



# “ENABLING DYNAMIC GEOSPATIAL DATA QUERY AND ACCESS THROUGH PLUGIN INTERFACE IN QGIS: IMPLEMENTATION AND EVALUATION”

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## ABSTRACT

All over the world, organizations are increasingly considering the adoption of open source software and open data. In the geospatial domain, this is no different, and the last few decades have seen significant advances in this regard. Focusing on the Open Source Geospatial Foundation (OSGeo) software ecosystem and its communities, as well as three kinds of open geospatial data (collaboratively contributed, authoritative and scientific). The current state confirms that openness has changed the way in which geospatial data are collected, processed, analysed, and visualized. A perspective on future developments, informed by responses from professionals in key organizations in the global geospatial community, suggests that open source geospatial software and open geospatial data are likely to have an even more profound impact in the future. This report delves into the development and implementation of a plugin interface tailored to streamline the querying and accessing of geospatial data within the QGIS environment. Central to this endeavour is the RIDaM (Raster Analytic System for Interactive Data Modelling) plugin, strategically crafted to tackle the complexities of dynamic data. Characterized by their diverse styling and features across various datasets and algorithms, dynamic data poses a significant challenge in terms of seamless integration and interaction. In response, RIDaM emerges as a pivotal intermediary, bridging the gap between QGIS and the multifaceted services it encounters. By harmonizing disparate styling and features, RIDaM empowers users with a cohesive platform for accessing and manipulating geospatial information effortlessly. This integration not only enhances user experience by simplifying data access but also ensures compatibility with QGIS's native interface, thus fostering a more intuitive and efficient data modelling environment. Through the adoption of RIDaM, this report underscores a pivotal stride in enhancing the accessibility and usability of geospatial data within the QGIS ecosystem. By facilitating smoother interactions with dynamic datasets, RIDaM not only optimizes the workflow for data analysts and GIS professionals but also lays the groundwork for more robust and informed decision-making processes. Its seamless integration with QGIS underscores a commitment to user-centric design, ensuring that advancements in geospatial technology are readily accessible and easily navigable. In essence, the implementation of RIDaM represents a significant leap forward in harnessing the full potential of geospatial data within QGIS, ultimately paving the way for more innovative and impactful data modelling endeavours.

**Keywords:** Geospatial Foundation, Raster Analytic System for Interactive Data Modelling, Data Modelling Environment, Algorithm Service.

## INTRODUCTION

One of the most popular open-source GIS platforms, Quantum Geographic Information System (QGIS), is well known for being user-friendly and flexible. QGIS, which was first created by a passionate group of programmers, has developed into a powerful toolkit that is employed in many different fields, such as disaster management, environmental science, urban planning, and agriculture. One of the key characteristics that distinguishes QGIS from many proprietary GIS solutions is its extensibility. When we talk about QGIS's extensibility, we mean that it can be enhanced and customized by creating plugins. These plugins give users the ability to modify QGIS to meet their own requirements by introducing new features, instruments,

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and processing powers. In addition, the QGIS Plugin Repository offers an extensive collection of user-contributed plugins, promoting a cooperative atmosphere for innovation and improvement among the QGIS community.

QGIS's extensibility enables users to customize the program to meet a variety of needs and workflows. QGIS's plugin architecture provides unmatched flexibility for a wide range of applications, including automating geospatial analyses, integrating with external data sources, and creating customized tools for specialized uses. Furthermore, QGIS's open-source design promotes cooperation and knowledge exchange, which boosts the platform's capacity and results in ongoing enhancements. All things considered, QGIS's extensibility is essential to both its success and broad use. QGIS lets users take advantage of the full potential of geospatial data for well-informed decision-making and problem-solving across a range of domains by offering a framework for customization and expansion.

### **MOTIVATION FOR DEVELOPING THE PLUGIN INTERFACE**

The purpose of this project is to develop and implement a plugin interface, known as RIDaM (Raster Analytic System for Interactive Data Modelling), within the QGIS environment. The primary objective is to address the challenges associated with querying and accessing dynamic geospatial data. By dynamic data, we refer to datasets characterized by varying styling and features across different datasets and algorithms. This project aims to fill a critical gap in the current geospatial analysis landscape by providing a seamless solution for handling dynamic geospatial data within the QGIS framework. The development of RIDaM is driven by the recognition of the growing complexity and diversity of geospatial datasets, which pose significant challenges for analysts and researchers.

RIDaM serves as an intermediary between QGIS and the diverse services that provide dynamic geospatial data. Its core functionality lies in combining disparate styling and features across datasets and algorithms, thereby facilitating seamless interaction with geospatial information. By integrating different styling and features, RIDaM enhances the accessibility and usability of geospatial data within the QGIS environment, empowering users to effectively analyze and model diverse datasets. In essence, the purpose of this project is to advance the capabilities and usability of geospatial analysis tools within QGIS by addressing the challenges posed by dynamic geospatial data. Through the development and implementation of RIDaM, we seek to empower users with the tools they need to navigate the complexities of dynamic geospatial data and unlock new insights into our ever-changing world.

### **OBJECTIVE OF THE STUDY**

This project's main goal is to create and implement the RIDaM plugin interface inside the QGIS environment in order to solve the difficulties involved in efficiently querying and gaining access to dynamic geospatial data. RIDaM seeks to facilitate the interaction with dynamic geospatial data by acting as a middleman between QGIS and the various services that offer it. To guarantee consistency and coherence in geospatial analyses, this involves harmonizing various datasets' and algorithms' disparate styles and features. The project's ultimate goal is to improve the usability and effectiveness of geospatial analysis tools, giving users the ability to successfully navigate the complexities of dynamic geospatial data and discover fresh perspectives on our constantly shifting world.

### **WMS URL CONSTRUCTION**

The Web Map Service (WMS) protocol is a standardized method for serving georeferenced map images over the internet. Developed by the Open Geospatial Consortium (OGC), WMS enables users to access maps from different sources using a standardized interface. It operates on a client-server model where the client requests map images based on specified parameters, and the server dynamically generates and sends back the requested image. A WMS URL (Uniform Resource Locator) is a web address used to access and interact with Web Map Service (WMS) servers. It serves as a gateway for clients to request map images and metadata from WMS servers over the internet. Typically, a WMS URL consists of several components.

1. Base URL
2. Service Name
3. Query Parameters
4. Other Optional Parameters

By constructing a WMS URL with appropriate parameters, clients can send requests to WMS servers and receive map images and metadata in response. This URL-based approach facilitates the integration of WMS services into various applications, including web mapping portals, geographic information systems (GIS), and custom mapping applications.

**VARIOUS SERVICES**

➤ **Map Services**

**Map Services**  
**URL:** <VEDAS Domain Name>/ridam-services/map/<MAP Protocol>  
**Example:**  
<https://vedas.sac.gov.in/ridam-services/map/wms>

**Usage with parameters(GET Map)**

```
raster_layer = new ol.source.TileWMS({
  projection: 'EPSG:4326',
  url: 'https://vedas.sac.gov.in/ridam-services/map/wms',
  params: {
    layers: '<map_otf_id1>, <map_otf_id2>, ...',
    args: 'key11-val: key12-val: key13-val: ... , key11-val: key12-val: key13-val: ...',
    style: '[0:#122309ff:30]; [30:#0000ffff:255]; nodata: #fff; default: #000, 0: #ffff00; 3: #000; no_data: #fff; no_val: #000, style_id1'
  }
});
```

separator  
 :=>key value                    , => param                    ; => rule/argument

**Operations for WMS Request:**

- GetMap
- GetLegendGraphic
- GetCapabilities

*Fig. 1 Image illustrating about Map service*

➤ **Data Service**

**Data Services**  
**URL:** <VEDAS Domain Name>/ridam-services/data

**Example:**  
<https://vedas.sac.gov.in/ridam-services/data>

**Usage with parameters:**  
**Request:**  
**Method:** POST  
**URL:** <https://vedas.sac.gov.in/ridam-services/data>  
**Parameters:**

- id: <data\_otf\_id> ,
- args: json,

**Response:**  
 {status: Status code, data: Data Array / JSON }

*Fig. 2 Image illustrating about Data Service*

➤ **Meta Services**

**Usage with parameters: (styles)**  
**Request:**  
**Method:** GET  
**URL:** <https://vedas.sac.gov.in/ridam-services/meta/styles>  
**Query Parameters:**

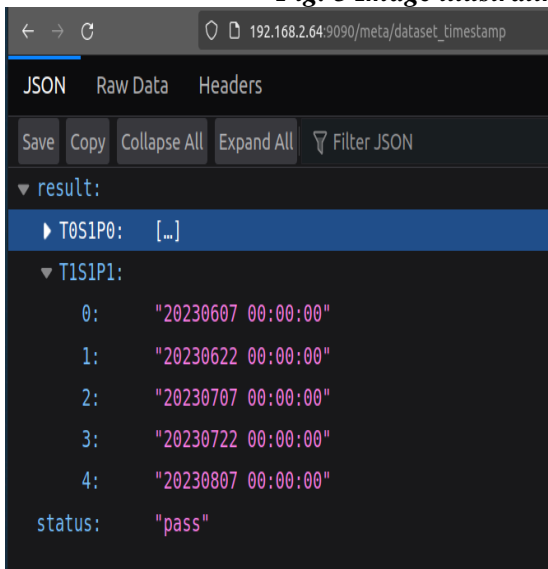
- filter: Registry\_params to filter

**Response:**

```
{
  status: Status code,
  data: Array of registry items satisfying filter criteria
}
```

*Fig. 3 Image illustrating about Service for styles of Meta Service*

*Fig. 4 Image of API for data\_timestamp of Meta Service*



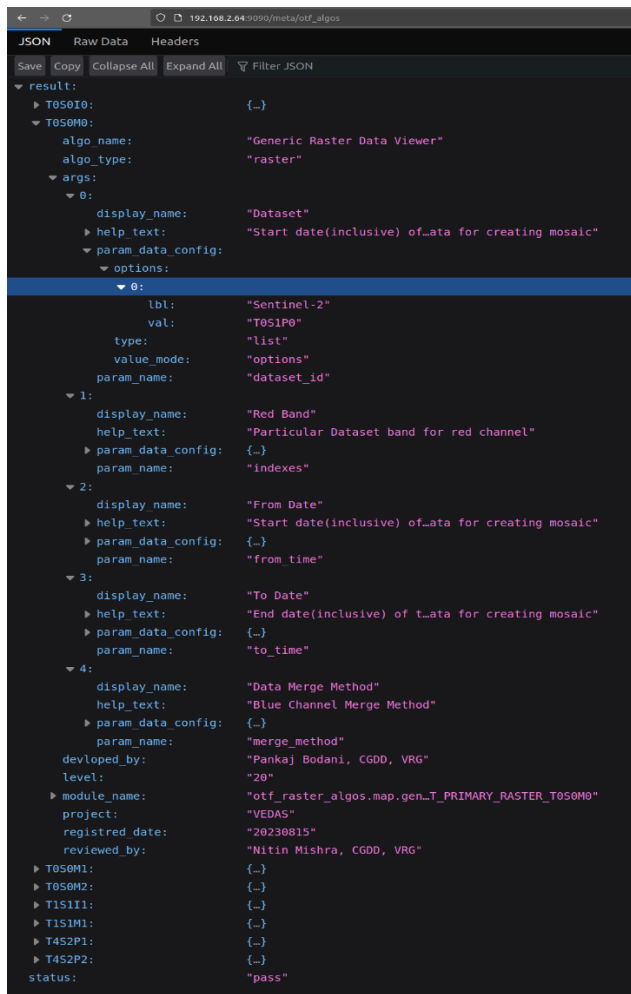


Fig. 5 Image of API for otf\_algos of Meta Service

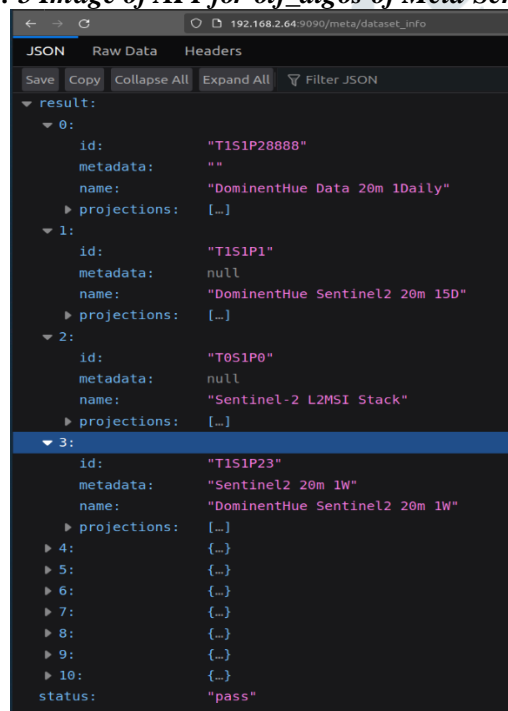


Fig. 6 Image of API for dataset\_info of Meta Service

### SPECTRAL BANDS OF SATELLITE

In terms of spectral bands in satellite data collection, there are several common bands used by satellite sensors. These include visible bands, near-infrared (NIR) bands, shortwave infrared (SWIR) bands, thermal infrared

bands, and microwave bands. Each band corresponds to a specific range of wavelengths within the electromagnetic spectrum and serves different purposes in remote sensing applications, ranging from mapping surface features to measuring temperature variations and detecting thermal anomalies.

The image is a table presenting information about the Sentinel-2 bands, including their central wavelengths in micrometers and resolutions in meters. The bands range from Coastal aerosol (Band 1) with a central wavelength of 0.443 um and a resolution of 60m to SWIR (Band 12) with a central wavelength of 2.190 um and a resolution of 20m. Each band is designated for specific purposes like vegetation monitoring, water vapor detection, and cirrus cloud observation. This table serves as a reference guide for utilizing different bands of the Sentinel-2 satellite imagery for various Earth observation applications.

Sentinel-2 Bands	Central Wavelength (µm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Fig. 7 Table of Spectral Bands of Sentinel-2A Satellite

### RIDaM Implementation

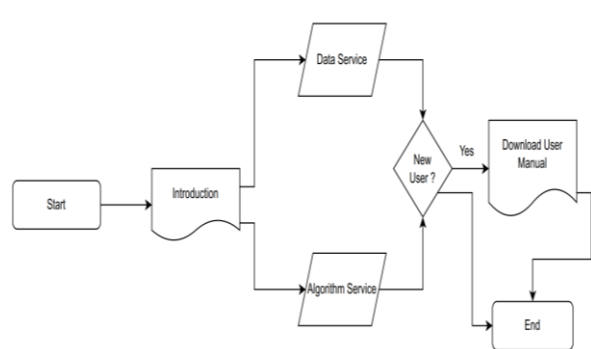


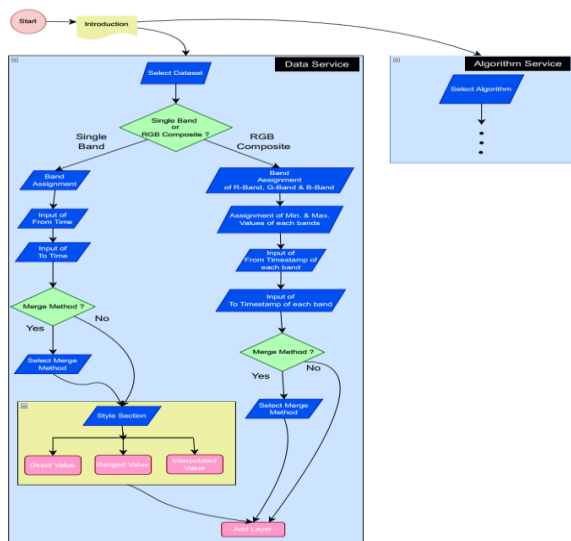
Fig. 9 Flow Chart representing the step-by-step execution of RIDaM plugin

**PLUG-IN IMPLEMENTATION**

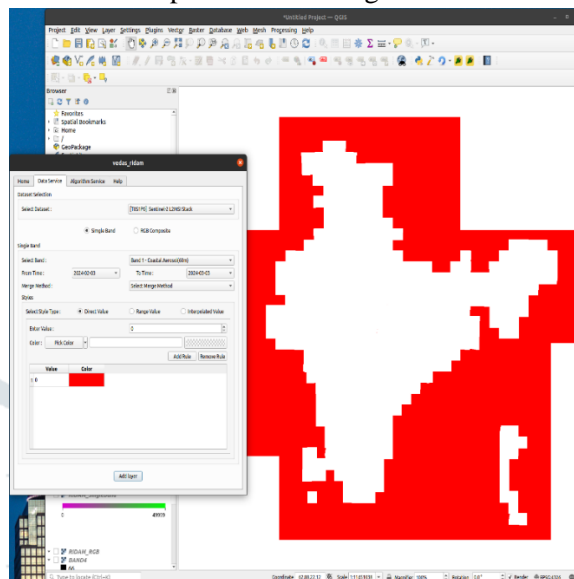
The idea that has led the entire development of the plugin is the following: to give to the user an instrument easy to

use, intuitive to be managed and at the same time flexible to leave the user free to choose the input features.

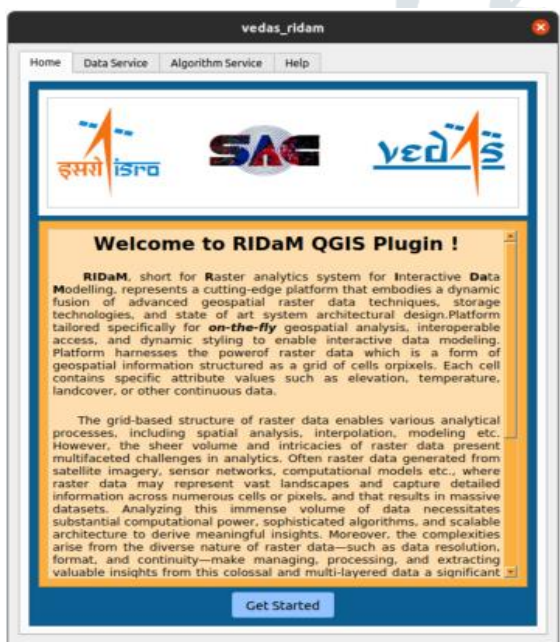
The step-by-step or overall execution of the various RIDaM tabs is depicted in the image below.



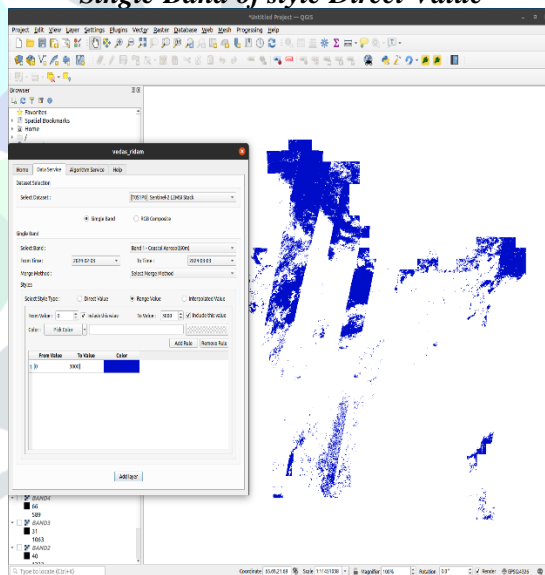
*Fig. 8 Flow Chart representing the step-by-step execution of Data Service Tab of RIDaM Plugin*



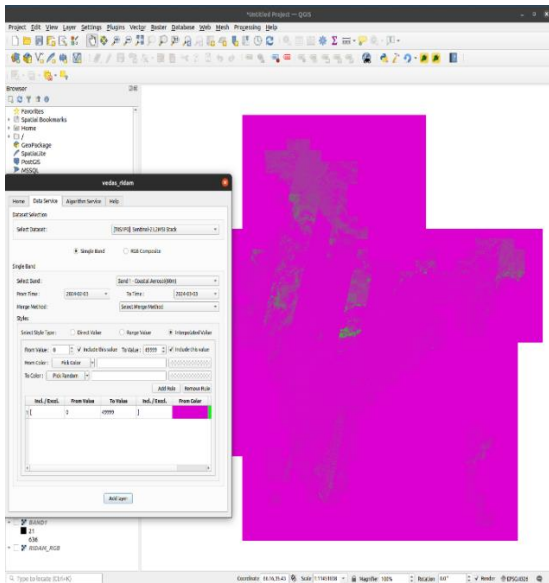
*Fig. 11 Output Image of Raster layer added for the Single Band of style Direct Value*



*Fig. 10 User Interface of Introducton Tab of RIDaM Plugin*



*Fig. 12 Output Image of Raster layer added for the Single Band of style Ranged Value*



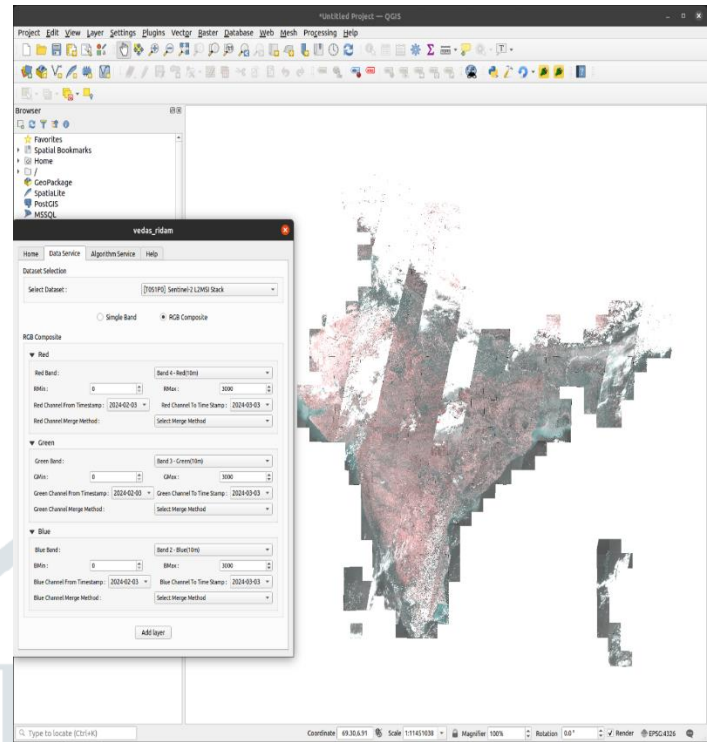
**Fig. 13 Output Image of Raster layer added for the Single Band of style Interpolated Value RGB BAND COMPOSITE**

In QGIS, adding a layer with RGB bands indicates that the raster dataset has data recorded in three different bands: red, green, and blue. Three values, one for each of these bands, are used to represent each pixel in the dataset and together they establish the pixel's color.

These three bands—red, green, and blue—are interpreted in QGIS as the primary colors of light. The raster imagery is displayed in full color by the software by combining the values from these bands. In essence, different intensities of red, green, and blue light are mixed to create the color of each pixel on the map, creating a thorough and aesthetically pleasing representation of the underlying data.

To represent the data between 03-02-2024 and 03-03-2024 (A Month), we have added a raster layer of RGB Band to this result. The minimum and maximum values of each band are 0 and 3000, respectively.

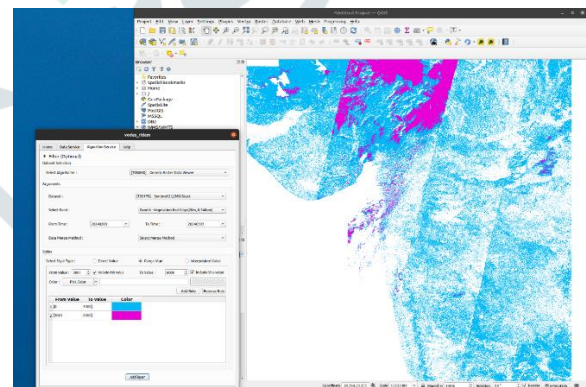
**ALGORITHM SERVICE SECTION**



**Fig. 14 Output Image of Raster layer added for the Algorithm TOS0M1**

**ALGORITHM TOS0M0**

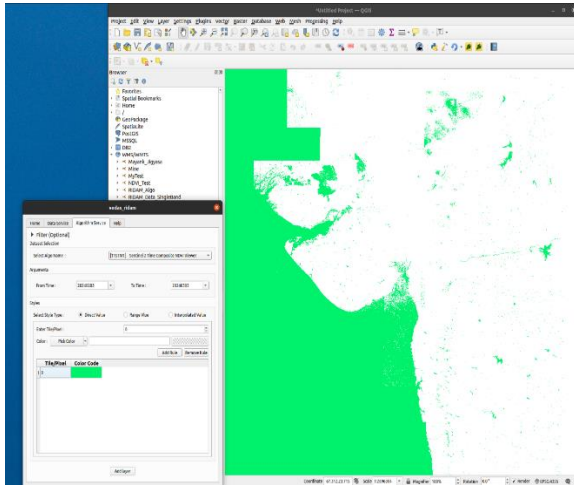
Below shown image is output of raster layer added from the chosen algorithm TOS0M0. As per newly updated GUI from the features provided in the API of algorithm, user needs to fill the data accordingly. Below added raster layer is of TOS1P0 dataset and is of Vegetation Red Edge band which has wavelength of 0740um and central wavelength as 20m. And Data is between 3<sup>rd</sup> February 2024 to 3<sup>rd</sup> March 2024.



**Fig. 15 Output Image of Raster layer added for the Algorithm TOS0M0**

**ALGORITHM T1S1M1**

Below shown image is raster layer added for the chosen algorithm T1S1M1. Which is between the time 3<sup>rd</sup> February 2024 to 3<sup>rd</sup> March 2024.



**Fig. 16 Output Image of Raster layer added for the Algorithm TISIMI**

## CONCLUSION

In conclusion, this project has achieved its goal of developing a plugin tailored for the QGIS environment, focused on facilitating the addition of raster layers. The plugin offers two core services: the Data Service, enabling seamless integration of raster datasets into QGIS projects, and the Algorithm Service, providing users with advanced processing capabilities for raster data within the familiar QGIS interface. Through careful planning, implementation, and testing, the plugin now serves as a valuable tool for simplifying raster data management tasks and enhancing the user experience in QGIS. Moving forward, ongoing maintenance, user support, and potential feature enhancements will ensure the continued usefulness and relevance of the plugin in the evolving landscape of geospatial technology. Overall, this project represents a significant contribution to the QGIS ecosystem, empowering users with efficient tools for working with raster data and advancing their geospatial workflows.

Expanding the project to incorporate vector layer integration represents a promising avenue for future development. While the current implementation of the RIDaM plugin focuses solely on raster data, the inclusion of vector layer functionality would significantly enhance its capabilities and utility within the QGIS environment. Incorporating vector layer integration would entail extending the plugin's architecture to support the querying, retrieval, and visualization of vector-based geospatial data sources. This could involve implementing mechanisms for handling vector data formats such as GeoJSON, Shapefile, or GeoPackage, and integrating them seamlessly with existing raster data functionalities. Overall, the addition of vector layer integration represents an exciting direction for future development, offering enhanced versatility, functionality, and interoperability to the RIDaM plugin. It opens up new

possibilities for geospatial analysis and modeling, paving the way for more comprehensive and integrated solutions within the QGIS ecosystem.

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