A

Internship Project Report

On

WATER RESOURCES INTEGRATED MANAGEMENT SYSTEM

Submitted to

RAJIV GANDHI UNIVERSITY OF KNOWLEDGE AND TECHNOLOGIES
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in partial fulfilment of the requirement for the award of the Degree of

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In

COMPUTER SCIENCE & ENGINEERING

Submitted by

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Under the Guidance of

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RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES

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R.K Valley,Vempalli(M), Kadapa(Dist) – 516330

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RGUKT-RK Valley

Vempalli, Kadapa, Andhrapradesh-516330.

CERTIFICATE OF PROJECT COMPLETION

This is to certify that I have examined the thesis entitled "**Water Resources Integrated Management System**" submitted by **G.Vamsi Krishna (R170656)** under our guidance and supervision for the partial fulfilment for the degree of Bachelor of Technology in computer Science and Engineering during the academic session September 2022 – April 2023 at RGUKT-RKVALLEY.

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DECLARATION

I, **G.Vamsi Krishna (R170656)** hereby declare that the project report entitled "**Water Resources Integrated Managemen**t **System**" done under guidance of **Ms. E.Susmitha** is submitted in partial fulfillment for the degree of Bachelor of Technology in Computer Science and Engineering during the academic session September 2022 – April 2023 at RGUKT-RK Valley. I also declare that this project is a result of our own effort and has not been copied or imitated from any source. Citations from any websites are mentioned in the references. To the best of my knowledge, the results embodied in this dissertation work have not been submitted to any university or institute for the award of any degree or diploma.

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With Sincere Regards,

G.Vamsi Krishna,

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ABSTRACT

This project aims to provide valuable insights into various types of enivornmental data, including rainfall, groundwater level, river water level, inflow forecast, soil moisture, flood forecasting and reservoir water level. The project collects data from various sensors and websites and analyzes it using various machine learning algorithms to provides insights into the current and future state of the environment.

The project's main objective is to provide real-time and accurate data on various environmental parameters to help decision-makers make informed decisions.The project collects data from various sources,including government websites,rainfall stations,weather stations and ground-based sensors.The data collected is stored in a database and analyzed using various machine learning algorithms to provide insights into the current state of the environment.

The project also uses predictive modeling techniques to forecast future enivornmental conditions such as flood levels and reservoir water levels.The predictions are made based on historical data,weather forecasts and other environment factors.

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CHAPTER 1

INTRODUCTION

Water management is a crucial aspect of sustainable development and with increasing pressure on water resources due to climate change, population growth and economic development,the need for effective water management systems is becoming increasingly important.

This project aims to provide real-time insights into various water-related data, including rainfall, groundwater level, river water level, inflow forecast, soil moisture, flood forecasting and reservoir water level by collecting data sensors and websites.This data is then processed and analyzed to generate dashboards, heatmaps, graphs and tables that provide valuable insights into water resources management.The project also includes several Decision Support System(DSS) products such as Flood forecasting, Reservoir Management & Planning, Canal Management System and Water Audit and Budgeting.

1.1 Motivation

The motivation behind this project is to address the growing need for effective water management system due to climate change, population growth, and economic development.Water is a scarce resource and with the increasing demand for water, there is a need for effective and efficient water management systems.

1.2 Features

- **Real-time Data Collection:** The System collects real-time data from sensors and website's related to water resources such as rainfall, groundwater level, river water level, inflow forecast,soil moisture, flood forecasting and reservoir water level
- **Data Processing and Analysis:** The collected data is processed and analyzed to generate dashboards, heatmaps, graphs and tables which provide valuable insights into water resource management.

- **Decision Support Systems(DSS)**: The System includes several DSS products such as Flood Forecasting, Reservoir Management and Planning, Canal Management System and Water Audit and Budgeting which can assist in efficient water resource management.
- **Interpolation and aggregation**: The System uses interpolation and aggregation techniques to provide data at various levels including village, mandal, district and state levels.
- **Scalability:** The System is designed to be scalabe and can handle large amounts of data with ease.
- **User-friendly interface:** The System providesa user-friendly interface that allows decision-makers to access real-time data and DSS products easily.
- **Integration with third-party systems:** The system can be easily integrated with third-party systems to provide a comprehensive water resource management solution.
- **Robust architecture:** The System is designed using Springboot, Java, Kafka Messaging queue, Quartz-Scheduler, Flink, Cassandra,PostgreSQL, Docker, Maven Git, Angular and GeoServer which makes the system robust and reliable.
- **High-speed data processing:** The System uses Flink, a high-speed stream processing framework to process data in real-time.

- **Security:** The System is designed with security in mind and all data is stored securely and encrypted to ensure data integrity and confidentiality.

Overall, the key features of this project make it a comprehensive water resource management system that can assist decision makers in maked informed decisions regarding water resource management.

CHAPTER 2

REQUIREMENT ANALYSIS

This project involved analyzing the design of a few applictions so as to make the application more users friendly.To do so, it was really important to keep the navigations from one screen to the other well-ordered and at the same time reducing the amount of typing the user needs to do.This also includes maintaining the flow of the application.

2.1 Requirement Specification

2.1.1 Functional Requirements

- Data collection from sensors and websites
- Real-time data processing
- Dashboards, heatmaps, graphs and tables generation
- Flood forecasting
- Reservoir managaement & planning
- Canal Management System
- Water Audit and Budgeting

2.1.2 Hardware Requirements

- Sensors for data collection
- High-speed internet connectivity
- Computer servers for data processing and storage
- Processor: A multi-core processor with a clock speed of at least 2.5 Ghz.
- RAM: At least 16 GB of RAM is recommended for running the system in production.However, the actual RAM requirements will depend on the amount of data being processed and the number of concurrent users accessing the system.

- Storage: The system requires a minimum of 500GB of storage for storing data.However, the actual storage requirements will depend on the amount of data being processed and the duration for which the data needs to be stored.
- Network: The system requires a reliable high-speed internet connection to ensure smoothe data transfer.
- Operating System: The System can any operating system that supports Docker containers.Howerver, Linx-based operating systems are recommended for running the system in production.
- Server: A dedicated server is recommended for running the system in production.The server should have sufficient resources to handle the load generated by the system.
- Backup and Recovery: The system should be backed up regularly to ensure data integrity and availability.A backup solution should be implemented to ensure that the system can be quickly restored in case of data loss or system failure.

2.2 Technologies Used

2.2.1 HTML

It is a markup language for formatting and displaying web documents and web pages.It gives basic structure to the webpage without any stylling.HTML elements tell the browser how to display the content.It can be assisted by technologies such as Cascading Style Sheets and scripting languages such as Javascript for styling and functionality.

2.2.2 CSS

It gives styling for the web pages created by HTML.It gives look adn feel to the website.

2.2.2.1 Types of CSS

- Inline CSS (Using styles as attributes in html elements)
- Internal CSS (Including a separate style tag in html document)
- External CSS (Using external file for styling)

2.2.3 Bootstrap

Bootstrap is a CSS framework which helps in developig web pages very faster and with little efforts.Helps to customize the CSS properties.Used for developing responsive and mobile-first websites.Componenets like navabar, carouse, utility, cards, dropdowns, buttons etc.

2.2.4 Javascript

Javascript is used to develop interactive web applications.Used to develop Dynamic websites.It is the programming language of the web and responsible for performing actions in a website.

2.2.5 Angular JS

Angular JS is a discontuinued free adn open-source javascript based web framework for developing single-page applications.It was maintained mainly by google and a community of individuals and corporations.

2.2.6 NodeJS

NodeJS is a open source sever Environment that allows us to run javascript on the server(outside a web broweser). It is an Event driven architecture capable of

Asynchronous Input/output.It is a Javascript built on Chrome v8 javascript engine.Runs equally well on all platforms(Windows,Mac and Linux).

2.2.7 PostgresSQL

PostgresSQL is a powerful open-source relational database management system(RDBMS) that uses and extends the SQL language.It is widely used as a backend database for web applicatins, mobile applications adn analytics platforms due to its reliability, stability and high performance features.PostgresSQL supports a varitey of data types, including numeric, string, date and tiem, boolean and spatial data. It also offers advanced features such as transaction management,multi-version concurreny control, table partitioning and full-text search.PostgresSQL is free and can be used on a variety of operating systems, including Linux,Windows and MacOS.

2.2.8 Cassandra

Cassandra is open-source distributed database management system that id designed to handle large amounts of data across many commodity servers, providing high availability with no single point of failure.It was developed by Facebook initially and is now maintained by the Apache Software Foudation.

Cassandra is a NoSQL database, which means that it does not use the traditional relational model of databases that orgainze data into tables with strict schema defintions. Instead, Cassandra uses a column-family data model, which allows for flexible and dynamic schema design. Data is stored in key-value pairs, where the key is used to uniquely identify each row of daa, and the value is a collection of columns that represent the data attributes.

2.2.9 Kafka

Kafka is an opensource distributed streaming platform that was originally developed by linkedin and is now maintained by the Apache Software Foundation.Kafka is designed to handle real-time data feeds and data processing,providing a fast, scalable and reliable solution for processing and analyzing data streams.

2.2.10 Flink

Apache Flink is an open-source distributed stream processing framework that was designed to handle real-time data processing applications.Flink supports both batch and streaming data processing and provides a powerful, flexible and fault-tolerant system for processing data streams.

2.2.11 Quartz Scheduler

Quartz is an opensource job scheduling framework that can be integrated into java applications.It allows developers to schedule jobs or tasks to run at specific times or intervals and provides a range of features for managing and monitoring those jobs.

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2.2.12 Geo Server

Geoserver is open-source server for sharing and publishing geospatial data.It provides a web interface for managing and publishing geospatial data in various formats, including Open Geospatial Consortium(OGC) standards such as Web Map Service(WMS), Web Feature Service(WFS) and Web Coverage Service(WCS).

2.2.14 Docker

Docker is an opensource platform for building, developing, deploying and running applications in containers.Containers are lightweight, portable and self-contained environments that allow developers to package their applications and dependencies into a single unit that can be easily depolyed across different environments.

2.2.15 Spring Boot

Springboot is an opensource java framework that provides a rapid application developement environment for building web applications.It is built on top of the popular Spring Framework and provides a set of tools and libraries that help developers getup and runnign quickly with minimal configuration.

2.2.16 Maven

Apache Maven is a build automation tool used primarily for Java projects.It is an opensource software that helps to manage project dependencies, build processes and project documentation.

Maven uses a declartive approach to build processes where a projects dependencies, configuration and other aspects of the build process are describe in a configuaration file called a pom.xml.This file defines the project’s dependencies, the build process and the output artifacts.

CHAPTER 3

SOFTWARE ARCHITECTURE

3.1 Event Driven Architecture

The event-driven architecture pattern is a popular distributed asynchronous architecture pattern used to produce highly scalable applications.It is also highly adaptable and can be used for small applications as well as large, complex ones.The event-driven architecture is made up of highly decoupled, single-purpose event processing components that asynchronously receive and process events.

Event channels are conduits in which events are transmitted from event emitters to event consumers.

Figure 3.1.1: Generic Design of an event-driven architecture

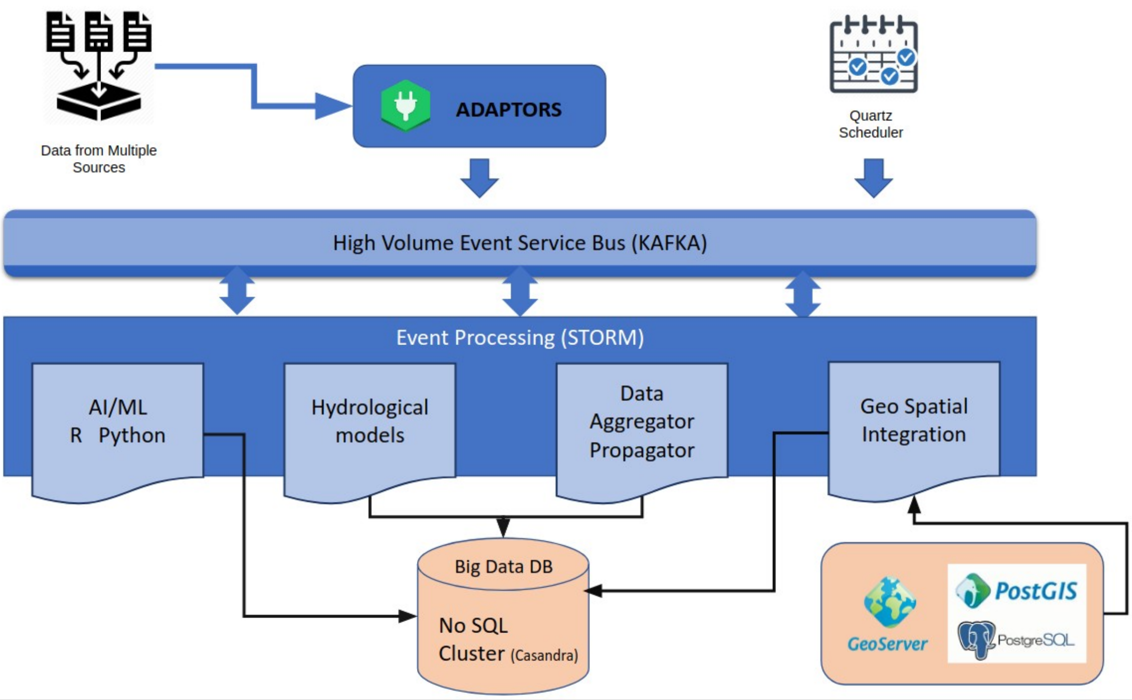

Figure 3.1.2: Event driven backend architecture

3.2 Web Application Overview/Architecture

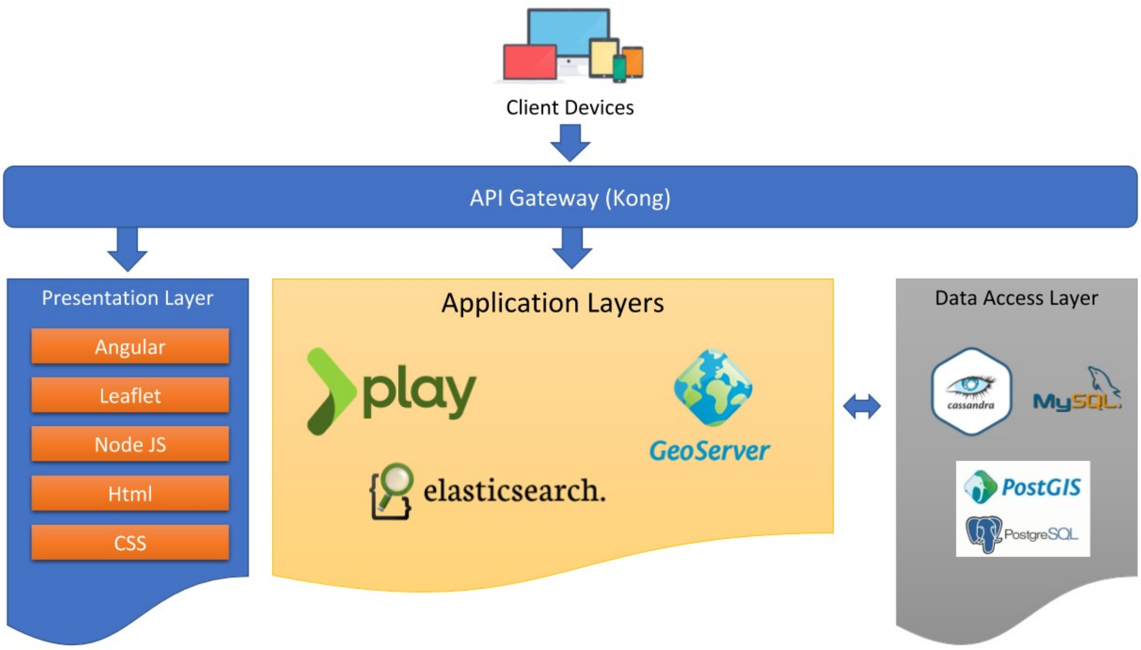

Figure 3.2.1: Web Application Architecture

CHAPTER 4

SOFTWARE ENVIRONMENT

4.1 Intellij IDEA

Intellij IDEA is a popular Integrated Development Environment(IDE) developed by JetBrains.It is primarily used for programming in Java,but also supports several other programming languages like Kotlin, Scala,Groovy and Python.

Intellij IDEA provides advanced features like code completion, syntax highlighting, code refactoring, debugging, and unit testing.It offers advanced code analysis, navigation features, code completion, refactoring tools, debugger and unit testing tools, integration with various web frameworks and application servers.It is available in both community and ultimate editions with the ultimate edition offering additional features.Intellij IDEA is known for its user-friendly interface and high productivity features for developers.

4.2 YAML Files

YAML(YAML Ain’t Markup Language) is a human-readable data serialization language that is often used for configuration files, data exchange, and data storage.It was designed to be easily readable by humans and is oftern used in modern software development practices.

YAML files use indention and whitespace to represent hierarchies, making it easier to read and wirte than other data serialization formats such as JSON or XML.YAML files are often used for configuration files in software developement such as defining application settings or specifying build and deployment configurations.

YAML supports a wide range of data types, including strings, numbers, booleans and null values as well as more complex data structures such as maps,lists and nested structures.It also supports comments,allowing developers to provide additional context or documentation within the configuration files.

CHAPTER 5

<u>IMPLEMENTATION</u>

5.1 River Gauge Component Functionalities

5.1.1 River Gauge Definition

A river gauge is a device to measure the height or depth of water in a river or other body of water.The data collected by river gauges is used to monitor water levels,track changes over time and help predict floods or other natural disasters. Accurate river gauge data can help emergency responders and officials make informed decisions about evacuations, road closures and other measures to protect people adn property.

5.1.2 Scraping

Web scraping is the process of extraction information from website using automated tools. It involves writing code to visit a website, inspects its HTML structure and extract the relevant data. The extracted data can be used for various purposes, such a research,analysis or building applications.Web scraping can be done manually but it is typically done using automated tools such as web crawlers, which systematically browse the web adn collect data from multiple websites.

When scraping data, it is important to adhere to ethical and legal guidelines such as respecting the website's terms of use, avoiding execessive or disruptive requests adn obtaining explicit consent if necessary.Additionally, it is important to ensure the quality and accuracy of the scraped data as well as protect the privary and security of any personal information that may be invovled.

5.1.3 Aggregation

Aggregation is the process of combining multiple data points into a single summary value either over time or over space to gain a better understanding of the data.The types of data aggregations we are using in this project are spatial and temporal data aggregation.

5.1.3.1 Spatial Aggregation

Spatial Aggregation refers to the process of collecting and combing data from lower-level geographic units into higher-level units.For example, in a village, data may be collected from various rivergauge stations, sensors.This data can then be aggregated at the mandal level which is a higher-level administrative division.The mandal data can then be aggregated at the District-level which is a higher-level administrative division from Mandal.Ths District data can then be aggregated at the State level,Which is a higher-level administrative division from district.

5.1.3.2 Temporal Aggregation

Temporal Aggregation can also refer to the process of summarizing data over time periods such as hourly to daily, monthly and yearly intervals. This type of aggregation is often used in time-series analysis to identify trends and patterns over time.Hourly data can be aggregated into daily data by summing or averaging the hourly values for each day.Similary, daily data can be aggregated into monthly data by summing or averaging the daily values for each month.Finally monthly data can be aggregated into yearly data by summing or averaging the monthly values for each year.

5.1.4 API’s

APIs(Application Programming Interfaces) are tools that allow users to access and retrieve information about data resources such as river gauge stations data,rating table data,time series data, aggregated date etc.They can also to used to update meta data and upload several meta data of rivergauge stations, rating table data and historical data.

Overall, APIs are powerful that can help users access and utilized software, systems and data in a more efficient and effective way while also providing flexibility and customization options.

5.2 Sample Screenshots

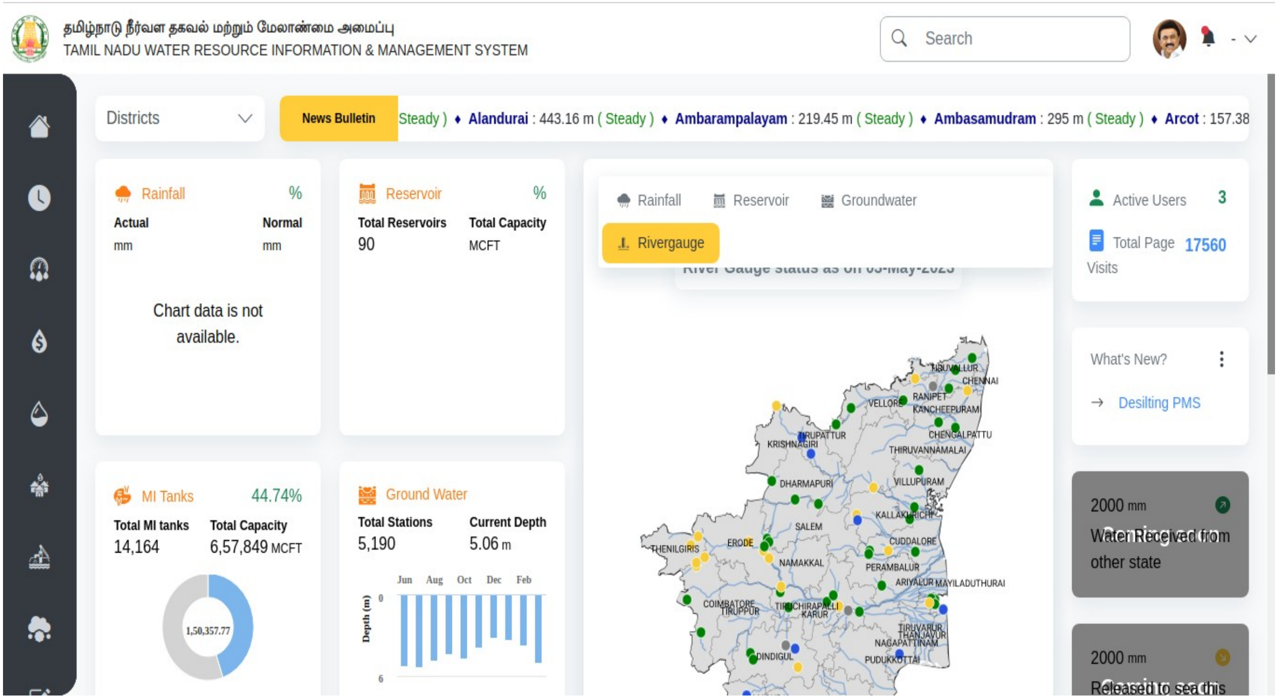

Figure 5.2.1 HomePage

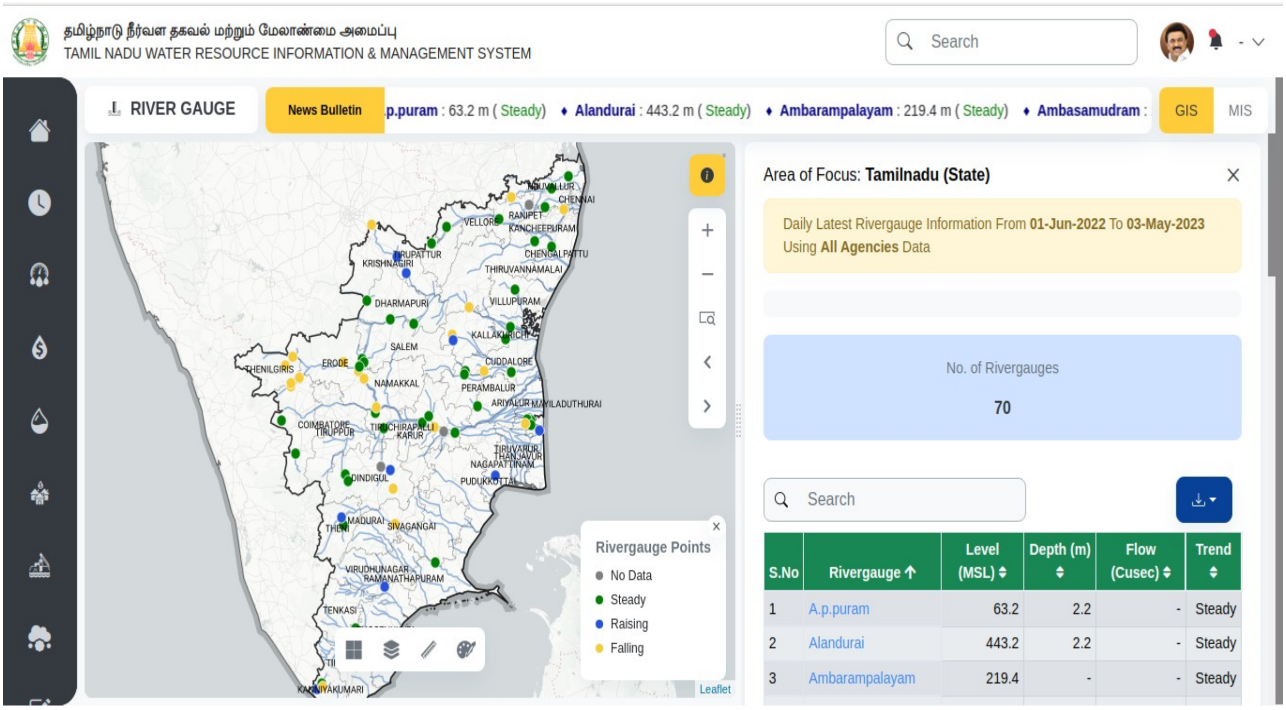

Figure 5.2.2 GIS View of RIVER GAUGE

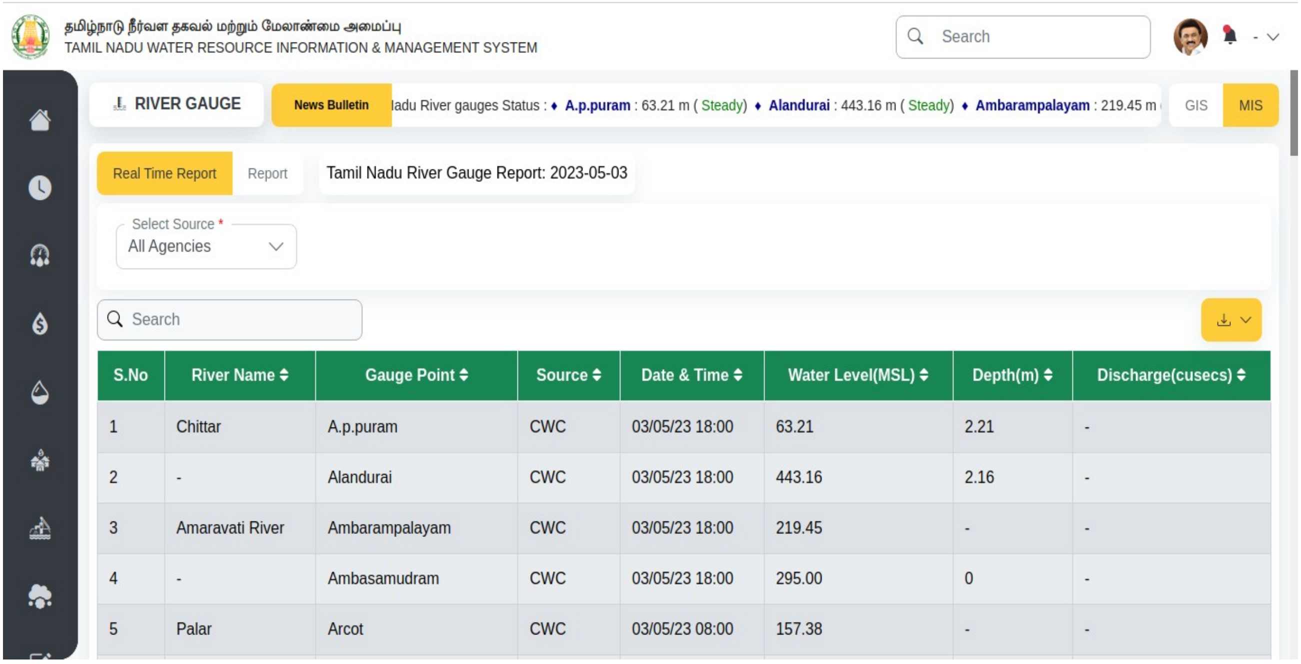

Figure 5.2.3 MIS View of RIVER GAUGE

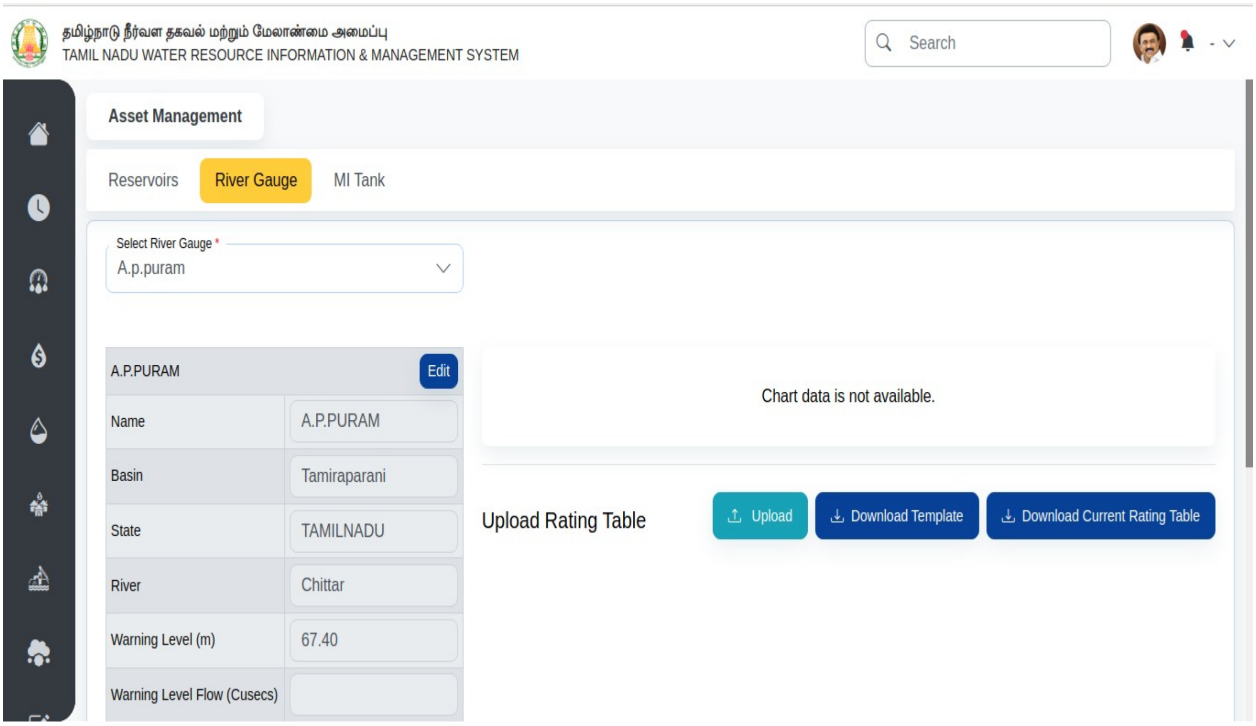

Figure 5.2.4 Content Management

CHAPTER 6

CONCLUSION & FUTURE SCOPE

6.1 Conclusion

In conclusion, the project aims to provide real-time insights into various water resource parameters such as rainfall,groundwater level, river water level, inflow forecast, soil moisture, flood forecasting and reservoir water level.This system collects data from various sensors and websites, processes it using advanced technologies such as Kafka, Flink, Cassandra and PostgresSQL and generate dashboards, heatmaps, graphs and tables for visualization.The project uses a wide range of technologies and software tools.These technologies and tools have been chosen carefully to ensure that the system is scalable, reliable and efficient.

The project addresses several challenges in water resource management such as flood forecasting, reservoir management and planning, canal management system and water audit and budgeting.The system can help governments and organizations make data-driven decisions to manage water resources effectively.

Overall, the project has the potential to bring significant benefits to the water resource management sector by providing real-time insights, optimizing resource utilization and improving water security.The project also has future scope for further development and expansion such as integrating with other systems and adding new features to address emerging challenges in the field of water management.

6.2 Future Scope

The proposed system has significant potential for future expansion including the integration of additonal sensors and data sources, the development of new DSS products and the deployment of the system in other regions.

Here are some possible areas that can be explored further:

- Additional water parameters: The project can be further developed to include additional water parameter such as water quality,sediment levels and dissolved oxygen levels.This will provide a more comprehensive view of the water resource and help in better decision making.

- Integration with other systems: The project can be integrated with other systems such as weather forecasting systems and agricultural data systems.This will provide a more complete view of the factors affecting water resources and help in better planning and management.
- Improved analytics: The project can be further developed to include more advanced analytics such as predictive analysis and machine learning algorithms.This will enable better forecasting and decision making and help in identifying trends and patterns that are not easily visible with traditional methods.
- User customization: The project can be further developed to allow users to customize the dashboard and visualizations according to their specific needs.This will make the system more user-friendly and enable users to get the insights they need quickly and easily.
- Increased Automation: The project can be further developed to increase automation such as automated data collection and analysis to reduce human error and make the system more efficient.
- Expansion to other regions: The project can be expanded to cover other regions and countries which will increase the scope of the project and enable better global water management.
- Enhanced reporting: The project can be further developed to include more advanced reporting features such as custom reports and data exports.This will enable users to generate reports quickly and easily and share the data with other stakeholders.

CHAPTER 7

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