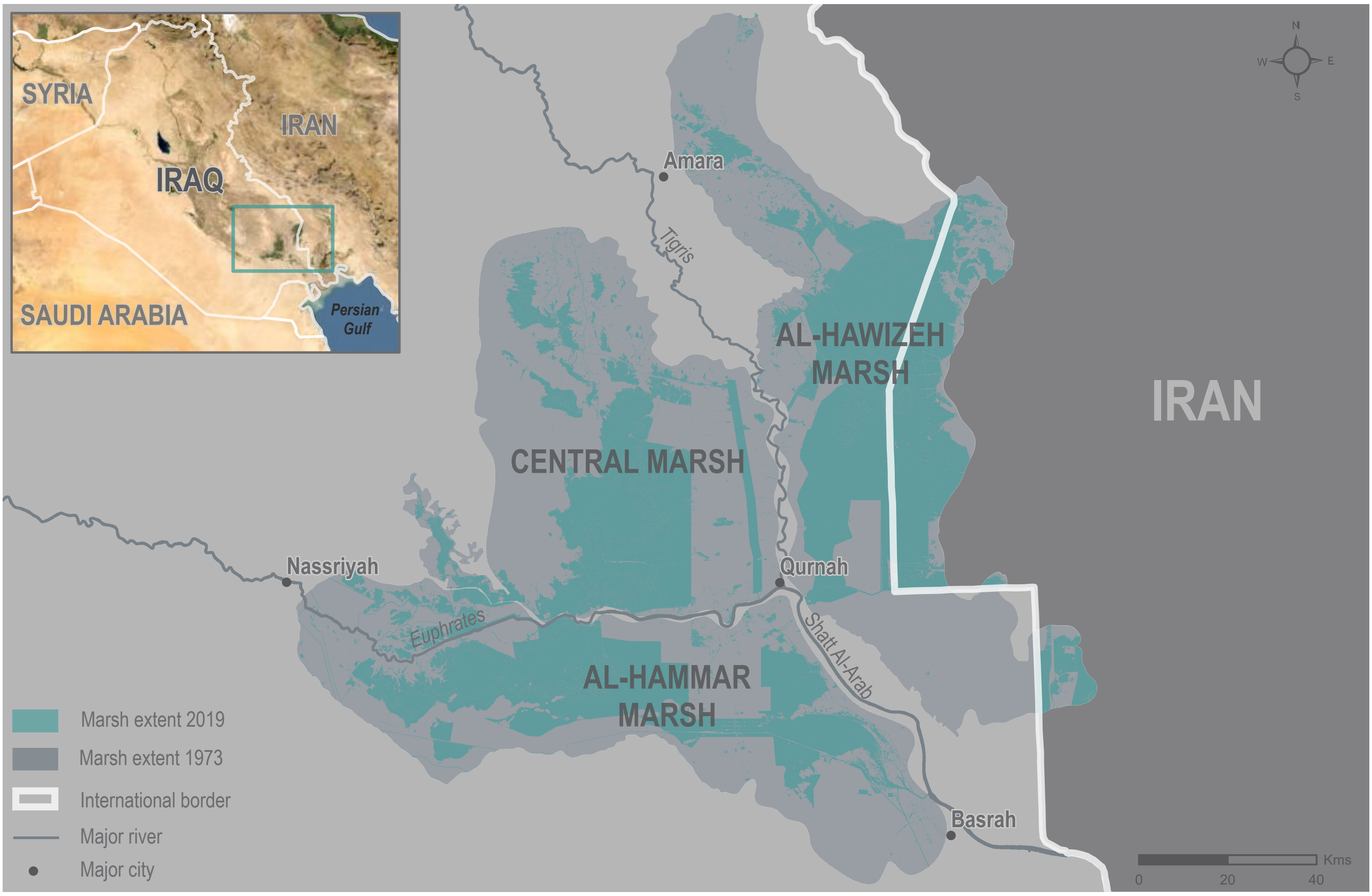
Land Cover Change and Livelihoods in the Mesopotamian Marshes

September 2020

HISTORICAL AND CURRENT EXTENT OF THE MARSHES



Background

Until the mid-20th century, the Mesopotamian marshes represented a source of cultural richness and biodiversity.[1] However, by 2002, the marshes were almost fully transformed into a desertscape due to conflicts, hydropower and irrigation development projects in upstream areas.[1] This transformation was accompanied by a destruction of natural habitats for a variety of bird and fish species as well as water buffalo.[2] Local communities who heavily relied upon the farming and trading of water buffalo and fishing soon experienced their livelihoods collapse because of this desertification. Soils became infertile and futile for agricultural activities.[1] In 2003, drainage structures were torn down to start the rehydration and ecological recovery of the former marsh areas.[2] The Iraq Marshlands Observation System (IMOS)[3] project, implemented by the United Nations Environment Programme (UNEP) (2003-2005), reported a recovery of 42% of the original marshland by November 2005. REACH, in close reference to the IMOS project, conducted a follow-up long-term land cover change analysis to inform the Water, Sanitation, and Hygiene (WASH) Cluster and other relevant stakeholders about the more recent progress and consequences of the marshland rehydration to further support the implementation of appropriate rehabilitation measures. For more details on the assessment, please see the methodology section on page 4.

Key findings

- After an initial increase in surface water and marsh vegetation reported by UNEP from 2003 to 2005, REACH found that the rehydration progress relatively stagnated around the peak extent measured for 2007 with some variations.
- Besides upstream water management, also climatic extremes such as drought periods in 2007/08[4] or years with extreme precipitation like 2018/19[4] appear to have had a great effect on the marshland recovery.
- The ecological status of the restored marshland area, and particularly its effects on the current livelihood situation of the Marsh Arabs, remains unclear 17 years after restoration began; additional research into the consequences of the restoration program is necessary to foster a better understanding of the sustainability of the marshlands and local livelihoods.

Timeline - showcasing major events with an effect on the marshes

1973 Marshland baseline extent (first satellite images)

1977 Start of the South-eastern Anatolia Project (step-wise water inflow reduction into Iraq due to dam and hydraulic power plant constructions in Turkey)[1]

1980 – 1988 **Iraq-Iran war** (destruction of the marshlands through development of war infrastructure)[1]

1990 – 2003 **Comprehensive marshland drainage works until almost complete desiccation.** Displacement and persecution of local Marsh Arab communities. Loss of livelihoods and biodiversity.[4]

2001 Completion of Karkheh Dam in Iran (depletion of main fresh water inflow into Al-Hawizeh Marsh)[1]

2003 **Start of rehydration of the marshlands.**[2]

2005 UNEP reports marsh rehydration of 41% of the historical extent.[3]

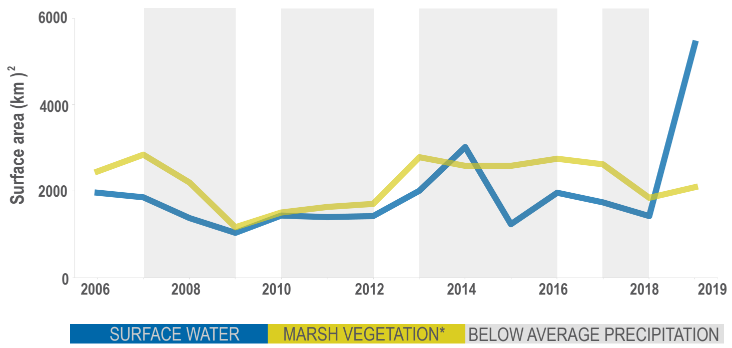
2019 Last assessed rehydration state.

1 UNEP (2001). The Mesopotamian Marshlands: Demise of an Ecosystem
2 Richardson et al. (2005). The Restoration Potential of the Mesopotamian Marshes of Iraq
3 UNEP (2005). Iraqi Marshlands Observation System UNEP Technical Report
4 REACH (February 2020). Long-term Precipitation Pattern in the Euphrates-Tigris Basin
5 Al-Handal (2014) MODIS Observations of Human-Induced Changes in the Mesopotamian Marshes in Iraq

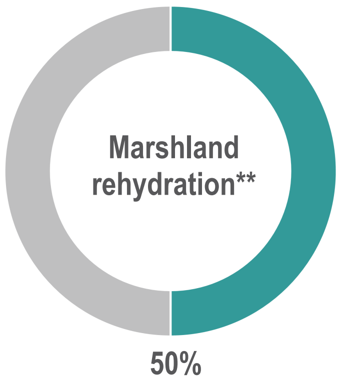
REHYDRATION PROCESS IN THE THREE MARSH UNITS

ALL MARSH UNITS   Land cover change between 2006 and 2019

Land cover change in the marshes between 2006 - 2019



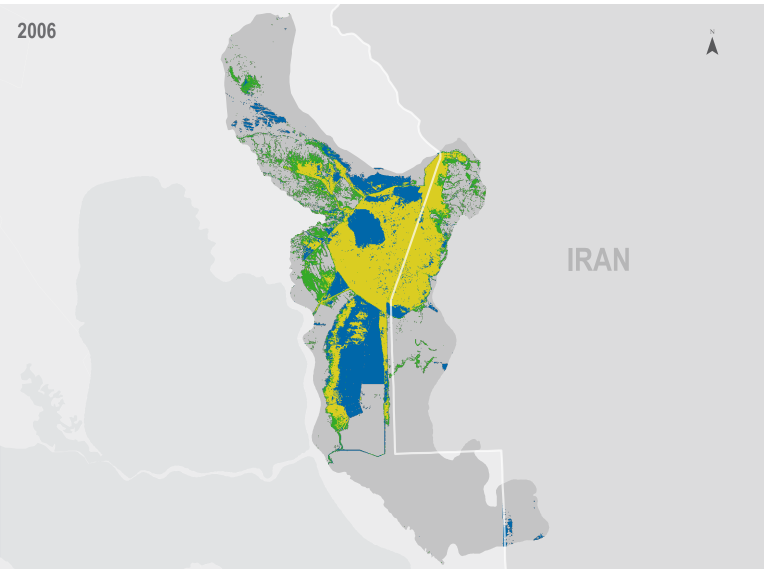
2019 marshland rehydration status in relation to desiccation in 2002

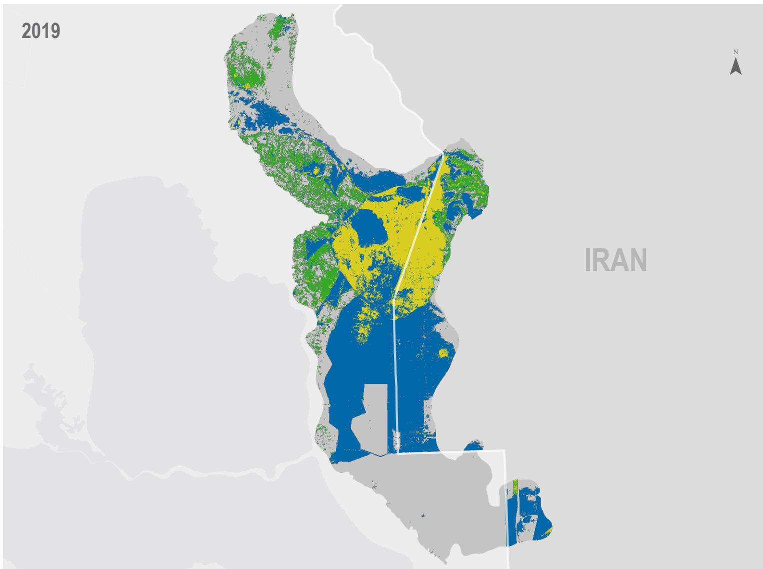


Time trend

REACH found that the nearly linear increase of the marshland extent reported by UNEP[6] in the period 2003 - 2005 continued until 2007, when the marsh vegetation growth experienced its peak in the time of rehydration. The following years of relatively low precipitation (2007-2008)[7] may have contributed to a decrease in marshland coverage. In 2013, the marsh vegetation again reached nearly the 2007 expansion, but seemed to plateau by 2017.

AL-HAWIZEH MARSH   Land cover distribution in 2006 and 2019

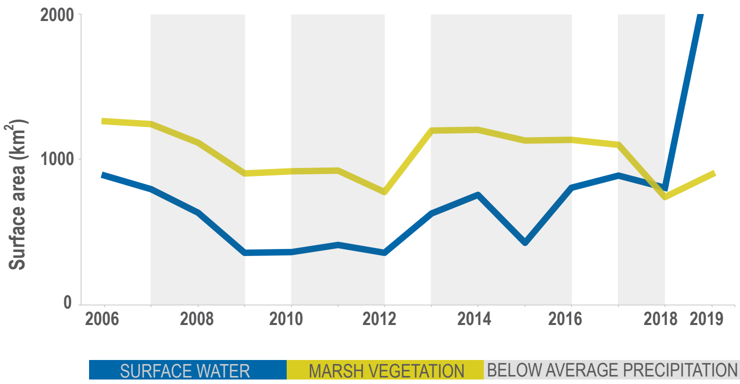




Kms 0 15 30

SURFACE WATER | MARSH VEGETATION | BARREN | TERRESTRIAL VEGETATION***

Land cover change between 2006 - 2019



Changes

Al-Hawizeh marsh is the only natural marsh unit that has survived the drainage works.[8] Throughout the rehydration process, the Al-Hawizeh marsh covers the largest area with a core area continuously covered by marsh vegetation. Impacts of dry years does not have a major effect in comparison to other marsh units. Consecutive dry years did not appear to have a major effect on marsh vegetation when compared to other marsh units, which could be a result of the additional freshwater supply coming from the Karkeh and Karun rivers (Iran).[8]

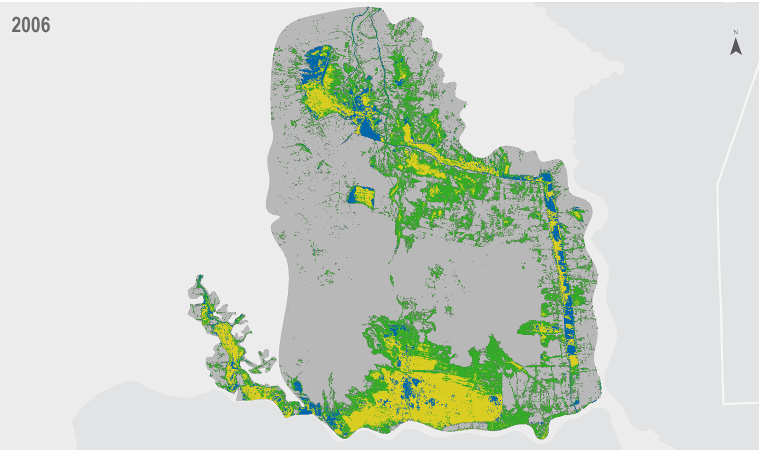
Distribution

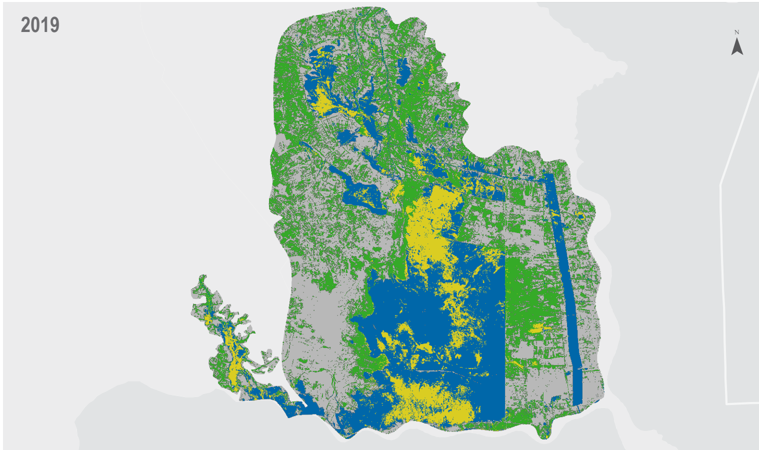
The analysis shows that, by 2006, marsh vegetation had spread almost to all corners of the marsh. By 2019, however, vegetation seems to have only accumulated in the upper central areas. Until the drought in 2018[7] marsh vegetation always prevailed the proportion of surface water.

6 UNEP (2005). Iraqi Marshlands Observation System UNEP Technical Report
7 REACH (February 2020). Long-term Precipitation Pattern in the Euphrates-Tigris Basin
8 Richardson et al. (2006). Restoring the Garden of Eden: An Ecological Assessment of the Marshes of Iraq

* The definition of marsh vegetation is based on the simplified assumption that it essentially consists of either green or dry hydrophytes.
** Rehydration was measured based on extent of surface water and marsh vegetation compared to the baseline extent from 1973. Conclusions regarding the ecological recovery, status of water quality, or soil conditions cannot be drawn.
*** Terrestrial vegetation represents a combination of agricultural vegetation and natural vegetation growing in dry locations.

CENTRAL MARSH Land cover distribution in 2006 and 2019





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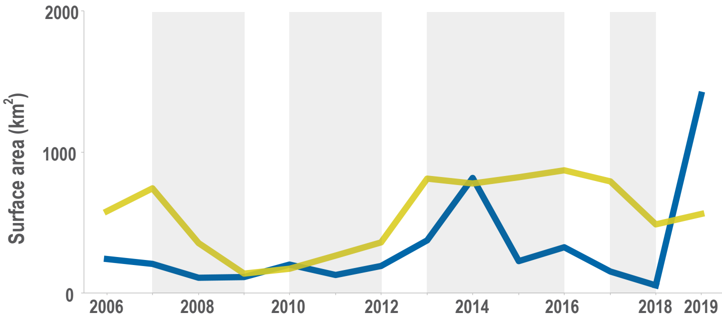
SURFACE WATER | MARSH VEGETATION | BARREN | TERRESTRIAL VEGETATION

Land cover change between 2006 - 2019



SURFACE WATER | MARSH VEGETATION | BELOW AVERAGE PRECIPITATION

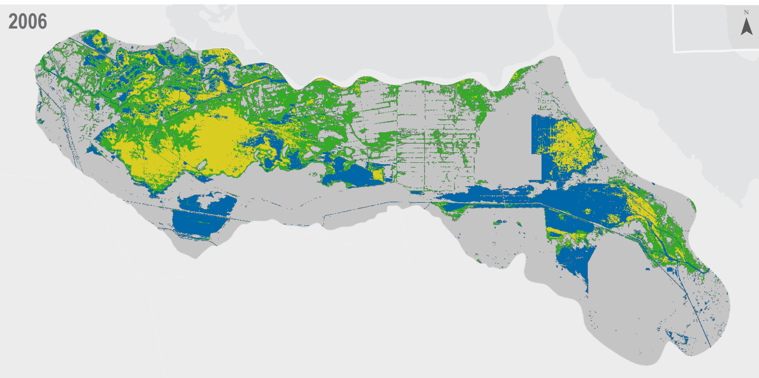
Changes

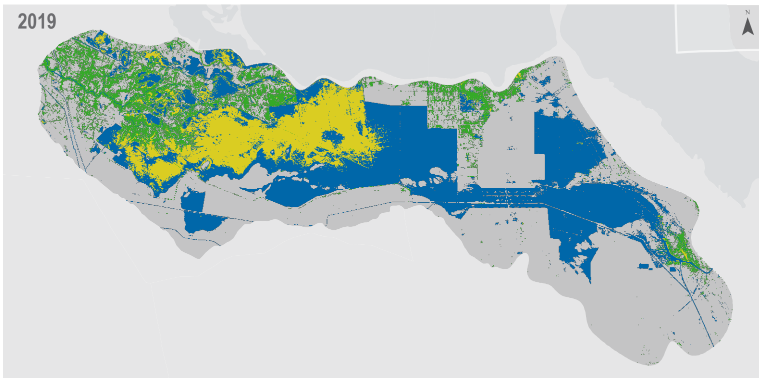
In line with the UNDP[9] findings, the analysis shows the central marsh to have the slowest rehydration progress compared to other assessed marsh units during the period 2006-2019. From 2013 onwards, vegetation growth stabilised somewhat close to the peak level in 2007 through to the drought year of 2018.[10]

Distribution

As shown in the maps above, by 2006, areas with dense marsh vegetation could be found mostly in the southern parts of the marsh unit. In 2019, surface water was found to be most prominent particularly in the central parts.

AL-HAMMAR MARSH Land cover distribution in 2006 and 2019





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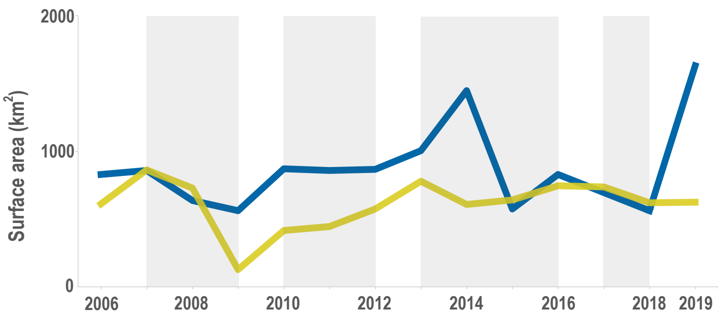
SURFACE WATER | MARSH VEGETATION | BARREN | TERRESTRIAL VEGETATION

Land cover change between 2006 - 2019



SURFACE WATER | MARSH VEGETATION | BELOW AVERAGE PRECIPITATION

Changes

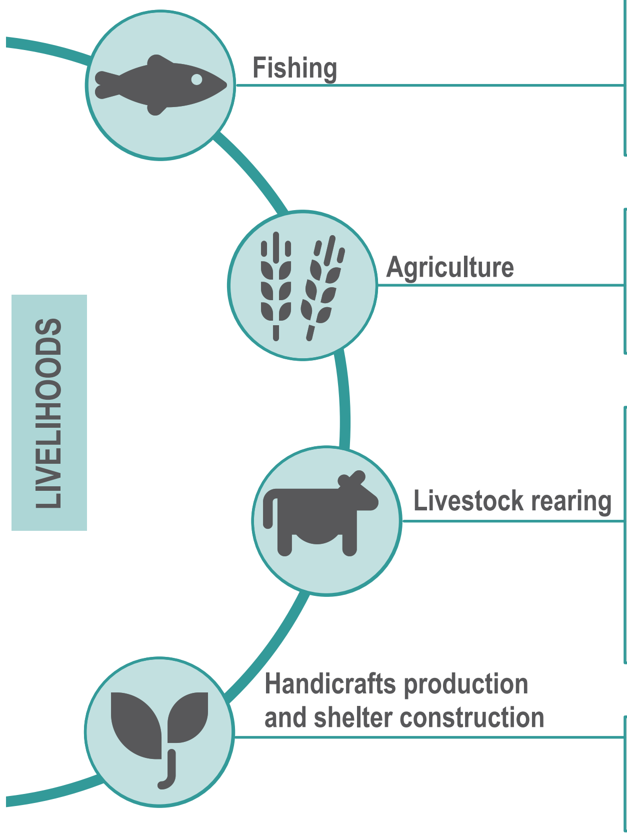
Following the beginning of the rehydration process in 2003, marsh vegetation growth reached its peak in 2007. Below average precipitation[10] in 2007 and 2008 may have caused almost the complete marsh vegetation in the Al-Hammar marsh to disappear. This testifies to a special sensitivity to the freshwater supply of this marsh unit.

Distribution

During most of the assessed years, the surface water seems to have held the greater share of the area compared to marsh vegetation. This is unique to this marsh unit and may be related to the high salt concentration[11] of the marsh water. Marsh vegetation seemingly accumulated in the western part of the region, near the freshwater inlet, while it decreased towards the east.

9 UNEP (2005). Iraqi Marshlands Observation System UNEP Technical Report
10 REACH (February 2020). Long-term Precipitation Pattern in the Euphrates-Tigris Basin
11 Richardson et al. (2006). Restoring the Garden of Eden: An Ecological Assessment of the Marshes of Iraq

TRADITIONAL LIVELIHOODS OF THE MARSH ARABS



Fishing has been one of the livelihoods activities most heavily impacted by the degradation of marshlands.[12] Fish populations have majorly decreased, especially economic valuable fish species have been reduced in size and numbers, because of the intrusion of salt water, overfishing and invasive species.[13, 14] Fishing still occurs on a small scale where Marsh Arabs will use electronic rods to fish to eat (subsistence fishing), the quality and quantity of haulage varies and now cannot be relied upon as a livelihood.[13]

Before the drainage of the marshes, the Marsh Arabs traditionally used the marsh soils, enriched with nutrients during annual spring floods, for crop cultivation.[14] Nowadays, dams, dykes, and canals reduce the historical inundation pattern of the marshes.[14] This in interaction with decreased water levels in the Euphrates and Tigris rivers and a progressing soil salinization is causing soil degradation, and impedes agricultural activities.[12]

Many families living in the marshlands still own and keep animal livestock to this day.[12] However, partly due salinization, livestock rearing as a livelihood has become unsustainable and expensive.[12] Again linked back to increasing salinity, buffalo are susceptible to sickness from salt in vegetation and water, and without medical attention can become sick and die.[12] Healthy reeds that buffalo rely on are relatively expensive and commonly unavailable since not all reed species returned with the rehydration.[14] Buffalo, in turn, are becoming increasingly scarce and many are underweight, limiting milk production.[12] The United Nations Assistance Mission to Iraq (UNAMI) estimated there to be 80,000 water buffalo in the marshlands prior to the 1990s. However, by 2011, only an approximate 5000 remained.[13]

Traditionally, reed has been used by local populations for building boats, rafts, and shelter, as well as weaving mats and baskets for trade.[12] The decreasing availability of reeds as a result of the marsh desiccation and salinization, compared to prior the drainage, has therefore considerably impacted local handicraft production and shelter construction.[12]

Conclusion & Next Steps

The analysis revealed that the initially reported upward trend of marsh rehydration by UNEP[17] could not be sustained long-term, this has lead to a plateauing of the marsh vegetation growth over time. After promising developments in the period 2003-2007, the rehydration progress experienced a considerable setback likely due to consecutive years with below average precipitation, and the effects of upstream water management projects. This underlines the fragility of the marsh ecosystem. Furthermore, a common misconception is that rehydration equals wetland restoration. The analysis has indicated that rehydration efforts do not necessarily equal wetland restoration, and instead suggests that the sustainability and ecological recovery of rehydrated areas is a more important driver of restoration than the sheer size of the rehydrated areas. Ecological well being of the marsh areas is closely linked to the economic situation of the Marsh Arabs residing in the marshes as their livelihoods are traditionally based on the marshlands flora and fauna (e.g. reed products, fishing, agriculture, and livestock).

Analysis revealed the following data gaps which need to be filled for a holistic situation overview:

- Additional research is needed on the current livelihoods and food security conditions of the Marsh Arabs to assess the long-term impacts of the marsh rehydration process.
- Alternative livelihood sources for the Marsh Arabs with anticipation of the effects of climate change and a continued degradation of upstream water management should be investigated.
- Needs assessment should be conducted to identify overall availability of basic services (e.g. healthcare and education). Those services may be

Methodology

Land cover classification was done in Google Earth Engine (GEE) for the years 2006 - 2019. For the classification four land cover classes were defined: (I) surface water; representing water open to the sky, (II) ,marsh vegetation; representing mostly hydrophytes such as Phragmites and Typha growing in wet locations, (III) barren areas; representing areas with limited vegetation (for simplification urban and built-up areas were included in this class), and (IV) terrestrial vegetation; representing a combination of agricultural vegetation and natural vegetation. Surface reflectance products of the U.S. Geological Service Landsat 5 and Landsat 8 were used to create median composite images for each year. Images were subjected to corrections to take into account for distortions caused by sensor, solar, atmospheric, and topographic effects as well as the bidirectional reflectance distribution function. For the classification Random Forest (RF) was used as supervised classification algorithm. The bands in the composites were exploited to calculate a series of covariates which were fed into the RF model.[14] Those covariates comprised, among others, well known normalized indices such as the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Water Index (NDWI). But also more complex indices such as the Soil Adjusted Vegetation Index (SAVI) and the Enhanced Builtup and Bareness Index (EBBI) were computed. Furthermore, the Global Surface Water Mapping dataset[18] from the Joint Research Center (JRC) was used as covariate layer. As reference data 600 reference data points were collected for each class and for each year using the generated Landsat median composites. The reference data was then randomly split into training data (90%) and validation data (10%). Subsequently, the RF model was trained using the training data. With the validation data the classification accuracy was evaluated in Rstudio using the package 'e1071' by computing the overall accuracy and the Kappa coefficient. All classifications achieved values of > 0.9 in both accuracy measures. Limitations of the assessment: (I) lack of ground data for a comprehensive accuracy assessment, (II) after May 2003, the satellite Landsat 7 was subjected to an anomaly which caused the Scan Line Corrector to stop functioning.[17] Hence, classifications between 2006-20012 may show partly inhomogeneous areas.

12 Fawzi et al. (2016). Effects of Mesopotamian marsh (Iraq) desiccation on the cultural knowledge and livelihood of Marsh Arab women, ecosystem health and sustainability
13 UNAMI (United Nations Integrated Water Task Force for Iraq) (2011). Iraqi Marshlands. Managing change in the Marshlands, Iraqi's critical challenge
14 Richardson et al. (2006). Restoring the Garden of Eden: An Ecological Assessment of the Marshes of Iraq
15 Hamdan et al. (2010). Vegetation Response to Re-flooding in the Mesopotamian Wetlands, Southern Iraq
16 Pournelle et al. (2010). Travels in Edin: deltaic resilience and early Urbanism in Greater Mesopotamia
17 UNEP (2005). Iraqi Marshlands Observation System UNEP Technical Report
18 Pekel et al. (2016). High-resolution mapping of global surface water and its long-term changes