Shamba

Release 1.0

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CHAPTER

ONE

ABOUT SHAMBA

Shamba provides the data and tools to build parametric real-world decentralized applications. Whether your application is crop insurance, carbon markets or ESG projects, we provide what you need to power it.

1.1 Our Data

The data we provide is derived from the satellite data of various space agencies. Most biophysical phenomena measured by earth observation satellites can be succinctly described using statistical metrics. As such, our oracle provides descriptive statistics that summarize how a measured value behaved over a given period. The specific metrics we provide are:

- Minimum
- Maximum
- Mean
- Median
- Standard Deviation
- Variance

Using these five metrics any spatial phenomena can be described in an objective and quantitative manner. We run analytics on various datasets to compute these descriptive statistics which can be used (individually or as a group) in smart contract logic.

Aside from statistically describing a dataset, we also provide fire occurrence analysis. More details on both of these analytics are provided in this documentation.

1.2 Our Tools

1.2.1 Insights Tool

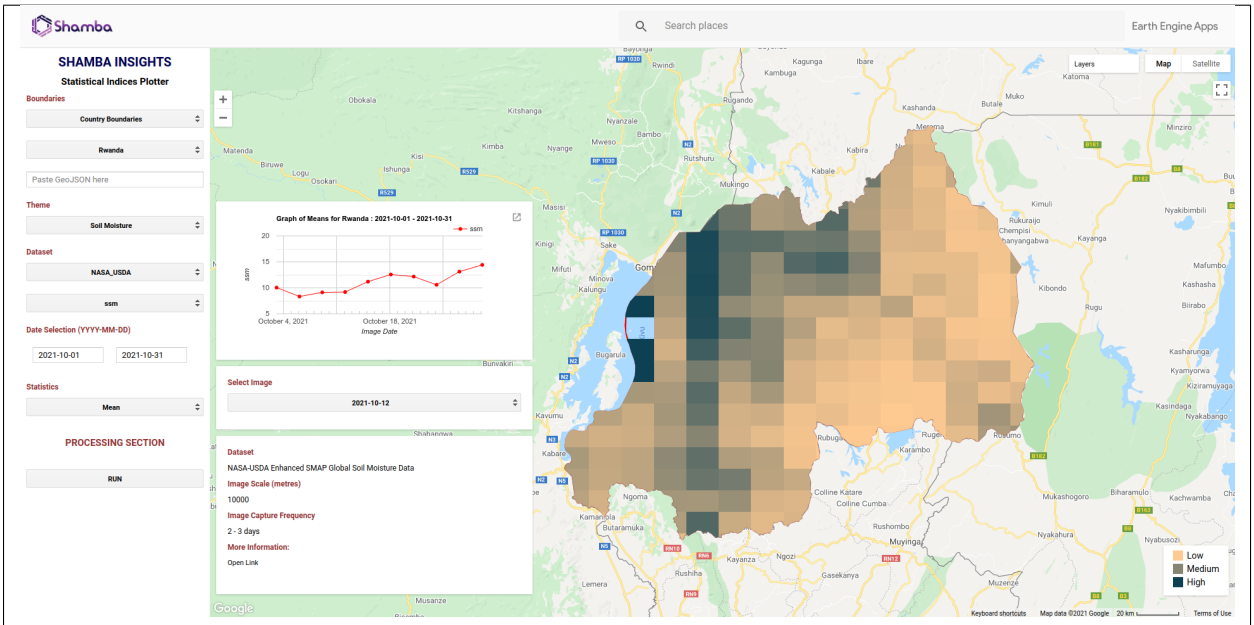


Fig. 1: Insights tool

Explore remote sensing datasets over an area of interest, examining both the temporal and spatial variation using graphs and maps.

1.2.2 Contracts Tool

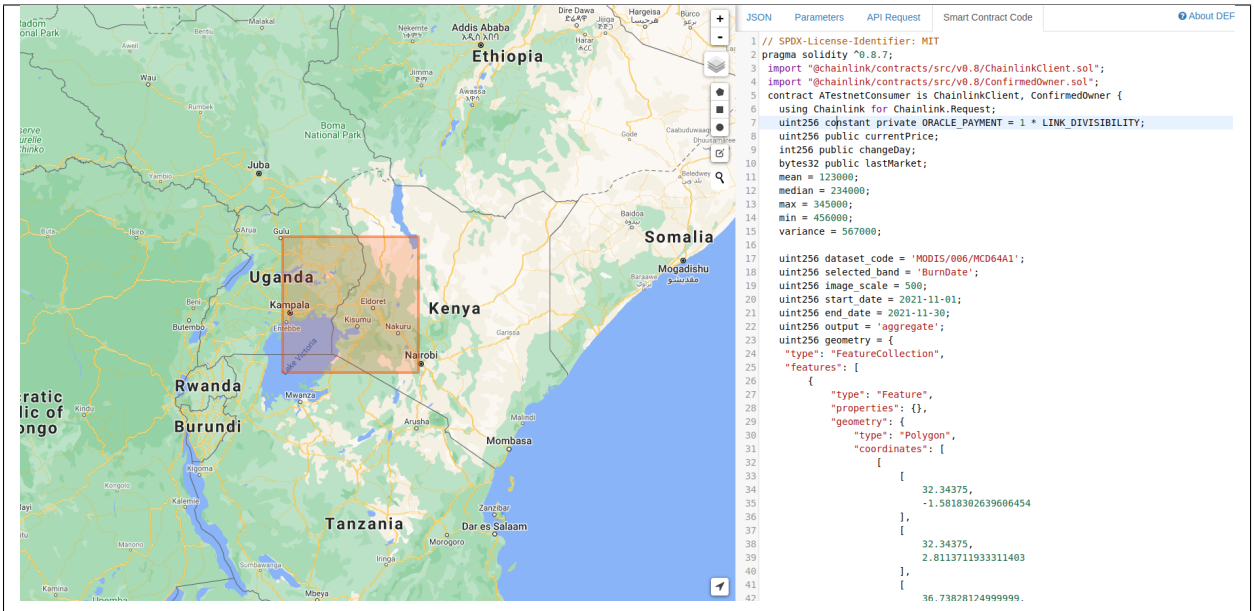


Fig. 2: Contracts tool

Create specifications for a parametric smart contract and generate boilerplate Solidity code that you can extend and customize into any application.

CHAPTER

TWO

QUICK START

Our data is accessible through the Chainlink decentralized oracle network. The table below gives the list of networks supported by our oracle and their corresponding details that you need to specify so as to get data from our oracle. You can visit the Chainlink documentation to learn more about working with their oracle network.

2.1 Shamba Oracle and Chain Ids

Network	ETH_CHAIN_ID	Mainnet Block Explorer for getting API key	Testnet Block Explorer for deployed contract
Avalanche Fuji	43113	https://snowtrace.io/myapikey	https://testnet.snowtrace.io/
Binance Testnet	97	https://bscscan.com/myapikey	https://testnet.bscscan.com/
Ethereum Goerli	5	https://etherscan.io/myapikey	https://goerli.etherscan.io/
Milkomeda-C1 Testnet	200101	https://explorer-devnet-cardano-evm.c1.milkomeda.com/api	https://explorer-devnet-cardano-evm.c1.milkomeda.com/
Moonbase Alpha	1287	https://moonscan.io/myapikey	https://moonbase.moonscan.io/
Optimism Goerli	420	https://optimistic.etherscan.io/myapikey	https://goerli-optimism.etherscan.io/
Polygon Mumbai	80001	https://polygonscan.com/myapikey	https://mumbai.polygonscan.com/

2.2 Accessing Shamba Chainlink Oracle

The Shamba Chainlink oracle provides geospatial data to smart contracts. To access it you need to import the ShambaGeoConsumer and ShambaFireConsumer smart-contracts from our smart-contract-kit or install it via our npm module. To make this process easier, we have provided tools like our contracts tool for generating boilerplate smart contract code to interact with our data oracle. And we also have our brownie and hardhat mixes setup for the Oracle Facing Smart Contracts to interact with the same.

2.3 Requesting Data From The Oracle

Deploy your Oracle Facing Smart Contract and then fund the same with 1 test LINK corresponding to your deployed contract's network, and then call the `requestGeostatsData()` or `requestFireData()` function with the required parameters as explained in this README.

NOTE: You can get the LINK addresses and their corresponding faucets from here.

2.3.1 Response Data for Geo-Statistics

Data returned is of type map having two corresponding fields as a string storing the value of cid and an integer storing the value of geostatistic result (which is getting the value from the API multiplied by 10**18. This multiplication is done to remove all decimals from the data being returned on-chain).

You can see the response by calling the `getGeostatsData()` and `getLatestCid()` functions.

2.3.2 Response Data for Fire-Analysis

Data returned is of type map having two corresponding fields as a string that is storing the cid and an array that is storing the values of fire detection in the sequence of property ids, like 1 (if the fire is detected) and 9 (if the fire is not detected). The reason behind having the values as 1 and 9 is because the by-default value in the solidity (smart contract) is 0, so if there's no data in any index of the array, then it returns it as 0.

We're getting the value of fire-detection from the API as true or false, so assigning a value of 1 if it returns true and 9 if it returns false.

You can see the response by calling the `getFireData()` and `getLatestCid()` functions.

CHAPTER

THREE

INSIGHTS TOOL

The Insights Tool is intended to help a user explore the datasets provided by our oracle for any specified area of interest. Use it to get insights into the right datasets, metrics and thresholds to use in your smart contract for any given area.

3.1 Introduction

Below is an interface for the insights tool. Use the input panel on the right and explore results on the main panel. You can maximize the time series graphs and interact with them to get exact numbers for any point in time.

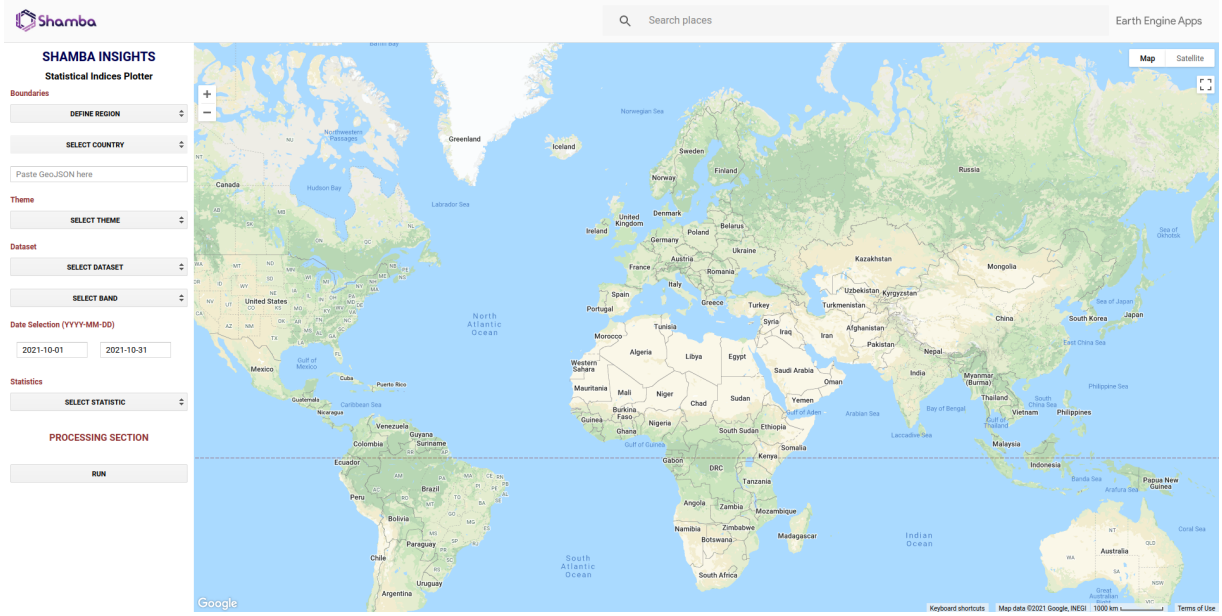


Fig. 1: Landing page

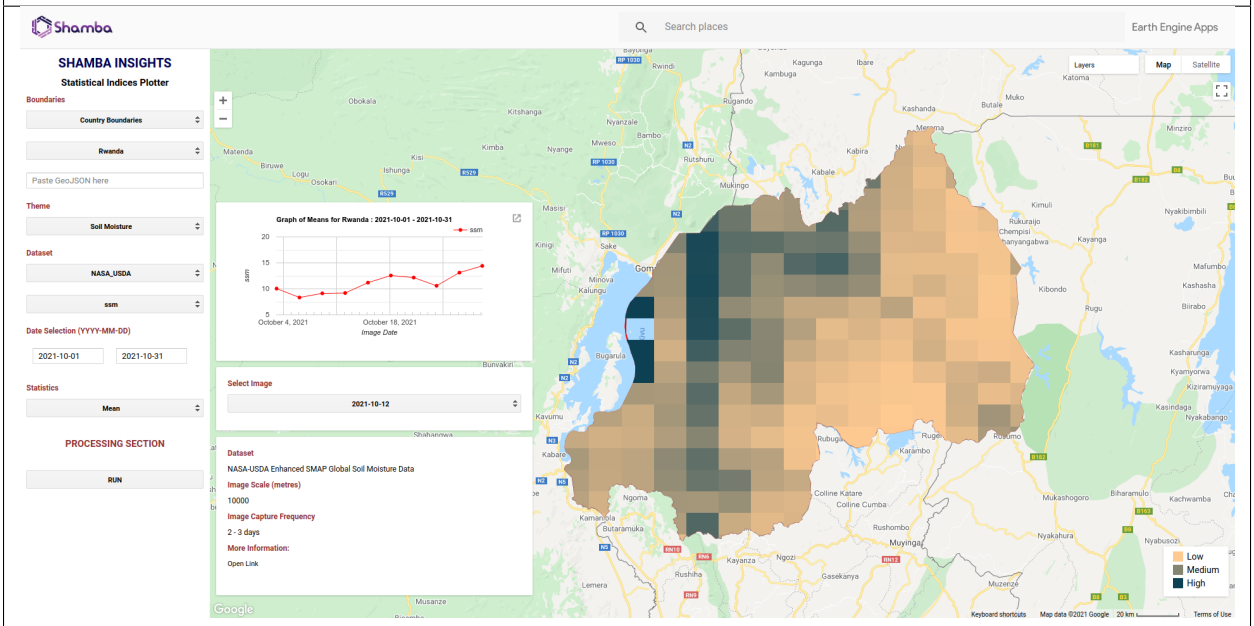
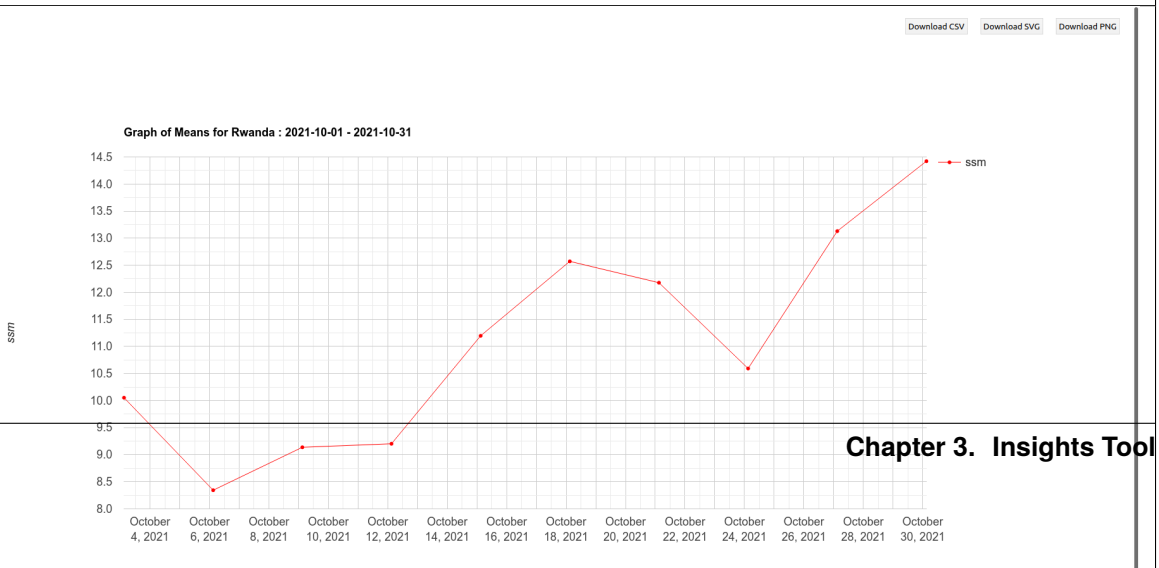


Fig. 2: Data view



3.2 Usage

1. Search for your area of interest on the search bar at the top.
2. Select ‘user-defined boundary’ on the input panel on the left.
3. Draw the area of interest using the tools on the map in the main panel.
4. Select the theme of interest e.g rainfall, vegetation etc.
5. Select the dataset you would like to explore within a theme.
6. Select the statistical metric of interest such as max, min, mean etc.
7. Select the time range over which you would like to explore the data.
8. Run the analysis and explore the time series insights through an interactive graph.
9. Select an image date to plot out the data on a map and explore the spatial insights.
10. Repeat the process with different metrics, datasets and durations to analyze your area.
11. In all cases, look for seasonal thresholds that define different environmental states.
12. State examples: wet vs dry season (precipitation), lush vs barren season (vegetation).
13. Define the dataset-metric-threshold combinations that characterize an area of interest.
14. Use these thresholds as parametric triggers in smart contracts for that area of interest.

CHAPTER

FOUR

CONTRACTS TOOL

The Contracts Tool aims to help a developer quickly generate smart contract boilerplate code with the parametric specifications of their choosing. It helps a user codify what they learned in the Insights tool into smart contract boilerplate code. This code can then be extended to serve any application a developer might need.

4.1 Introduction

Below is an interface from the Contracts tool. The webmap on the left allows you to designate your area of interest while the panel on the right helps you codify the specifications for your parametric smart contract.

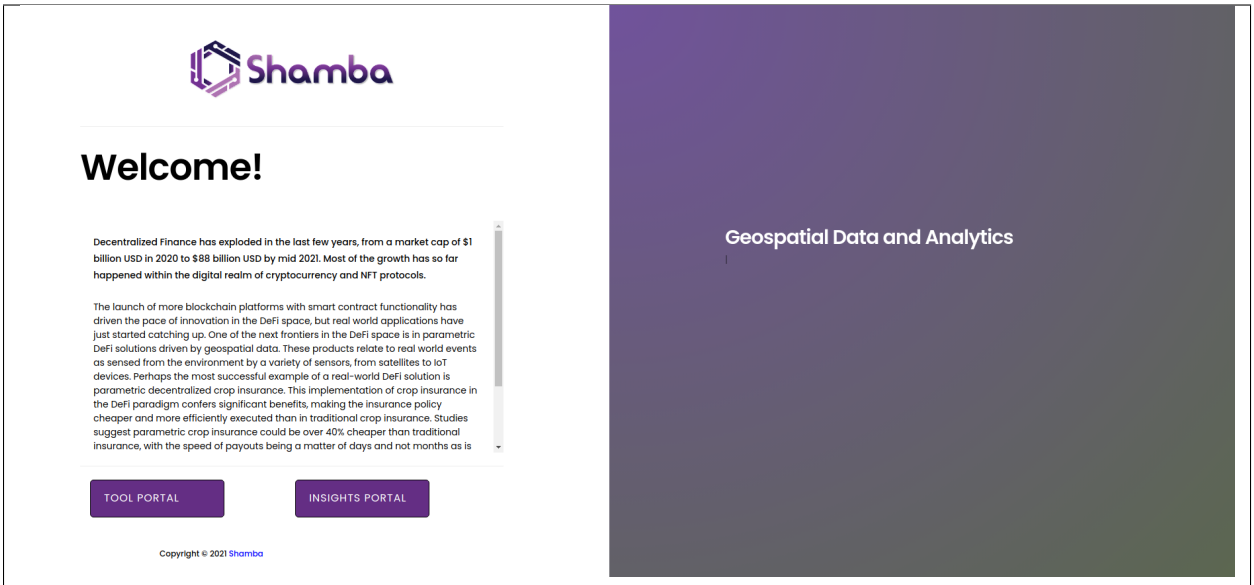


Fig. 1: Landing page

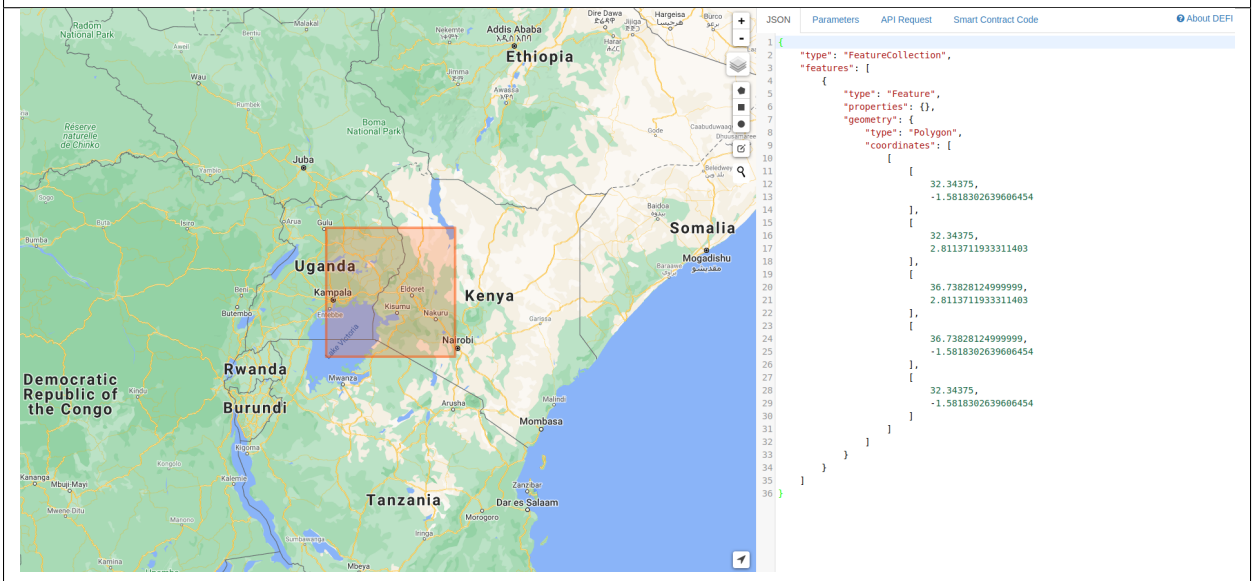


Fig. 2: Drawing section

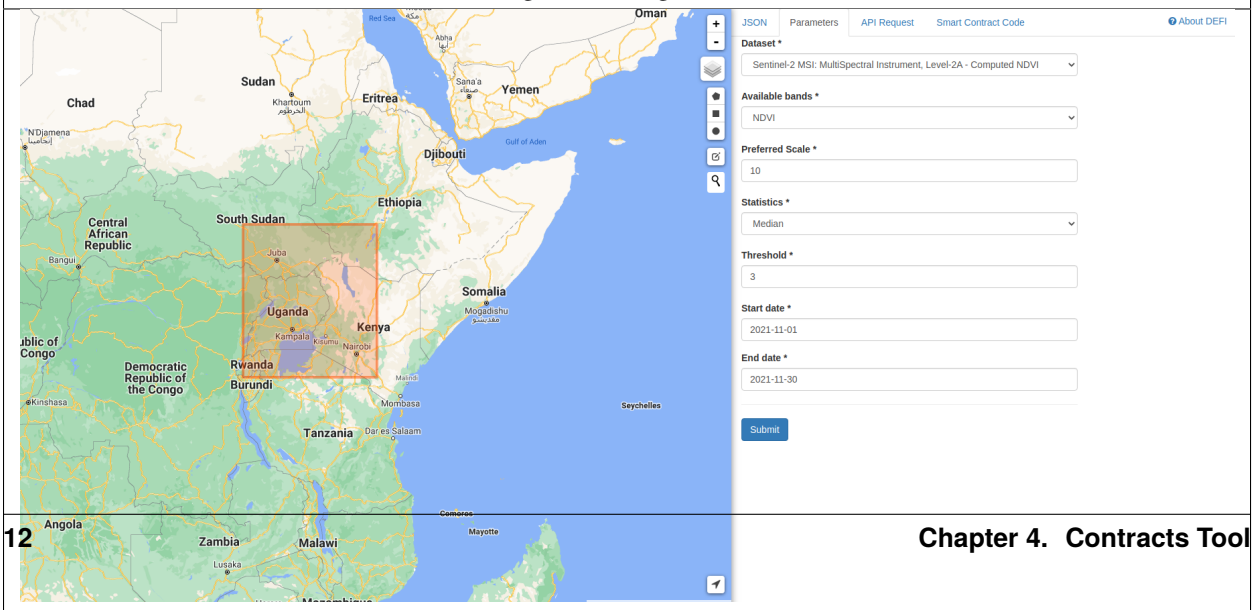


Fig. 3: Parameter setup

4.2 Usage

1. First do some research to determine the parameters for your area of interest.
2. The web map allows you to search for an area and designate its boundary.
3. Use the search input to search by name and zoom into your area of interest.
4. Use the drawing tools on the web map to specify what your area of interest is.
5. This will generate some Json that describes the boundaries of this area.
6. Next use the parameters tab to specify the input dataset and band.
7. Select the option for each input field and submit the form to generate code.
8. On the request tab, you will find the Json representation of your specification.
9. On the code tab, you will find the smart contract boilerplate code with these specs.
10. Copy this code from this tab and into your favorite development environment to extend.

CHAPTER

FIVE

DATA MODEL

The Shamba oracle currently supports running two types of analytics on geospatial data. Below we describe each of these including their inputs and output.

5.1 Descriptive Statistics Analysis

This analysis aims at getting descriptive statistics. Given an area of interest and a dataset to reference, this analysis returns standard metrics such as maximum, minimum, mean, median and variance. These descriptive statistics are useful for setting thresholds and triggers in many parametric smart contracts. The required statistical metric is specified in the "agg_x" parameter of the request body.

Input:

- "requestIpfsCid" : "string" (IPFS CID i.e., the content identifier pointing to the request body stored on IPFS)

  The request body should contain these parameters:

  - "agg_x": "string",
  - "dataset_code": "string",
  - "selected_band": "string",
  - "geometry": {json},
  - "start_date": "string",
  - "end_date": "string",
  - "image_scale": integer

NOTE: You can get the request IPFS CID from the contracts tool after selecting and entering the required parameters, and then clicking on "**RUN**".

Output:

- int256

5.2 Fire Analysis

This analysis aims at determining if an area of interest falls within a detected fire. It performs a topology analysis to determine if a fire extends to a specified area of interest. Given an area of interest and a dataset to reference, this analysis returns a boolean indicating whether a fire was detected or not. Boolean values (1 - TRUE, 9 - FALSE).

Input:

- "requestIpfsCid" : "string" (IPFS CID i.e., the identifier pointing to the request body stored on IPFS)

  The request body should contain these parameters:

  - "dataset_code": "string",
  - "selected_band": "string",
  - "geometry": {json},
  - "start_date": "string",
  - "end_date": "string",
  - "image_scale": integer

NOTE: You can get the request IPFS CID from the contracts tool after selecting and entering the required parameters, and then clicking on "**RUN**".

Output:

- uint256 (1 - TRUE, 9 - FALSE)

5.3 Thematic Areas & Dataset

The Shamba oracle uses regularly updated geospatial data from various global providers. Different providers use different algorithms to compute the same metric, so it is recommended that users go through the literature for each dataset. Normalization has been performed where necessary to standardize values from different datasets under a common theme.

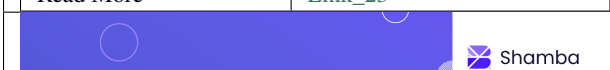
5.3.1 Air Quality

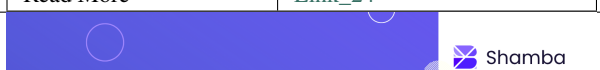
Properties	Value
Pixel Size (metres)	1113.2
Image Capture Frequency	Daily
Dataset Code	SENTINEL_5_NRTI_CO_AIR
Bands	CO_column_number_density
Units	mol/m^2
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2018-11-22 12:00:13 - CURRENT
Read More	Link_21

Properties	Value
Pixel Size (metres)	1113.2
Image Capture Frequency	Daily
Dataset Code	SENTINEL_5_OFFL_CO_AIR
Bands	CO_column_number_density
Units	mol/m^2
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2018-06-28 10:24:07 - CURRENT
Read More	Link_22

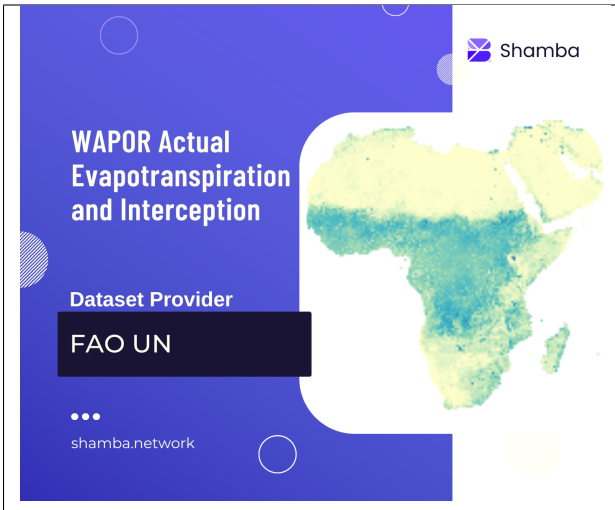
Properties	Value
Pixel Size (metres)	1113.2
Image Capture Frequency	Daily
Dataset Code	SENTINEL_5_NRTI_SO2_AIR
Bands	SO2_column_number_density
Units	mol/m^2
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2018-07-10 11:17:44 - CURRENT
Read More	Link_23

Properties	Value
Pixel Size (metres)	1113.2
Image Capture Frequency	Daily
Dataset Code	SENTINEL_5_OFFL_SO2_AIR
Bands	SO2_column_number_density
Units	mol/m^2
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2018-12-05 11:53:01 - CURRENT
Read More	Link_24

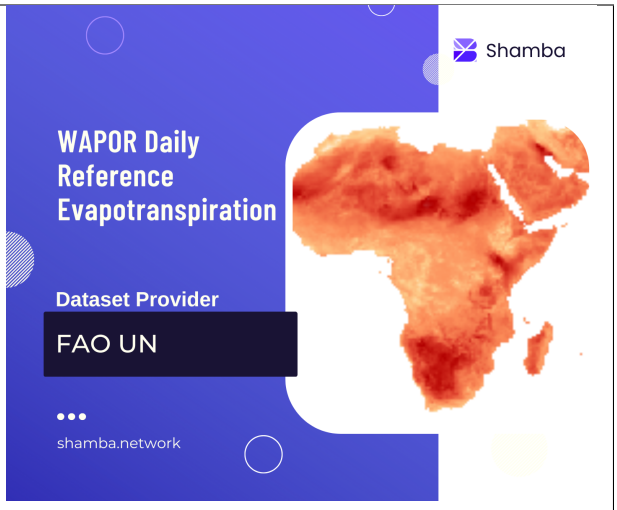




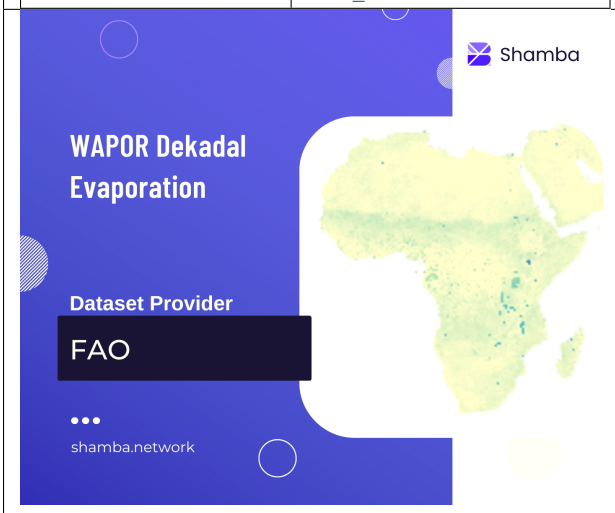
5.3.2 Evapo-Transpiration



Properties	Value
Pixel Size (metres)	248.2
Image Capture Frequency	10 days
Dataset Code	WAPOR_I_ET
Bands	L1_AETI_D
Units	mm
Geographic Coverage	Africa
Timeperiod Coverage (UTC)	2009-01-01 00:00:00 - CURRENT
Read More	Link_1



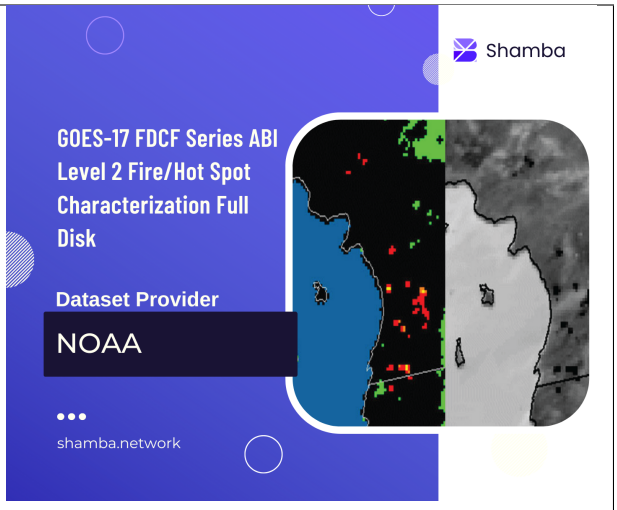
Properties	Value
Pixel Size (metres)	18924
Image Capture Frequency	Daily
Dataset Code	WAPOR_R_ET
Bands	L1_RET_E
Units	mm
Geographic Coverage	Africa
Timeperiod Coverage (UTC)	2009-01-01 00:00:00 - CURRENT
Read More	Link_2



Properties	Value
Pixel Size (metres)	248.2
Image Capture Frequency	10 Days
Dataset Code	WAPOR_10_ET
Bands	L1_E_D
Units	mm
Geographic Coverage	Africa
Timeperiod Coverage (UTC)	2009-01-01 00:00:00 - CURRENT
Read More	Link_38

5.3.3 Fire

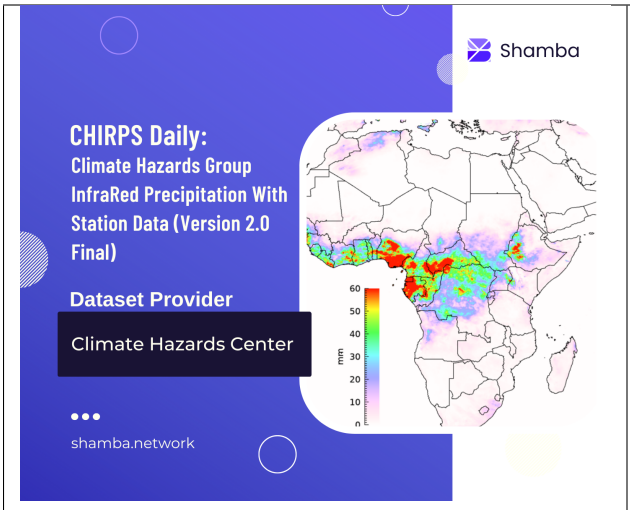
Properties	Value
Pixel Size (metres)	2000
Image Capture Frequency	5 - 15 minutes
Dataset Code	GOES_16_FIRE
Bands	Power
Units	MW
Geographic Coverage	Americas, West Africa
Timeperiod Coverage (UTC)	2017-05-24 00:00:00 - CURRENT
Read More	Link_19



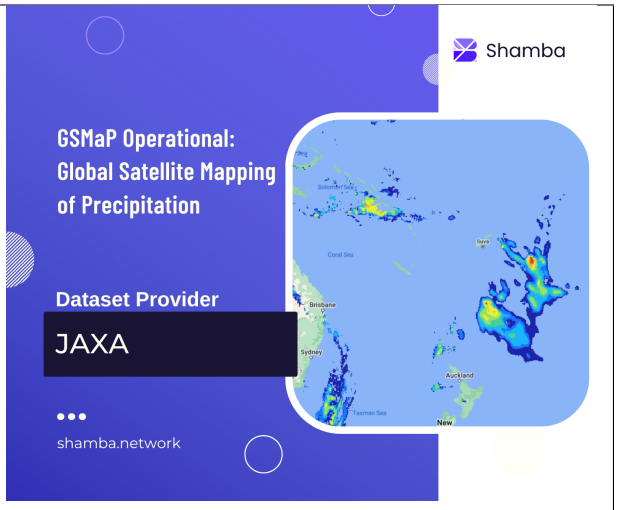
Properties	Value
Pixel Size (metres)	2000
Image Capture Frequency	5 - 15 minutes
Dataset Code	GOES_17_FIRE
Bands	Power
Units	MW
Geographic Coverage	Americas, West Africa
Timeperiod Coverage (UTC)	2018-08-27 00:00:00 - 2023-01-10 16:00:00
Read More	Link_20

Properties	Value
Pixel Size (metres)	1000
Image Capture Frequency	Daily
Dataset Code	FIRMS_FIRE
Bands	T21
Units	K
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2000-11-01 00:00:00 - CURRENT
Read More	Link_39

5.3.4 Precipitation



Properties	Value
Pixel Size (metres)	5566
Image Capture Frequency	Daily
Dataset Code	CHIRPS_PPT
Bands	Precipitation
Units	mm/day
Geographic Coverage	Global
Timeperiod Coverage (UTC)	1981-01-01 00:00:00 - CURRENT
Read More	Link_6



Properties	Value
Pixel Size (metres)	11132
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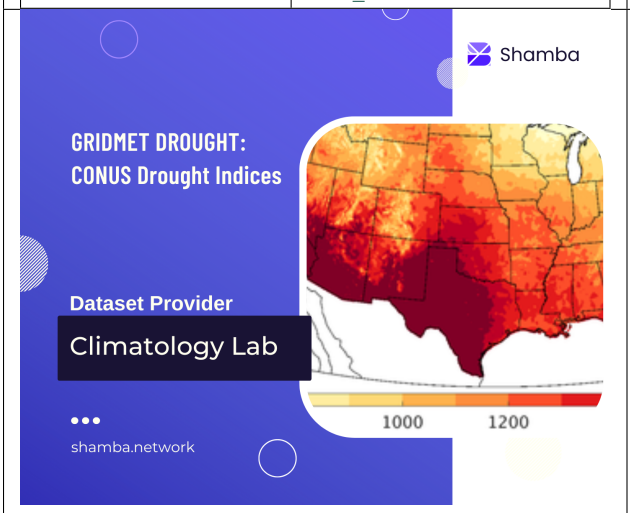
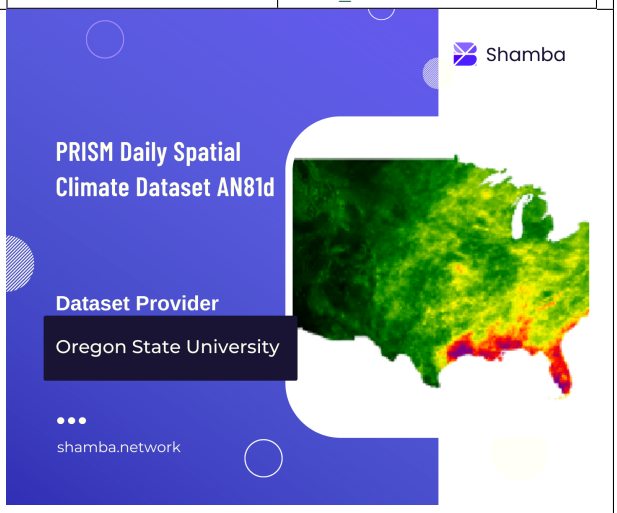
Dataset Code	GSMAP_PPT
Bands	hourlyPrecipRate
Units	NA
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2014-03-01 00:00:00 - CURRENT
Read More	Link_7

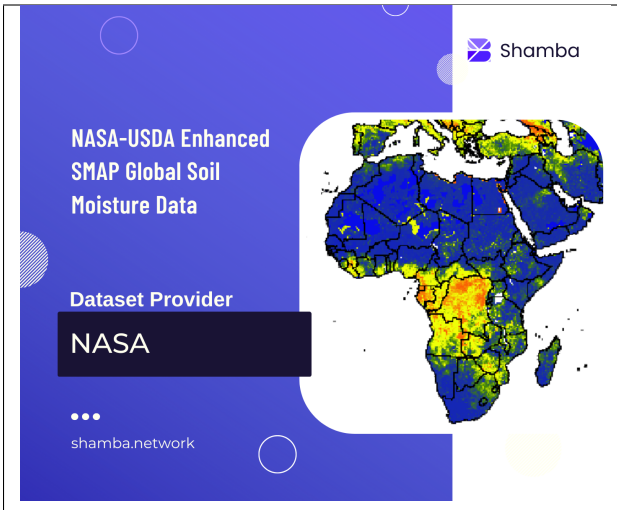


Properties	Value
Pixel Size (metres)	4638.3
Image Capture Frequency	10 days
Dataset Code	GRIDMET
Bands	pdsi
Units	NA
Geographic Coverage	USA
Timeperiod Coverage (UTC)	1980-01-05 00:00:00 - CURRENT
Read More	Link_28



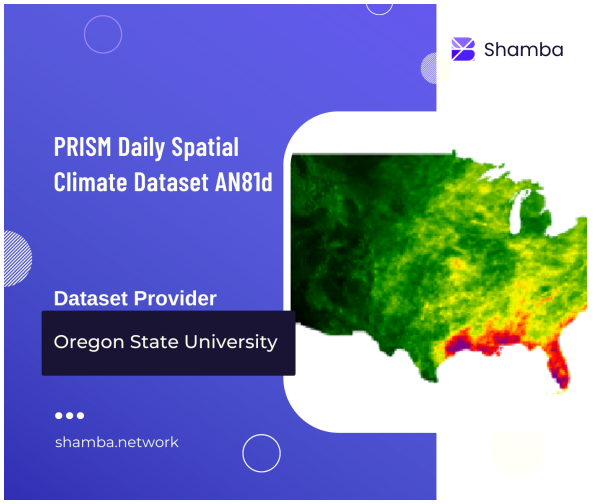
Properties	Value
Pixel Size (metres)	4638.3
Image Capture Frequency	Daily
Dataset Code	PRISM_PPT_TEMP
Bands	ppt, tmean
Units	mm, °C
Geographic Coverage	USA
Timeperiod Coverage (UTC)	1981-01-01 00:00:00 - CURRENT
Read More	Link_44

5.3.5 Soil Moisture

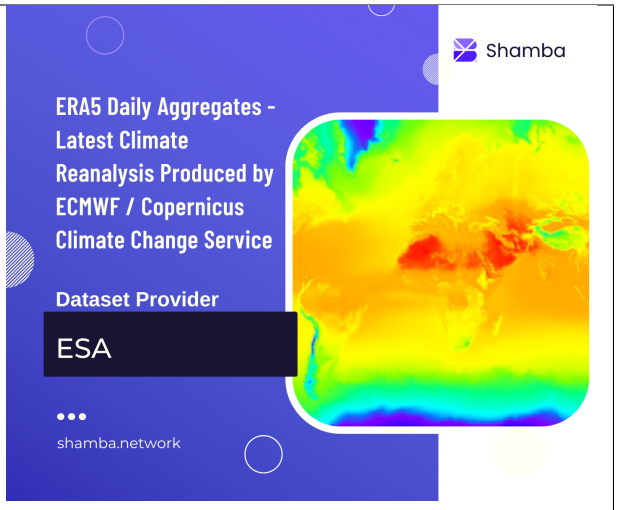


Properties	Value
Pixel Size (metres)	10000
Image Capture Frequency	Monthly
Dataset Code	SMAP_SM
Bands	ssm
Units	mm
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2015-04-02 12:00:00 - CURRENT
Read More	Link_8

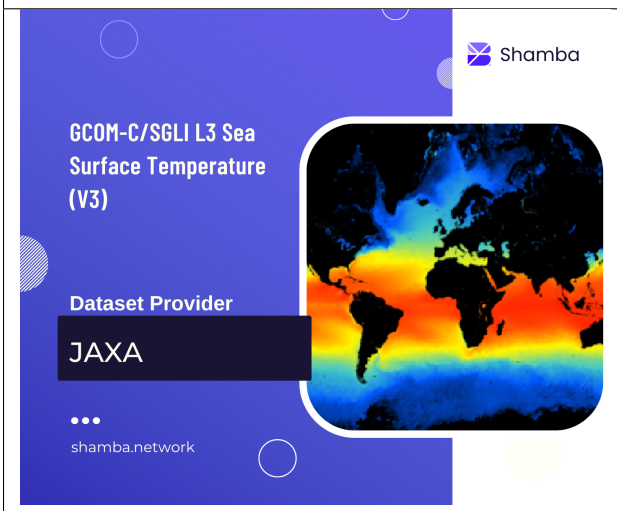
5.3.6 Temperature



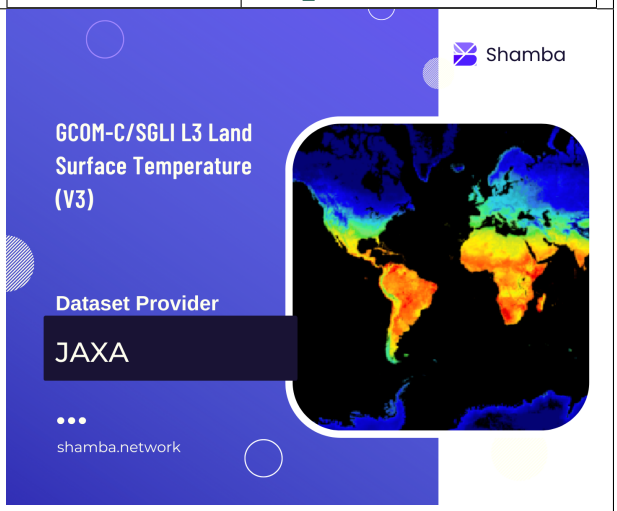
Properties	Value
Pixel Size (metres)	4638.3
Image Capture Frequency	Daily
Dataset Code	PRISM_PPT_TEMP
Bands	ppt, tmean
Units	mm, °C
Geographic Coverage	USA
Timeperiod Coverage (UTC)	1981-01-01 00:00:00 - CURRENT
Read More	Link_44



Properties	Value
Pixel Size (metres)	27830
Image Capture Frequency	Daily
Dataset Code	ERA5_PPT_AIRTEMP
Bands	mean_2m_air_temperature, total_precipitation
Units	K, m
Geographic Coverage	Global
Timeperiod Coverage (UTC)	1979-01-02 00:00:00 - CURRENT
Read More	Link_49

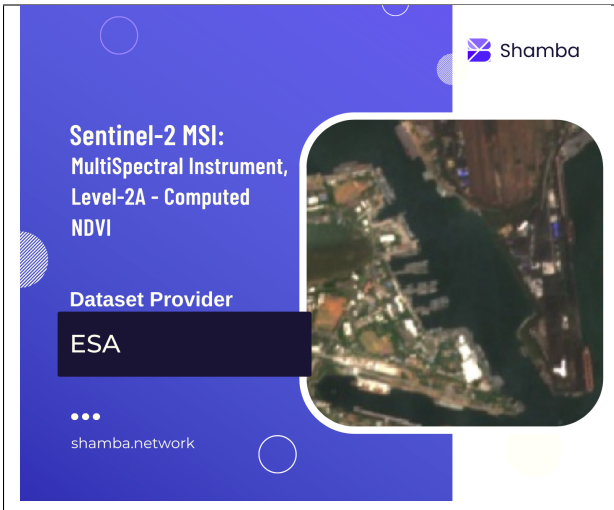


Properties	Value
Pixel Size (metres)	4638.3
Image Capture Frequency	Daily
Dataset Code	GCOM_S_TEMP
Bands	SST_AVE
Units	°C
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2021-11-29 00:00:00 - CURRENT
Read More	Link_47

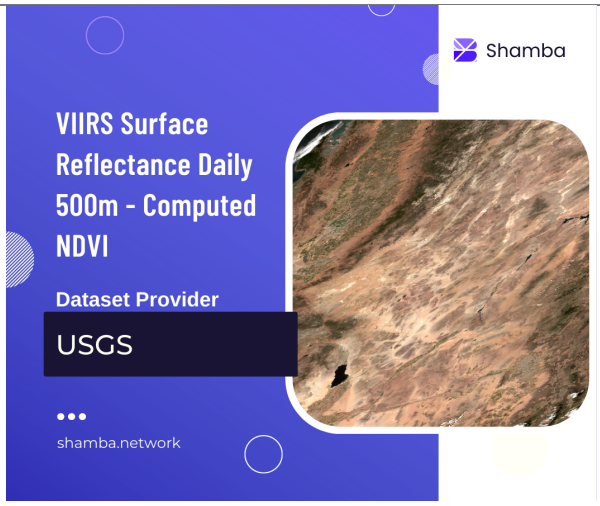


Properties	Value
Pixel Size (metres)	4638.3
Image Capture Frequency	Daily
Dataset Code	GCOM_L_TEMP
Bands	LST_AVE
Units	°C
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2021-11-29 00:00:00 - CURRENT
Read More	Link_48

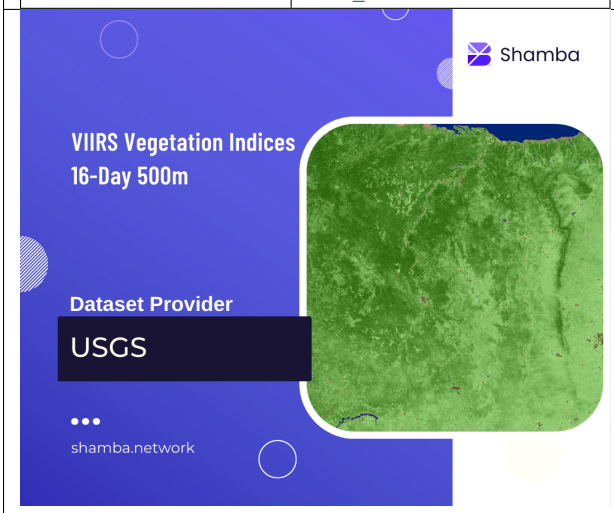
5.3.7 Vegetation



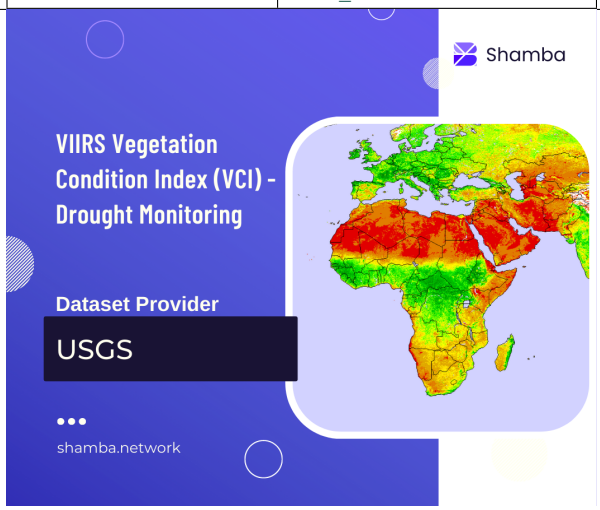
Properties	Value
Pixel Size (metres)	10
Image Capture Frequency	5 days
Dataset Code	SENTINEL_2_VEG
Bands	NDVI, EVI
Units	NA
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2017-03-28 00:00:00 - CURRENT
Read More	Link_4



Properties	Value
Pixel Size (metres)	1000
Image Capture Frequency	Daily
Dataset Code	VIIRS_VI
Bands	NDVI, EVI
Units	NA
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2012-01-19 00:00:00 - CURRENT
Read More	Link_60

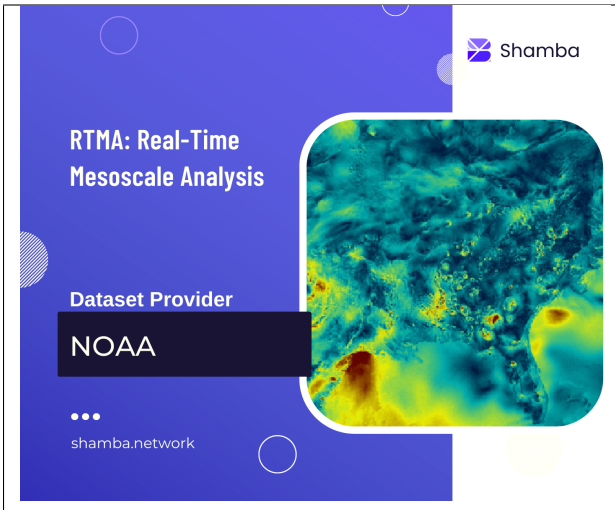


Properties	Value
Pixel Size (metres)	500
Image Capture Frequency	16 days
Dataset Code	VIIRS_16_VEG
Bands	NDVI, EVI, EVI2
Units	NA
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2012-01-17 00:00:00 - CURRENT
Read More	Link_15



Properties	Value
Pixel Size (metres)	1000
Image Capture Frequency	Monthly
Dataset Code	VIIRS_VCI_VEG
Bands	VCI
Units	Percent
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2012-01-19 00:00:00 - CURRENT
Read More	Link_61

5.3.8 Weather



Properties	Value
Pixel Size (metres)	2500
Image Capture Frequency	Daily
Dataset Code	RTMA_WEATHER
Bands	PRES, TMP, SPFH, WDIR, WIND, TCDC
Units	Pa, °C, kg/kg, deg true, m/s, percent
Geographic Coverage	Global
Timeperiod Coverage (UTC)	2011-01-01 00:00:00 - CURRENT
Read More	Link_59

CHAPTER

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INDICES AND TABLES

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