Monitoring the Changes in the Mesopotamian Marshlands During Drought Periods

O. Özcan [1*], M. Türkeş[2] and N. Musaoğlu[3]

[1*] Eurasia Institute of Earth Sciences, Istanbul Technical University, TURKEY.

(E-mail: ozcanork@itu.edu.tr)

[2]Bogazici University, Center for Climate Change and Policy Studies, 34342 Bebek, Istanbul/Turkey

[3]Istanbul Technical University, Civil Engineering Faculty, Geomatics Engineering Department, 34469

Maslak, Istanbul/Turkey

5th International Workshop on Sand and Dust Storms

(Dust Sources and their Impacts in Middle East)

October 23 to 25, 2017Istanbul TURKEY

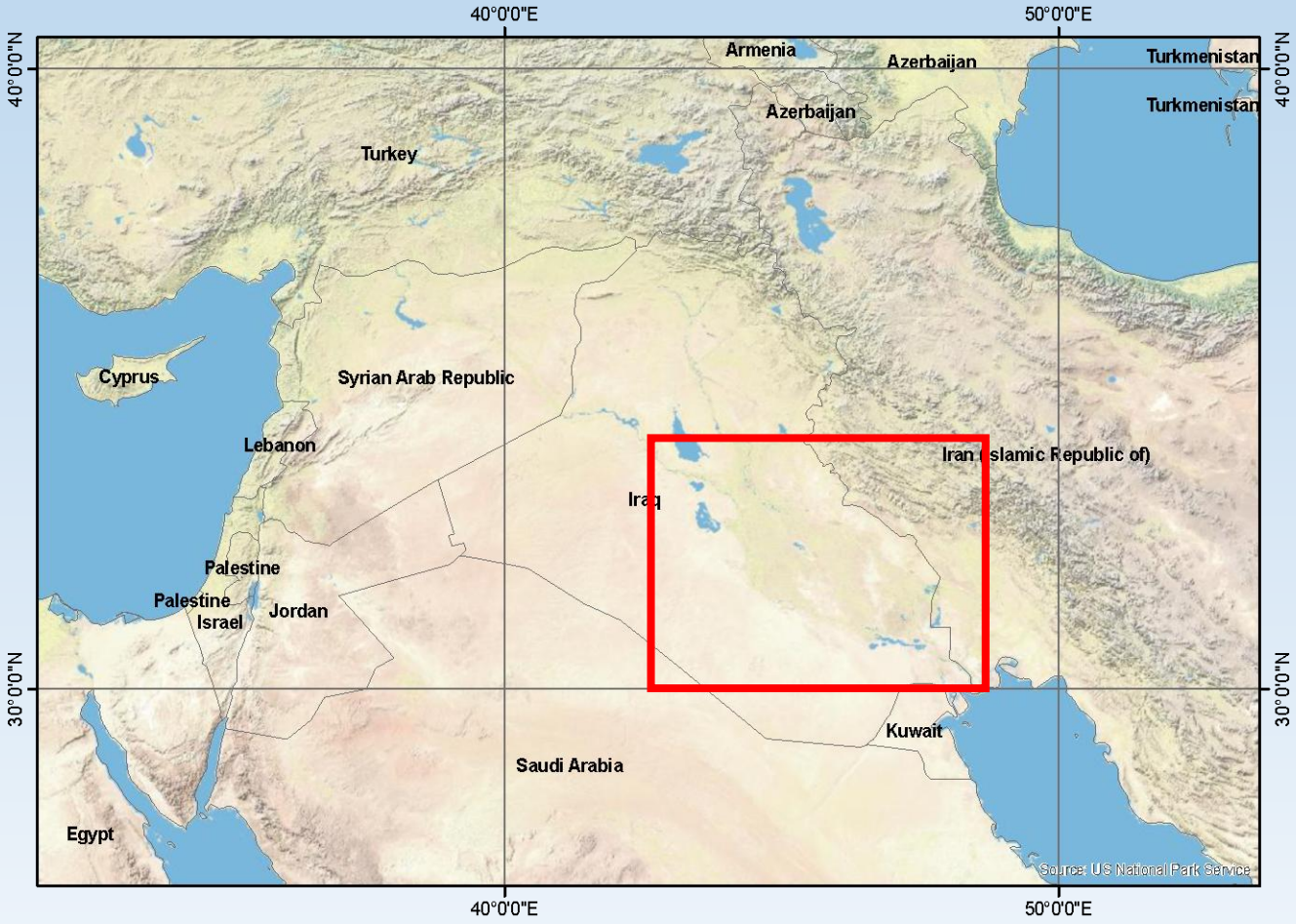
AIM

- To characterize the change in the distribution of marshland and near surroundings that took place due to drying operations and the consequences on the environment.

- To assess aspects of the response of the marshes during the period of 1988–2017.
  - the intensive localized human intervention occurred during the 1990s through 2002, and continues to be subject to ongoing human activities at a greater distance
    - (dam construction and increased water retention in the upper portions of the Tigris-Euphrates basin).
  - This period also shows responses to changes in water available due to changes in weather and climate.

STUDY AREA

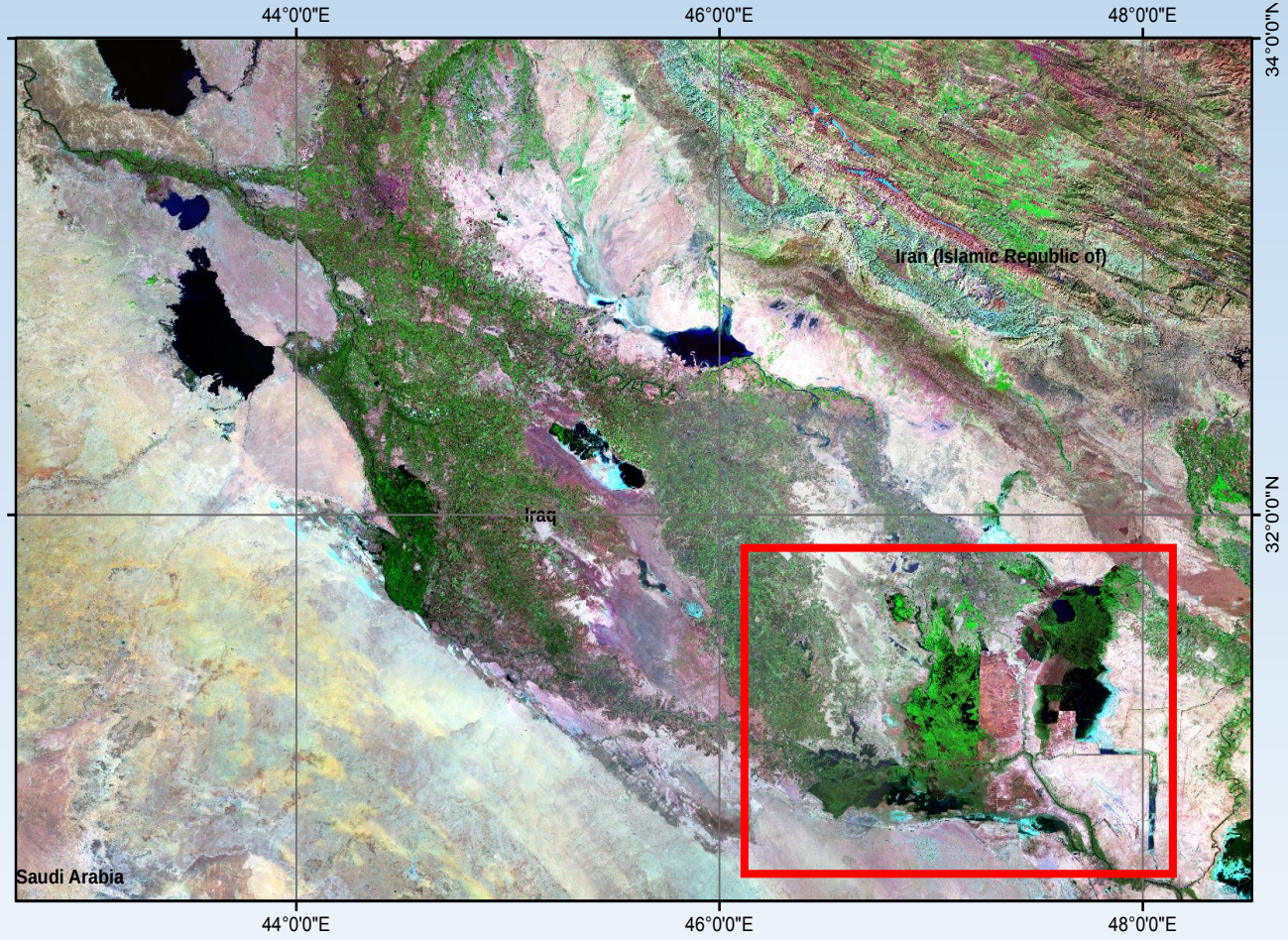
The Mesopotamian marshes



- The largest wetland ecosystem in the Middle East and Western Eurasia.
- The scale and speed of land cover change have been extraordinary during the late 1980s.
- The loss of the Mesopotamian marshlands may have serious impacts on climate characteristics.
  - water scarcity,
  - extreme temperature variations
  - potential dust storms

STUDY AREA

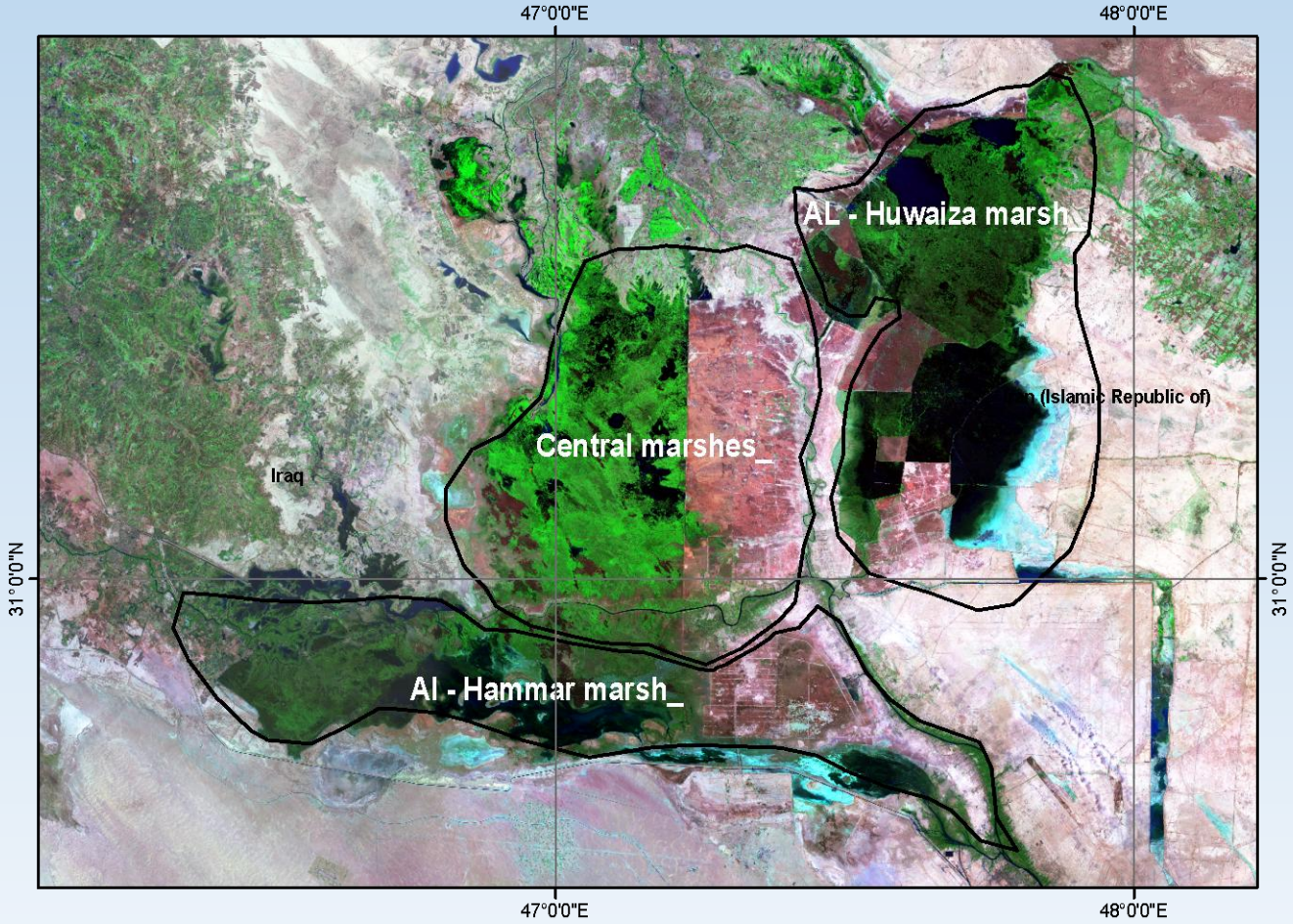
The Mesopotamian marshes



- Rapid damage that caused severe ecological impacts.
- A complex of freshwater and brackish water lakes
- Impoundments constituting several sedimentary sub-environments.

STUDY AREA

The Mesopotamian marshes



- The Al-Hammar marsh's major water source is the Euphrates
- The Central marshes receive water mainly from the Tigris
- The Al-Huwaiza marsh lies on the border between Iraq and Iran and receives water from the Tigris

DATA DESCRIPTION
MODIS & Landsat

- To map the evolution of the marshlands,
  - a multistage approach using low- and medium-scale resolution satellite imagery was followed to obtain a comprehensive coverage and analysis.
  - MODIS and Landsat data were used to map the extent of changes in the Mesopotamian marshes from 1988 to 2017.
  - Normalized difference vegetation index (NDVI) and modified normalized difference water index (MNDWI) images were calculated for the region to determine the marshlands and the extent of open water.
  - the changes in Mesopotamian marshlands were investigated within the periods in which the marshes were exposed to significant droughts during the last 30 years.

METHODOLOGY
NDVI & MNDWI

- **NDVI – (The Normalized Difference Vegetation Index)**

$$(\mathrm{IR} - \mathrm{R})/(\mathrm{IR} + \mathrm{R})$$

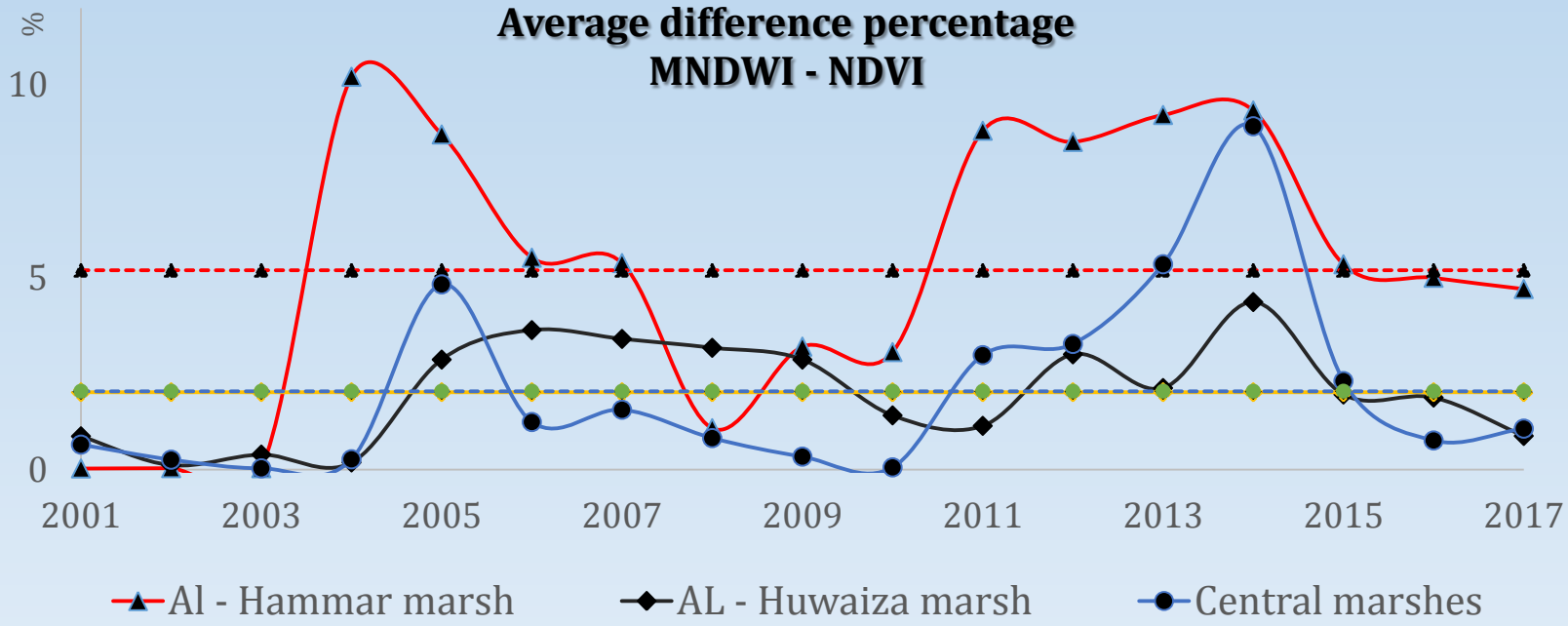
- **MNDWI - (The Modified Normalized Difference Water Index)**
  - an index used to determine extent of open water
  - it is possible to achieve reliable quick discrimination of open water features

$$(\mathrm{GR} - \mathrm{MIR})/(\mathrm{MIR} + \mathrm{GR})$$

MODIS and Landsat scenes for each year (second week in March) were used to get the maximum surface water extent .

METHODOLOGY

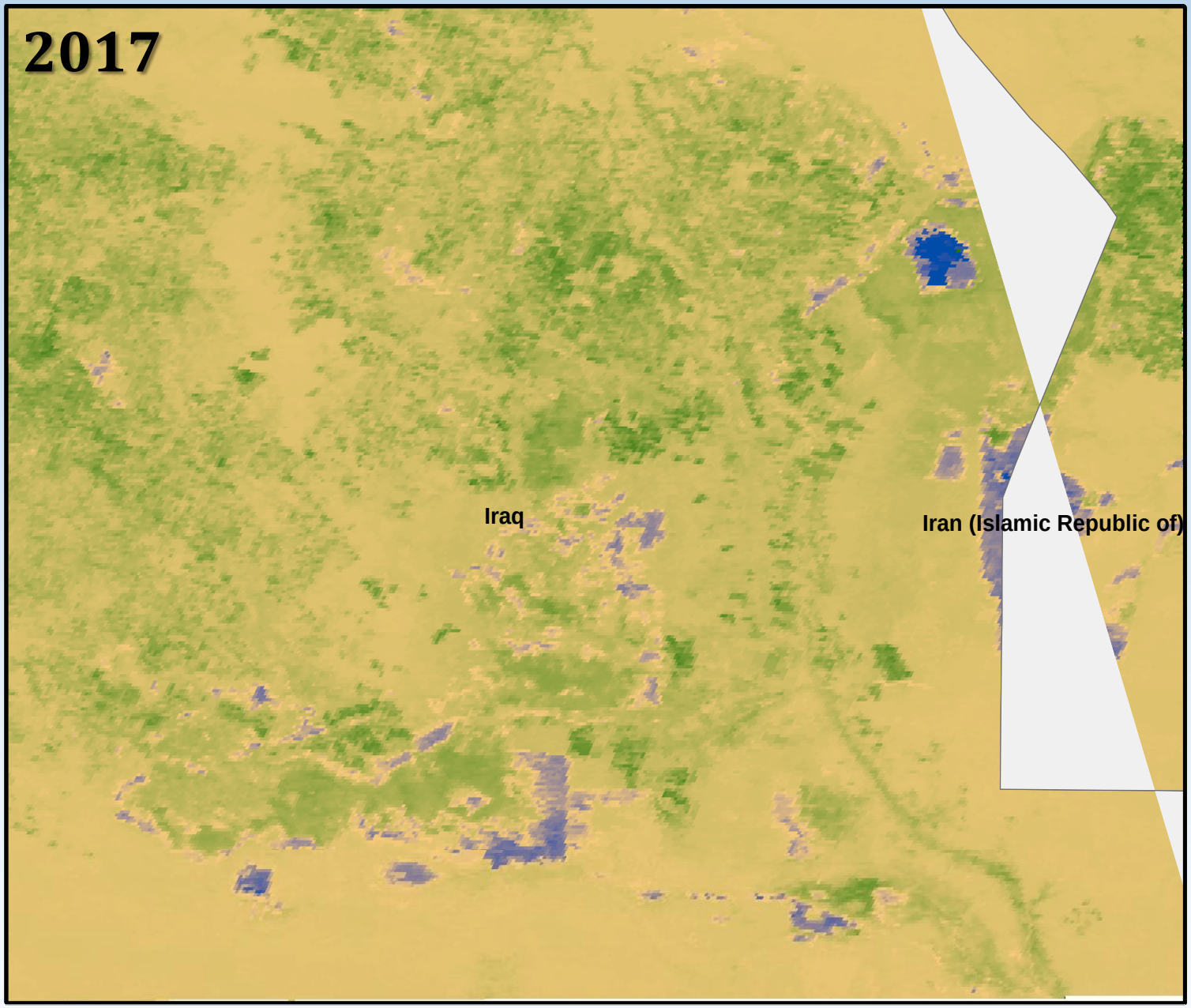
NDVI & MNDWI



- A uniform threshold was applied to MNDWI and NDVI images to identify the areal coverage of the wetlands.
- MNDVI works well due to the extremely high absorption of water throughout the infrared region, particularly relative to the visible region (represented by the green band).
- MNDWI provides an estimate of open water extent accurate to 3 %.

RESULTS AND DISCUSSION

NDVI Maps for MODIS & Landsat

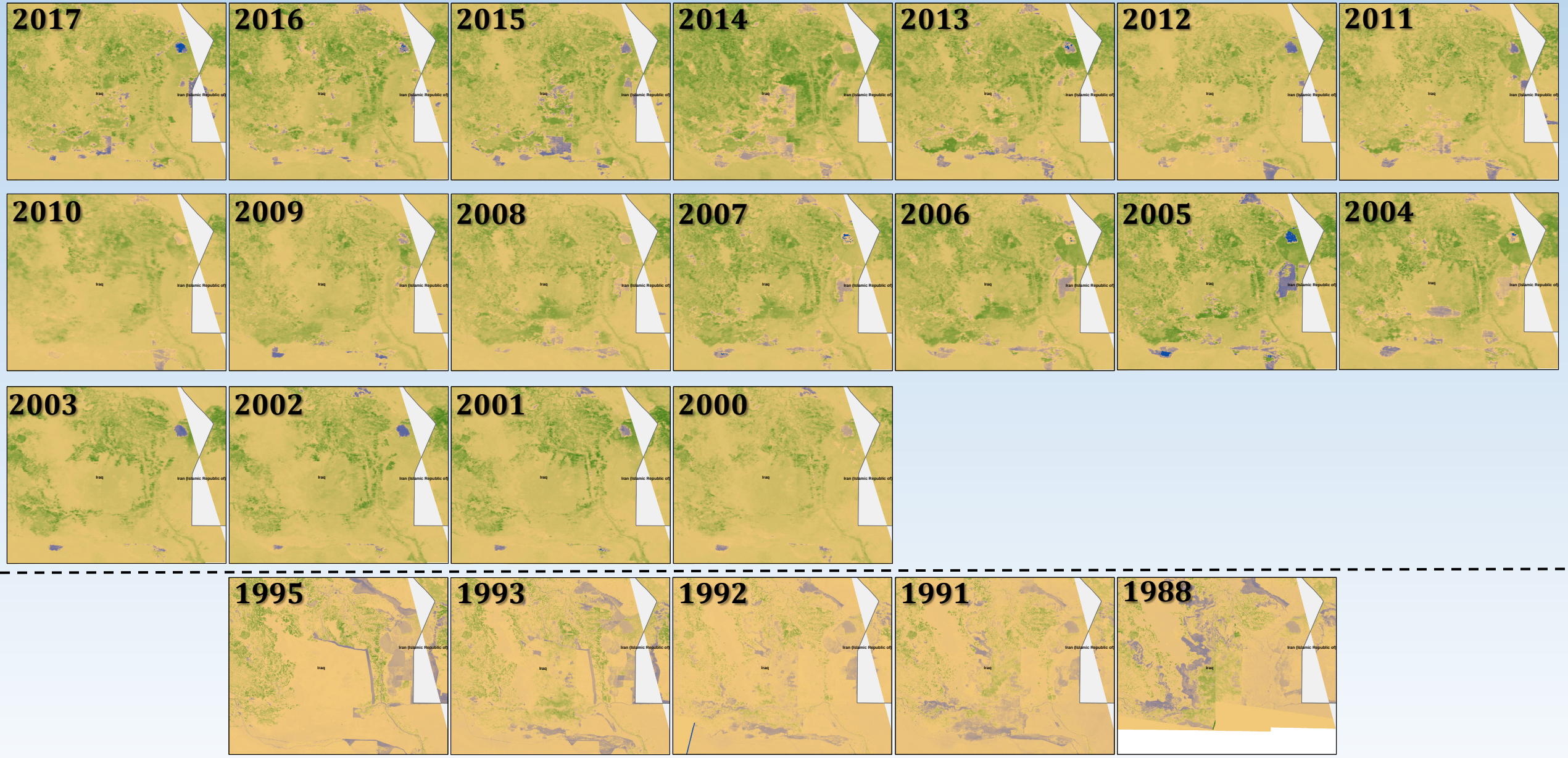


RESULTS AND DISCUSSION

NDVI Maps for MODIS & Landsat

5th International Workshop on Sand and Dust Storms
(Dust Sources and their Impacts in Middle East)
October 23 to 25, 2017Istanbul TURKEY

- Monitoring the Changes in the Mesopotamian Marshlands During Drought Periods -

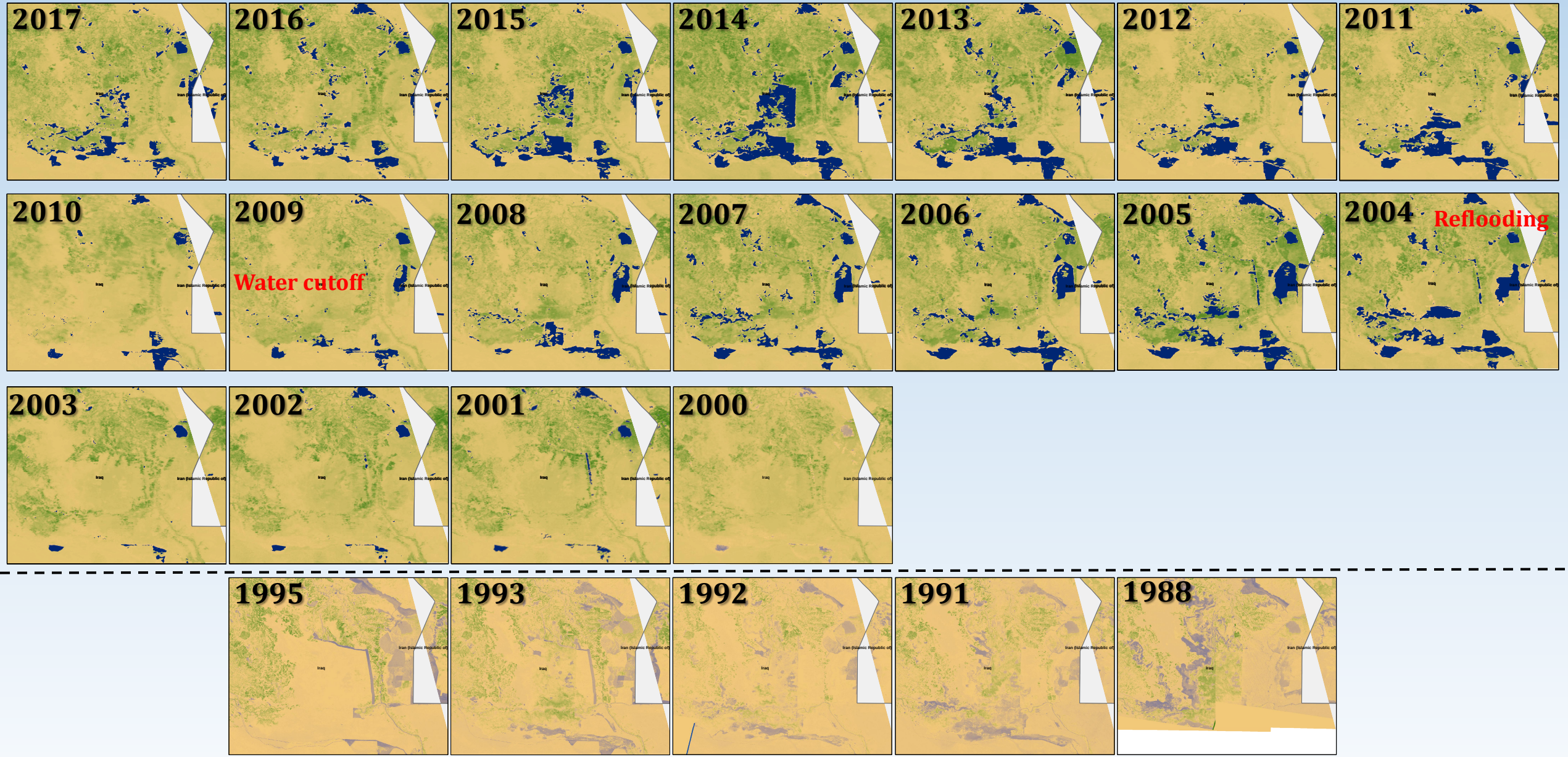


RESULTS AND DISCUSSION

5th International Workshop on Sand and Dust Storms
(Dust Sources and their Impacts in Middle East)
October 23 to 25, 2017Istanbul TURKEY

Combined MODIS NDVI-MNDWI Images

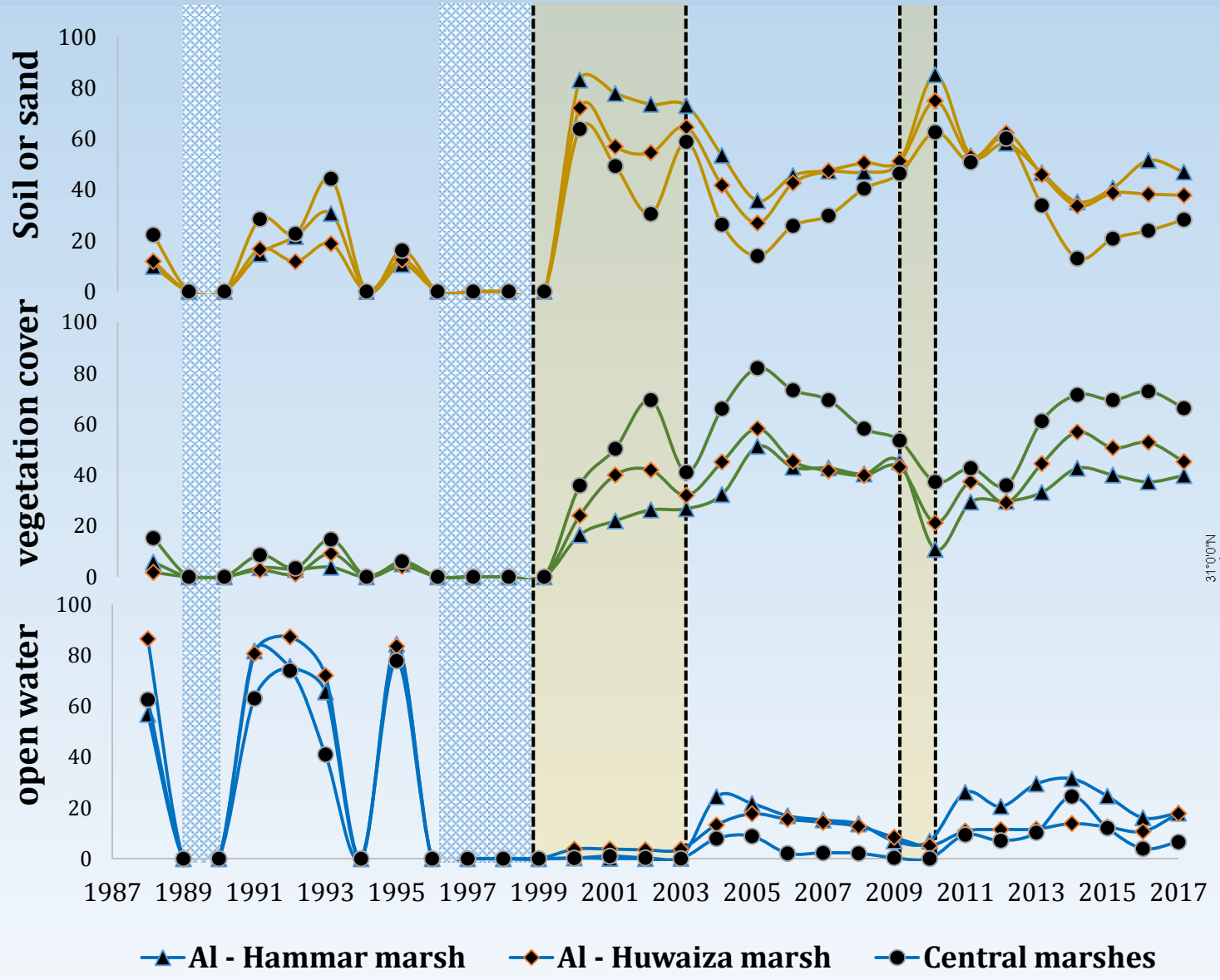
- Monitoring the Changes in the Mesopotamian Marshlands During Drought Periods -

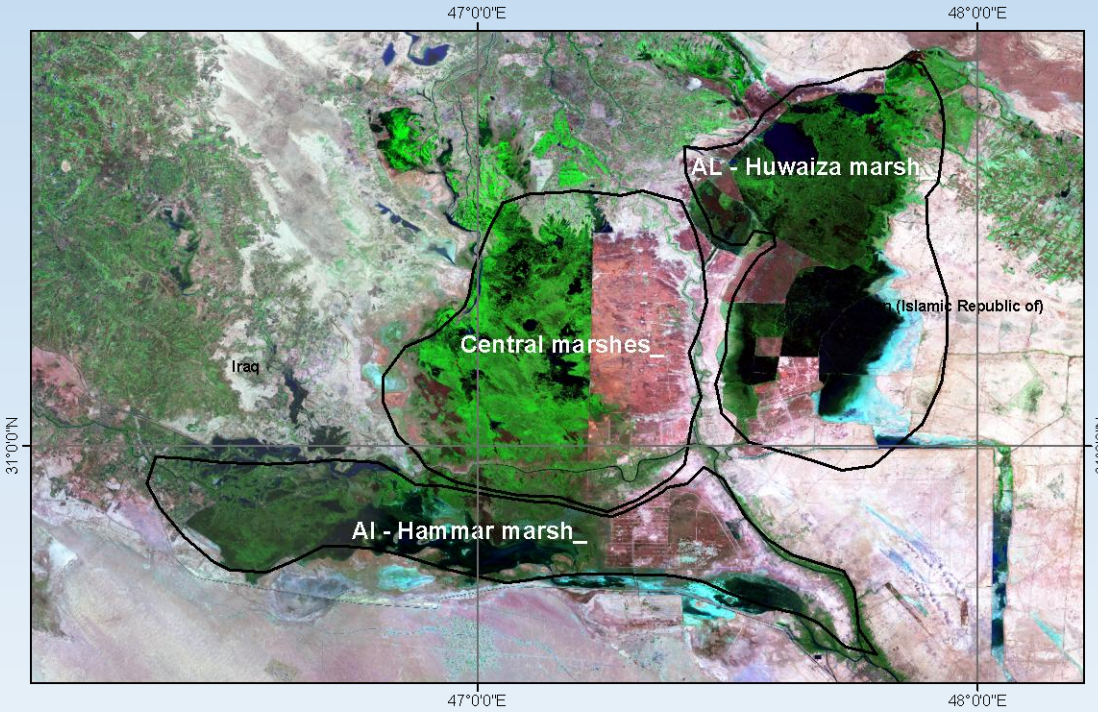


RESULTS AND DISCUSSION

- Monitoring the Changes in the Mesopotamian Marshlands During Drought Periods -

Time Series - Marshlands



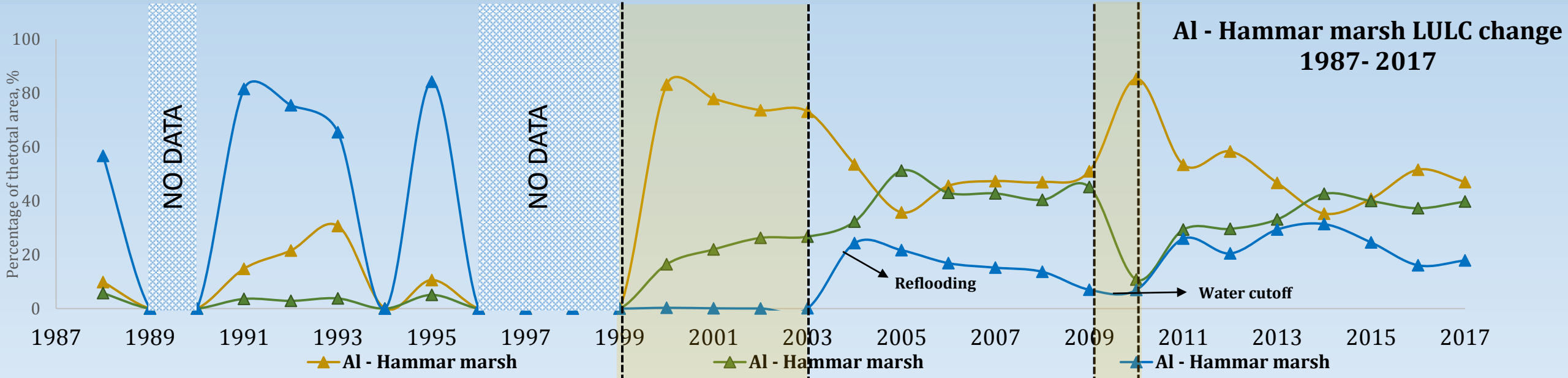


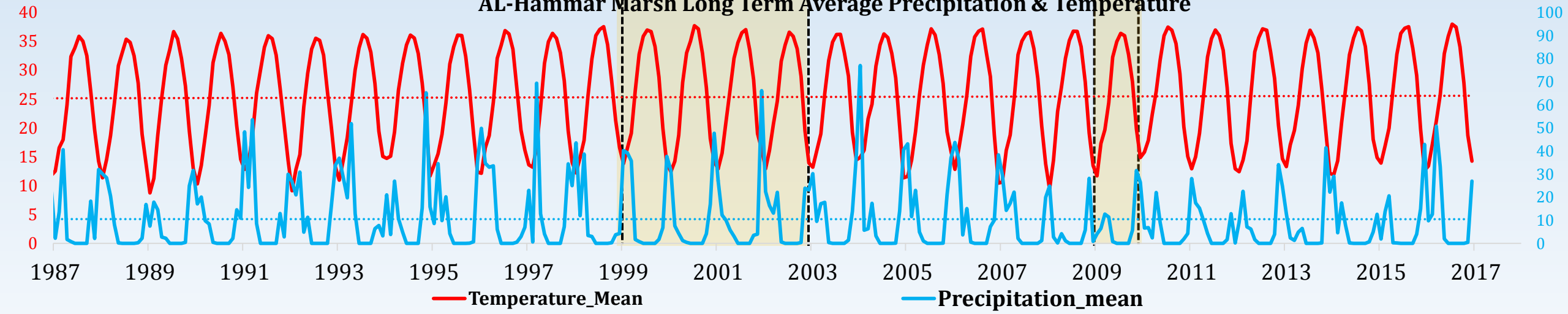
RESULTS AND DISCUSSION

5th International Workshop on Sand and Dust Storms
(Dust Sources and their Impacts in Middle East)
October 23 to 25, 2017Istanbul TURKEY

Time Series – Al-Hammar Marsh

- Monitoring the Changes in the Mesopotamian Marshlands During Drought Periods -





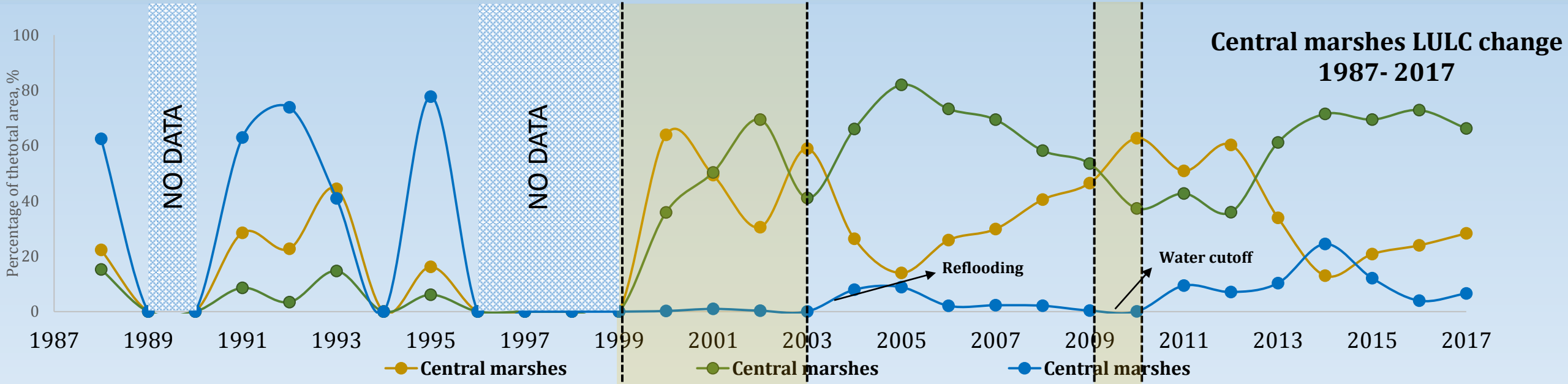
Source: Climatic Research unit

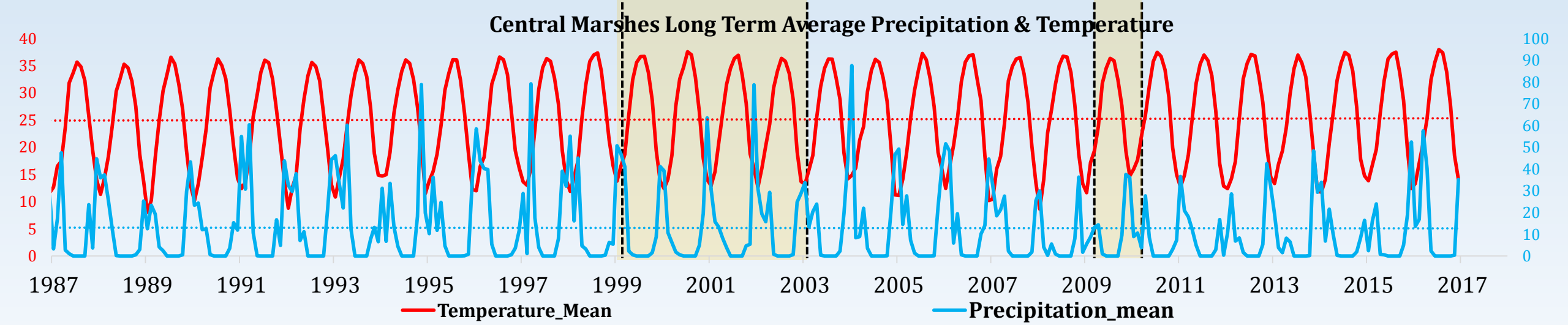
RESULTS AND DISCUSSION

5th International Workshop on Sand and Dust Storms
(Dust Sources and their Impacts in Middle East)
October 23 to 25, 2017Istanbul TURKEY

Time Series – Central Marshes

- Monitoring the Changes in the Mesopotamian Marshlands During Drought Periods -





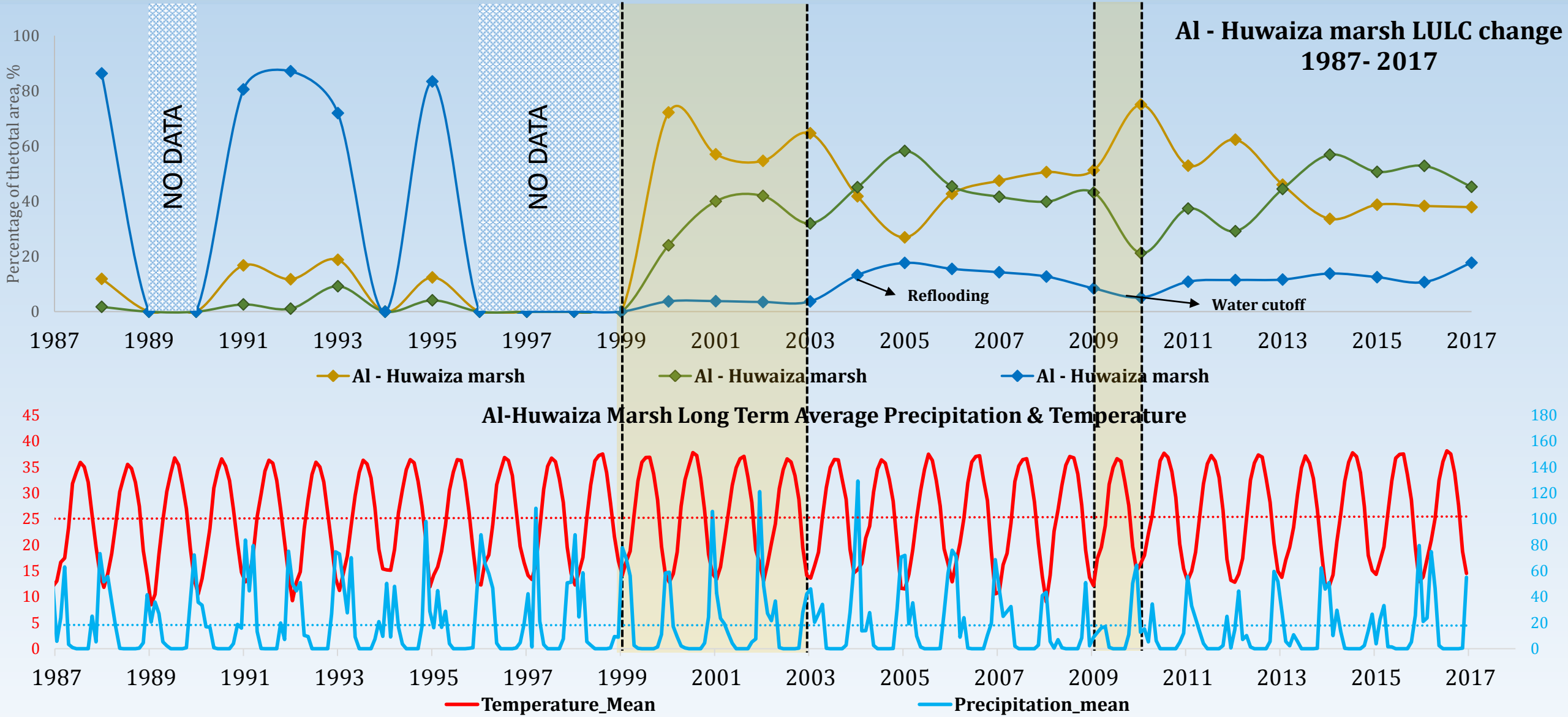
Source: Climatic Research unit

5th International Workshop on Sand and Dust Storms
(Dust Sources and their Impacts in Middle East)
October 23 to 25, 2017Istanbul TURKEY

RESULTS AND DISCUSSION

Time Series – Al-Huwaiza Marsh

- Monitoring the Changes in the Mesopotamian Marshlands During Drought Periods -



Source: Climatic Research unit

RESULTS AND DISCUSSION

- MODIS and Landsat data were used to map the extent of changes in the marshlands from 1988 to 2017
  - 2003: the marshes extent degraded by active drainage and water diversion prior to the Second Gulf War.
  - 2003 – 2005: A great increase both in areal extent and in marsh mass, due to increased water storage.
  - 2004 – 2006: increase in open water along with vegetated areas.
  - 2006 – 2009: A sharp decline in water amount.
  - 2008 – 2009: falls reached low in open water in 2009, and vegetation in 2010.
  - 2009 – 2012:both wetting and drying periods, with precipitation above average.
  - 2000 – 2012:human activities correspond well with the observed changes, dramatic changes in vegetation coverage between 2003 and 2004 and 2009–2010.
  - 2011 – 2013: open water expanded together with vegetation.
  - 2010 – 2017: marshes recover to a sustainable size.

- A continuous monitoring program is required to evaluate the long-term and short-term changes in the marshes in response to changes in policies and management efforts regarding dust monitoring and impacts.

RESULTS AND DISCUSSION

Thank you.