



राष्ट्रीय पृथ्वी विज्ञान अध्ययन केन्द्र  
NATIONAL CENTRE FOR EARTH SCIENCE STUDIES

पृथ्वी विज्ञान मंत्रालय, भारत सरकार  
*Ministry of Earth Sciences, Govt. of India*

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Dr. K. Sreelash  
Scientist D

11/01/2024

**Internship Certificate**

This is to certify that **Ms. Anaswara A** Register No: **61522100002**, MSc Environmental Sciences student., All Saints' College, Trivandrum has carried out her internship project titled **"EVALUATION OF SUBMARINE GROUNDWATER DISCHARGE (SGD) INDUCED CHANGES IN CHLOROPHYLL CONTENT IN THE TRIVANDRUM DISTRICT USING REMOTE SENSING"** under my guidance at the National Centre for Earth Science Studies, Akkulam during the period from 21<sup>st</sup> December, 2023 to 11<sup>th</sup> January, 2024. During her internship Ms. **Anaswara A** has been trained on using remote sensing data for analysis of ocean chlorophyll content. During the period of internship works, she was found to be punctual, hardworking, and inquisitive.

(K. Sreelash)

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# **EVALUATION OF SUBMARINE GROUNDWATER DISCHARGE (SGD) INDUCED CHANGES IN BIOLOGICAL GROWTH IN TRIVANDRUM DISTRICT USING REMOTE SENSING.**

## **INTERNSHIP REPORT**

Submitted to  
National Centre for Earth Science Studies



Submitted by  
Anaswara A  
61522100002



DEPARTMENT OF ENVIRONMENTAL SCIENCES  
ALL SAINTS' COLLEGE,  
THIRUVANANTHAPURAM  
DECEMBER 2023- JANUARY 2024

## **DECLARATION**

I hereby declare that this dissertation entitled **“EVALUATION OF SUBMARINE GROUNDWATER DISCHARGE (SGD) INDUCED CHANGES IN BIOLOGICAL GROWTH IN TRIVANDRUM DISTRICT USING REMOTE SENSING** “is a record of bonafide study carried out by me under the supervision of Dr. K Sreelash, Scientist D, National Centre for Earth Science Studies, Akkulam, Thiruvananthapuram and that no part of this work has previously been presented for any other degree or diploma in any university.

January 2024

Thiruvananthapuram

Anaswara A

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I take this opportunity to thank Asha Rani, Project Fellow, NCESS for her support for the completion of my project.

Thiruvananthapuram

Date: 10.01.2024

Anaswara A

## ABSTRACT

SGD is a hydrological process of coastal areas in which submarine inflow fresh and brackish groundwater takes place from land to sea. SGD mainly occurs due to freshwater release from land to sea as base flow as well as overflow through the unconfined aquifer medium. SGD is also characterized by a unique biogeochemical signature compared to other sources, owing to the biogeochemical Submarine groundwater discharge (SGD) is important for understanding the hydro-geological of transformations occurring in the coastal aquifer. SGD supplies solutes to the coastal ocean, which directly impact the productivity of coastal ecosystems. SGD can also supply dissolved contaminants to the coastal ocean derived from anthropogenic sources (e.g., agriculture, industrial, mining activities, domestic wastewaters), which can endanger the coastal ecosystems and the well-being of local population living around them. The aim of the present study is to identify the SGD induced changes in biological activity mainly variation in chlorophyll-a content in the coastal waters of Varkala region, Kerala.

**Key Words: Submarine Groundwater Discharge, Chlorophyll-a, Aqua MODIS**

## INTRODUCTION

The coastal zone is the most important part and most intensively used area compared to all other areas settled by humans in the world. The exchange of groundwater between land and sea is a major component of the hydrological cycle. This exchange, called submarine groundwater discharge-Willard S. Moore (2010)(5) SGD is the net groundwater discharge to the ocean, which comes essentially from aquifer recharge. The marine and coastal ecosystems are economically important. Remote sensed images can play an important role in coastal area management, by providing the synoptic view of the landscape. Phytoplankton microscopic, free-floating, marine organism and are consist of chlorophyll which convert sunlight into energy. As the chlorophyll content increase the image become more greenish. Phytoplankton are the primary producers of marine ecosystem. The algal blooms were found to be substantially influenced by the seasonal-nutrients flux and discharge location. Our study is expected to increase the understanding of a rarely reported eco-hydrological response to terrestrial-marine water interactions and their implications in the tropical ocean adjoining the Indian Subcontinent. Das, K., Debnath, P.,Duttagupta, S. et al. Implication of submarine groundwater discharge to coastal ecology of the Bay of Bengal. J Earth Syst Sci 129, (1)

increased phytoplankton growth due to presence of optimum growth conditions(light and nutrients) at the subsurface (Cornec et al., 2021; Cullen,2015; Ryan et al., 2010; Beckmann and Hense, 2007; Huisman et al.,2006, (2)Hodges and Rudnick, 2004), model-based approach has been used to study its formation, maintenance, seasonal and diurnal variability using satellite, bio-Argo floats data and field experiments(Prasanth et al., 2023, 2021; Jayaram et al., 2021, Smitha et al., 2021)(3)Difference in level of submarine ground water discharge result in variation in chlorophyll concentration. Varkala one of the regions in India show submarine ground water discharge. Thus, it is a valid location for study.

## **OBJECTIVES**

- 1.Identifying the point of submarine ground water discharge using satellite image
- 2.studying the change in chlorophyll -a concentration at the point of SGD
- 3.Analysing the monthly data of variation in chlorophyll -a concentration in the year2018 using satellite image.

## **STUDY AREA**

Trivandrum is the capital city of Kerala, and it is in the southern end of Kerala. The location consists different type of beaches and coastal areas. Many regions of Trivandrum show submarine groundwater discharge. Thus, the location has crucial role in hydrological cycle. The areas are high geological significance by the presence of unique geological formation. The following figures 2(a),2(b),2(c) represent the study location.

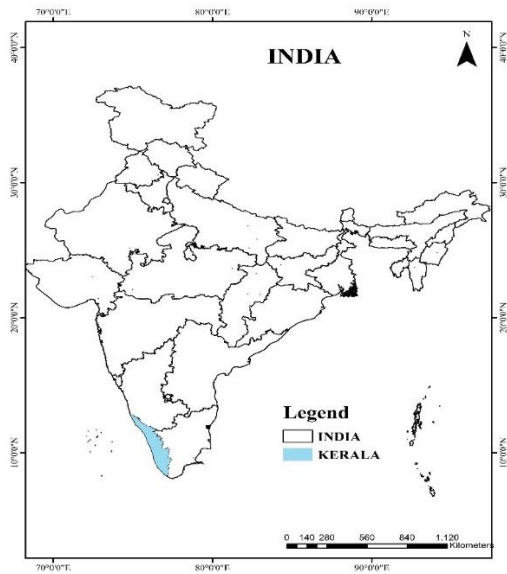


Figure 2 (a).

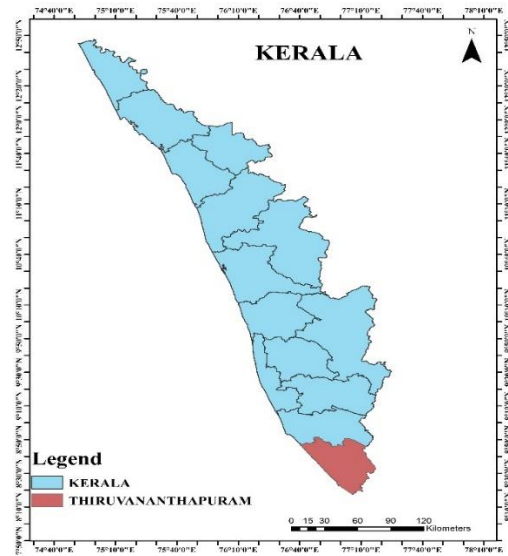


Figure 2 (b)

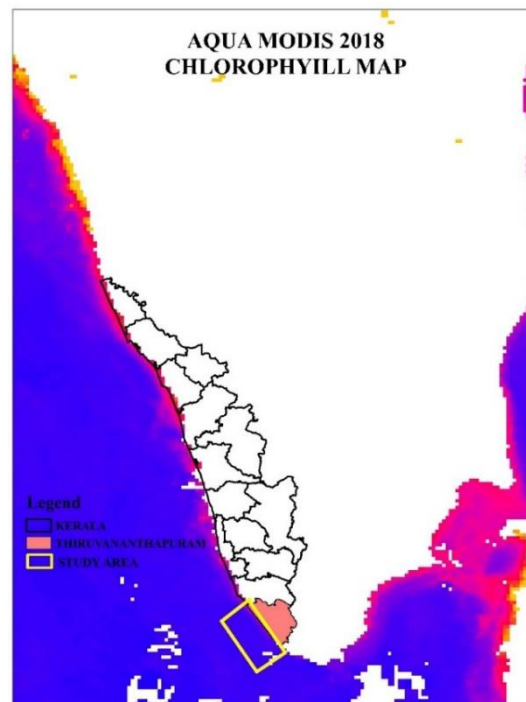
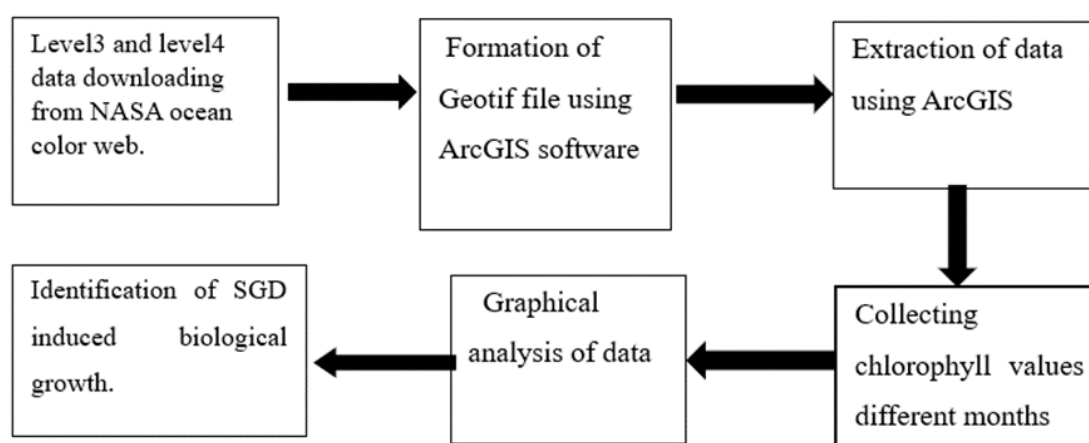


Figure 2 (c).

Figure 2 (a)(b)(c): Figure showing the area selected for the study

## METHODOLOGY

In the study various methodologies are followed. The methodology starts with acquisition of data, mainly level 3 and level4 browser data from NASA Ocean colour web, specifically Aqua-modis satellite images are collected. Data span in monthly temporal scale, and have a spatial resolution of 4 kilometres, covering entire month of 2018 in the next step start processing of collected data using ArcGIS software. The data collected from Aqua -modis is in the format of .nc and it is converted into Geotif format using the tool present in ArcGIS toolbox. It is followed by extraction using ArcGIS toolbox. The study area identified and extracted, high and low values of chlorophyll-a of each month of 2018 noted. The extracted data are arranged for map formation with suitable scale. In the next step attribute table of corresponding months are calculated using conversion tool. After analysing the attribute tables suitable Excel sheet created result in graph formation which show monthly chl-,a concentration variation at selected point.



*Figure 1. Methodological flowchart for the data acquisition, processing and analysis of Chlorophyll content*



## OBSERVATION AND RESULT

In this study, the submarine ground water discharge in Varkala region is identified using satellite images. The location with SGD show colour variation in satellite images. The submarine groundwater discharging locations contain nutrients which promote biological growth. Thus, variation is seen in chlorophyll value and is detected by colour change. The location of ocean associated submarine groundwater discharge contain high chlorophyll content. Along with Varkala places like Vettoor, Anchuthengu, Perumathura, Kochuveli contain relatively high chlorophyll content. Seasonal variation and surface temperature also affect the chlorophyll content. The following map show monthly variations in chlorophyll content in the year 2018.

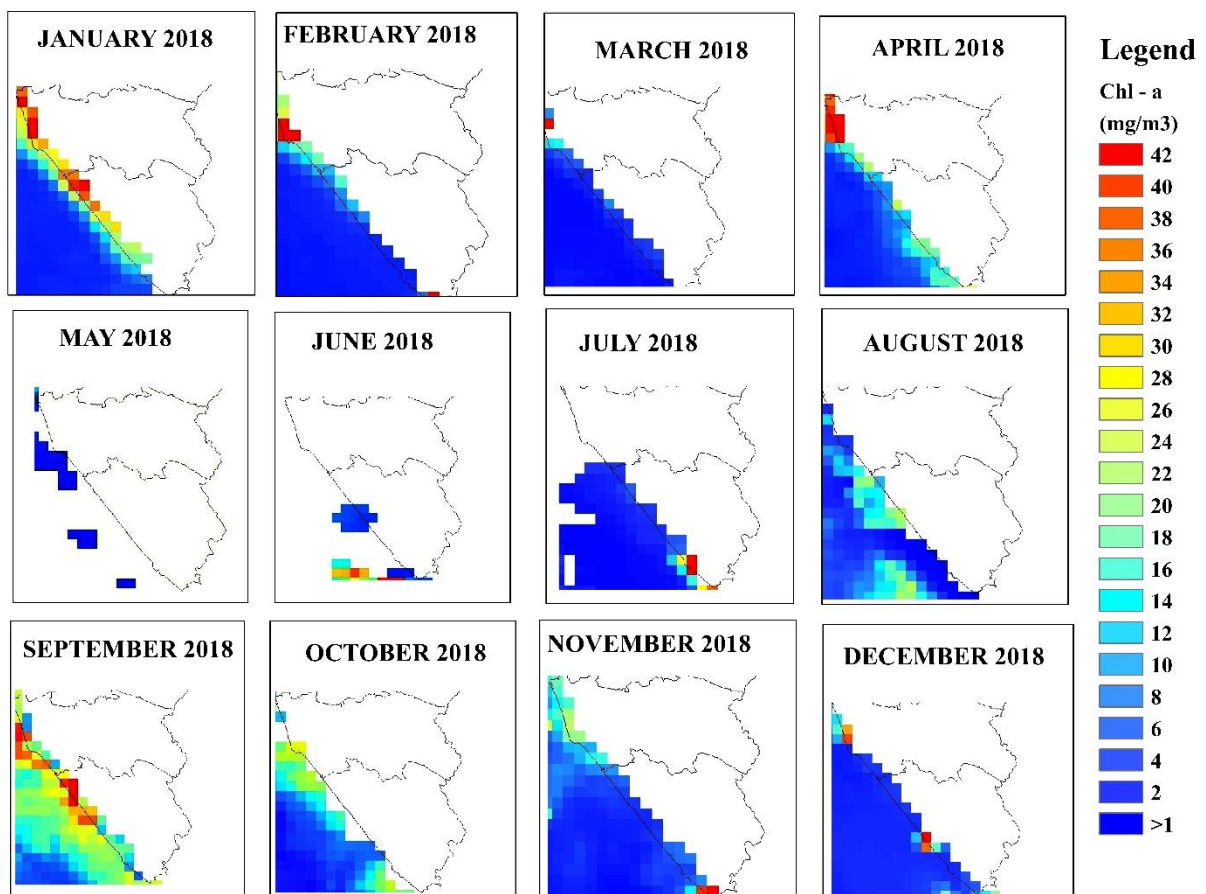
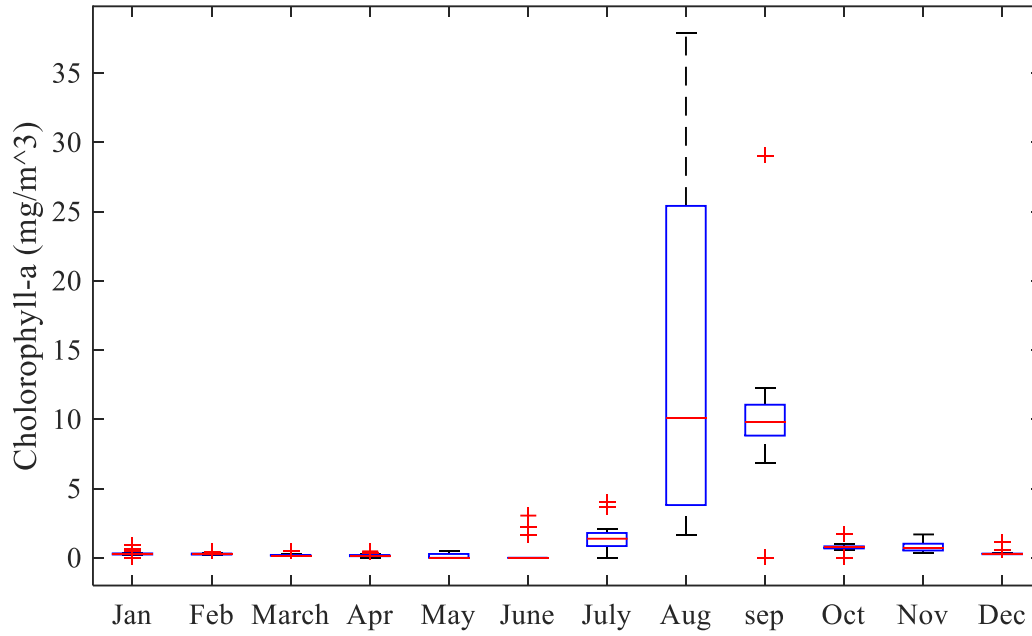
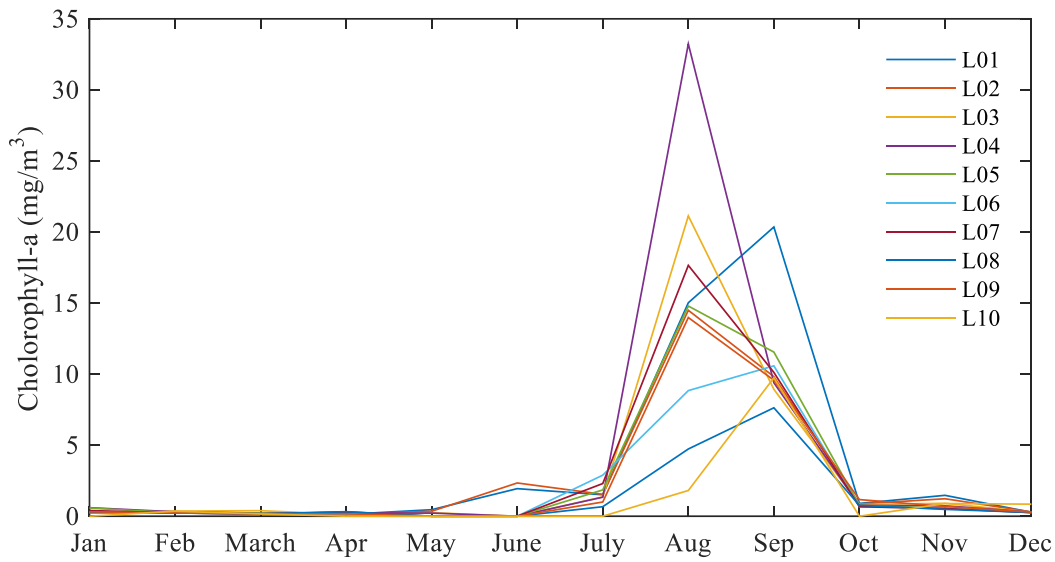


Figure 3: Map showing the monthly variation in chlorophyll-a (in mg/m<sup>3</sup>) in the study area



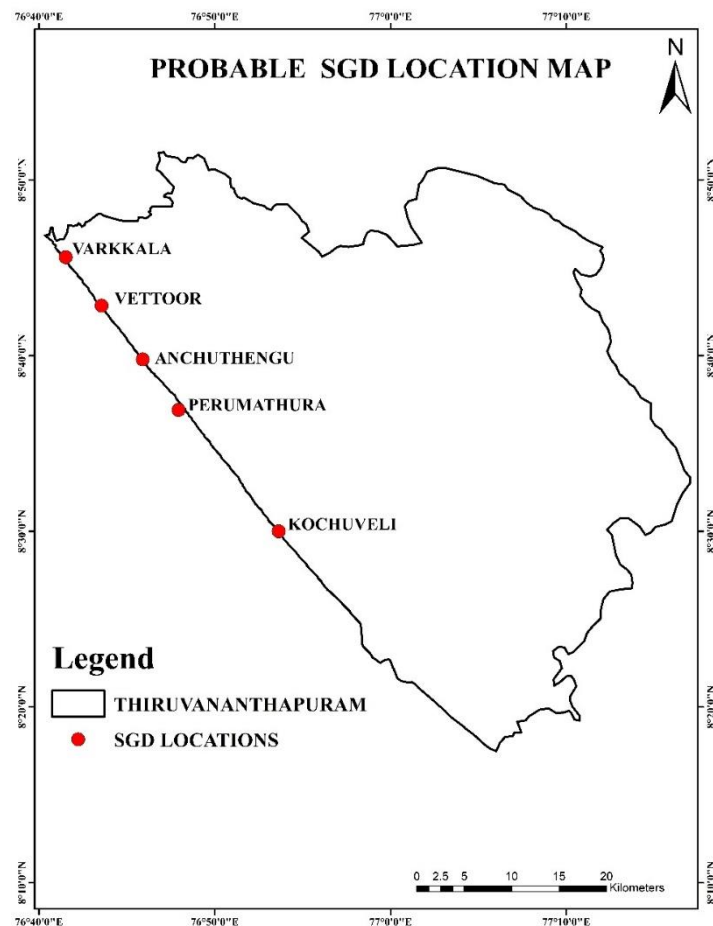
*Figure 4: Boxplot showing the variation of Chlorophyll-a along the coastal regions of Trivandrum District*



**Figure 5:** Spatio-temporal variation of Chlorophyll-a along the coastal regions of Trivandrum District. Locations L01 to L10 indicate the locations from North to South of Trivandrum coast

## DISCUSSION

The detailed analysis of the chlorophyll-a along the Trivandrum coasts showed five probable locations for SGD. Varkkala, Vettoor, Anchuthengu, Perumathura and Kochuveli in the Trivandrum district showed relatively higher chlorophyll-a content as compared to the other regions. Since the groundwater is relatively richer in nutrients it is expected that the SGD zone – where groundwater mixes with sea exhibit a relatively larger biological productivity than the surrounding waters. Hence Varkkala, Vettoor, Anchuthengu, Perumathura and Kochuveli regions can be inferred as indicating the possibility of SGD occurring along these regions. However seasonal variations in chlorophyll-a were also evident in the region. A detailed assessment has to be carried out using a time series of multi-satellite ocean color data (over several years) to delineate the spatial extent of the SGD zones. This further need validation with in-situ biological measurements on the identified zones.



**Figure 4:** Probable SGD locations of Trivandrum district.

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