The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

2066-26

Workshop and Conference on Biogeochemical Impacts of Climate and Land-Use Changes on Marine Ecosystems

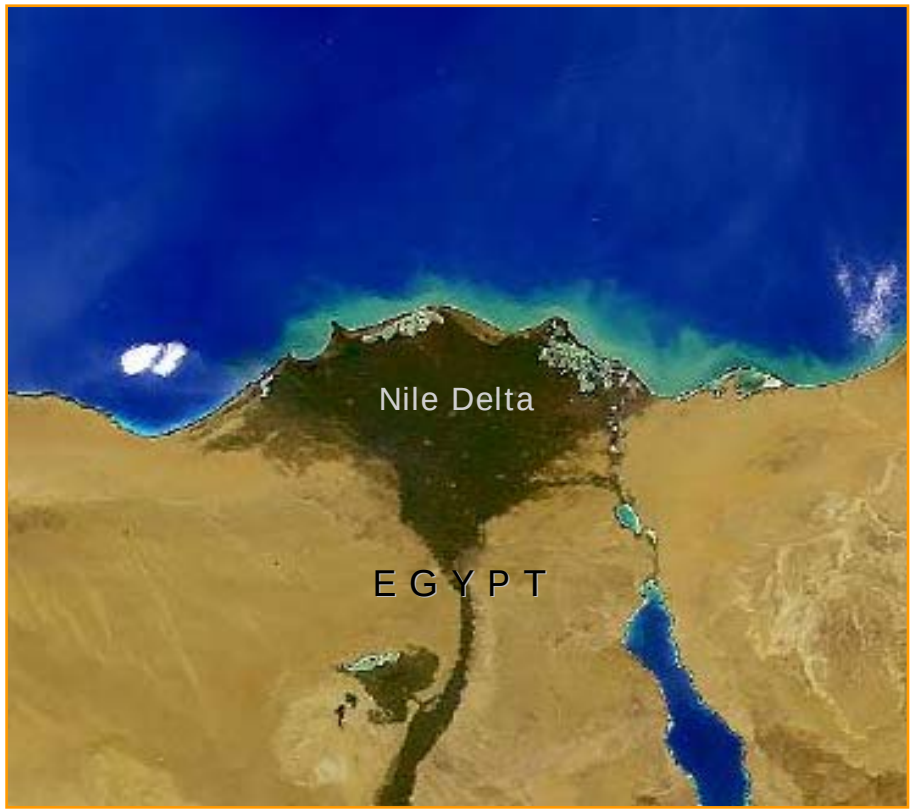
2 - 10 November 2009

Assessment of the possible key factors responsible for fall and rise of the coastal fisheries off the Nile delta, Egypt: A remote sensing approach

W.M. Moufaddal

National Institute of Oceanography and Fisheries
Egypt

Assessment of the possible key factors responsible for fall and rise of the coastal fisheries off the Nile delta, Egypt: A remote sensing approach



Wahid M. Moufaddal (Ph.D)

National Institute of Oceanography & Fisheries (NIOF)
Alexandria, Egypt

Assessment of the possible key factors responsible for fall and rise of the coastal fisheries off the Nile delta, Egypt: A remote sensing approach

Wahid Moufaddal [1] **and Samantha Lavender** [2]

[1] National Institute of Oceanography & Fisheries (NIOF), 21556 Alexandria, Egypt

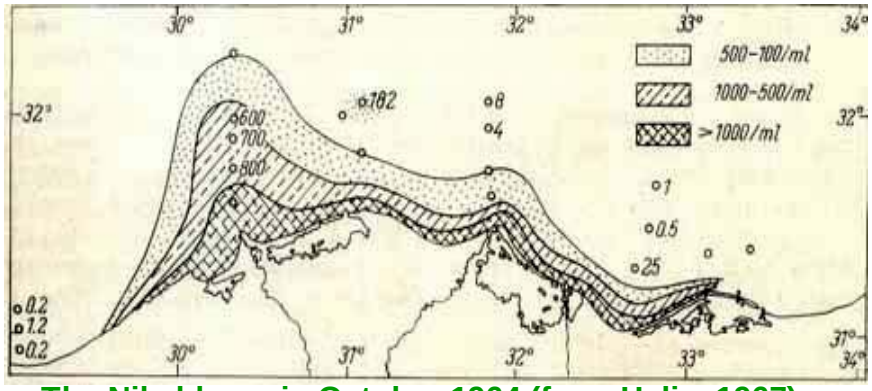
[2] SEOES & Marine Institute, University of Plymouth, Plymouth, Devon, PL4 8AA, UK

Abstract

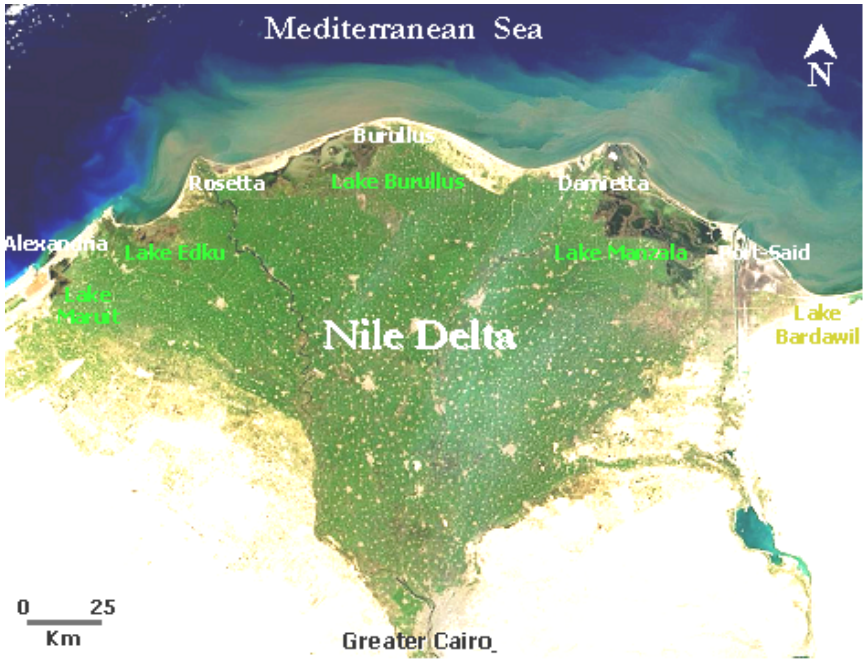
Marine Egyptian fisheries off the Mediterranean showed some apparent and rapid downward and upward shifts in mid 1960s and early 1980s, respectively. There are two main hypotheses attempt to interpret casual drivers responsible for these changes. The first refers fall and rise of marine fisheries to improvement of fishing efforts and techniques, whereas the second assumes that nutrient enrichment through increased anthropogenic activities is responsible for flourishing of these fisheries again. Despite these research efforts, debate is still ongoing and reasons of these shifts are not fully resolved yet. Lack of long-term monitoring data and research studies on variability and trend of change chlorophyll phytoplankton concentrations and primary productivity constrained previous research efforts and didn't allow providing conclusive facts to end this debate.

This paper aims to fill part of this gap and attempts to resolve that debate through trend analysis of long-term data relevant to ocean-colour remote sensing and fish landings. A time series analysis of total fish catch, pelagic to demersal (P/D) ratio and satellite-derived chl-a concentrations in the Nile delta shelf and coastal lakes of the delta, allowed to provide several qualitative evidences for responsibility of surface nutrient enrichment for recovery of the Egyptian marine fisheries since early 1980s. Results of this study show the potential role and importance of ocean-colour satellite data for monitoring changes of marine productivity and hence, for proper management of the coastal and marine fisheries.

The Nile phytoplankton bloom



The Nile bloom in October 1964 (from Halim 1967)



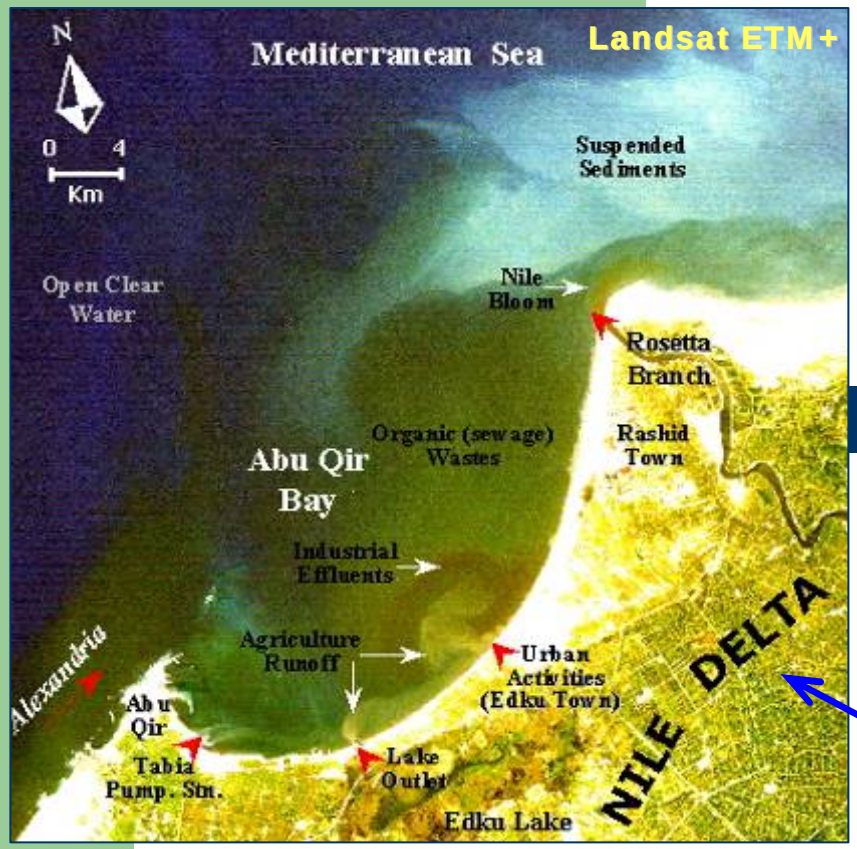
The Nile bloom in Feb. 2003 (MODIS Image courtesy of NASA)

Classic historical Nile bloom < 1965

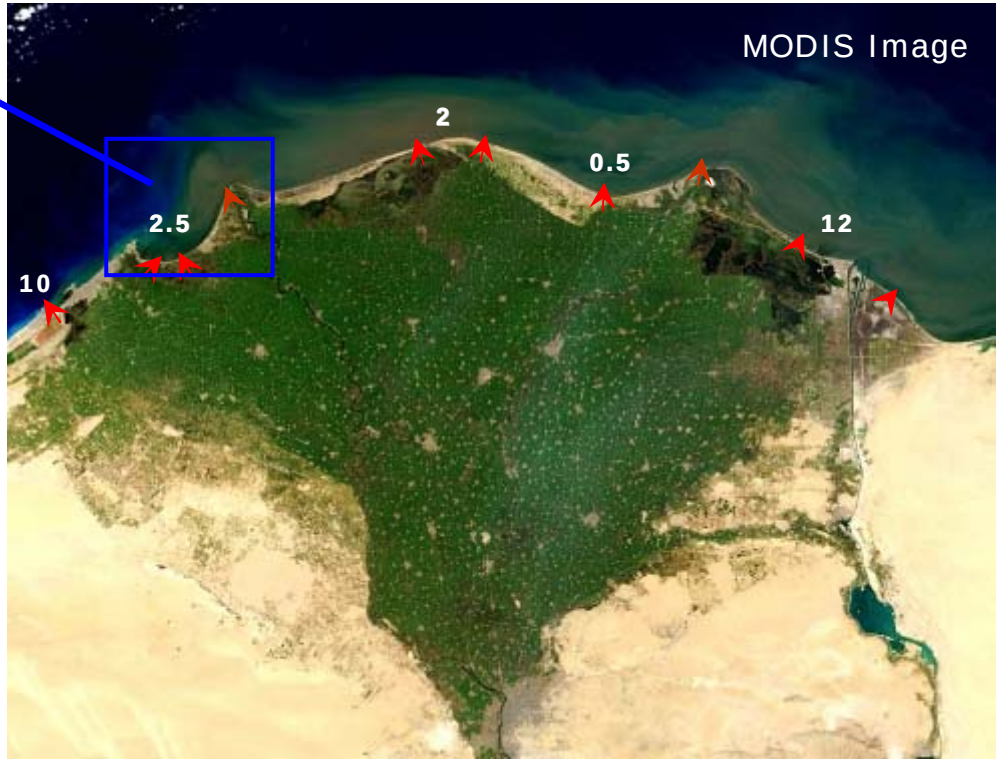
Natural, monospecific (diatomic), variable in magnitude, unimodal and timely in autumn only

Modern Nile bloom > 1980s ??

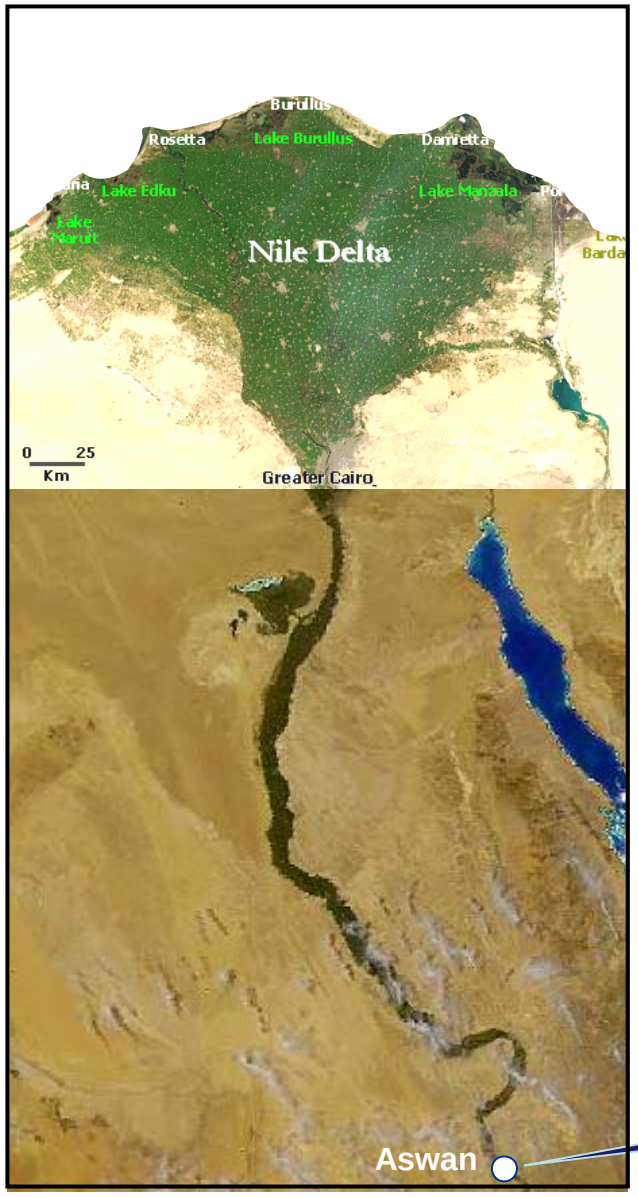
Anthropogenic, multispecies (dinoflagellates and diatoms), multimodal and extensive in time and space (winter and spring)

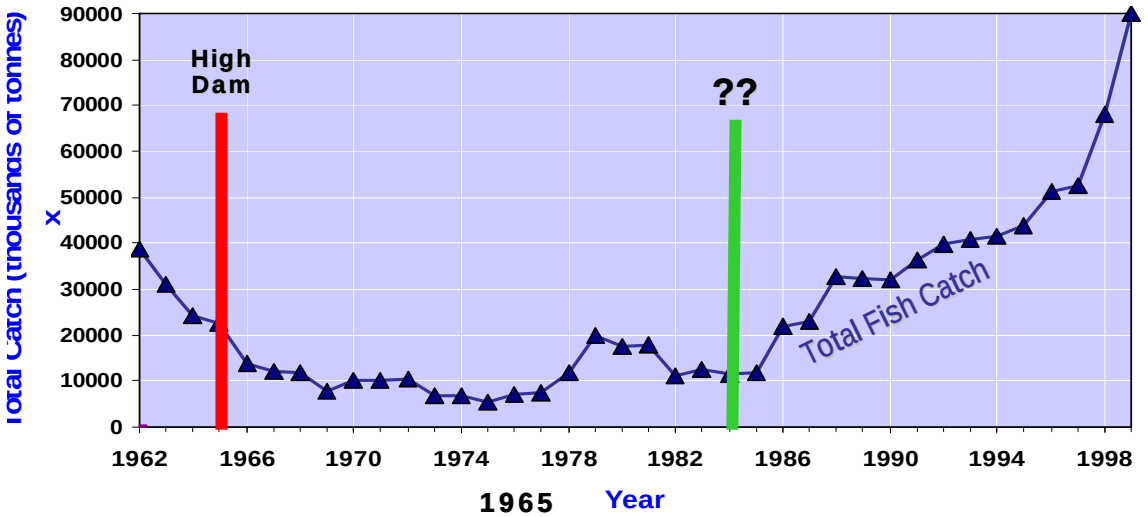


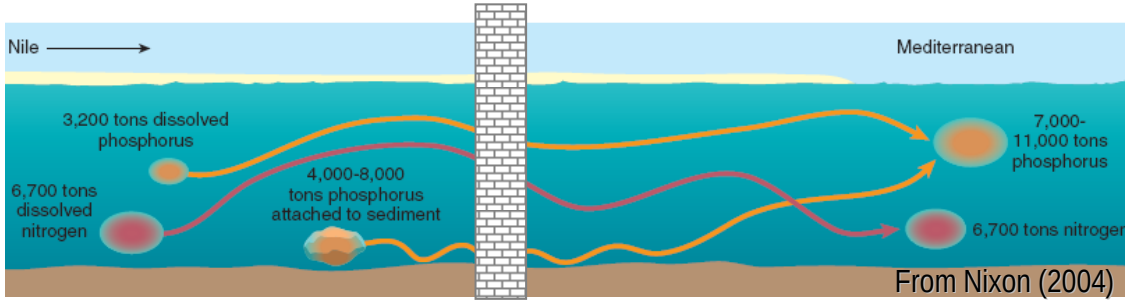
Moufaddal (2005), IJRS

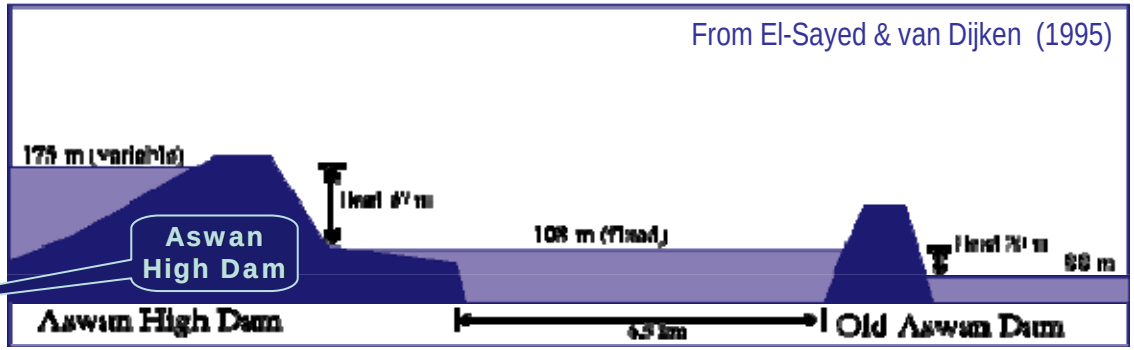


Impacts of the High Dam on nutrient influx and fisheries

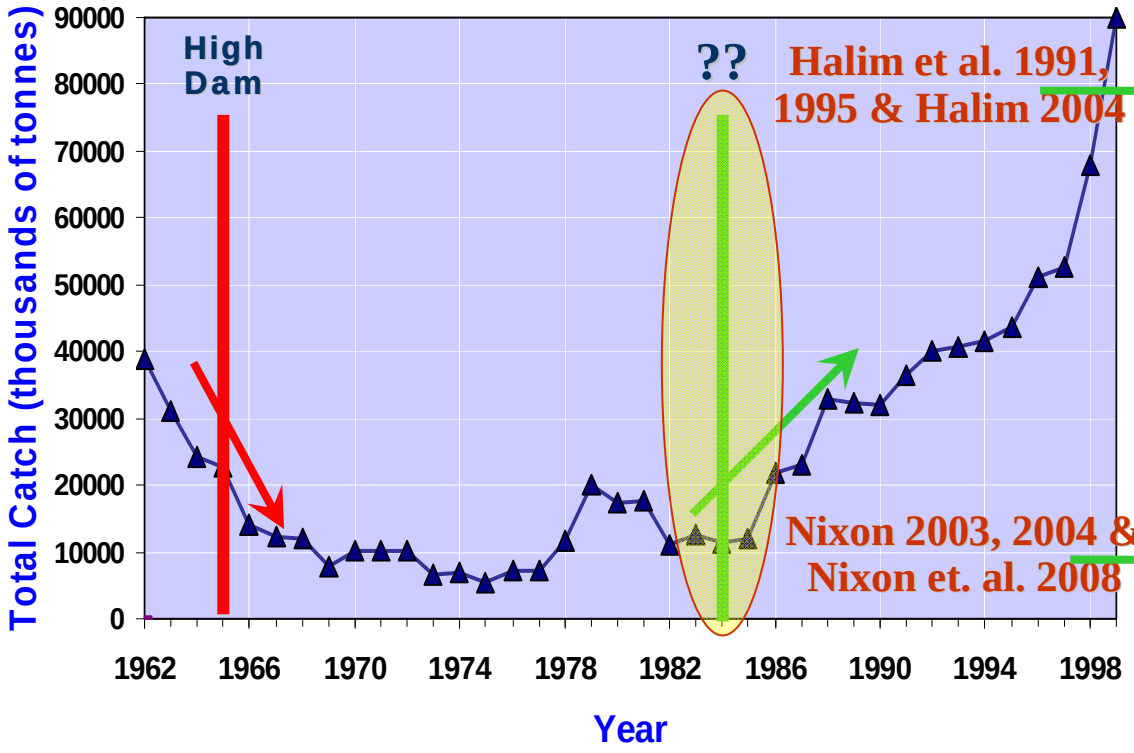








Rise of coastal and marine fisheries off the Nile delta coast



1 **Theory of fishing**

- improvement of fishing efforts and techniques,
- increase of fishing grounds after signing a peace treaty with Israel

2 **Theory of anthropogenic nutrient loading**

Recovery of fisheries is due to: improvement of nutrient supply to Nile delta coastal waters through increased fertilizer use, urban and domestic discharge

Unfortunately, the scientific community can not end this debate simply because we don't have enough background data on changes of *chl-a* conc or phyto or nutrients.

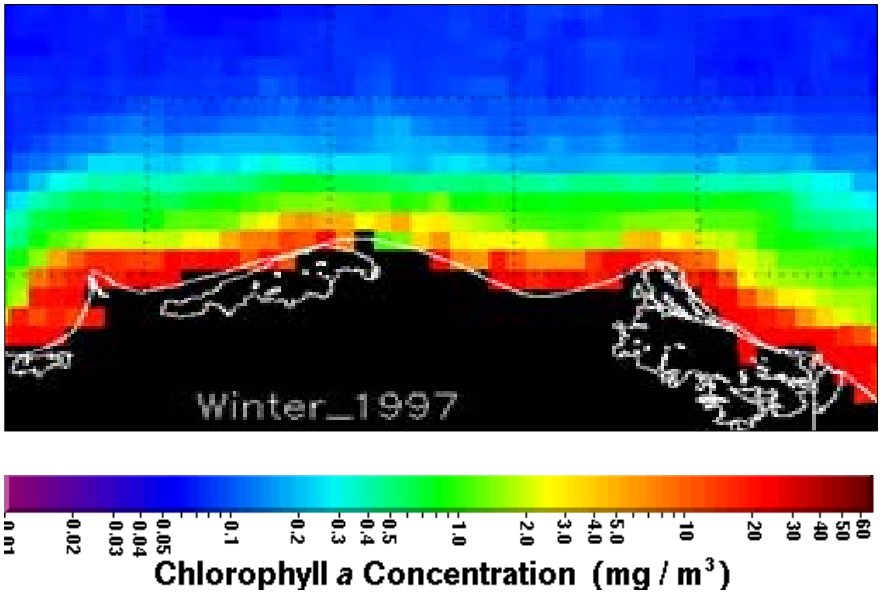
In situ measurements and field data on phytoplankton *chl-a* concentrations or productivity in the Nile delta shelf are generally very limited or without continuity in time. Data collected from other short-term programs are often difficult to obtain and interpret.

Methodological Approaches

Approach 1: Ocean-color remote sensing

Satellite retrieval of chlorophyll

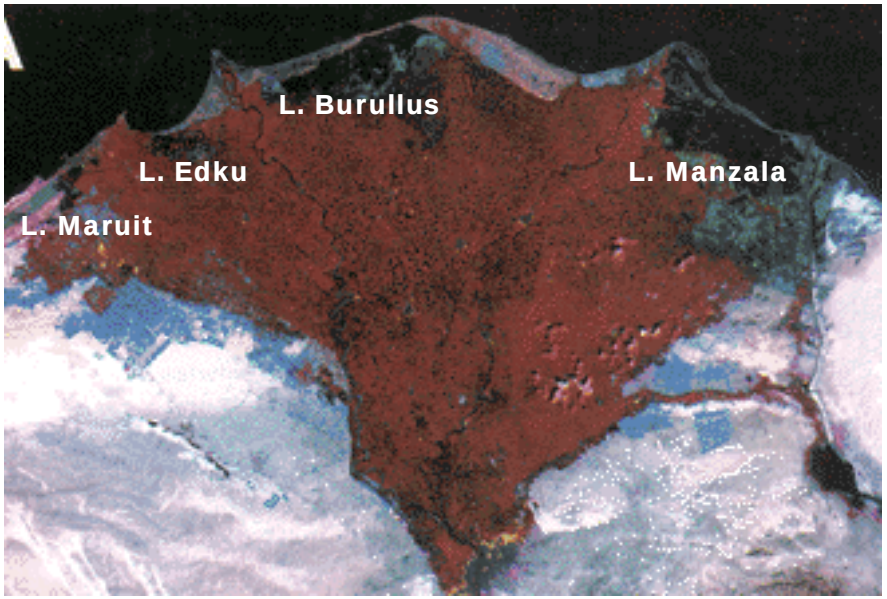
- **Long –term (10 years) variability and trend of chlorophyll growth.**
- **Seasonal pattern of chl-a distribution off Egyptian Mediterranean coast.**



Approach 2: In-situ & field data

Time series analysis of fish landings

- **Mode & pattern of change of coastal lakes fisheries.**
- **Assessment of Pelagic to Demersal (P/D) fish ratio → (Halim et al. 1995).**



Approach 1: Data and Methods

1. GlobColour Merged Data

The main data set for this study is a 10-year time series (September 1997 to December 2006) of GlobColour monthly averaged data (fully normalised reflectance data set).

The GlobColour project started in November of 2005, after having been set up by the European Space Agency "Data User Element" (ESA DUE). The GlobColour web portal provides scientists with a long time series of consistently calibrated global ocean colour information. The aim of GlobColour is the development of a 10-year global ocean color data set by merging together information from four satellite sensors:

- **OrbView-2/SeaWiFS**
- **AQUA/MODIS**
- **ENVISAT/MERIS**

2. MedOC4 Correction Algorithm

The standard global NASA algorithms (OC2v4 and OC4v4) lead to a significant overestimation and uncertainty in the satellite derived chl-a concentration within coastal areas whose optical water properties and water-leaving radiances are affected by the presence of colored dissolved organic matter (CDOM) and/or suspended particulate matter (SPM) input from river channels and land-based sources

Regional algorithms can provide a solution as they can perform better where there is local in-situ data to train them.

- **GITEL → → → Gitelson et al. (1996)**
- **BRIC → → → Bricaud et al. (2002)**
- **DORMA → → → D'Ortenzio et al. (2002)**
- **MedOC4 → → → Volpe et al. (2007)**

The MedOC4 algorithm, adopted by Volpe et al. (2007), has been shown to be the best algorithm for the SE Mediterranean; in terms of unbiased satellite chl-a estimates and an improving satellite uncertainty in coastal Mediterranean waters.

Available online at www.sciencedirect.com
ScienceDirect
Remote Sensing of Environment 107 (2007) 625–638
Remote Sensing of Environment
www.elsevier.com/locate/rse

The colour of the Mediterranean Sea: Global versus regional bio-optical algorithms evaluation and implication for satellite chlorophyll estimates

G. Volpe [a,*], R. Santoleri [a], V. Vellucci [b], M. Ribera d'Alcalà [b], S. Marullo [c], F. D'Ortenzio [d]

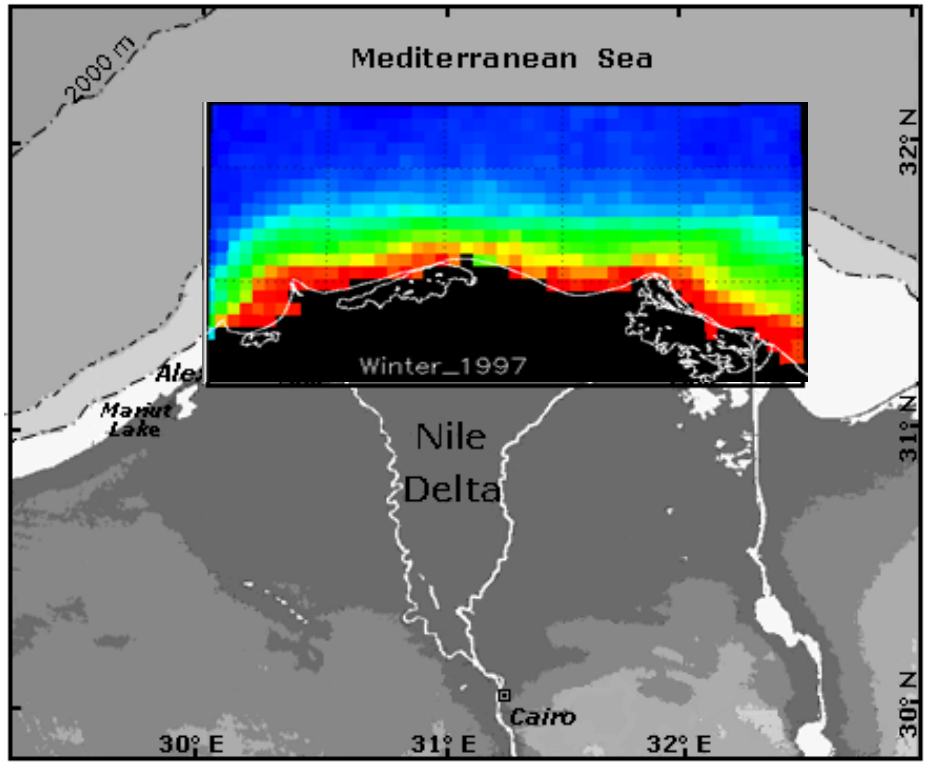
[a] *Istituto di Scienze dell'Atmosfera e del Clima (ISAC), Roma, Italy*
[b] *Stazione Zoologica 'A. Dohrn' (SZN), Napoli, Italy*
[c] *Ente per le Nuove tecnologie l'Energia e l'Ambiente (ENEA), Dipartimento Ambiente, CR Frascati, Frascati, Italy*
[d] *Observatoire de Villefranche sur Mer, Villefranche, France*

Received 11 August 2006; received in revised form 19 October 2006; accepted 21 October 2006

It is a 4th order polynomial expression based on the OC4 functional form (O'Reilly et al., 1998, 2000), but the coefficients are locally determined for the Mediterranean Sea.

$$Chl_{MedOC4} = 10^{(0.4424 - 3.686R + 1.076R^2 + 1.684R^3 - 1.437R^4)}$$

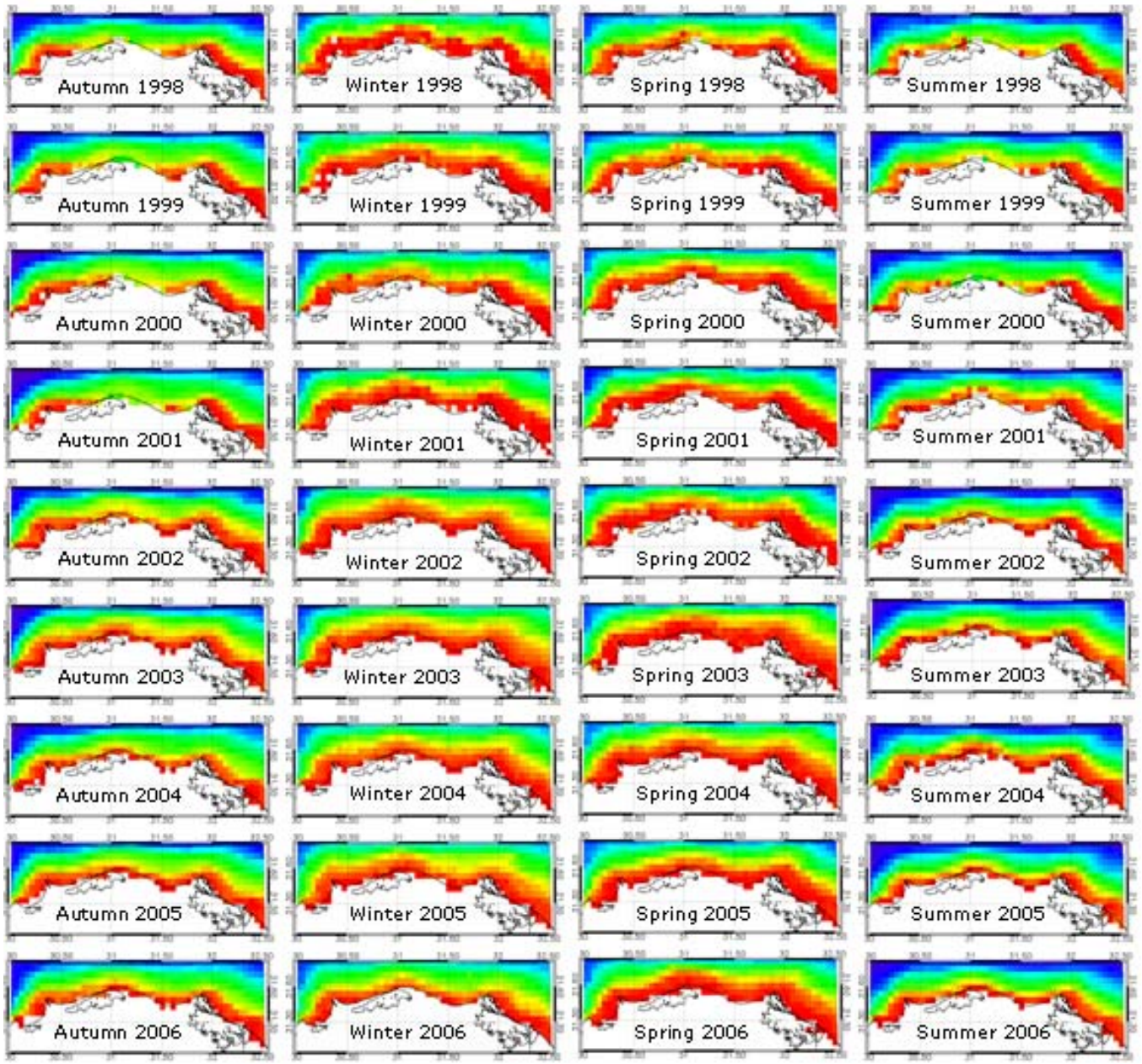
Where, $R = \log_{10}(\max(\rho 443, \rho 490, \rho 510)/\rho 555)$



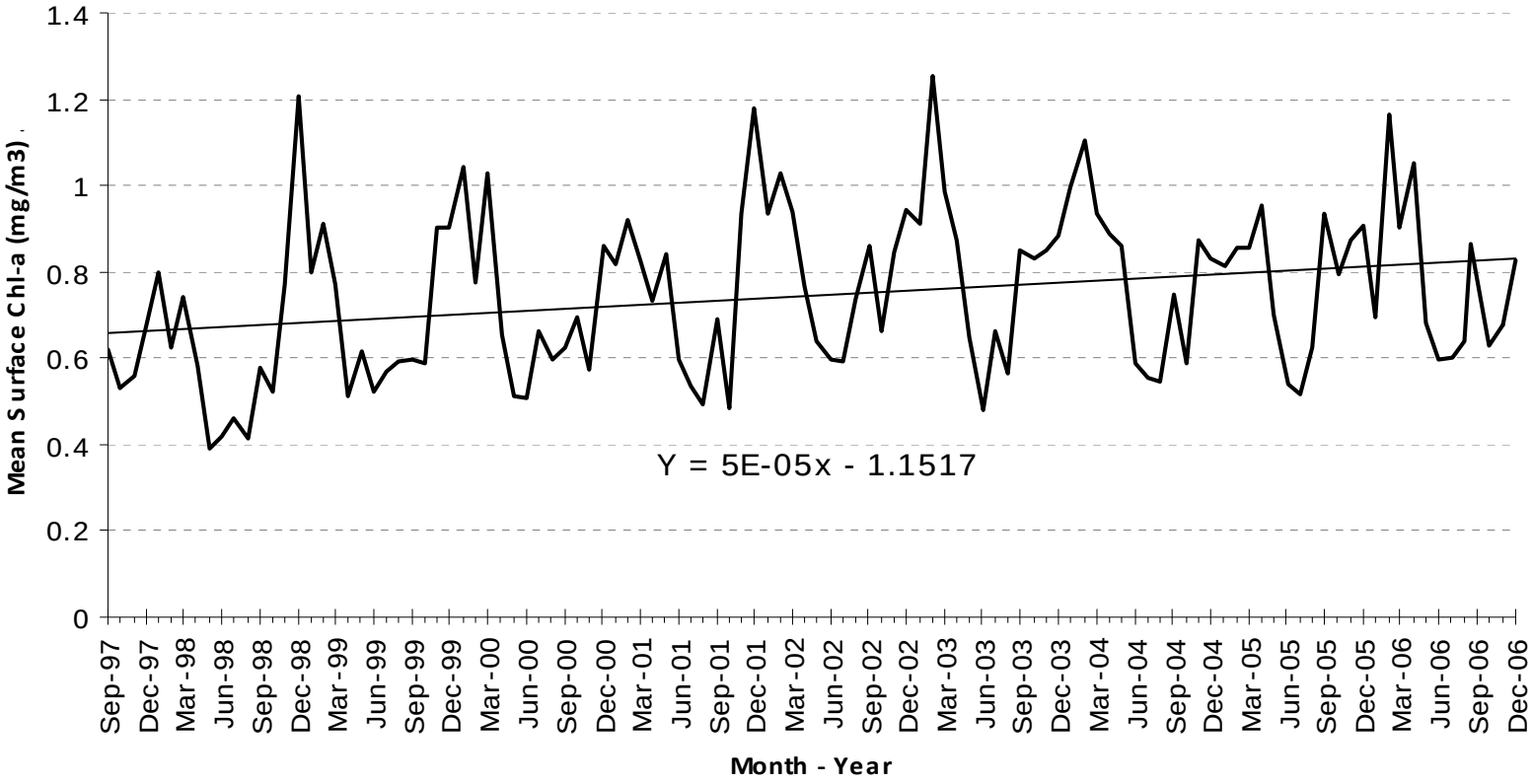
It is a 4th order polynomial expression based on the OC4 functional form (O'Reilly et al., 1998, 2000), but the coefficients are locally determined for the Mediterranean Sea.

$$Chl_{MedOC4} = 10^{(0.4424 - 3.686R + 1.076R^2 + 1.684R^3 - 1.437R^4)}$$

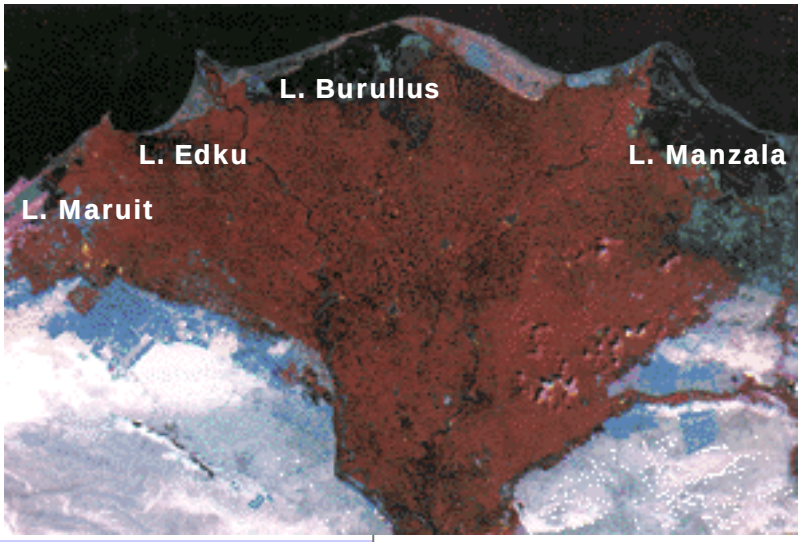
Where, R = $\log_{10}$ (max (ρ443, ρ490, ρ510)/ ρ555)

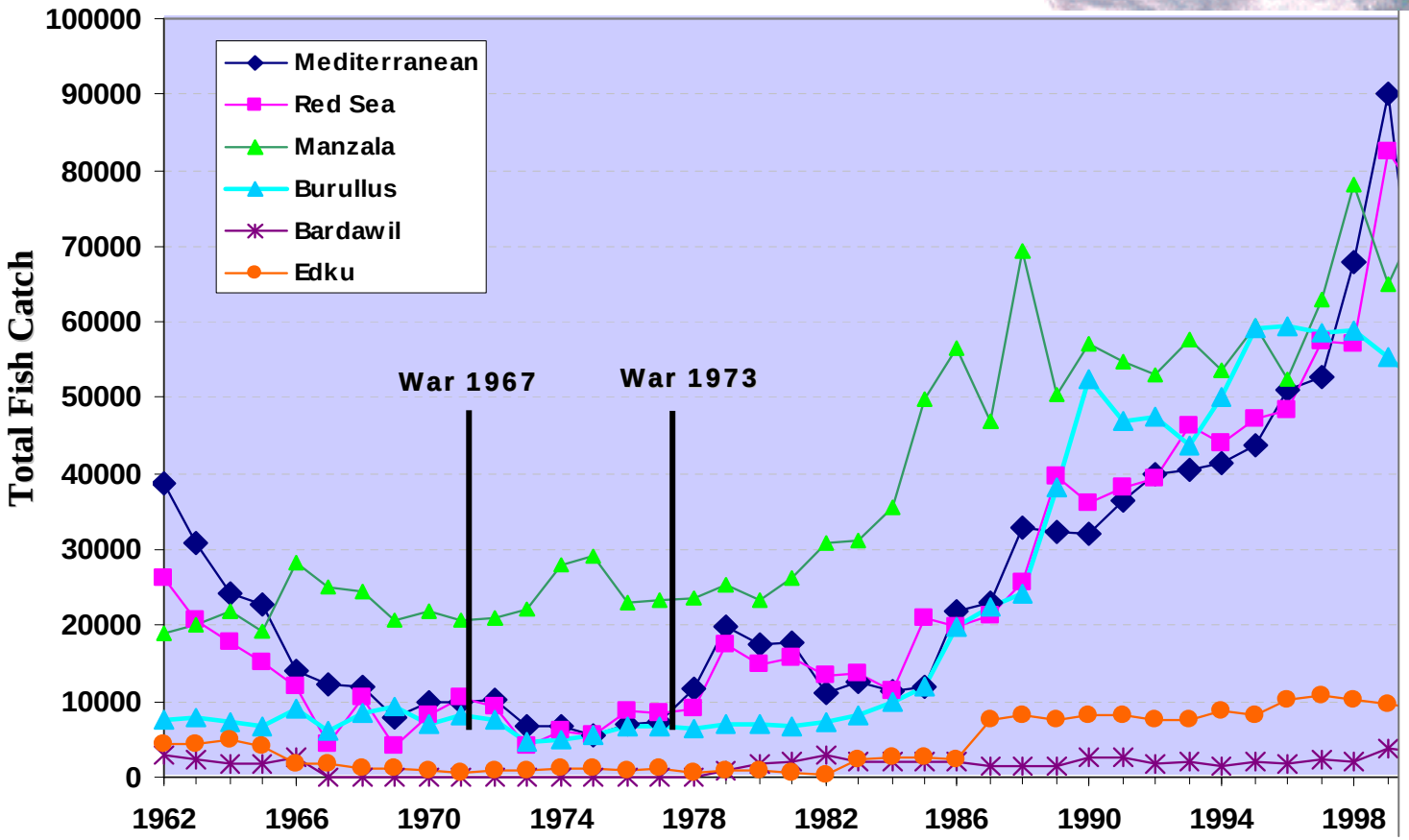

Autumn 1998
Winter 1998
Spring 1998
Summer 1998
Autumn 1999
Winter 1999
Spring 1999
Summer 1999
Autumn 2000
Winter 2000
Spring 2000
Summer 2000
Autumn 2001
Winter 2001
Spring 2001
Summer 2001
Autumn 2002
Winter 2002
Spring 2002
Summer 2002
Autumn 2003
Winter 2003
Spring 2003
Summer 2003
Autumn 2004
Winter 2004
Spring 2004
Summer 2004
Autumn 2005
Winter 2005
Spring 2005
Summer 2005
Autumn 2006
Winter 2006
Spring 2006
Summer 2006
CHL_MedOC4 [mg/m³]
0.01
1.67
3.34
5.01
6.67
8.34
10.00

Recent trend and variability of surface chl-a in the Nile delta shelf

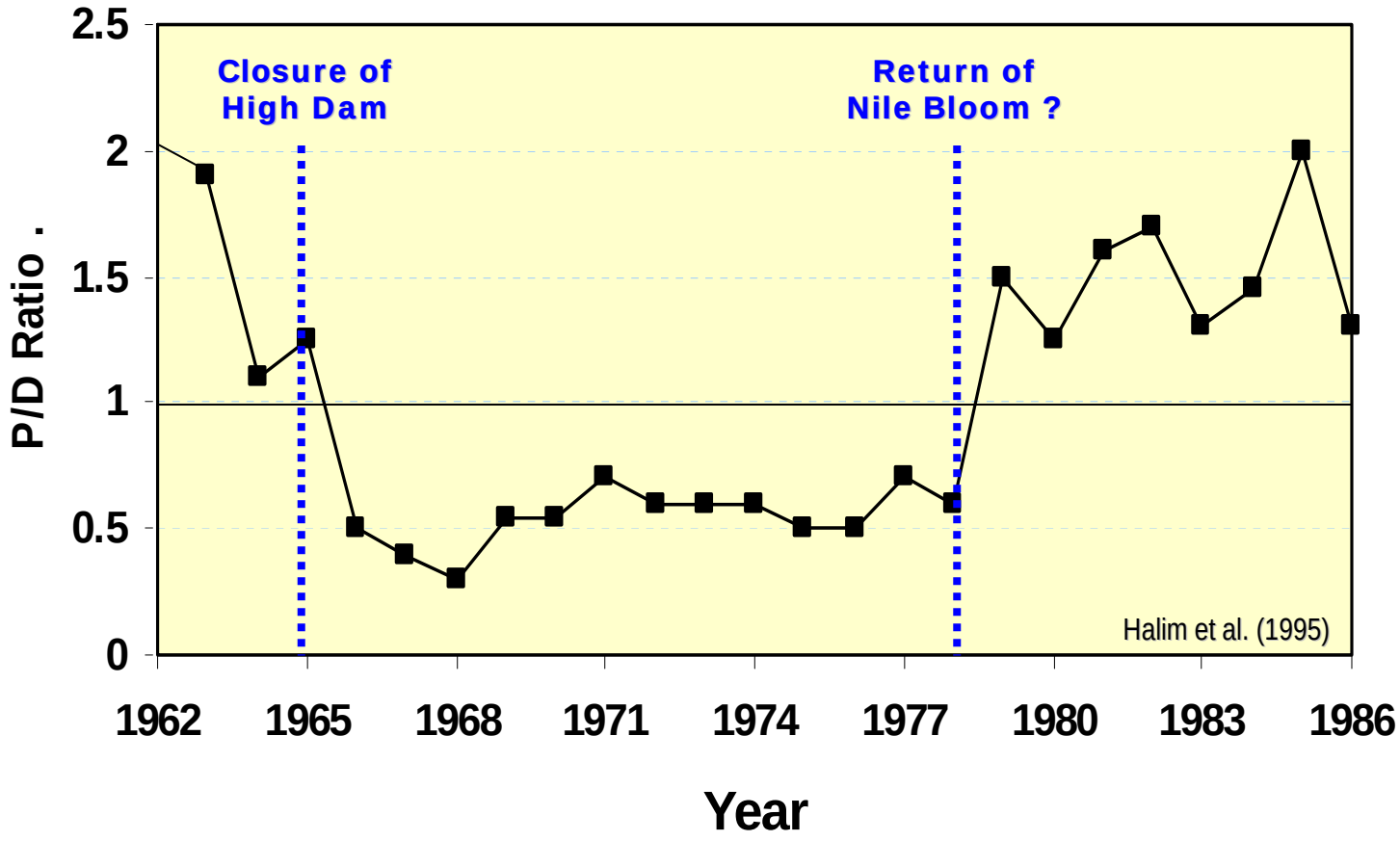


Approach 2: Results





P/D Ratio


2.5
2
1.5
1
0.5
0
P/D Ratio .
Closure of
High Dam
Return of
Nile Bloom ?
Halim et al. (1995)
1962
1965
1968
1971
1974
1977
1980
1983
1986
Year

Conclusions

- **There is more than one qualitative and quantitative evidence tend to support the nutrient loading theory for of rise of the Egyptian marine fisheries since early 1980s.**

- **Therefore, we agree with Nixon (2003) that the increases in the Egyptian marine fisheries are so large and sustained that they must reflect more than improved accounting and increased effort.**

- **The upward trend of chl-a conc in the coastal area off the Nile delta may be linked with the ever-increasing human activities along the coast.**

- **The MedOC4 bio-optical algorithm, despite being validated in the SE Mediterranean, still needs validation within the Nile bloom region and strengthens the urgent need for a regular monitoring programme within the Egyptian Mediterranean shelf and more specifically in front of the Nile Delta.**

- **Additional analysis have to undertaken at a regional or local level in order to better understand impacts of anthropogenic activities on fishery ecosystem of the Nile delta.**

Acknowledgements:

- UK Royal Society & POGO Secretariat for support
- Plymouth University (UK) for supplying some facilities
- Dr. Sam Lavender (from UoP) for collaboration & support

Thank You!