

FINAL REPORT

ON

**"Analysis, Visualization and Retrieval of Remotely Sensed
Data on Ocean Colour of Waters around Sri Lanka."**

Submitted by

**Dr. (Mrs.) K.K.A.S. Yapa
Department of Physics
University of Ruhuna
Matara**

NSF Grant No: RG/98/P/001

Period of Contract: 15.01.1998 - 15.01.2000

FR 1059

FINAL REPORT

A. (a) **Contract Number:** RG/98/P/001

(b) **Title of Project:**

Analysis, Visualization and Retrieval of Remotely Sensed Data on Ocean Colour of Waters around Sri Lanka.

(c) **Institute:** University of Ruhuna

(d) **Chief Scientific Investigator:** Dr. (Mrs.) K.K.A.S. Yapa

(e) **Date of award of the grant:** 15.01.1998

(f) **Date of completion:** 15.01.2000

(g) **Total Allocation:** Rs. 298,000.00

For 1998

Personnel (RA) Rs. 84,000.00

Equipment Rs. 120,000.00

Consumables Rs. 10,000.00

For 1999

Personnel (RA) Rs. 84,000.00

(h) **Total Spent:** Rs. 227,390.00

Personnel (RA)

For 1998 Rs. 77,000.00

For 1999 Rs. 35,000.00

Total **Rs. 112,000.00**

Equipment - following items have been purchased

(I) IBM 4.3 GB HDD SCSI 50PIN Hard Disk Rs. 25,000.00

(II) YAMAHA CRW4X4X16S SCSI CD drive Rs. 45,000.00

(III) INITIO PCI SCSI card and a Four head SCSI cable Rs. 8,000.00

(IV) Memory upgrade from 64 to 128 Mb Rs. 27,240.00

Consumables

(I) Five CD's (re-writable) Rs. 3,750.00

(II) 40 writable CD's Rs. 6,400.00

Total **Rs. 115,390.00**

Grand Total **Rs. 227,390.00**

(i) **No. of research assistants:** 01

Period of service: 16 months - Full time

Part time since June 15th 1999

(j) RA has registered for M.Phil. degree since May 1998

2. **Description of research carried out:**

Processed sea surface chlorophyll data of waters around Sri Lanka from Coastal Zone Colour Scanner (CZCS) was available for the period 1978-1986. A database was developed to include these processed data in a user friendly viewing environment with the help of Visual Basic software which comes under Visual Studio software package. At the moment users are required to be physically present in the Department of Physics, Univ. of Ruhuna, to gain access to the database. The user is required to give his/her name, official address, phone number, email address and a user selected password for the registration at the first visit to the database. Once registration is accepted the user is given a username. Registered users can access the database giving the user name and the password.

A User can select the type of data (e.g. Chlorophyll, SST etc.) to visualize and then he/she can select one file at a time for viewing with their choice of year and date. (Though the satellite operated for about 9 years, there were many days of missing data due to many reasons). All data files are within the area of latitudes between 4.5N-11N and longitudes between 78E-84.5E of the ocean surrounding Sri Lanka. While visualizing a user is able to select a smaller area of interest, enlarge for better viewing, if needed, and to extract all or any portion of data that has been selected. User has the option of selecting an area with the mouse or by giving upper left corner and the bottom right corner of coordinates (lat. and long.). All files included in the database are in ASCII format for the benefit of users. The output files will have the same format as the original file. Selected data will be first stored in the hard disk and then the user may select to write into floppy diskettes or to a compact disk depending on the size of the data.

As processed SST (Sea Surface Temperature) data are available for the period between Jan. 1996-June 1997, steps will be taken to include these into the database as well. Steps are already taken to include access of the database via Internet using Internet Explorer software. Writing programmes to do this task has begun and we hope to complete within next month. The department of physics does not have direct access to Internet at present time. The University of Ruhuna has taken measures to give direct Internet access to all its departments and the work has begun accordingly. This networking project is expected to complete by end of June, 2000.

3. **Results obtained and discussions:**

At present, only sea surface chlorophyll data from CZCS are included in the database. Once a user registers to use the database, the other steps need to be followed for viewing, extracting, etc. are very clearly indicated. For any user who is familiar with the window environment

will be able to handle and use the database. Some of the viewing pages of the database are attached under the section B of this report.

The graphics interface is somewhat slow even with 128MB memory. A full picture takes about 3-5 seconds to appear on the screen. This can't be improved without upgrading the hardware itself.

A paper titled "Construction of a database of processed remotely sensed data of waters around Sri Lanka" was presented at 55th SLAAS Annual Meeting held in December 1999. (A copy of the published proceedings is attached). Full details are given in the section B of this report.

The database is expandable to include processed data from current and future satellites as well. We expect to process raw data from the current SeaWiFS satellite (for colour data) and NOAA satellite (for SST data) under a project funded through NRC and we hope to include these data in the database as well. Use of remotely sensed data in research and industry is still new in Sri Lanka. However, data included in this database will be useful to interested scientists for many years to come.

4. **Conclusions drawn:**

A user-friendly, database of remotely sensed colour data (from CZCS) of waters around Sri Lanka has been setup with easy access and extraction of data to one's interest. Users will be able to access the database via Internet after June, 2000. The address of the web-site will be informed to NSF as well.

The database will be updated with the images from the new satellite (SeaWiFS) as soon as we start processing them.

We will be able to purchase, through the NRC grant a new graphics software (IDL) which is especially suitable for satellite image processing, visualizing and analysis. The statistical analysis of the images that we expected to include in this database will be done with that software as current analysis software we have is not capable to handle these large data matrices. (However, histograms, averages etc. for a selected area of smaller size, which would be only a small portion of the original data file, are currently being programmed to include in the database (as an option) using visual basic programming).

5. **[A] Citation:**

K.K.A.S. Yapa, K.G.S. Champika and S.C. Jayewardane 1999. Construction of a database of processed remotely sensed data of waters around Sri Lanka. Abstract. Pages 201-202, Proceedings of Sri Lanka association for the advancement of science, Part I. 55th annual session, 29 Nov - 03 Dec 1999. SLAAS, Colombo.

[B] Other relevant literature references:

- (1) Web site for image processing: <http://www.mathworks.com/products/image>
- (2) Learning Visual Basic 5.X - Level 6
- (3) NASA web site: <http://daac.gsfc.nasa.gov>
- (4) NOAA web site: <http://www.saa.noaa.gov>

(5) Internet programming with Visual Basic 6

6. An explanation of any significant departure from the level of activity foreseen by the contract:

About 80% of the database development has been completed. Only portion that remain to be done is providing access to the database via internet, inclusion of processed SST data (these data needs to be reformatted) and inclusion of detailed statistical analysis of a picture while viewing. As it was mentioned earlier the internet programming work is currently underway. Even without these facilities any interested user can view and extract ocean colour data by visiting the Dept. of Physics, University of Ruhuna. As I stated in the last progress report the student who worked under this project, Ms. K.G.S. Champika, is working on the project only part-time now and therefore work got delayed. Since this project needed special knowledge on computers and also on computer languages it is difficult to find a replacement. As Ms. Champika was already registered for the M.phil. degree and she continued to show her interest on working on the project, I allowed her to work during her free times. I again apologize for the delay.

B. SUMMARY

Title of Project:

Analysis, Visualization and Retrieval of Remotely Sensed Data on Ocean Colour of Waters around Sri Lanka.

Research Institute: University of Ruhuna

Chief Scientific Investigator: Dr. (Mrs.) K.K.A.S. Yapa

Period of Contract: 15.01.1998 - 15.01.2000

Scientific Background and Scope/Objectives of the Project:

Monitoring world oceans using multi-spectral scanning devices aboard earth-orbiting satellites, have been in practice for many years by scientists in the field of oceanography. Synoptic views from remote sensors offer spatial and temporal variability of valuable oceanographic parameters such as surface temperature and surface chlorophyll concentration in large areas of the ocean, which would have been impossible to achieve using research vessels. Ocean colour is an indicator of sea surface chlorophyll concentration and it is affected by marine plants, suspended sediments and dissolved organic matter. Ocean colour data are considered to be very critical by the oceanographic community for the study of ocean primary production and ocean biogeochemistry. The concentration of microscopic marine plants, phytoplankton, can be derived from satellite observation and quantification of ocean colour. Thus it is a valuable tool to assess the ocean's role in the global carbon cycle and the exchange of other critical elements and gases between the ocean and the atmosphere.

Coastal Zone Colour Scanner (CZCS), designed to monitor ocean colour was operational during the period 1978-1986. CZCS has supplied a wealth of synoptic views of colour of large areas of the world's oceans at a spatial resolution of about 1km square. An impressive archive of data is available at NASA's data archive center for processing and analysis. The derived chlorophyll maps from ocean colour data can be used in many areas of oceanographic research. Few examples are,

- a) to estimate primary productivity of ocean waters
- b) to identify areas of upwelling
- c) to identify fishing grounds, etc.

I had a rare opportunity to visit Bedford Institute of Oceanography (BIO), Dartmouth, Canada with a kind invitation from Dr. Trevor Platt (Head/Biological Oceanography Division) and with a visiting scientist award granted by START (a global change SysTem for Analysis, Research and Training) in Washington DC, USA, during summers of 1996 and 1997. There I processed CZCS raw data (1978-1986) of waters surrounding Sri Lanka and NOAA data (Jan. 1996-Jun. 1997) and made surface chlorophyll-a and temperature maps. As this information is immensely valuable to scientists who work in the fields such as fisheries, oceanography, meteorology, etc. we decided to share it with the scientific community in Sri Lanka by developing a database with these data. Our goal was to setup the database, which include all processed chlorophyll data in a user-friendly manner with easy access and easy extraction of data to one's interest.

Experimental Method:

We used Visual Basic software in the Visual Studio package as the programming language in setting up the database. At the moment users are required to be physically present in the Department of Physics, Univ. of Ruhuna, to gain access to the database. The user is required to give his/her name, official address, phone number, email address and a user selected password for the registration at the first visit to the database. Once registration is accepted the user is given a username. Registered users can access the database giving the user name and the password.

A User can select the type of data (e.g. Chlorophyll, SST etc.) to visualize and then he/she can select one file at a time for viewing with their choice of year and date. (Though the satellite operated for about 9 years, there were many days of missing data due to many reasons). All data files are within the area of latitudes between 4.5N-11N and longitudes between 78E-84.5E of the ocean surrounding Sri Lanka. Each data file is about 6Mb capacity. While visualizing a user is able to select a smaller area of interest, enlarge for better viewing, if needed, and to extract all or any portion of data that has been selected. User has the option of selecting an area with the mouse or by giving upper left corner and the bottom right corner of coordinates (lat. and long.). All files included in the database are in ASCII format for the benefit of users. The output files will have the same format as the original file. Selected data will be first stored in the hard disk and then the user may select to write into floppy diskettes or to a compact disk depending on the size of the data.

As processed SST (Sea Surface Temperature) data are available for the period between Jan. 1996-June 1997, steps will be taken to include these into the database as well. Steps are already taken to include access of the database via Internet using Internet Explorer software. Writing programmes to do this task has begun and we hope to complete within next month. The department of physics does not have direct access to Internet at present time. The University of Ruhuna has taken measures to give direct Internet access to all its departments and the work has begun accordingly. This networking project is expected to complete by end of June, 2000.

Results obtained:

We have completed the database with CZCS processed data. Some pages that a user sees while accessing the database are attached. The abstract of the paper presented at SLAAS Annual Sessions, 1999 is attached as well.

Conclusions:

A user-friendly, database of remotely sensed colour data (from CZCS) of waters around Sri Lanka has been setup with easy access and extraction of data to one's interest. Users will be able to access the database via Internet after June, 2000. The address of the web-site will be informed to NSF as well.

The database will be updated with the images from the new satellite (SeaWiFS) as soon as we start processing them.

We will be able to purchase, through the NRC grant a new graphics software (IDL) which is especially suitable for satellite image processing, visualizing and analysis. The statistical analysis of the images that we expected to include in this database will be done with that software as current analysis software we have is not capable to handle these large data matrices. (However, histograms, averages etc. for a selected area of smaller size, which would be only a small portion of the original data file, are currently being programmed to include in the database (as an option) using visual basic programming).

Papers Published on work done under the contract:

K.K.A.S. Yapa, K.G.S. Champika and S.C. Jayewardane 1999. Construction of a database of processed remotely sensed data of waters around Sri Lanka. Abstract. Pages 201-202, Proceedings of Sri Lanka association for the advancement of science, Part I. 55th annual session, 29 Nov - 03 Dec 1999. SLAAS, Colombo.

Grantee(s) signature:



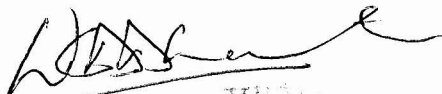
Dr. (Mrs) K.K.A.S. Yapa

Dr. S.C. Jayewardena
(on sabbatical leave as of March, 99)

Comments of the Head of the Department:

Quite useful piece of work.

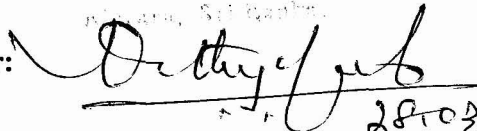
Signature of the Head of the Department:



22/03/2000

Department of Earth
University of Ruhuna
Matsara, Sri Lanka.

Signature of the Vice-Chancellor:



28/03/00

Vice-Chancellor
University of Ruhuna
Matsara
Sri Lanka

Welcome to the Data Base of Remotely Sensed Ocean Data of Waters Around Sri Lanka

*Developed and Maintained by
Dept. of Physics, University of Ruhuna, Matara, Sri Lanka*

This data base contains processed CZCS (Coastal Zone Colour Scanner) Ocean Color data (period between 1978-1986) and NOAA (National Oceanic and Atmospheric Administration) Sea Surface Temperature (SST) data (period between Jan 1996 - June 1997). All data files are in ASCII format. Users who are interested in viewing or obtaining any portion of the data must register before accessing the data base. All data are free of charge.

We hope you find these data worthwhile.

Note: Steps will be taken to include data from present SeaWiFS and NOAA Satellites.

Enter As Registered User

Enter As New User

Registration

Please Fill this Form and Press "Submit" Button.

Last Name

First Name

Password

Password Verily

Official Address

Phone No:

Email

Submit

Cancel

Username

Your Username

ruby1

Please don't forget your "Username" and "Password". Whenever you access our database, you need "Username" and "Password".

OK

Username and Password Required

Enter "Username" and "Password" for Registered User

Username

Password

Submit

Cancel

File Searching

Select the Data Type

- Chlorophyll Concentration
- Sea Surface Temperature
- Wind

Sea Surface Chlorophyll-a concentrations are derived from visible wavelength bands of C2CS on board Nimbus-7 Satellite. (One data point represents an area of about 1 square km of ocean surface). Chlorophyll-a concentration is the parameter which is used in calculating primary production of ocean waters.

Select the Date

Date

Year
Month
Day

Relevant File is:

Close

Date

Please Select the Date

Year:

Month:

Day:

Day

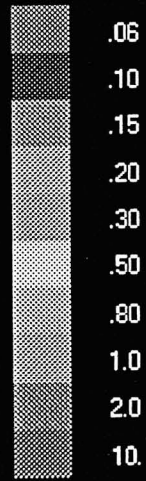
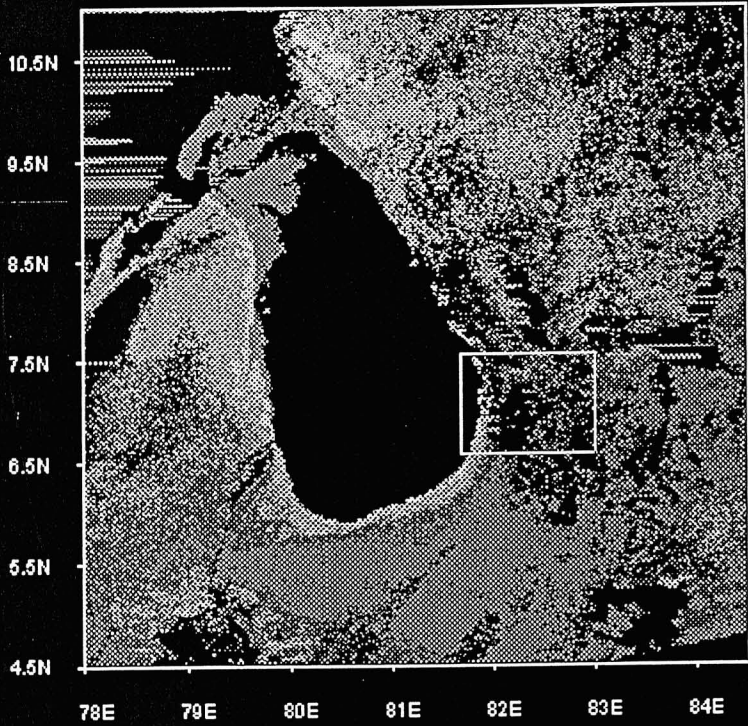
January 1981

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

OK

Map

19 Jan 1981



mg Chl m-3

- Draw
- Display
- Zoom
- Save
- Close
- Home

Select Area

X

Y

Upper Left Corner
Coordinates

Bottom Right Corner
Coordinates

OK

Cancel

Help

Save File as

File Name

Save

Cancel

Save as Type

.dat

.txt

dopant precursor. Variations of AC and DC conductivities of the compressed pellets with the temperature are studied in the temperature range from 150 °C to 350 °C.

The conductivity of doped TiO₂, which is purely electronic, increases by three to four orders of magnitude. The temperature dependence is Arrhenius type, ($\sim 10^{-9} \Omega^{-1} \text{cm}^{-1}$ to $\sim 10^{-5} \Omega^{-1} \text{cm}^{-1}$ at 330 °C). In addition, unlike the previously studied dopant precursors, the conductivity varies with Cr₂O₃ concentration. The highest conductivity is obtained when the Cr₂O₃ concentration is about ~5 - 6%.

The activation energy of the doped sample, which is reduced significantly (by ~70%) as a result of doping, is in the range of 0.31 - 0.35 eV depending on the dopant concentration. Furthermore, it is very interesting to note that the activation energy varies with the dopant concentration within the above range and the lowest activation energy is obtained when the conductivity is highest. The enhancement of conduction properties is due to the excess electrons, which contributes to the conduction band from the dopant.

Financial assistance by University of Ruhuna for grant RU/SF/RP/98/2 is acknowledged.

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Construction of a database of processed remotely sensed data of waters around Sri Lanka

K K A S Yapa¹, K G S Champika¹ and S C Jayewardane²

¹Dept. of Physics, University of Ruhuna, Matara

²Dept. of Computer Science, University of Ruhuna, Matara

Remotely sensed data such as ocean colour and sea surface temperature have broad applications in fields such as oceanography, fisheries and meteorology. We have processed remotely sensed raw data of 1 km resolution from CZCS (operated between 1978-1986) obtained through NASA of waters around Sri Lanka.

The final data set includes sea surface chlorophyll-a concentrations covering the area of latitudes between 4 5N-11N and longitudes between 78E-85E for relatively cloud free days within the above period. A user friendly, database is constructed to include these processed data for the benefit of scientists in Sri Lanka.

Visual Basic, running in dos/windows environment, is used as the primary software in building the database. Users are able to visualize available data, select areas of interest and extract all or portions of data according to their interest. All processed data are in ASCII format, enabling easy access for users.

Processed sea surface temperature data from NOAA 12 and NOAA 14 satellites will be included in the database as well. The database is expandable to include any such remotely sensed data from present and future satellites. Also, steps will be taken to include other oceanographically important measured parameters such as surface wind and ocean currents, as available. Interested persons may be able to obtain permission to access the database by contacting the authors.

Financial assistance by NSF for research grant RG/98/P/001 is acknowledged.

E1 27

Behaviour of longitudinal movements of OLR field over the Indian ocean during the time period of 1974 - 1990

N B P Punyadeva and W L Sumathipala

Department of Physics, The Open University of Sri Lanka, Nawala, Nugegoda.

This investigation focuses on the longitudinal movements of Outgoing Longwave Radiation (OLR) field over the Indian ocean during the time period of 1974/ 1990 in the belt from 10° N to 10° S latitude and 30° E to 110° E longitude with the use of time-longitude sections. It is found that the OLR field over this region exhibits two behavioural types of longitudinal movement. During the period, 1974 - 1982, it shows dry condition type movement (low convective activity) and from 1983 - 1990, it shows wet condition type longitudinal movement (high convective activity).

Considering the period from 1974 - 1982, the lowest convective activity occurred in 1976 and highest convective activity took place in 1984 and 1988. From the end of the year 1975, low convective activity has started to move eastward till the end of the year 1976. During this time period there are three type of El-Nino events (1976 - 1977, 1982 - 1983, 1986 - 1987). The pattern of OLR behaviour in 1976/1977 and 1986/ 1987 is different from that of 1982/ 1983.

It is worthy to note that the two El-Nino events 1976/ 1977 and 1986/ 1987 show opposite type of OLR behaviour with compared to 1982/ 1983 El-Nino event. During the period of 1983 - 1990, year to year behaviour of OLR was similar except for the El-Nino event that took place in 1986/ 1987. In 1976 - 1977 and 1986 - 1987, OLR show dry condition type (low convective activity) longitudinal movement and 1982 - 1983 shows wet condition type (high convective activity) longitudinal movement in the region. Comparing these three events together (76 - 77, 82 - 83, 86 - 87) it can be seen that the OLR field alternates between dry condition to wet condition in 5 - 6 year.

FINANCIAL REPORT FOR THE PERIOD FROM 02.06.1998 TO 31.01.2000

		TOTAL EXPENDITURE			
		Up to 02.06.98	During the Period	Up to 31.01.2000	Balance as at 31.01.2000
Grant total					
	298,000.00	-	227,390.00	227,390.00	70,610.00
Total	<u>298,000.00</u>	-	<u>227,390.00</u>	<u>227,390.00</u>	<u>70,610.00</u>


Details of funds received during the period


Name of the institution - National Science Foundation	Cheque no	Amount	Date
	992173	151,000.00	02.03.98
	905221	42,000.00	17.08.98
	926985	60,000.00	10.02.99
	663099	45,000.00	22.10.99
		<u>298,000.00</u>	

Details of payments during the period

Personnel (R.A.)	Equipment (Local)
112,000.00	115,390.00
	<u>227,390.00</u>

Date: 2000/02/16

Bursar: 

 Dr. K.K.A.S. Yapa
2000/03/15