

***CyberGISX* for Reproducible Geospatial Research and Education**

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Outline

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RESEARCH ARTICLE

CyberGIS-Jupyter for reproducible and scalable geospatial analytics

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Summary

The interdisciplinary field of cyberGIS (geographic information science and systems (GIS) based on advanced cyberinfrastructure) has a major focus on data- and computation-intensive geospatial analytics. The rapidly growing needs across many application and science domains for such analytics based on disparate geospatial big data poses significant challenges to conventional GIS approaches. This paper describes CyberGIS-Jupyter, an innovative cyberGIS framework for achieving data-intensive, reproducible, and scalable geospatial analytics using Jupyter Notebook based on ROGER, the first cyberGIS supercomputer. The framework adapts the Notebook with built-in cyberGIS capabilities to accelerate gateway application development and sharing while associated data, analytics, and workflow runtime environments are encapsulated into application packages that can be elastically reproduced through cloud-computing approaches. As a desirable outcome, data-intensive and scalable geospatial analytics can be efficiently developed and improved and seamlessly reproduced among multidisciplinary users in a novel cyberGIS science gateway environment.

KEYWORDS

cloud computing, computational reproducibility, cyberGIS, geospatial big data

Purposes

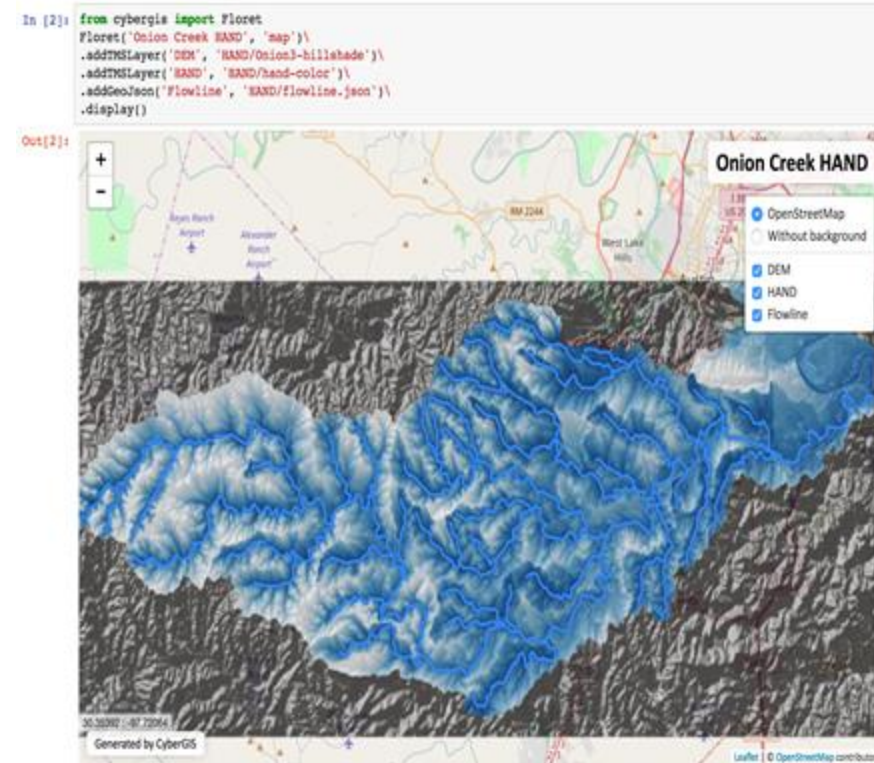
- Achieves data-intensive, reproducible, and scalable geospatial analytics using Jupyter Notebooks
 - Provides a holistic solution
 - Makes sharing code and workflows easy
- Reduces the barrier to accessing advanced cyberinfrastructure and cyberGIS capabilities
 - Exploits JupyterHub, cloud, and high performance computing resources

Capabilities

- Provides notebook servers with cyberGIS libraries and many geospatial software packages installed
 - Built-in cyberGIS capabilities to accelerate gateway application development
 - E.g., HAND Application
 - Data, analytics, and workflow runtime environments are encapsulated into application packages
- Deployment can be elastically scaled to accommodate the computational needs of cyberGIS users
 - Straightforward management and maintenance of computational infrastructure
 - Seamless scaling between Virtual ROGER and XSEDE JetStream

CyberGISX: Geovisualization

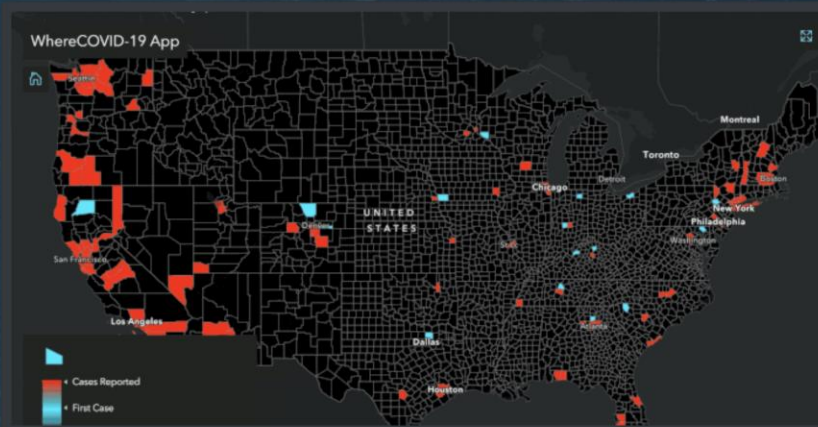
- Interactive map generation inside notebooks
- Support multiple formats of geospatial data
- Layer management, transparency, and styles





CyberGISX ^(alpha)

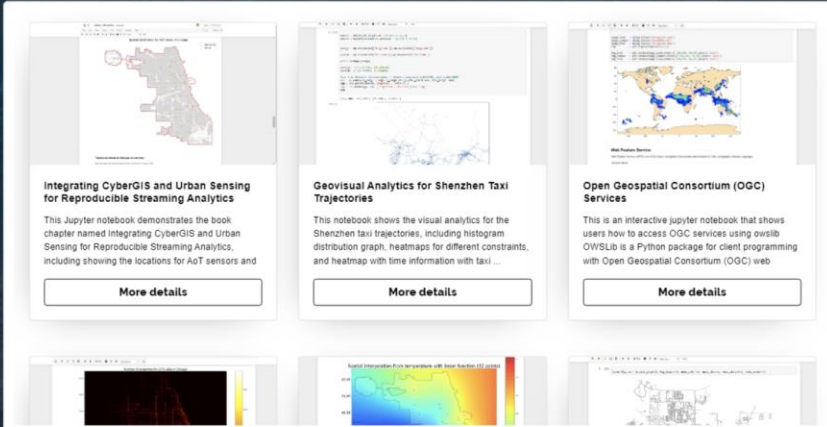
Providing streamlined cyberinfrastructure access and an integrated software stack for computationally reproducible research and education across a variety of geospatial-related domains.



WhereCOVID-19 App

WhereCOVID-19 notebooks map multi-scale spread of COVID-19 and assess related impacts by integrating diverse geospatial data, analysis, and modeling capabilities based on CyberGIS-Jupyter, an innovative cyberGIS framework for conducting data-intensive, reproducible, and scalable geospatial analytics using Jupyter Notebooks as the primary user environment.

See Our COVID-19 Related Notebooks



Integrating CyberGIS and Urban Sensing for Reproducible Streaming Analytics

This Jupyter notebook demonstrates the book chapter named Integrating CyberGIS and Urban Sensing for Reproducible Streaming Analytics, including showing the locations for AOT sensors and

More details

Geovisual Analytics for Shenzhen Taxi Trajectories

This notebook shows the visual analytics for the Shenzhen taxi trajectories, including histogram distribution graph, heatmaps for different constraints, and heatmap with time information with taxi ...

More details

Open Geospatial Consortium (OGC) Services

This is an interactive jupyter notebook that shows users how to access OGC services using owslib. OWSLib is a Python package for client programming with Open Geospatial Consortium (OGC) web

More details

Get Started with CyberGISX

CyberGISX notebooks include geospatial codes, workflows with comments, and visualizations providing a solid foundation for conducting computationally reproducible research and education.

See Community Notebooks



Welcome to

CyberGISX

CyberGISX is an innovative cyberGIS framework for conducting data-intensive, reproducible, and scalable geospatial analytics using Jupyter Notebook as its primary user environment. The framework adapts Jupyter Notebook with built-in cyberGIS capabilities to accelerate cyberGIS application development and sharing while associated data, analytics, and workflow runtime environments are encapsulated into application packages that can be elastically reproduced through cutting-edge cloud computing approaches. As a desirable feature, data-intensive and scalable geospatial analytics can be efficiently developed, improved, and seamlessly reproduced among multidisciplinary users in a novel cyberGIS science gateway environment.

[More Details](#)

[Sign in](#)

[Create account](#)



Behind the Scenes

- Docker
- DockerSwarm
- JupyterHub

Bridging Local Cyberinfrastructure and XSEDE with CyberGIS-Jupyter

[Extended Abstract]

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INTRODUCTION

The fabric of national and international cyberinfrastructure ecosystems for scientific discovery and innovation can be viewed as distributed computing environments composed of powerful supercomputers, various cloud computing resources, and numerous local cyberinfrastructure (including both cloud and HPC) resources. However, extensive computational work conducted by academic researchers are often siloed in one of these environments. Science Gateways [5, 6], by simplifying access to advanced cyberinfrastructure resources, have made significant progress on connecting these silos by enabling researchers in many fields to access advanced cyberinfrastructure through web browsers. In this context, this research bridges between national and local cyberinfrastructure resources through: (a) horizontal scaling of CyberGIS-Jupyter between the cloud resources provided by JetStream on the Extreme Science and Engineering Discovery Environment (XSEDE) and a VMWare-based cloud environment on Virtual ROGER, a local cyberinfrastructure resource hosted by the CyberGIS Center for Advanced Digital and Spatial Studies at the University of Illinois at Urbana-Champaign campus; and (b) enabling the submission of computationally intensive models to the batch systems of both Virtual ROGER and Comet (an XSEDE resource).

Specifically, we have developed a mechanism to provide access to a scalable JupyterHub platform together with cutting-edge cyberGIS software and hardware [4], called CyberGIS-Jupyter [7], which allows seamless access to high-performance computing (HPC) resources while shielding the complexity of managing cyberinfrastructure access from users. The user-friendly environment provided by CyberGIS-Jupyter along with computational scalability achieved through this research provides a powerful environment for conducting collaborative and reproducible research at scale with seamless access to advanced cyberinfrastructure at both local and national levels. The rest of this paper describes the architecture of our solution and articulates the corresponding implementation.

ARCHITECTURE AND IMPLEMENTATION

The architecture consists of four major layers: (a) user layer; (b) application layer; (c) cloud resources; and (d) HPC resources. The components of each of these layers and the interactions between them can be depicted in Figure 1. There are two levels at which users interact with cyberinfrastructure resources: (1) logging into JupyterHub and accessing their single user Jupyter Notebook server as an interactive session which runs transparently on local and national resources, and (2) submitting computationally intensive jobs that leverage HPC resources locally and on XSEDE.



CyberGISX User Interface

Registration part 1

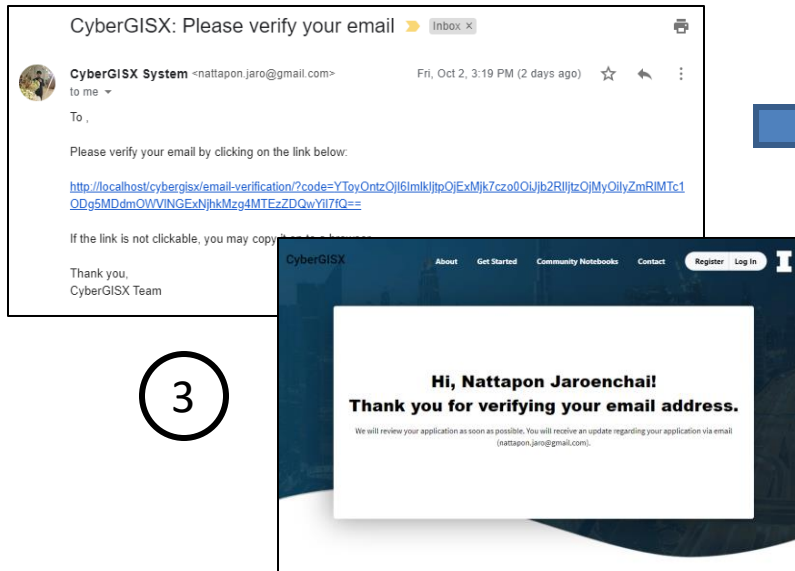


A screenshot of the CyberGISX registration form. The navigation bar at the top includes 'About', 'Get Started', 'Community Notebooks', 'Contact', 'Register', and 'Log in'. The 'Register' button is highlighted with a white circle and the number '2'. The main heading is 'Register to use CyberGISX' with a sub-heading: 'Register here to use CyberGISX. A Github username is currently required to access CyberGISX.' The form contains several input fields: 'Full Name *' (filled with 'Nattapon Jaroenchai'), 'Organizational Email *' (filled with 'nattapon.jaro@gmail.com'), 'Organization *' (filled with 'The Office of Educational Affairs'), 'Github Username *' (filled with 'N-jaro'), and 'Personal Website Link *' (filled with 'http://www.9bombs.com'). There is a text area for 'What do you want to use CyberGISX for?' with a placeholder text: 'Please submit a 200-300 word abstract about your research and your plans for using CyberGISX.' Below the text area is a 'Submit' button.

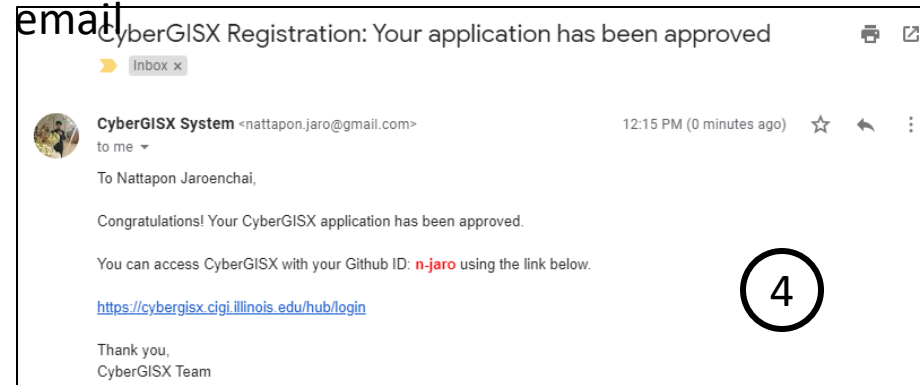
1. Go to the “Registration” page on the menu bar
2. Fill out the registration form

Registration part 2

Verify your email by clicking the link



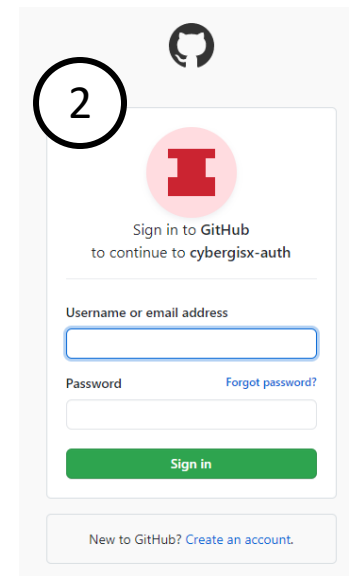
When you are approved, you will get an approval email



3. Verify your email address

4. Wait for approval email

Logging in part 1



Logging in part 2

There are 3 options:

1. Click the username to see your profile
2. Click “Edit Profile” to edit your profile page
3. Click “Log Out” to log out from this username

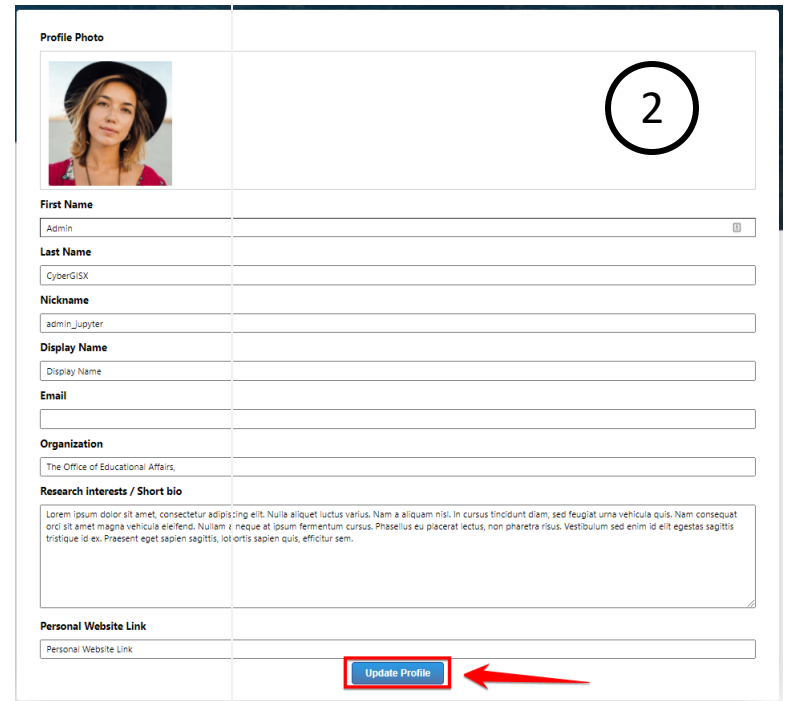
Hover over your username to see more



Editing your profile page



After logging in, click “Edit Profile”.
You then will be redirected to the
profile edit page.

A screenshot of a profile edit page with a white background. At the top left is a 'Profile Photo' section with a placeholder image of a woman and a circled '2' to its right. Below this are several input fields: 'First Name' (containing 'Admin'), 'Last Name' (containing 'CyberGISX'), 'Nickname' (containing 'admin_jupyter'), 'Display Name' (containing 'Display Name'), 'Email', 'Organization' (containing 'The Office of Educational Affairs'), and 'Research interests / Short bio' (containing placeholder text). At the bottom, there is a 'Personal Website Link' field and a blue 'Update Profile' button highlighted with a red box and a red arrow pointing to it from the right.

Edit your information and then click
“Update Profile” to save your progress.

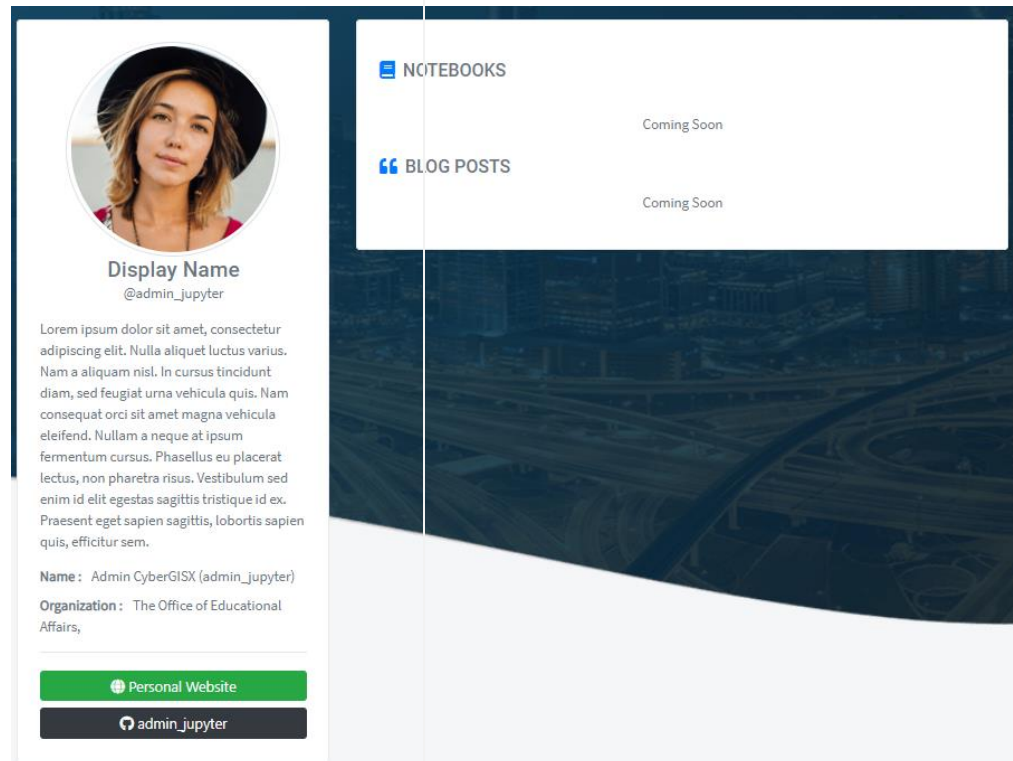
Recommended profile image size: 300x300.

About your profile page

Your profile page is public. You can share it anywhere and anyone can access your profile page.

The link to your profile page is:
<http://cyberigx.org/user-profile/{username}>

Note: Notebooks and Blog post profile page sections are still under development.



The screenshot displays a user profile page for 'admin_jupyter'. On the left, there is a circular profile picture of a woman with long brown hair wearing a black hat. Below the picture, the text reads 'Display Name' and '@admin_jupyter'. A paragraph of placeholder text follows: 'Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nulla aliquet luctus varius. Nam a aliquam nisl. In cursus tincidunt diam, sed feugiat urna vehicula quis. Nam consequat orci sit amet magna vehicula eleifend. Nullam a neque at ipsum fermentum cursus. Phasellus eu placerat lectus, non pharetra risus. Vestibulum sed enim id elit egestas sagittis tristique id ex. Praesent eget sapien sagittis, lobortis sapien quis, efficitur sem.' Below this text, it says 'Name : Admin CyberGISX (admin_jupyter)' and 'Organization : The Office of Educational Affairs,'. At the bottom of the profile section, there are two buttons: a green one labeled 'Personal Website' and a dark grey one labeled 'admin_jupyter'. To the right of the profile, there are two sections: 'NOTEBOOKS' and 'BLOG POSTS', both with a 'Coming Soon' message.

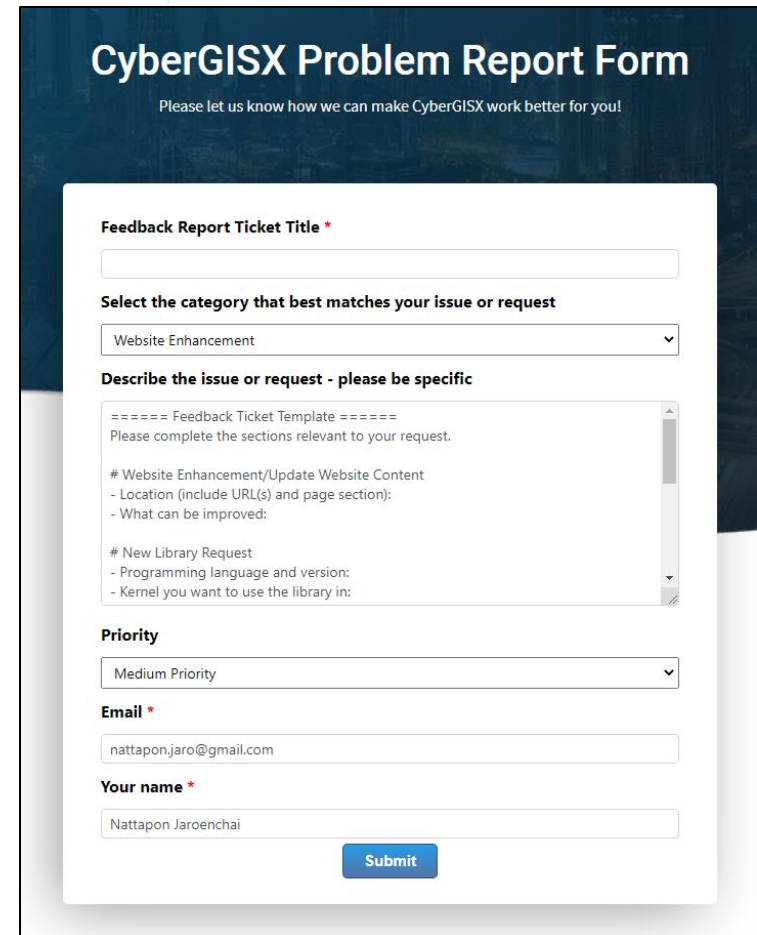
Submitting feedback and reporting problems



If you have feedback, want to submit a request, or find a problem, you can report it by going to “Contact > Problem Report” on the CyberGISX main menu.

We have provided a template in the description field. Please fill as much information as you can in the template section that corresponds to your request or issue.

Then click “Submit”.

A screenshot of the 'CyberGISX Problem Report Form'. The form is white with a dark blue header. The header contains the title 'CyberGISX Problem Report Form' and the subtitle 'Please let us know how we can make CyberGISX work better for you!'. The form fields are: 'Feedback Report Ticket Title *' (text input), 'Select the category that best matches your issue or request' (dropdown menu with 'Website Enhancement' selected), 'Describe the issue or request - please be specific' (large text area containing a template with sections for 'Website Enhancement/Update Website Content' and 'New Library Request'), 'Priority' (dropdown menu with 'Medium Priority' selected), 'Email *' (text input with 'nattapon.jaro@gmail.com'), and 'Your name *' (text input with 'Nattapon Jaroenchai'). A blue 'Submit' button is located at the bottom right of the form.



Demo – Using CyberGISX

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- XSEDE ECSS



Questions?

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