

Development of an interactive web-based user interface for AIMS (Computer model demonstration)

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Introduction

Agricultural Integrated Management System (AIMS) is a powerful and easy to use web-based tool for evaluating the impact of agricultural and channel conservation management practices for any watershed in the United States. AIMS provides a seamless map server for downloading geospatial data and running simulations with minimum user intervention. The integration of TopAGNPS, a topographic analysis tool that provides comprehensive processing and evaluation of the digital elevation model (DEM), and ANNualized AGricultural NonPoint Source model (AnnAGNPS), a tool to evaluate the impacts of management decisions on water, sediment, and chemical loadings within a watershed system, is currently underway.

The AIMS interface uses a state-of-the-art framework which is based on Python-based modules and applications for user authentication, management, and manipulation of geospatial data layers and databases. The new AIMS interface provides for project management by offering different scenarios within an administrative panel to manage user groups and projects. Users have access to a variety of geospatial layers including Watershed Boundary Dataset (WBD), National Elevation Dataset (NED), Cropland Data Layer (CDL), SSURGO soil data. In addition to these geospatial data layers, users can have access to TopAGNPS generated stream network and sub-catchments (AnnAGNPS cells) for automatic generation of the computation area by only selecting the outlet. The new AIMS back-end scripts generate AnnAGNPS input files from these datasets. In what follows, the current capabilities and key features of AIMS are summarized.

Framework Architecture

Web-GIS framework is the architectural approach for implementing the modern GIS applications which gives the users the distribution of maps and processing tools without time and location restrictions. AIMS is designed to allow visual interaction with the geospatial data on the web practically anywhere on any device with internet access.

The architecture used in AIMS is a dynamic extensible design to enable appending GIS components and other modeling tools such as TopAGNPS and AnnAGNPS. Figure 1 illustrates the AIMS Web-GIS architecture of the AIMS system. In this workflow, the user can access AIMS

via the Web GIS application on the client side, which is under a web browser and sends requests over the Internet via HTTP to the web server (NGINX). The web server sends the user requests to GeoDjango, a geographic web framework powered by Python. GeoDjango retrieves the required data from the database and examines the request, which can result in generating a map, performing a query, or performing an analysis. Data, maps, and other results are sent to the client by Graphical User Interface (GUI) via HTTP. GUI is responsible for communication and interaction with the user. In this system, Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), and Bootstrap are used to structure the content of the web page. JavaScript as a web-side programming language is used to make the interface interactive. The mapping library (LeafletJS) is the most important component in the GUI. The Mapping Library makes the GUI able to display and use maps and data in the form of tile images or digital maps obtained from the database and Tile Servers. Tile Servers takes the sliced geospatial vector tiles and efficiently delivers them to the Mapping Library. AIMS serves its tile servers to control the traffic and the data such as Watershed Boundary Dataset (WBD), National Elevation Dataset (NED), Cropland Data Layer (CDL), SSURGO soil data.

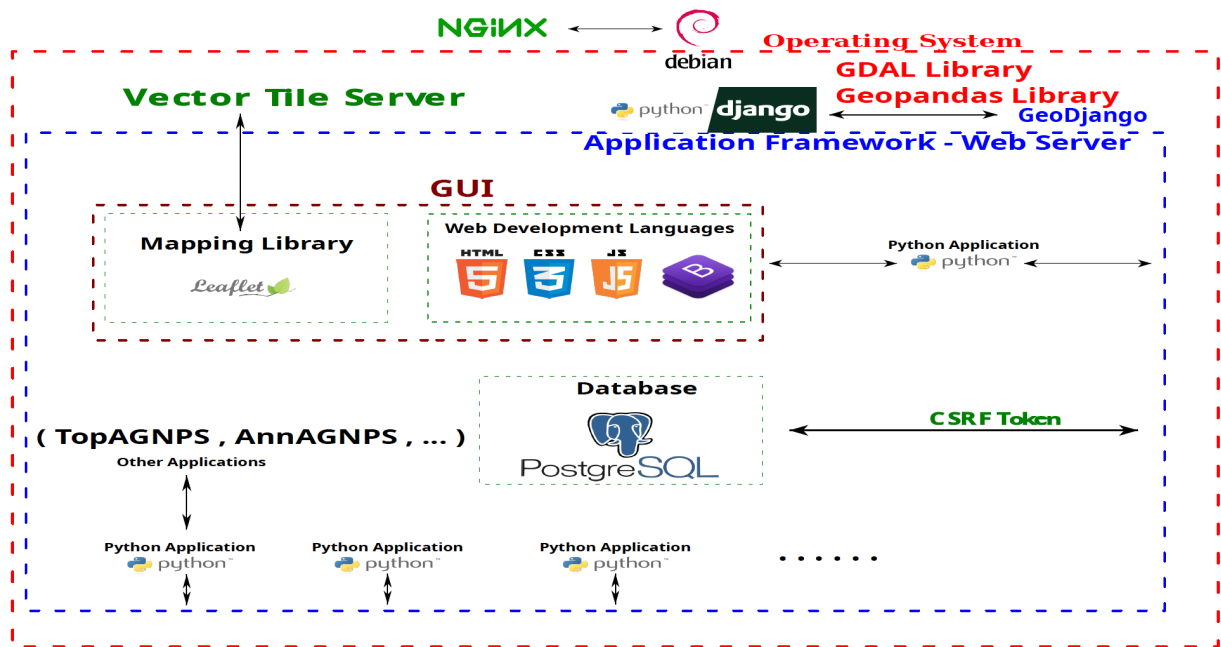


Figure 1. Flowchart that summarizes the whole Web-GIS architecture of the AIMS system.

The Backend Interactions include management, data storage, user, and complex database query processing. Django provides administrative tools and robust security features such as user tokenization for backend operations to avoid SQL injection, clickjacking, cross-site request forgery, and scripting. This procedure is illustrated in Figure 2. AIMS Admin Panel allows limited AIMS administrators to manage system users, and perform adding, editing and deletion of system content such as users, projects and scenarios.

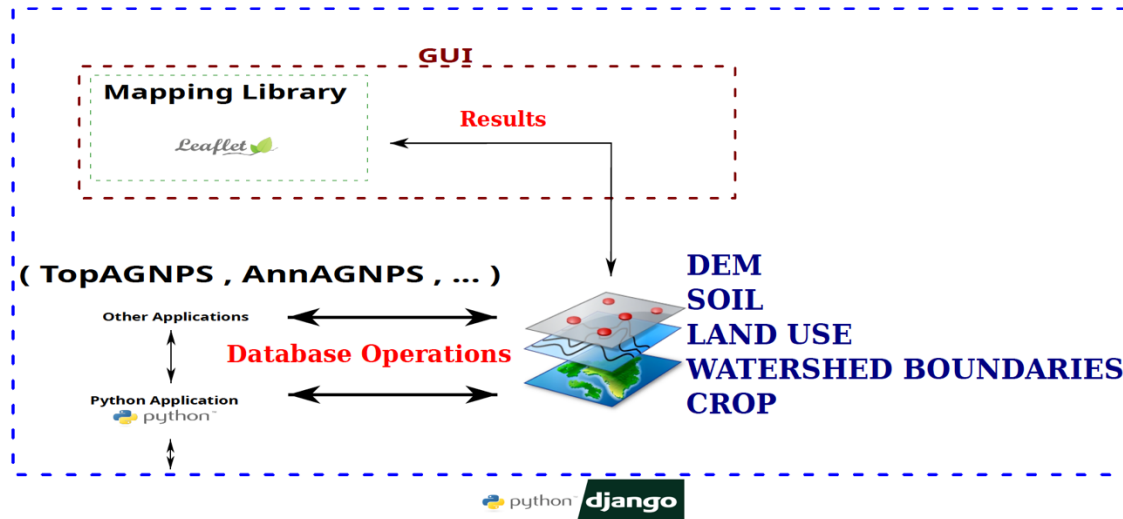


Figure 2. Flowchart of the backend interactions.

The homepage of AIMS which is shown in Figure 3, includes the destinations and information, right up front, guiding visitors to the registration and login steps. AIMS has an authentication system that allows users to register new users (including admin/superusers), assign groups and permissions, limit specific pages only to logged-in users or just users who meet certain criteria, and so much more. After registration on the system, user could access to dashboard page to access projects and scenarios which are created and attached to the user by foreign keys in the database.



Figure 3. Homepage of AIMS.

The mapping tool is able to display and use mapping services in the form of tile images and digital maps of the data as shown in Figure 4. Also, it enables users to select watershed boundaries for AnnAGNPS simulations. Breadcrumb schema is located on the top of the mapping tool. This schema is a secondary navigation aid that helps users easily understand the relation between their project and scenario. Also, users can access dashboard page via this schema which provides a streamlined way to make CRUD (Create, Read, Update, and Delete) operations and display the projects and scenarios.

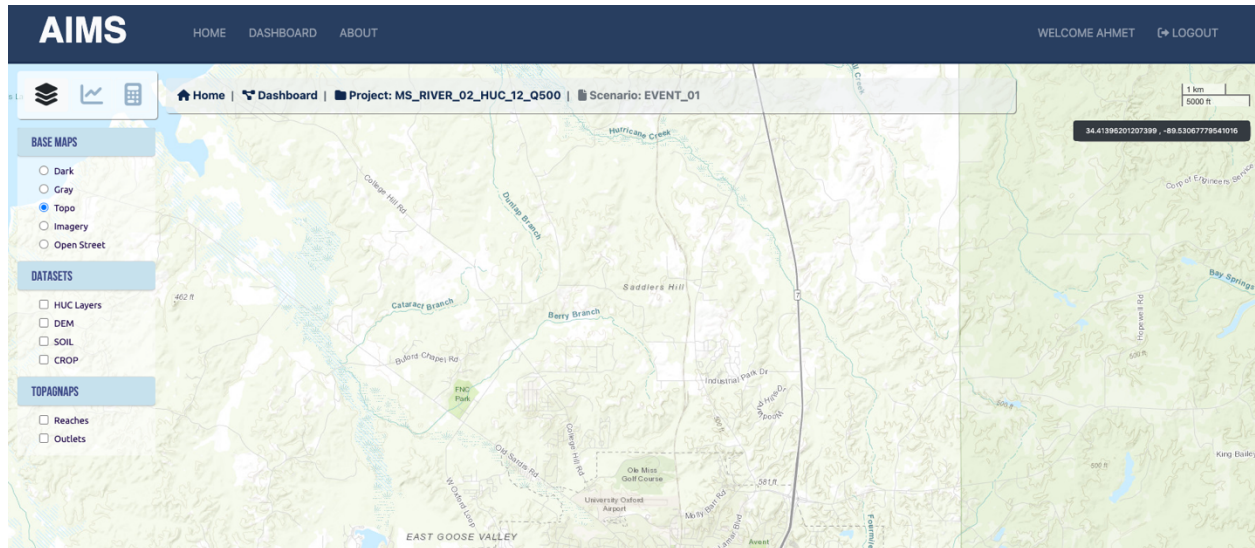


Figure 4. Mapping Tool.

Conclusion

In this study Web-GIS architecture of the AIMS system and its workflow is presented. The AIMS interface is based on Python-based modules and applications for user authentication, management, and manipulation of geospatial data layers and databases. Project management is designed as database relation attached to users via foreign keys and security tokens. Mapping tool enables users to access a variety of geospatial layers including Watershed Boundary Dataset (WBD), National Elevation Dataset (NED), Cropland Data Layer (CDL), SSURGO soil data. The new AIMS back-end scripts generate AnnAGNPS input files from TopAGNPS generated stream network and sub-catchments (AnnAGNPS cells) by selecting TopAGNPS pre-run boundaries. The key features of AIMS along with example simulations will be demonstrated.

Acknowledgments

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