Hydrological and Enviromental Aspects of wetlands

Analytical Tools for Wetlands Managment

Wetlands Monitoring in the Nile Basin

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(GIS & Modelling Research Cluster, Wetlands Research Group, 2011)

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Why Wetlands?

- **Wetlands are dynamic, living complicated ecosystems**
- **Need for better understanding of wetlands processes**
- **Important functions**
- **Values and benefits**
- **Different stakeholders**
- **Losses and degradation**
- **Restoration and best management practices**

Wetlands in the Nile basin

- **Wetlands in the Nile Basin are facing several threats including;**
  - **Reduction of wetland water supply, wetland water quality and quantity which reduces the productivity of fisheries – usually through wetland alteration for other purposes,**
  - **Complete conversion of wetlands and damaging changes in their catchments – sometimes due to agricultural and forestry practices – also as a result of climate change,**
  - **Limiting access to wetland natural fisheries through increasing number of fishers and general fishing pressures and conflicts,**

Therefore there is a need to better understand, conserve and manage wetlands to retain their importance and their economic values.

Research Project Overview

- **This is research project no. 24 Supported by ESA - TIGER CB II.**
- **The project is supervised by ITC, the Nehterlands (Dr. Zoltan Vekerdy)**
- **The project has a regional dimension as it focuses on wetlands in the Nile Basin.**
- **The project team involves research members from the GIS & Modelling Research Cluster of the Nile Basin Capacity Building Network (NBCBN) fom Egypt, Tanzania, Rwanda, D.R. Congo and Uganda.**

Main Research Objectives

- To better understand the different wetlands systems in the Nile basin
- To develop tools and means for management and conservation of wetlands, applying available EO data, analysis and modelling techniques.
- To demonstrate the value of the exisiting tools for wetlands monitoring and mapping using EO data and remote sensing techniques;
- To emphasize the importance of using online GIS mapping facilities to dessiminate the project outputs and exchange information and data on wetlands in the Nile basin.
- To build a new regional professional community of practice focusing on Wetlands management and restoration.

Main Research Activities & Milestones

- Developing a geo-database of wetlands in the Nile basin on regional, national and pilot wetlands level
- Mapping different types of wetlands in the Nile basin, (delineation of water bodies, vegetation mapping, fisheries) (applications on selected case studies)
- Identification of major changes affecting the selected pilot wetlands (degradation)
- Applying remote sensing techniques for developing evapotranspiration time series (applicatioon on Edko case study)
- Developing an applicable monitoring system for wetlands based on the use of EO data, ground truth and remote sensing analysis techniques including time series analysis.
- Publishing research results via an online mapping system to be accecible by a braoder community of professionals.

Pilot Areas and Case Studies

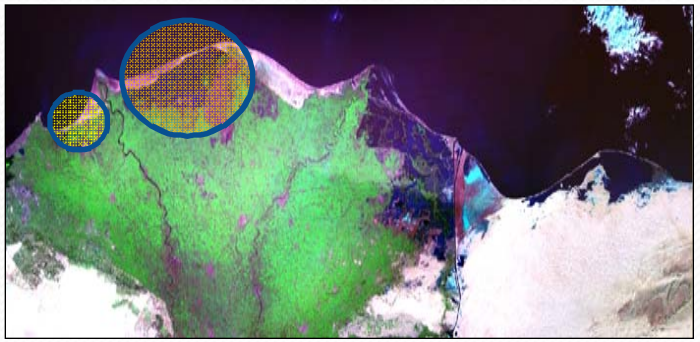
Egypt: Nile Delta Northern Coastal Wetlands (**Burullus and Edko Wetlands**)

Tanzania: **Mara wetlands,** Mara River Basin, Lake Victoria

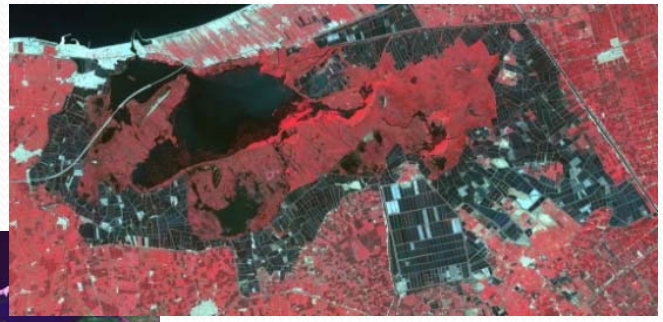
Pilot Areas and Case Studies

Egypt: Nile Delta Northern Coastal Wetlands (Burullus and Edko Wetlands)

Burullus and Edko are two of the coastal Nile Delta wetlands of Egypt, both are shallow brackish lagoons with a thick vegetation belt and numerous small islands. the lakes are open to the sea through narrow canals. Depths of water body vary from 0.7-2.4 m, Burullus is a RAMSAR site.



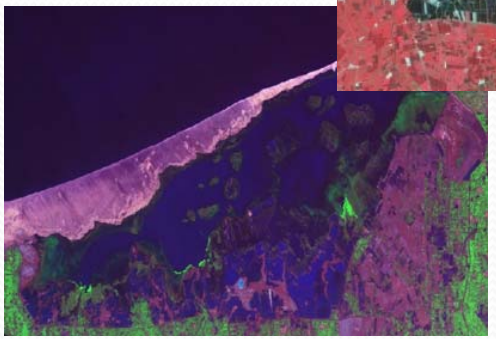
Nile Delta



Edko

Main Issues:

- **Wetlands degradation**
- **Diverse and conflicting human activities in the catchment, and lakes region**
- **Land use change**
- **Severe water quality pollution from the upstream catchements**
- **Stressed and endagered ecosystem**

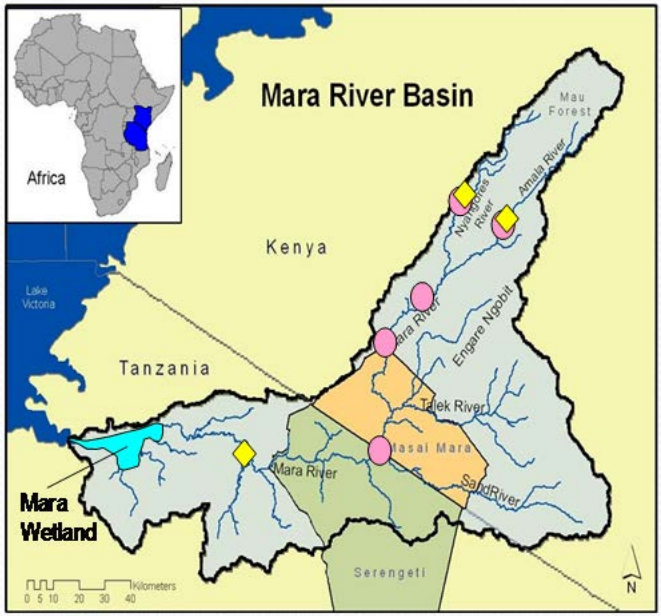


Burullus

Pilot Areas and Case Studies

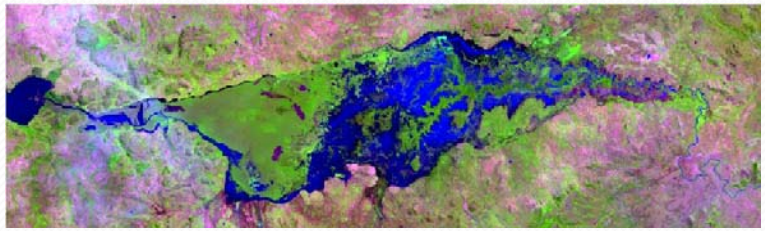
Tanzania: Mara Wetland

The Mara wetland is a riverine floodplain wetland located near Lake Victoria where the Mara River discharges it waters into Lake Victoria.



Main Issues

- In the upstream river catchment, there are a lot of economic activities
- Significant land use changes
- Changes of Mara River hydrology regime and water quality.
- Ecological status of Lake Victoria and the Mara wetlands will also change.



Current Status

- **Research Activities**

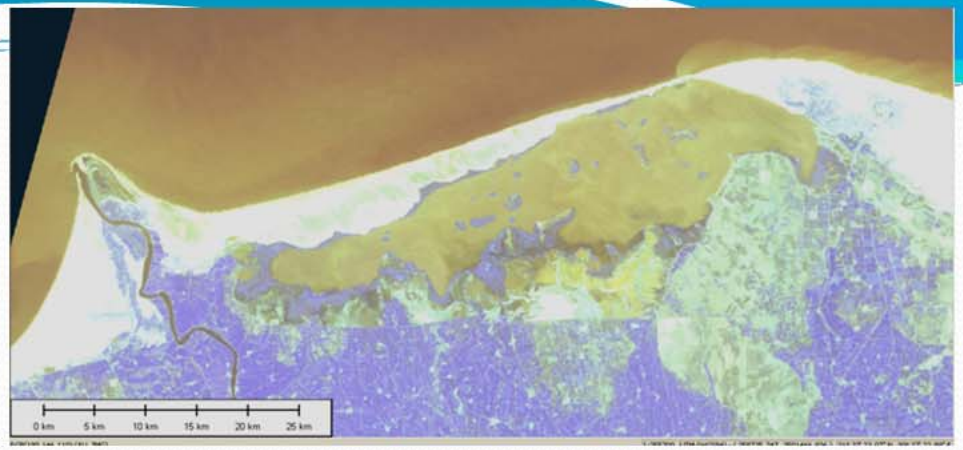
1. **Development of the geo-database framework and structure**
2. **Collection of data for different pilot areas (GIS layers, Satellite images, hydrologic and hydrodynamic data, climate and meteorological data,….)**
3. **Application of change detection analysis for case studies (Burullus, Edko and Mara Wetlands)**
4. **Vegetation mapping ofMara Wetlands**
5. **Examination of time series analysis for water quality parameters (coastal wetlands case studies)**

Research Results

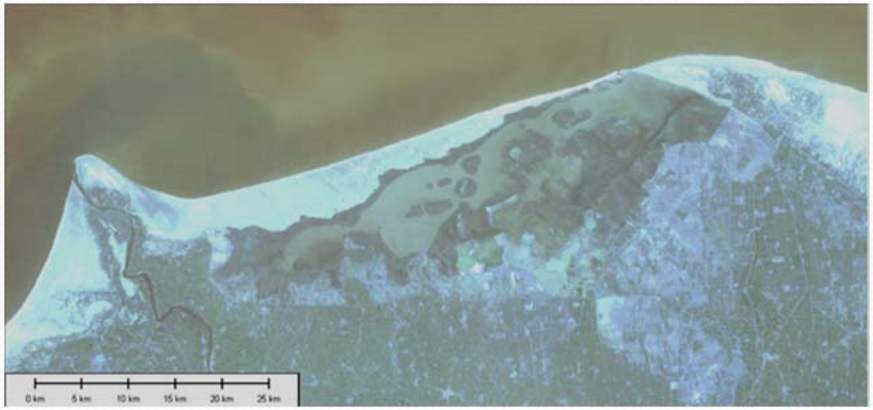
- **Chage Detection Lake Burullus 1972-1999**

Used images

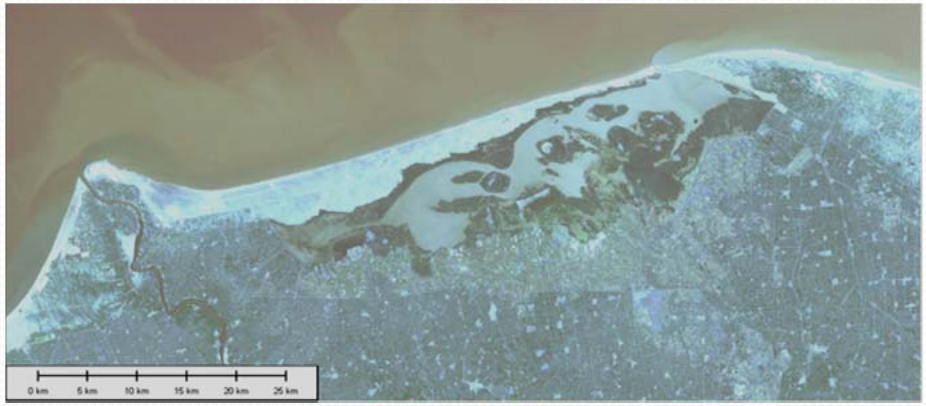
Satellite	Sensor	Band#s	Spectral Range	Scene Size	Pixel Res
L 1-4	MSS multi-spectral	1,2,3,4	0.5 - 1.1 µm	185 X 185 km	60 meter
L 4-5	TM multi-spectral	1,2,3,4,5,7	0.45 - 2.35 µm		30 meter
L 4-5	TM thermal	6	10.40 - 12.50 µm		120 meter
L 7	ETM+ multi-spectral	1,2,3,4,5,7	0.450 - 2.35 µm		30 meter
L 7	ETM+ thermal	6.1, 6.2	10.40 - 12.50 µm		60 meter
Panchromatic	ETM+ thermal	8	0.52 - 0.90 µm		15 meter



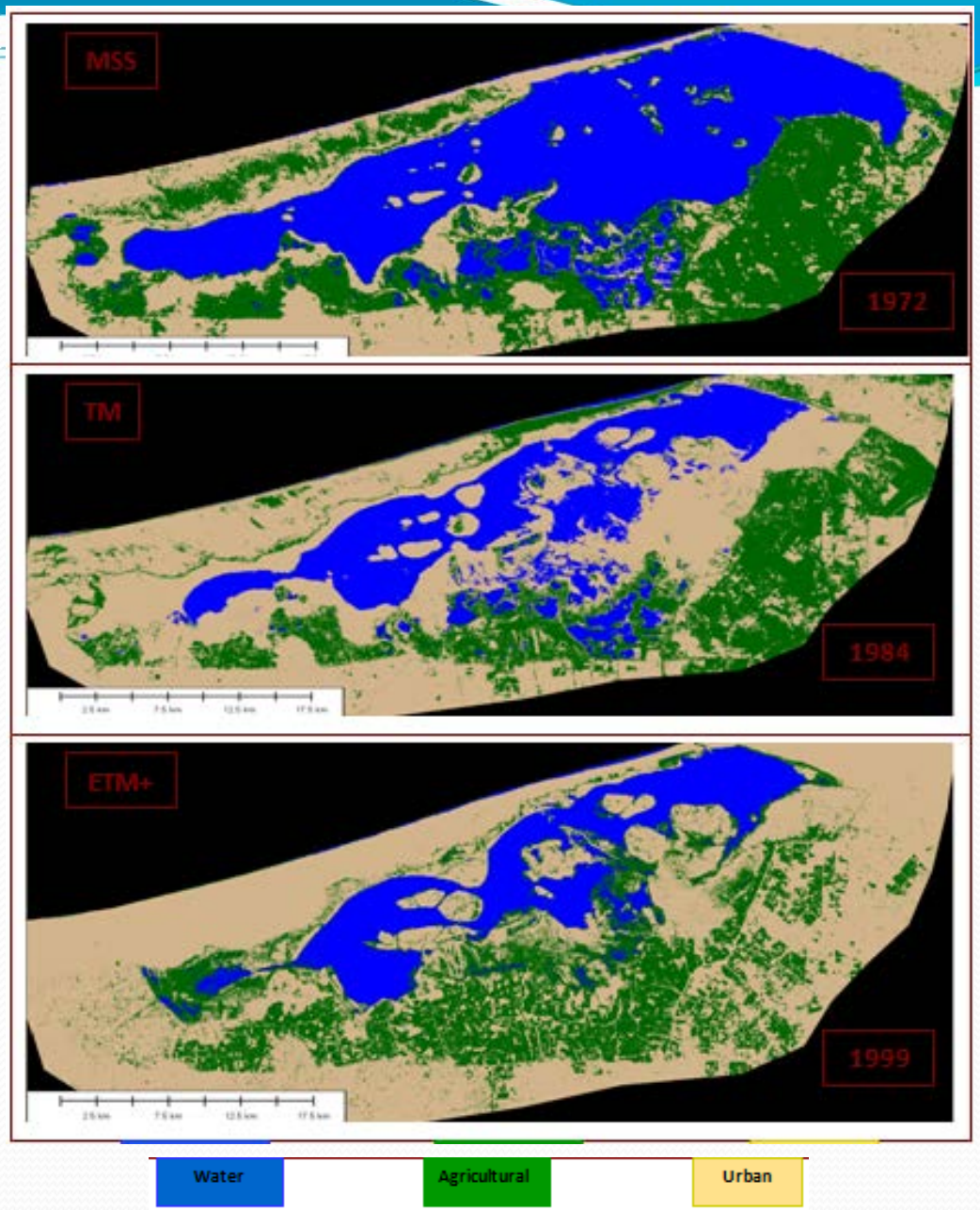
MSS in 19-09-1972

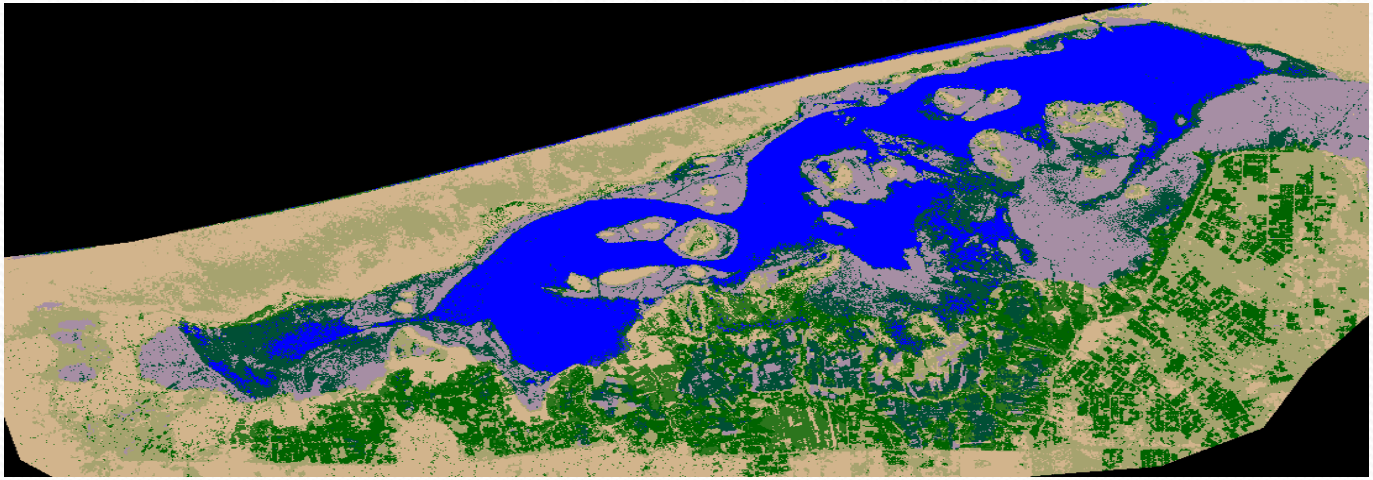


TM in 11-09-1984



ETM+ in 11-7-1999:

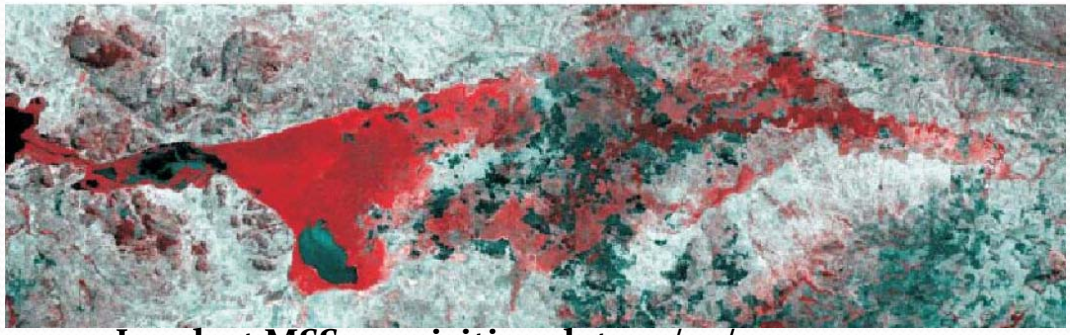

MSS
1972
TM
1984
ETM+
1999
Water
Agricultural
Urban



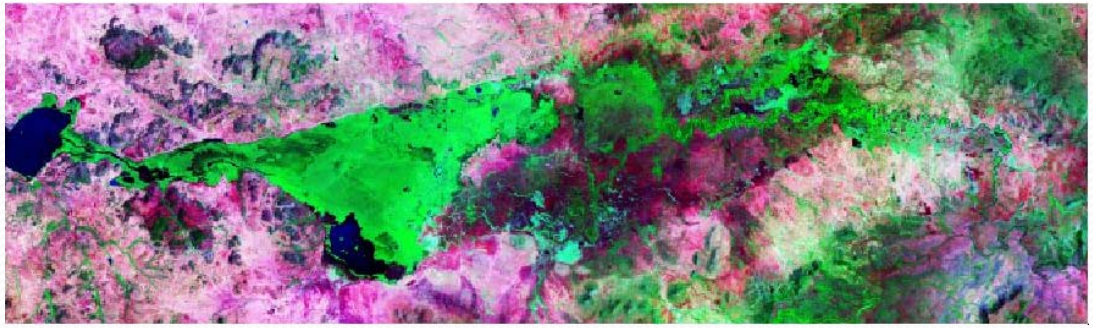
The final result of Change Detection Lake Burullus

Satellite	water	urban	Agricultural
MSS	466.7km	385.7km	466.7km
TM	237.2km	769.1km	237.2km
ETM+	192.8km	947.5km	192.8km

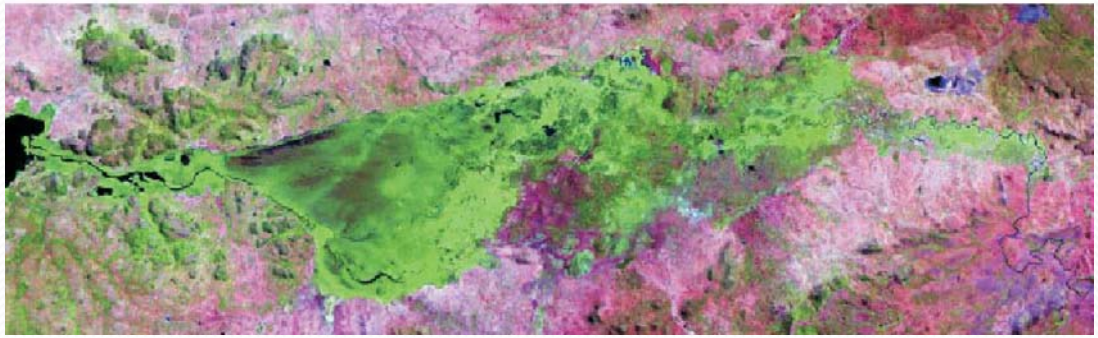
Change Detection Mara wetland



Landsat MSS acquisition date 13/07/1973



Landsat TM acquisition date 09/12/2002



Landsat ETM+ acquisition date 11/06/2009

Visual observation and manual delineation of imagery

Landsat Sensor	Date of acquisition	Area of Swampy wetland (km^2)	Non inundation wetland (km^2)	Total area of wetland (km^2)	Weather/ observations
7-ETM+	13/07/2009	270.20	311.54	581.74	After flood event of may2009
7-ETM+	11/06/2009	275.77	305.97	581.74	After flood event of may2009
7-ETM+	18/05/2003	556.00	25.74	581.74	flood event
7-ETM+	15/05/2002	559.00	22.74	581.74	flood event
7-ETM+	09/12/2002	230.00	351.74	581.74	Trench and pond created
5-TM	1990 composite	203.07	378.67	581.74	Light rain
5-TM	31/12/1984	173.80	407.94	581.74	Light rain
MSS	31/07/1973	196.62	385.12	581.74	After flood event, seasonal swamps observed

Vegetation Change Detection in the wetland

S/no	Class Name	Reference totals	Classified total	Number Correct	Producers Accuracy	Users Accuracy
1	Water	11	9	6	54.55%	66.67%
2	Swamps	31	34	21	67.74%	61.76%
3	Partially submerged vegetation	61	58	38	62.00%	65.52%
4	Papyrus/ thicket	75	78	54	72.00%	69.23%
5	Regenerated papyrus/ shrub	56	52	37	66.07%	71.15%
6	Eichorhoea crassipes/ Grassland	37	43	29	78.38%	67.44%
7	Agriculture / Bareland	29	26	22	75.86%	84.62%
TOTALS		300	300	207		
OVERALL CLASSIFICATION ACCURACY = 69.00%						

Overall Change Detection

S/ no	Class Name	1984 Image	2009 image	change	Comments
		(km^2)	(km^2)	% ge change	
1	Water	23.0	30.0	30.3	increased
2	Swamps	81.4	50.7	-37.7	decreased
3	Partially submerged vegetation	138.4	194.2	40.3	increased
4	Papyrus/ thicket	187.5	171.1	-8.7	decreased
5	Regenerated papyrus/ shrub	125.8	104.1	-17.3	increased
6	Eichorhoea crassipes/ Grassland	103.7	105.3	1.5	increased
7	Agriculture / Bareland	61.4	65.5	6.7	increased
	Total area	721.5	721.0		

Remaining Research Activities

- Wetlands mapping of all pilot selected wetlands
- Prepapring and processing the MERIS datasets for the time series analysis (2003-2010)
- Water quality (TSM& CHL-a) time series analysis for coastal wetlands lagoons
- Evapotranspiration time series analysis of Edko wetland
- Guidelines Wetlands monitoring planning and strategy for pilot case studies using EO data & remote sensing tools.

Capacity Building Activities

Accomplished Training Tctivities at ITC (2010)

1. **Integrated EO and Modelling for WRM with emphasis on Environmental Hydrology** HRI (Egypt) Mr. Soliman Badawy , BSc.
2. **Earth Observation and Quantification of Water Cycle Components** Univ. of Dar Es Salam (Tanzania) Mr. Joseph David MSc
3. **Retrieval of Land Surface Hydrological Parameters** NBCBN (Egypt) Mr. El-Sayed Dewidar PhD
4. **Remote Sensing Methods for Deriving Geo-biochemical Properties of Aquatic Ecosystems** NBCBN (Egypt) Ms. Amel Azab PhD
5. **Web Technology for GIS and Mapping and Programming** NBCBN- (Egypt) Mr. Mohamed Saeed, BSc.
6. **Environmental Impact Assessment and Strategic Environmental Assessment using spatial decision support tools (**Egypt) Mr. Soliman Badawy Soliman BSc

Capacity Building Activities

- Future Training activities (2012)

(proposed online training modules, ITC)

NO	Title	Start	Duration
1	Geostatistics and Open-Source Statistical Computing	23 Jan 2012	6 weeks
2	Hyperspectral Remote Sensing	30 Jan 2012	6 weeks
3	Systems analysis and modeling	13 Feb 2012	6 weeks
4	GIS Data Quality	12 Mar 2012	7 weeks
5	Multi-Hazard Risk Assessment	14 May 2012	6 weeks
6	Spatial Decision Support Systems	15 Oct 2012	8 weeks
7	Digital Terrain Model Extraction, Processing and Parameterization for Hydrology	03 Dec 2012	8 weeks

Project Impacts

- Emphasising the important role of EO and remote sensing as useful tools for water and environmental management
- Getting access to ESA EO products and tools.
- Building capacity of NBCBN wetlands research group on the use and applications of EO.
- Training five NBCBN memebrs (MSc, PhD)
- Linking NBCBN wetlands research project to TIGER project, with financial support from NBCBN to conduct field work for the year 2012

Future Recommendations

- Extension of TIGER II wetlands research project to All Nile basin countries (with 11 case studies from all basin countries) (ESA support is needed!)
- Launching a Focused regional capacity building and training programme on wetlands and ecological mapping & monitoring
- Developing a partnership mechanism between NBCBN, ESA, TIGER Regional and International offices for capacity building (Researh and training) on EO applications (bringing EO technologies and tools closer to a wider water professionals communities) to serve the following *NEW* NBCBN research clusters (launching 2012-2013):

1. Climate Change Research Cluster
2. Wetlands and Ecology Research cluster
3. DSS Research Cluster (GIS, RS and Modelling tools) research cluster

- Linking TIGER projects to other relevant and similar on going ESA projects in Africa for knowledge and experince exchange

Thanks For Your Attention!

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