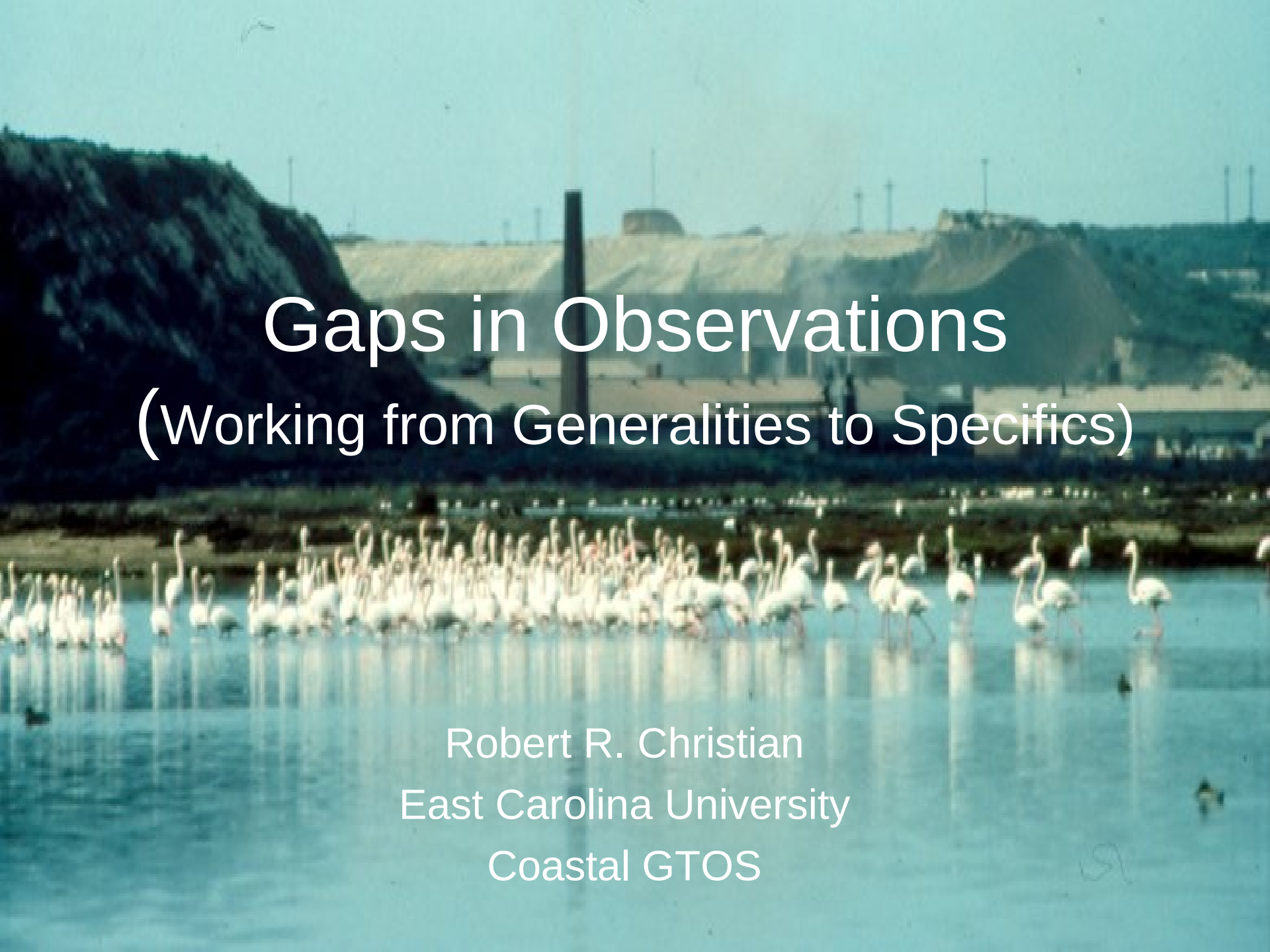


Gaps in Observations
(Working from Generalities to Specifics)

Robert R. Christian
East Carolina University
Coastal GTOS

Observing System Goals for this Workshop

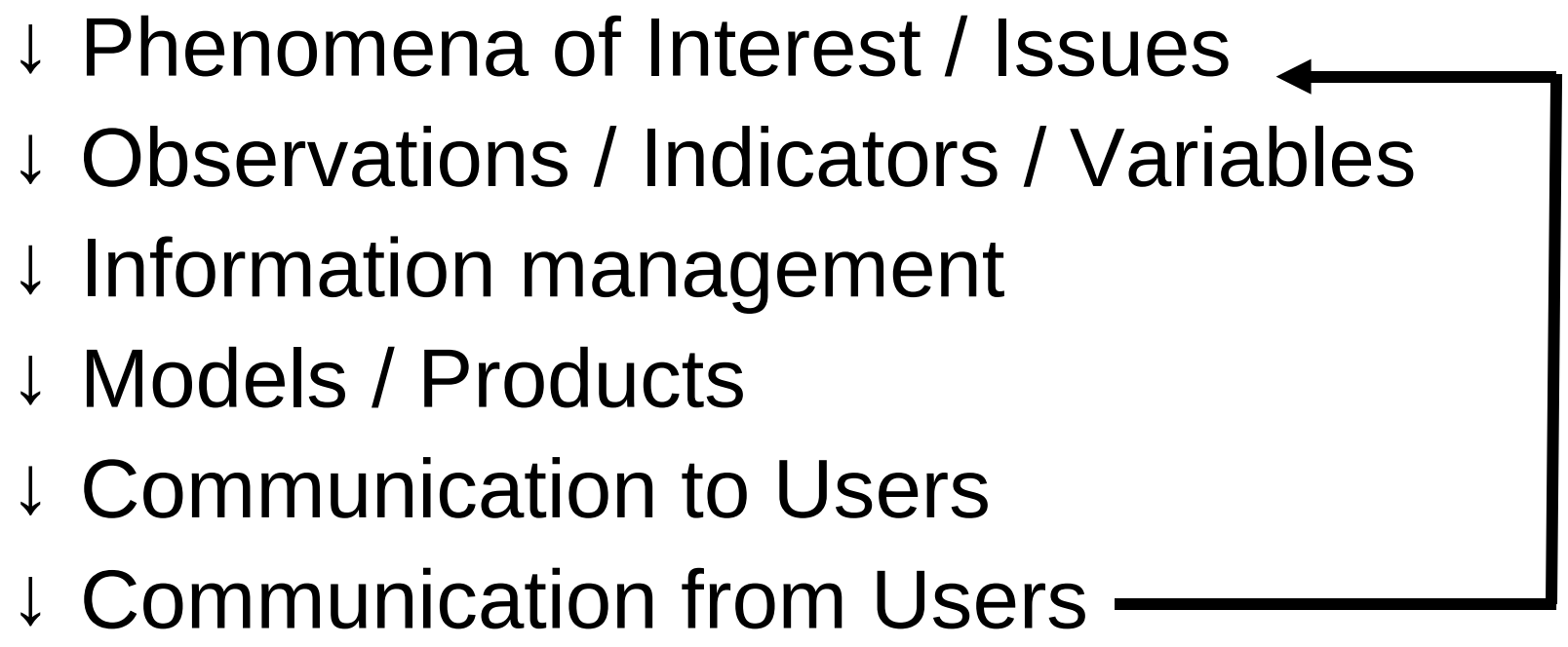
- Observing System Requirements for Managing and Mitigating the Impacts of Human Activities and Coastal Inundation in the *Mediterranean Region*





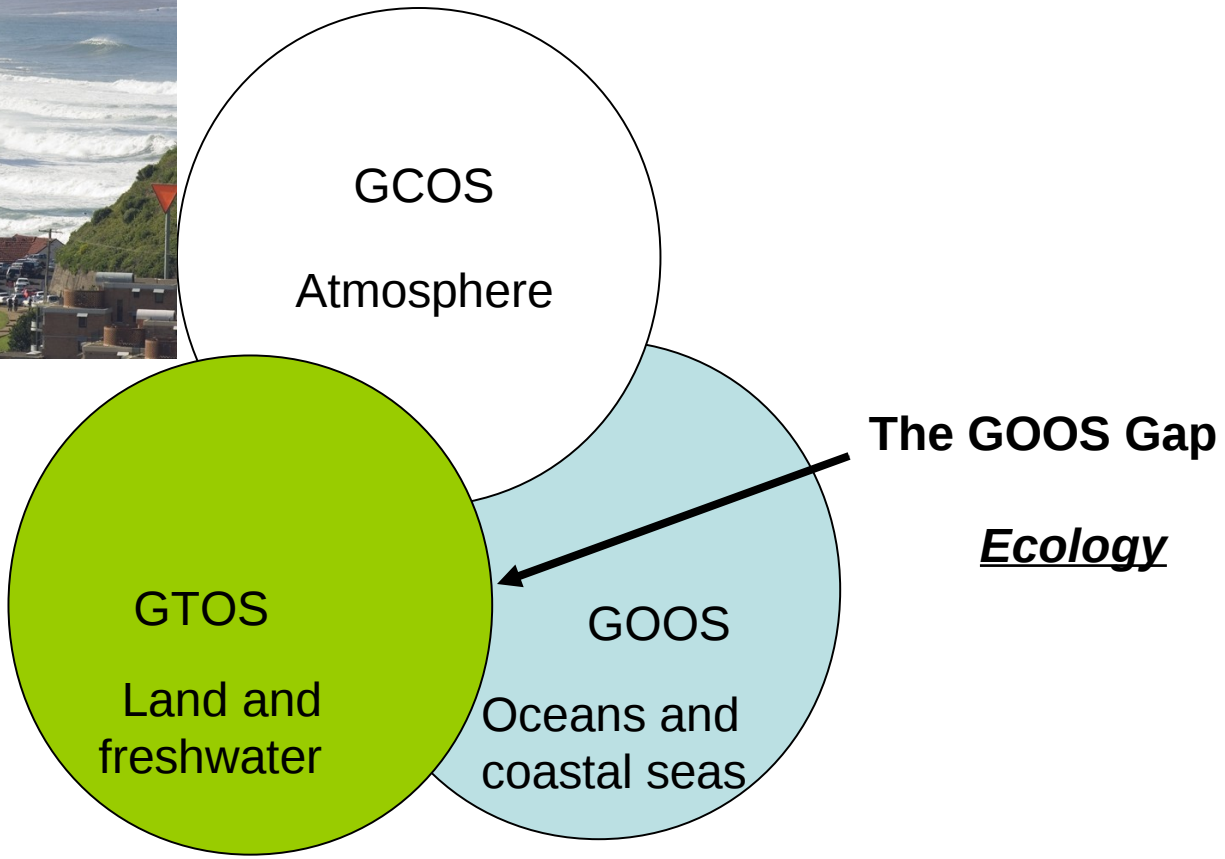
Needs for End-to-end System Structure

Elements of observing systems



Observing Systems under the United Nations & GEO





Observing Systems under the United Nations & GEO



Observing Systems under the United Nations & GEO

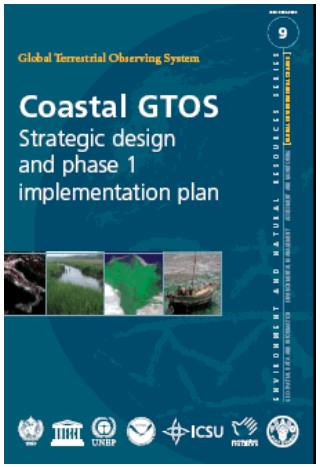


Numerous *General* Gap & Needs Assessments of Observing Systems





- But we need to focus on the specific gaps & needs for the Mediterranean Region



Two general observation approaches

- Remote sensing: available through space agencies, operational agencies and individual government initiatives
- In situ measurements: generally available through individual government funded activities



IGOS COASTAL THEME REPORT

- Published January 2006, IOC
- http://www.igospartners.org/docs/theme_reports/IGOS%20COASTAL%20REPORT%20midrez.pdf
- Also see related article:

  Christian et al., *Opportunities and Challenges of Establishing Coastal Observing Systems*, Estuaries and Coasts. 29(5):871-875. 2006

IGOS COASTAL THEME REPORT

CROSS-BOUNDARY ISSUES	REPRESENTATIVE PRODUCTS (NOT COMPREHENSIVE)	IMPORTANT FIELDS[1] (PARTIAL LISTING)	EXISTING SOURCES[1] (PARTIAL LISTING)
COASTAL HAZARDS	· Assessments & Risk maps: Episodic events Long term trends · Early warnings of where & extent (temporal and spatial) · Risk-based planning: Building codes Transportation	· Wind · Bathymetry · Shoreline · Topography · Land use/cover	· Tide gauge · Buoys, SAR · ADCP, HF radar, drifters · Field sensors, SCAT, SAR · Lidar, VIS imagery, Sonar · Lidar, VIS imagery, surveys · Radar, Lidar, VIS imagery · VIS/IR sat imagery, radar, lidar
COASTAL DEVELOPMENT & URBANIZATION	· Public health risks and hazards forecasts: Sewage contamination maps Beach closures Harmful algal bloom alert · Water quality classification maps · Air quality classification maps · Siting of energy production facilities · Port development & shipping · Spill contingency plans · Urban planning & zoning · Risk maps of shoreline contamination	· Demographics · Night-time lights · Land use/cover · Shoreline/ocean use and cover · DEM · Discharge · Precipitation · Salinity · Wind · Surface roughness · Particulate/dissolved matter; pigments	· Census data · VIS/IR sat imagery · VIS/IR sat imagery, surveys, radar, lidar · VIS/IR sat imagery, surveys, radar, lidar · Radar · Gauges · Gauges, Doppler radar · Field/airborne sensors · ADCP, HF radar, drifters · Field sensors; SCAT, SAR · SAR · Bio-optical field sensors; ocean colour sat imagery · Field/lab assays

“Sea-surface height measurements in the coastal zone require improved spatial and temporal resolution and coverage, perhaps leveraging technologies such as wide-swath (resolution of 1-15 km), delayed-Doppler, or GPS (Global Positioning System) altimetry. Improved models are also needed to accurately remove tidal signals.”

Coastal (Land-Sea) Observing Requirements

	PARAMETER	HOR. RES	HR MIN	OBS. CYCLE	OC MIN	AVAIL	AVAIL MIN	ACCURACY	ACC. MIN
GEOPHYSICAL OBSERVATIONS	Sea surface temperature	100 m	1 km	3 h	6 h	1 h	3 h	0.2°C	0.5°C
	Wind speed and direction	300 m	5 km	1 h	6 h	1 h	3 h	1 m/s 10°	2 m/s 20°
	Sea surface height	1 km	15 km	1 d	10 d	1 h	3 h	4 cm	6 cm
	Surface wave height & direction	1 km	10 km	3 h	1 d	1 h	3 h	0.2 m 5°	0.2 m 10°
	Salinity	1 km	25 km	1 d	7 d	1 h	3 h	0.1 psu	0.3 psu
	Currents	300 m	5 km	1 h	24 h	1 h	3 h	3 cm/s	10 cm/s
	Streamflow/river discharge	10 m	100 m	1 h	3 d	1 h	3 h	10%	30%
	Precipitation	1 km	15 km	1 h	8 h	1 h	3 h	0.5 mm/h	2 mm/h
	Ice cover	50 m	100 m	6 h	24 h	1 h	3 h	100 m	200 m
BIOLOGICAL/BIOGEOCHEMICAL OBSERVATIONS	Phytoplankton pigments (e.g., chl-a)	100 m	500 m	1 h	2 h	1 h	3 h	20%	30%
	Total suspended matter	100 m	500 m	1 h	2 h	1 h	3 h	30%	40%
	Coloured dissolved organic matter	100 m	500 m	1 h	2 h	1 h	3 h	30%	40%
	Optical properties (includes PAR)	100 m	500 m	1 h	2 h	1 h	3 h	10%	20%
	Chlorophyll fluorescence	100 m	500 m	1 h	2 h	1 h	3 h	30%	40%
	Aerosol properties (includes AOT)	100 m	500 m	1 h	2 h	1 h	3 h	10%	20%
	Nutrients	10 km	100 km	1 d	1 mo	1 d	7 d	10%	30%
	O_2 and pCO_2	10 km	100 km	1 d	1 mo	1 d	7 d	10%	30%
	Slicks/films (sea surface roughness)	25 m	50 m	3 h	2 d	1 h	3 h	50 m	100 m
MAPPING/PHYSICAL/GEOG.	Bathymetry	30 m	50 m	2 d	24 d	4 h	1 d	0.1 m (depth)	1 m (depth)
	Land Topography	30 m	50 m	3 mo	1 yr	--	--	5 cm (height)	10 cm (height)
	Shoreline position	1 m	5 m	15 d	3 mo	1 d	7 d	1 m	5 m
	Habitat maps (e.g., mangroves)	5 m	20 m	15 d	3 mo	1 d	7 d	--	--
	Reef maps	1 m	5 m	15 d	3 mo	1 d	7 d	2 m	10 m
	Land cover/use	15 m	1 km	1 yr	10 yr	--	--	--	--
	Night-time lights	1 km	5 km	1 yr	5 yr	--	--	--	--

IGOS Coastal Theme Report, 2006

Common needs & gaps vis-à-vis existing and planned capabilities:

- Existing global observing assets generally provide *inadequate* spatial, temporal and spectral resolution.
- Continuity required of some existing capabilities for context and assessment of climate variability and change.
- Some observations needed for coastal users not presently made, especially synoptically and/or from space.

Coastal Observing Challenges and Priorities

OBSERVATION	KNOWLEDGE CHALLENGES[1]	RESOLUTION/COVERAGE CHALLENGES[1]	CONTINUITY CHALLENGES[1]
CROSS-CUTTING	· Satellite Cal/Val · Standardize & QA/QC *in situ* observations · Adaptive sampling · Power/telemetry/biofouling issues	· Require improved temporal & spatial resolution from satellite sensors (also see knowledge) · Expand coverage of *in situ* measurements	· Need to facilitate transition from research to operational satellites · Need to maintain and replace *in situ* assets
GEOPHYSICAL	· Improve SSH & wind measurements from space · Measuring coastal surface currents and river discharge from space · Measuring salinity remotely · Assimilate HF radar data and derive user products · Develop SAR algorithms & assess other SAR products · Measuring sea ice thickness remotely	· Extracting higher resolution information from satellite wind sensors · Add additional Doppler weather radar & HF radar sites · Densify stream & tide gauge networks	· Maintain existing stream & tide gauge networks · Maintain microwave RS capabilities for ice · Facilitate shore-based HF radar transition: research to operational mode · Make GHRSST-PP operational (see page 32)
BIOLOGICAL & BIOGEOCHEMICAL	· Use radar and/or lidar to obtain vegetation structure, regrowth, biomass · Improve bio-optical algorithms & atmospheric corrections · Merged chlorophyll & other VSR products · VSR/SAR data relationships with ecology · Functional type discrimination · Improve aerosol characterization	· Geostationary, hyperspectral, visible spectral radiance observations (VSR; i.e., ocean colour) · Expand coverage of nutrient measurements · Rapid & accurate pollutant assays	· Maintain high-quality global multi-spectral VSR observations for context and climate data records
MAPPING	· Require high spatial res. hyperspectral imagery for corals and vegetation assessments · Require InSAR for coastal subsidence/erosion · Need a common habitat classification system · Spatially explicit socio-economic variables	· Improve availability and use of high-resolution optical and lidar data for physical mapping · Access to highest resolution (spatial and vertical) DEMs	· Maintain DMSP-OLS (or related capabilities) for human population assessments · Maintain high-res. multispectral optical imagers for habitat maps

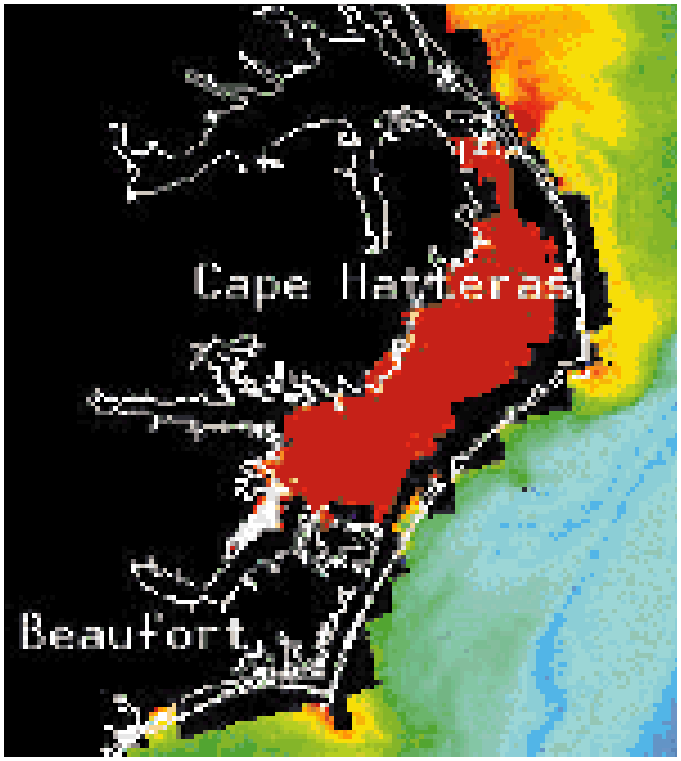
PROVIDE	Geostationary, hyperspectral visible spectral radiance (i.e., ocean colour) data for coastal waters
	Higher resolution/improved coverage for ocean vector winds & sea surface height
	High spatial and spectral resolution capacity to assess changes in coral reef & other terrestrial and aquatic habitats (e.g., estuaries)
	Ocean surface current observations and river discharge in coastal regions
	InSAR measurements for coastal subsidence and erosion
IMPROVE	Calibration/validation of measurements in coastal regions
	Data management infrastructure (near-real-time delivery; climate data records)
SUPPORT	Development of an integrated COastal Data Assimilation System
	Adaptive, coordinated remote and *in situ* sampling

IGOS Coastal Theme Report, 2006

The Black & Blue Coast

(The 2 observing communities *& cultures* of the coastal science)

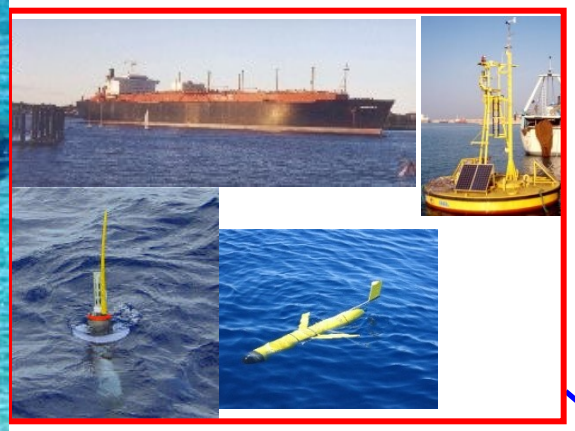




Two Sides of the Coast in the Mediterranean

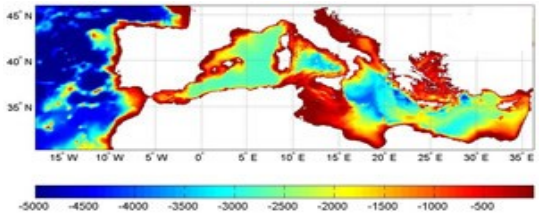
- Open marine observing systems: reasonably well established
- Marine coastal waters: Involves more national government control, not as coherent & integrated
  - the national buoy networks - mainly Greece and Spain (actually more shelf and less coastal). The Italian network focuses mainly on waves and France has a more research oriented network of coastal stations.
  - the sea level network - situation here is mixed because some networks operate by research organizations and others by the navies or hydrographic services
- Terrestrial and transitional and freshwaters: Directly involves national control, little information is near real time.

The Real Time Mediterranean data dissemination network



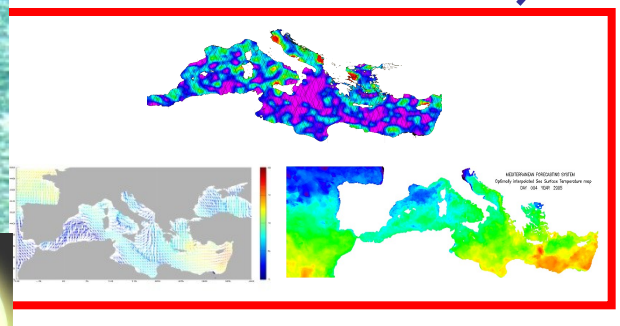
In situ data

MFS Models



Mediterranean Thematic Centers

satellite data

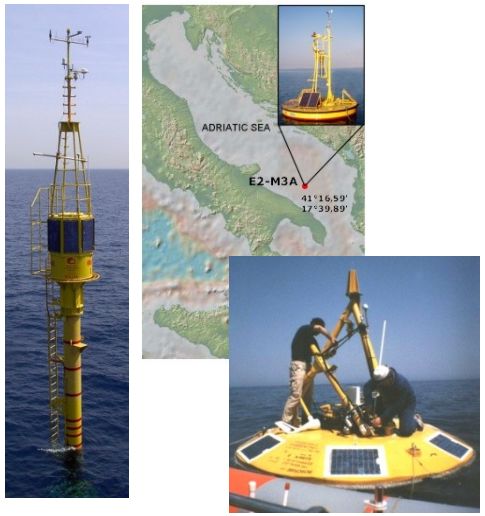


World-wide Data Dissemination Center (IFREMER)

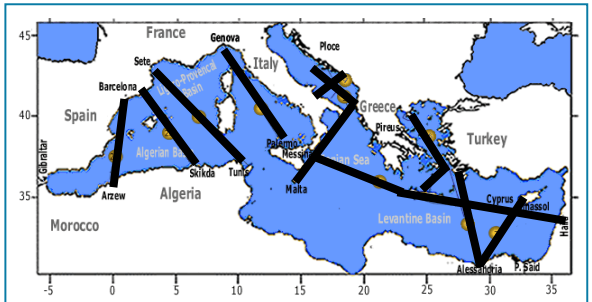
GTS

WMO

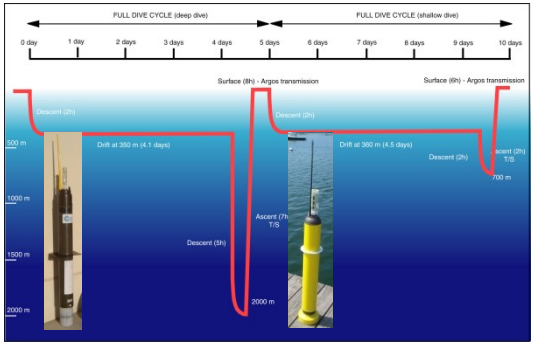
Overall Basin Scale RT Observing System



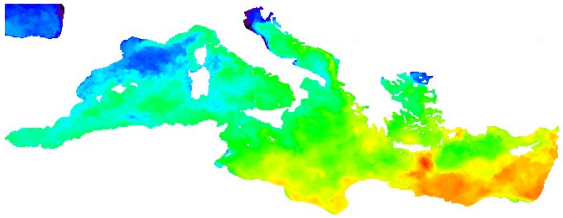
Multiparametric buoys in: Ligurian Sea, Adriatic Sea and Cretan Sea (few hours delay)



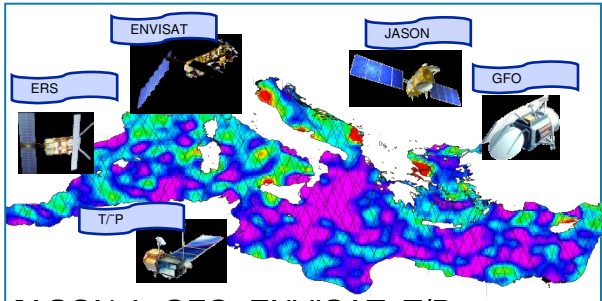
XBT VOS high resolution system (12 nm along track and full profile transmission, few hours delay)



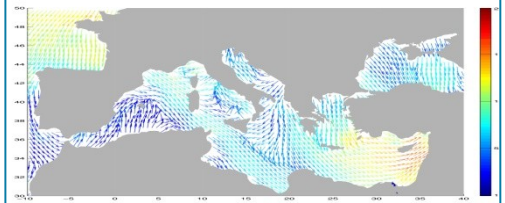
20 ARGO floats deployed from VOS (few hours delay)



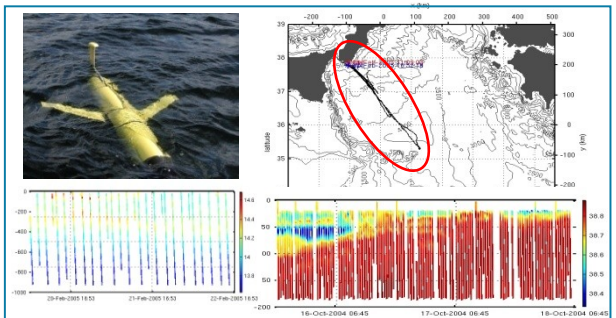
Daily satellite SST interpolated in RT on model grid (one day delay)



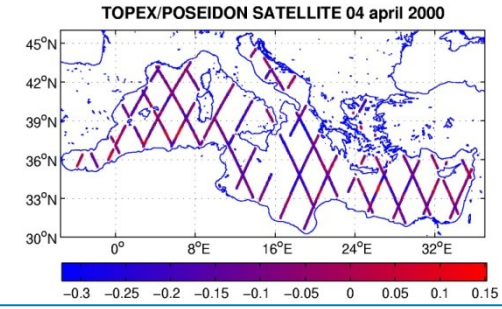
JASON-1, GFO, ENVISAT, T/P Sea Level Anomalies (few days delay)



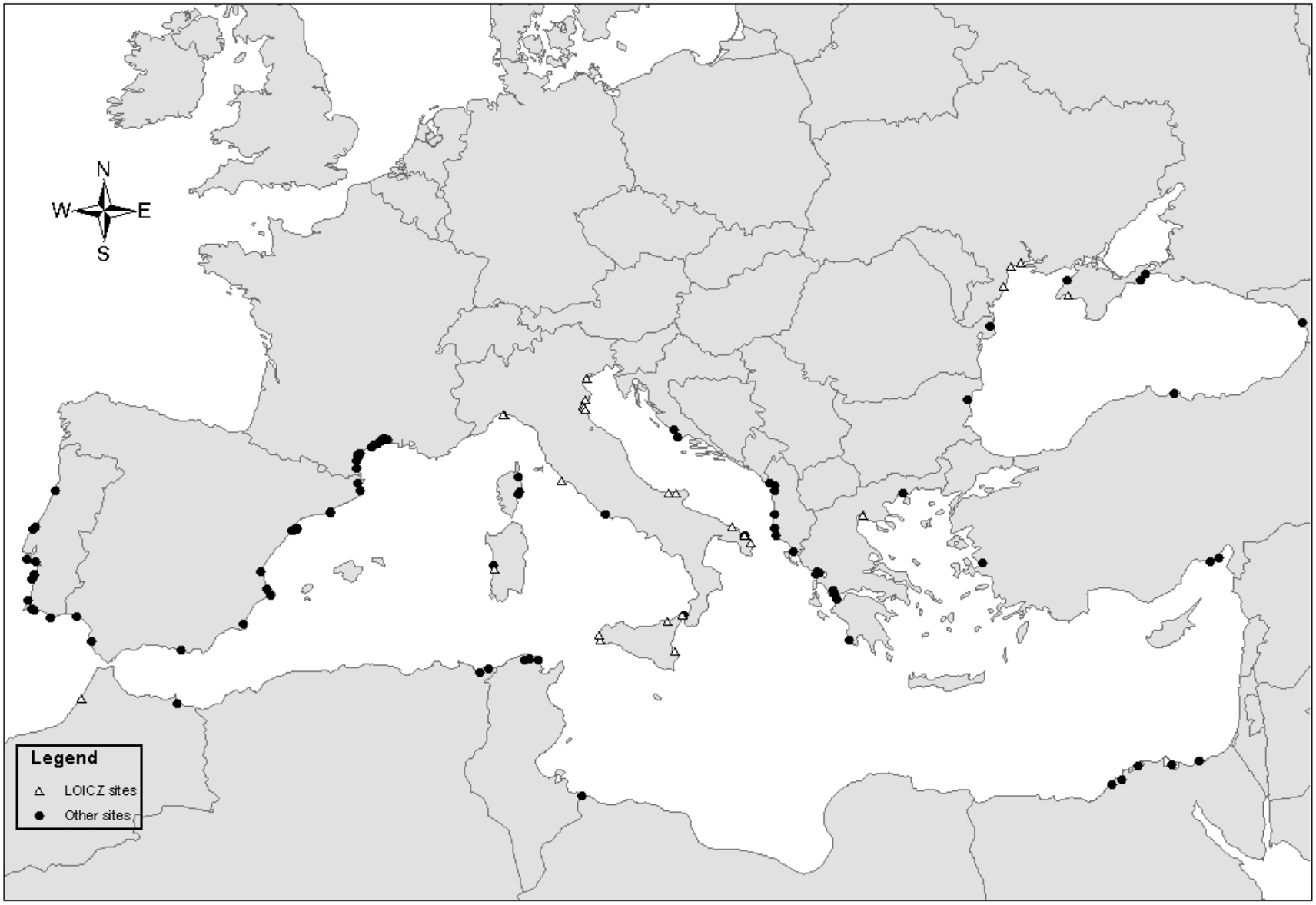
Scatterometer DAILY winds analysis, 1/2x1/2 (one week delay)



Open ocean monitoring by gliders (few hours delay)



C-GTOS & DITTY Delivery System sites from Mediterranean & Black Sea Region



MELMARINA

مشروع رصد ونمذجة البحيرات الساحليه

Monitoring and modelling coastal lagoons:
Making management tools for aquatic resources in North Africa



Merja Zerga Ghar El Melh Lake Manzala

Primary Sites

Major Challenge to engage the southern rim nations!!!!

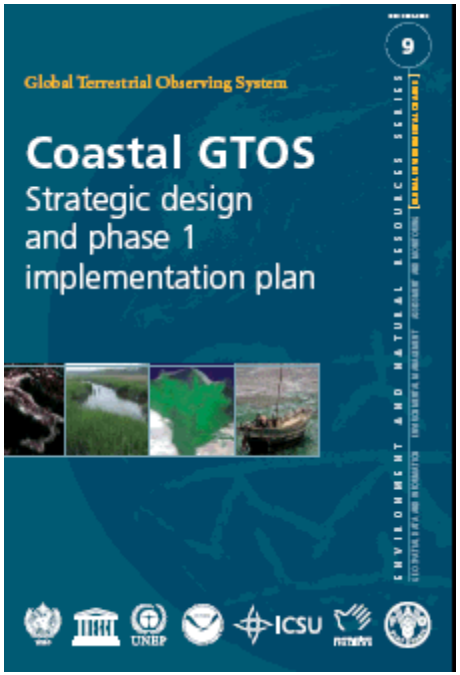
Sea Level Measurements and related issues

- MedGLOSS
- Issues
  - Tsunamis
  - Storm surges
  - Seiches
  - Depressions
  - Mean sea level changes
    - Climate change
    - Multi-decadal oscillations
    - Tectonic activity



Coastal GTOS

Offers opportunities for coordination, communication and capacity building



Strategic design and phase 1 implementation plan
http://www.fao.org/gtos/pubs.html

Indicators and variables of effects of sea-level, storms and flooding

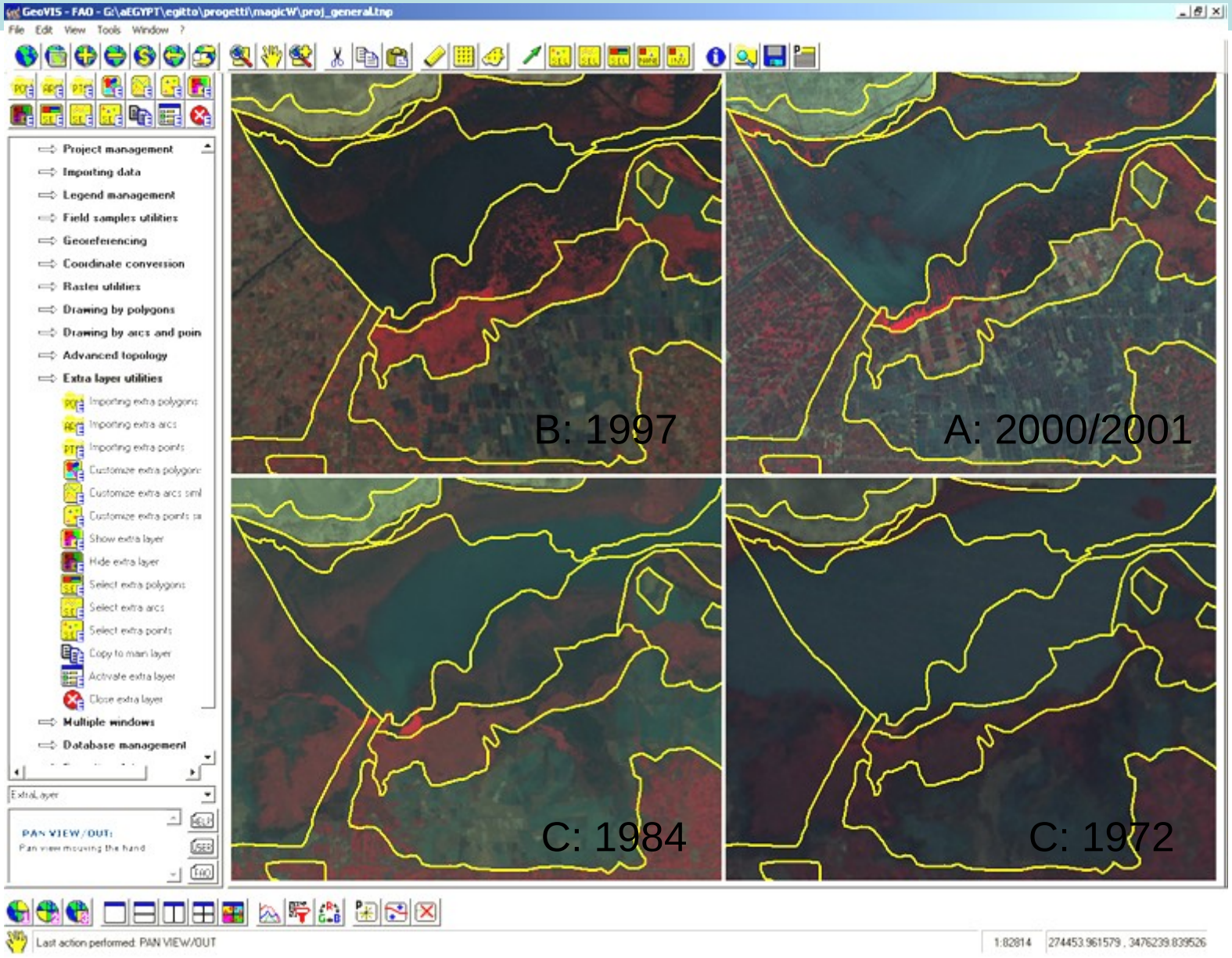
Observation variables / indicators	*ource*
Current Variables	
Glacier change in length	TEMS[1]
Glacier mass balance	TEMS[1]
Water discharge	TEMS[1]
Water surface temperature	TEMS[1]
Wind velocity	TEMS[1]
Proposed Variables	
Bathymetry	*USGS*
Height of dykes	*TEMS*
Length of dykes	*TEMS*
Sea level height	CEOS[2]
Upwelling	FAO Fisheries

Plus socio-economic variables, which need development as indicated in CGTOS implementation plan.

Land Cover / Land Use

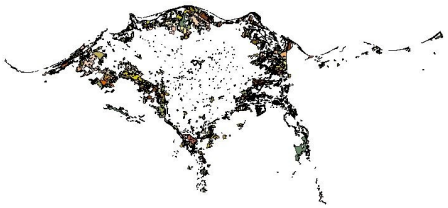
- From Global Land Cover Network:
  - LC in the south Egypt and Libya are complete, Morocco is due to start this year, nothing has been done for Algeria, and methodology is being tested in Tunisia now.
- Numerous other initiatives
  - Some discussed already

Land Cover Change Analysis
(from GLCN)

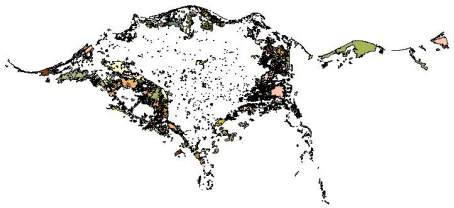


Main changes resulting layers

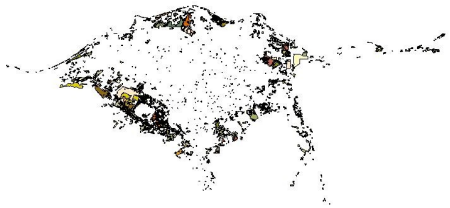
Land cover changes in the Nile delta study area
from 1972 to 1984



Land cover changes in the Nile delta study area
from 1984 to 1997



Land cover changes in the Nile delta study area
from 1997 to 2000



Main changes are founds in:

- **desert areas**
- **lagoon system**
- **coastal strip**
- **coastal line**
- **urban areas**

GEO Capacity Building survey instrument progress (2006 - 2007)



Survey instrument progress (per 01/2007) *

Reported by
Chris Mannaerts (ITC)
Imraan Salojee, Datong Zhao, E.Christia (GEO)

General recommendations for observing system sustainability:

- Sustainable systems need cultivation. *Positive feedback* mechanisms are required.
- Governments are unlikely to provide sustained support without connection to *human wellbeing*. Observing systems must provide clearly articulated value to society beyond "preserving nature."
- Local monitoring programs in isolation have a significant probability of being non-sustainable. *Redundancy* among monitoring programs (resilience) should not be discouraged.
- *Information management* plays a central role and must target a timely delivery of products to address environmental problems appropriately.
- Sustainable observing systems in the *developing world* are the largest challenge to global coverage.

Adapted from: Christian, R. R., P. M. DiGiacomo, T. C. Malone, and L. Talaue-McManus. 2006. Opportunities and challenges of establishing coastal observing systems. Estuaries and Coasts 29: 871-875.