ERDC SR-23-12

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Rotorcraft Resupply Site Selection (RRSS) v1.0 and the USACE Model Interface Platform (UMIP)

Documentation and User's Guide

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November 2023

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Engineer Research and Development Center

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Final Report

Prepared for US Army Corps of Engineers
Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Under FLEX-4 (2363/FIF)

Abstract

This research effort aimed to create an operational prototype of the Geomorphic Oscillation Assessment Tool (GOAT) v1.0, developed by the US Army Engineer Research and Development Center, as a part of the US Army Corps of Engineers' Model Interface Platform (UMIP). This platform is a web-based software that allows for easy and rapid construction and deployment of spatial planning and analysis capabilities. The prototype tool in UMIP represents the science embedded in GOAT while providing a user-friendly interface for interaction and spatially referenced result viewing. It also includes user access control, data storage, and integration with a long-term data management system, enabling users to access, share, and interrogate past analyses through profile management and result persistence. The prototype tool incorporates surface roughness into terrain suitability assessment tools used in the forward arming and refueling point (FARP) site-selection process.

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Figures and Tables

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Preface

This study was conducted for the Engineer Research and Development Center under Flex-4 (2363/FIF), "Enterprise Solution for Deployed Force Infrastructure Assessment and Site Selection."

The work was performed by the Training Lands and Heritage Branch of the Operational Science and Engineering Division, Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). At the time of publication, Ms. Angela Rhodes was branch chief, Dr. George Calfas was division chief, and Mr. Jim Allen was the technical director for Environmental Quality and Installations. The deputy director of ERDC-CERL was Ms. Michelle Hanson, and the director was Dr. Andrew Nelson.

The Information Generation and Management Branch of the Geospatial Research Division, ERDC Geospatial Research Laboratory (ERDC-GRL), also performed this work. At the time of publication of this report, Mr. Michael F. Mailloux was branch chief, and Mr. Jeffrey B. Murphy was division chief. The deputy director of the ERDC-GRL was Ms. Valerie L. Carney, and the director was Mr. David R. Hibner.

Further work was performed by the Hydrologic Systems Branch of the Flood and Storm Protection Division, ERDC Coastal and Hydraulics Laboratory (CHL). At the time of publication, Dr. Hwai-Ping "Pearce" Cheng was branch chief, and Ms. Lauren Dunkin was acting division chief. The deputy director of ERDC-CHL was Mr. Keith Flowers, and the director was Dr. Ty Wamsley.

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COL Christian Patterson was commander of ERDC, and Dr. David W. Pittman was the director.

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1 Introduction

The US Army Corps of Engineers (USACE) Model Interface Platform (UMIP) is a web-based software platform that allows for rapid construction and deployment of spatially focused planning and analysis capabilities. It allows data to be easily stored for future use or imported or exported to other engineering planning tools. It also allows close control of user access—thus ensuring adequate training can be provided prior to the full use of a software tool. Last, it provides flexibility for future integration with a long-term data management system.

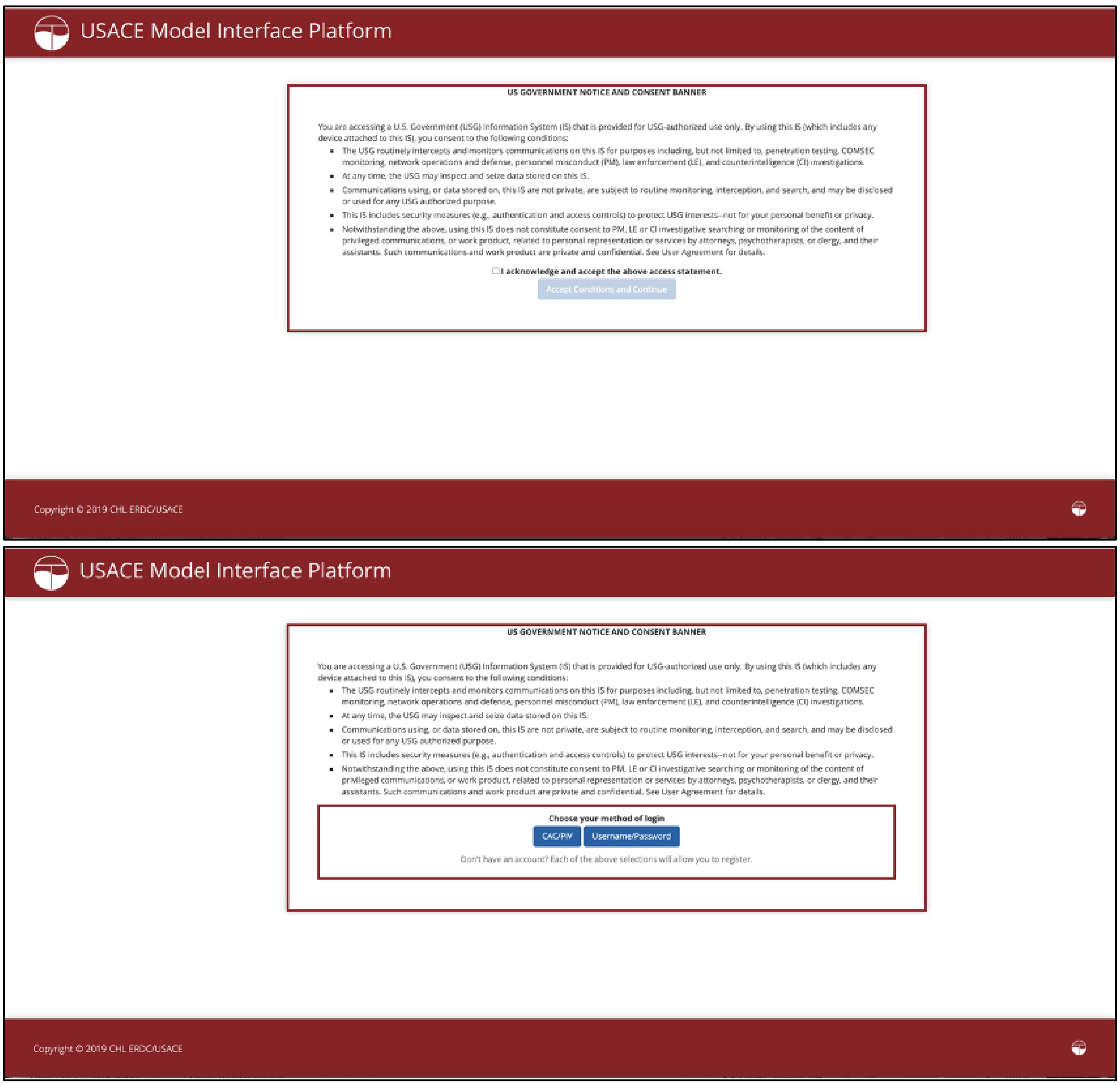
The overarching goal of this research effort was to provide an operational prototype of the Engineer Research and Development Center–developed helicopter landing zone (HLZ) site-selection algorithm known as the geomorphic oscillation assessment tool (GOAT), which incorporates surface roughness into terrain suitability assessment tools used in the forward arming and refueling point (FARP) site-selection process (Ekegren and LeGrand 2021). In UMIP, there now exists a prototype tool that represents to the most exact degree possible the science embedded in the established GOAT capability while also providing a user-friendly interface through which users can interact with the algorithm and view results in a spatially referenced manner. As a component of this effort, we have also included the ability for users to access, share, and interrogate past analyses through management of user profiles and result persistence.

2 Rotorcraft Resupply Site Selection (RRSS) in UMIP: Quick Start Guide

2.1 Accessing the RRSS Tethys app

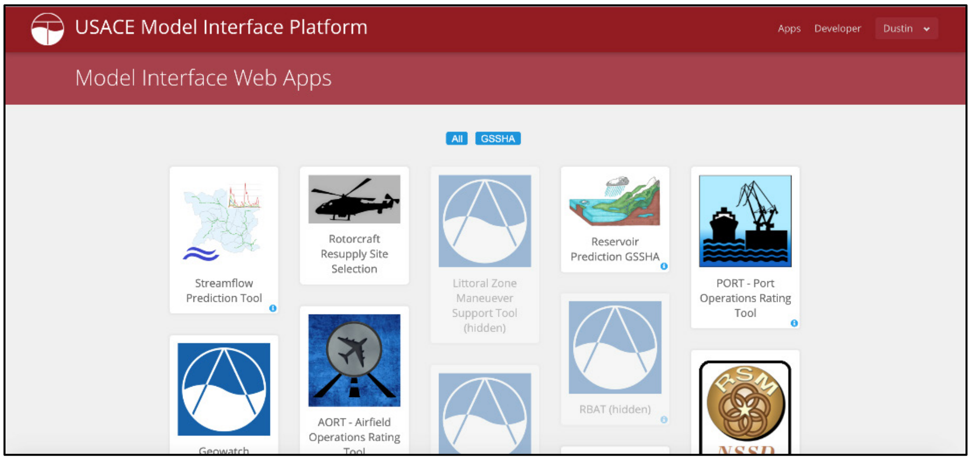
The Rotorcraft Resupply Site Selection (RRSS) app is accessible via common access card (CAC) authentication from https://umip.erdc.dren.mil, as shown in Figure 1. Log-in with username and password is available to non-CAC holders by request for those with system access and adequate justification.

Figure 1. US Army Corps of Engineers (USACE) Model Interface Platform (UMIP) log-in screen.



Once the login process is complete, the user is redirected to the UMIP home page with all the web applications that are available to the user, as shown in Figure 2. To access the RRSS app, select the "Rotorcraft Resupply Site Selection" tile.

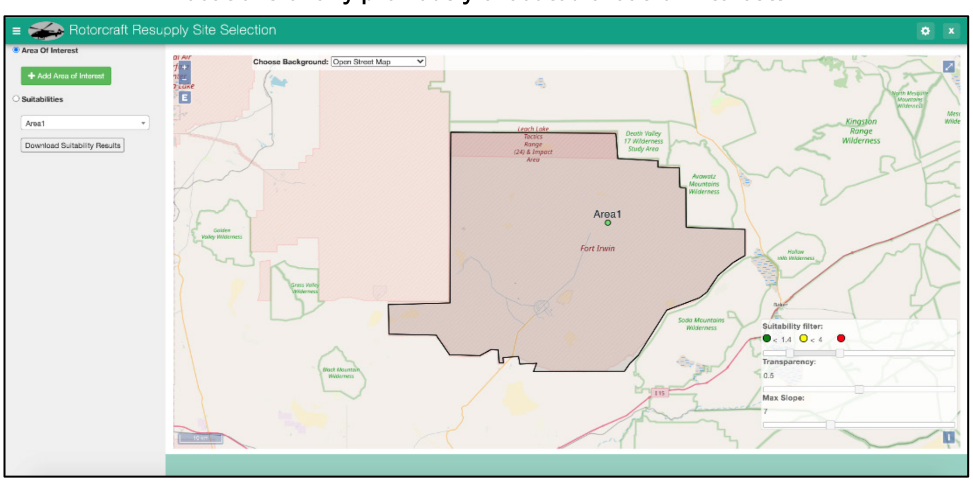
Figure 2. A view of UMIP home page showing a selection of available web applications.



2.2 Content and symbology

After selecting the RRSS app, the user is redirected to the RRSS landing page shown in Figure 3.

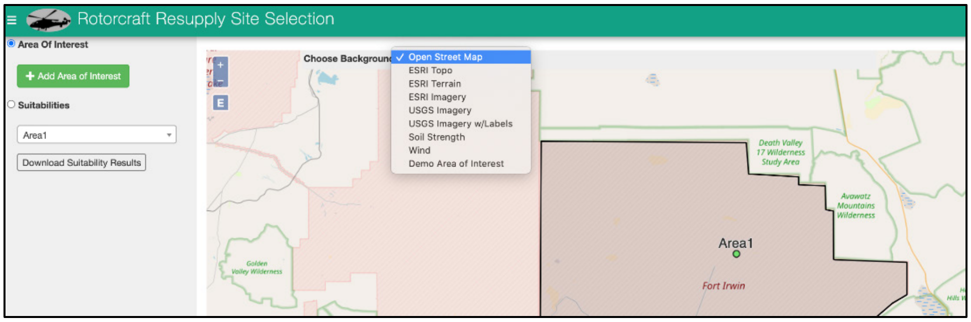
Figure 3. The rotorcraft resupply site selection (RRSS) landing page consists of a map interface showing a polygon that represents the area of available data and the locations of any previously executed areas of interests.



2.3 Navigation

The user can interact with the map through pan and zoom functionality that works similar to other web-based map interfaces. A control panel centered below the top banner provides some additional display options (Figure 4).

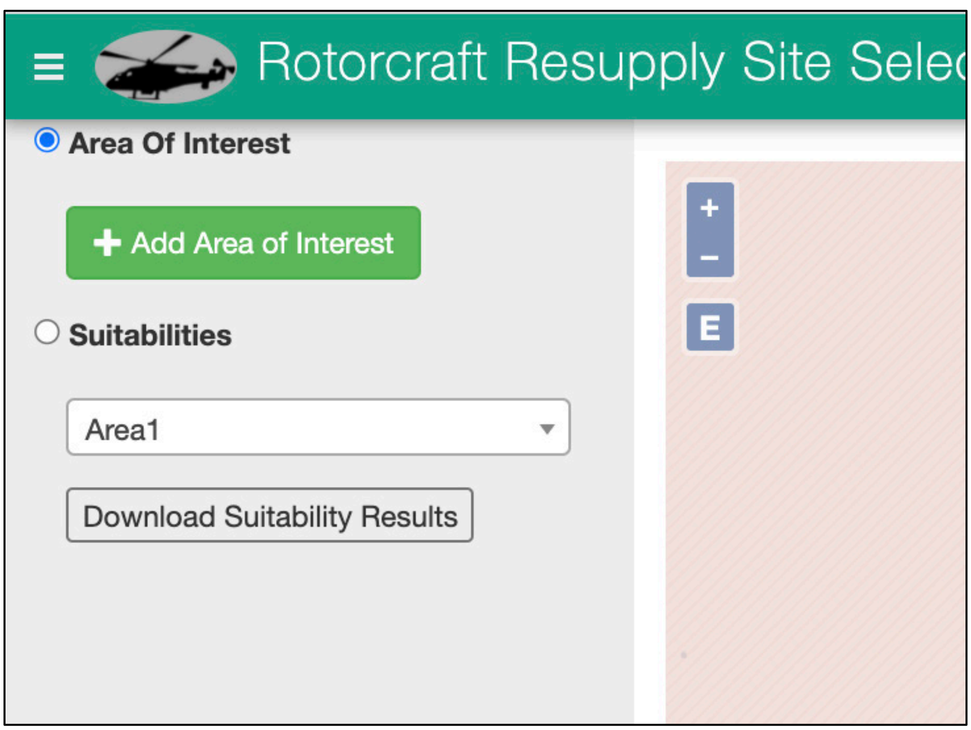
Figure 4. Navigating between multiple background imagery options.



2.4 Creating an area of interest

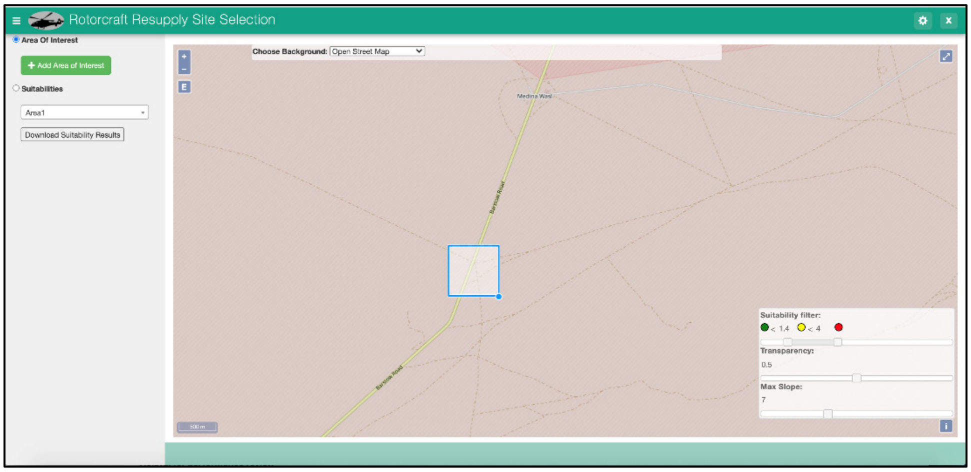
Step 1–Drawing Area: The first step to create an area of interest (AOI) is to draw out the desired area. To make this interaction available, the user must press "Add Area of Interest" from the menu on the left side of the app (Figure 5).

Figure 5. Detail of the area-of-interest (AOI) route available for analysis.



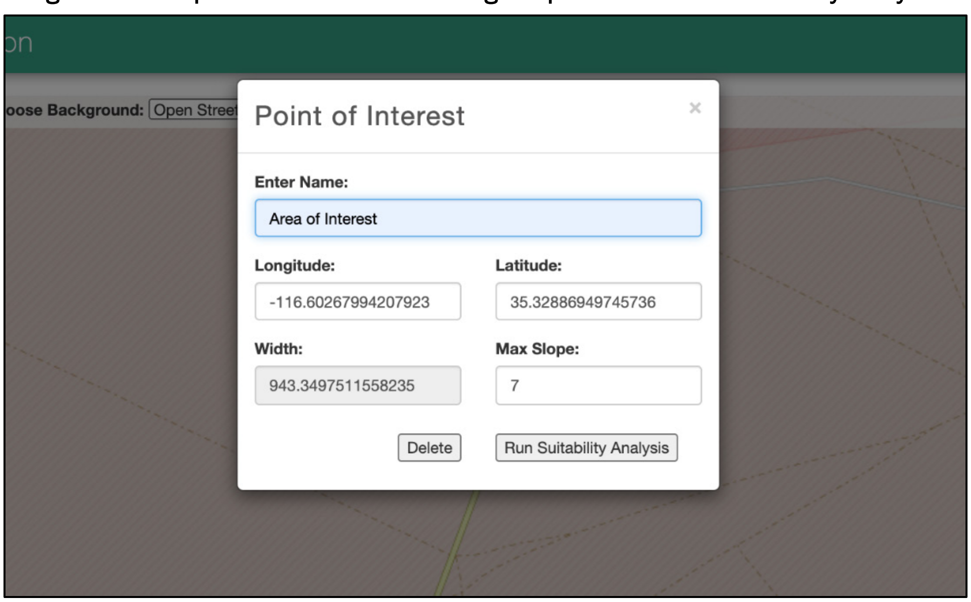
Users can now draw a box on the map. To do so, the user must click on a point on the map. This point becomes the bottom left corner of the area being drawn. Moving the cursor farther to the right will increase the size of the AOI (Figure 6). The box has a minimum and maximum size, so it is best to zoom in far enough for placing the box in the correct desired location.

Figure 6. Illustration of a bounding box.



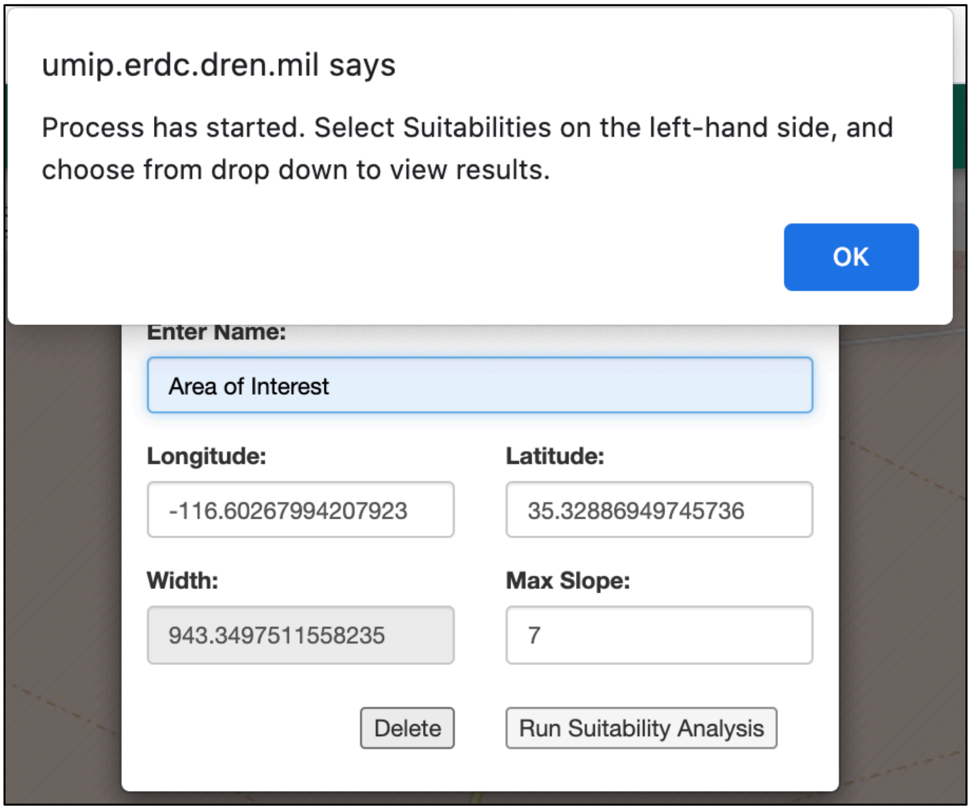
Step 2–Entering Parameters: The second step is to enter parameters for the RRSS function to use for execution (Figure 7). This becomes available after finishing the drawing of the AOI.

Figure 7. Example of the “wizard” defining the parameters of a suitability analysis.



The user can change the name, longitude, latitude, and max slope. The width value is decided by the size of the box drawn. After the correct parameters are entered into the boxes, users can press the “Run Suitability Analysis” button to execute. This will send a command to the server to start executing the suitability analysis with the given parameters. The process can take a few minutes, depending on the size of the area made (Figure 8).

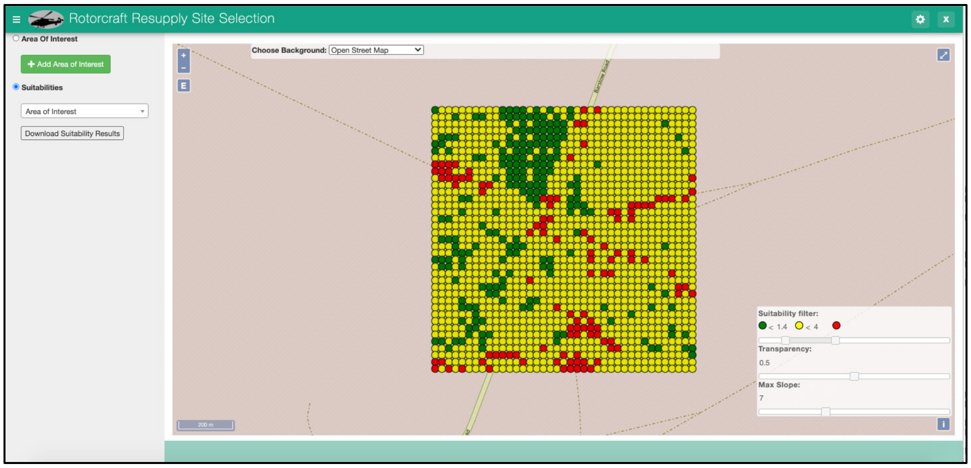
Figure 8. UMIP will run the “Suitability Analysis” and display results



2.5 Viewing the results

Step 1–Selecting the AOI: The first step is to select the desired AOI for viewing. To do so, click on the Suitabilities radio button on the left menu, and then select the AOI by name in the dropdown menu below it. The map should automatically zoom into the area where the suitability data were made (Figure 9). If the data do not show up, it is possible that the suitability analysis is still running and needs more time to finish.

Figure 9. "Suitability Filter" results are displayed in red, amber, and green, depending on previously defined parameters.

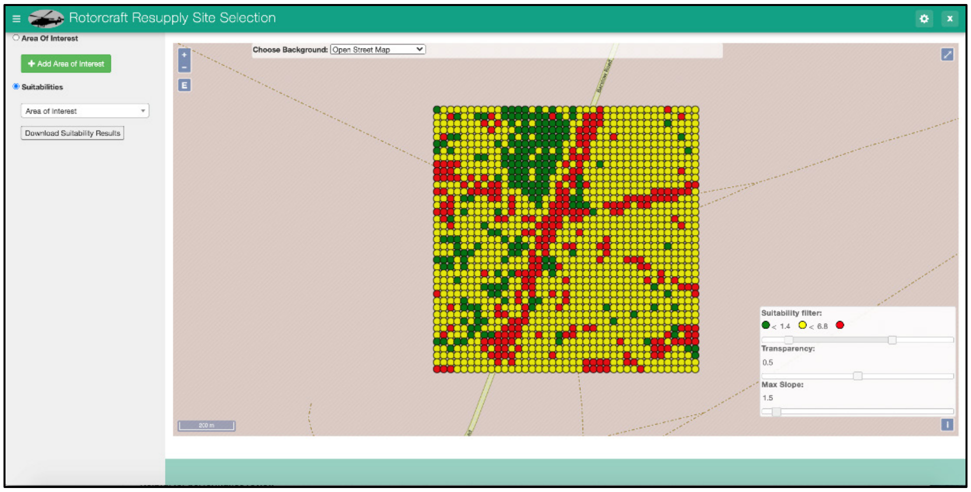


Step 2–Refine Results: After the results are made, the points on the map will have different colors. These represent the suitability of the region. The indicators can, however, be changed by the user by using the slider on the bottom right (Figure 10). There are three regions on the slider. The left represents the green, the middle represents the yellow, and the right represents the red. Left to middle to right on the slider is also good suitability to cautionary suitability to bad suitability.

Figure 10. The user can manually and dynamically change the red, amber, and green thresholds of the "Suitability Filter".

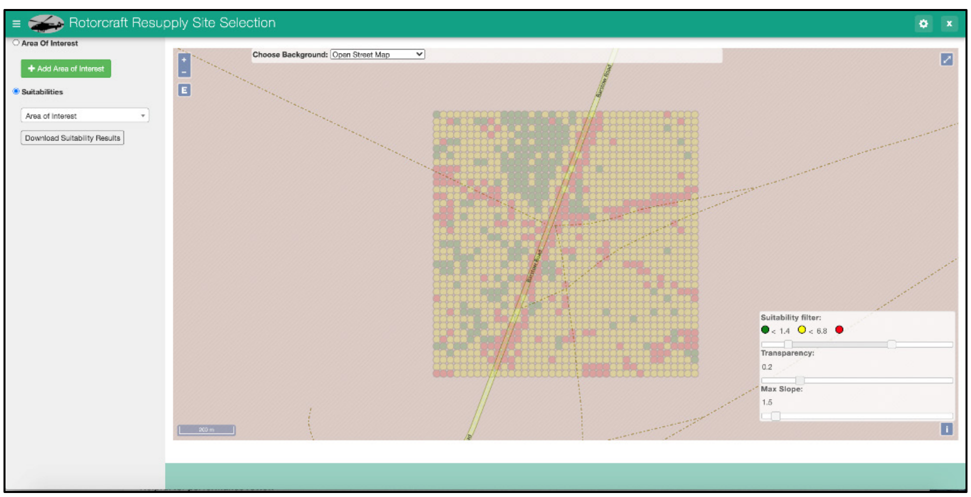
Another way in which the user can refine the results is by using the "Max Slope" in the legend slider. This will override the suitability filter and display a location point red if the raster cell's value goes over the selected max slope value (Figure 11).

Figure 11. Using the “Max Slope” parameter leads to different display characteristics.



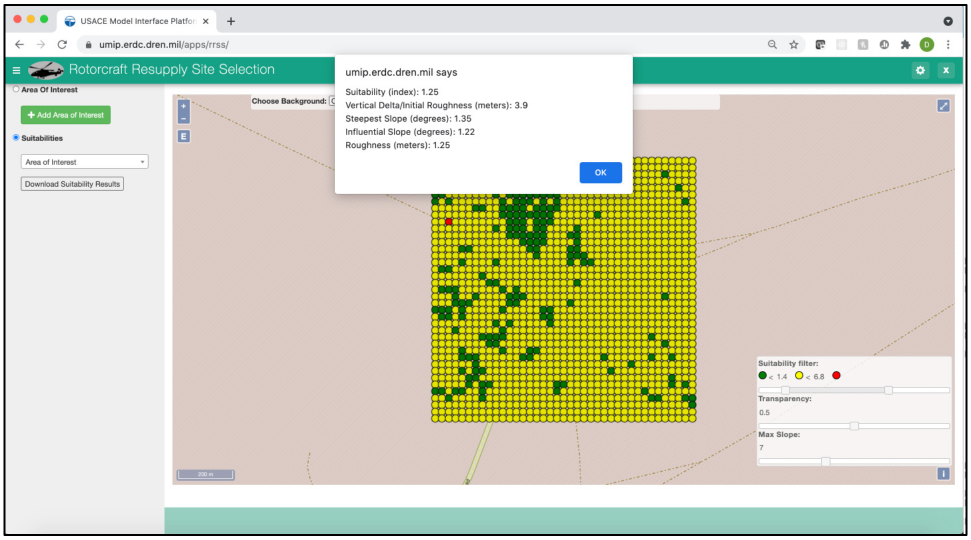
If the user wants or needs to thoroughly examine the data on the underlying map or imagery, there is an option for that as well. Changing the “Transparency” slider value located in the legend will change the data layer’s opacity (reference Figure 12).

Figure 12. Changing the display "Transparency” allows visualization of the underlying imagery.



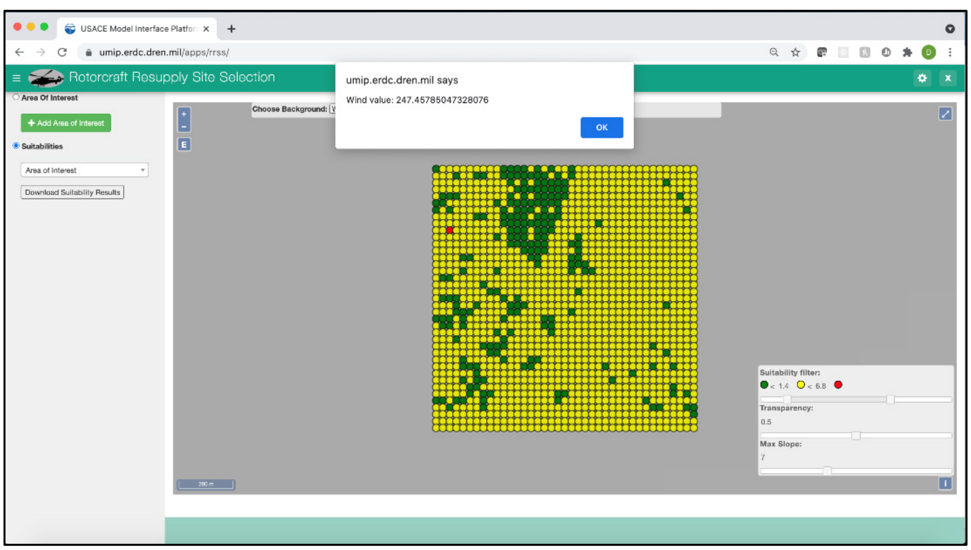
Step 3–Examine specific location: The user may also view all the available attributes for a location. To do so, a user needs to simply click on one of the colored locations while viewing the suitability results (Figure 13).

Figure 13. Each point of the analysis results can be examined individually.



Step 4–Examine prevailing wind direction: The user may also view the annual average prevailing wind direction value in terms of degrees from north for a given point on the map. This option is available only if the wind background is selected and the suitability layer is currently selected (Figure 14). Users interested in how the prevailing wind term is diagnosed are encouraged to review the report by Hoch and Cook (2023).

Figure 14. Each point in the underlying data can be examined individually.



Step 5–Download all results for that AOI as a comma-separated values (CSV) file: The user can click on the “Download Suitability Results” button to download and view the results from the script as a CSV.

(Figure 15 shows an example of the button, and Figure 16 shows a snapshot of the CSV.)

Figure 15. Detail of the "Suitabilities" route available for analysis.

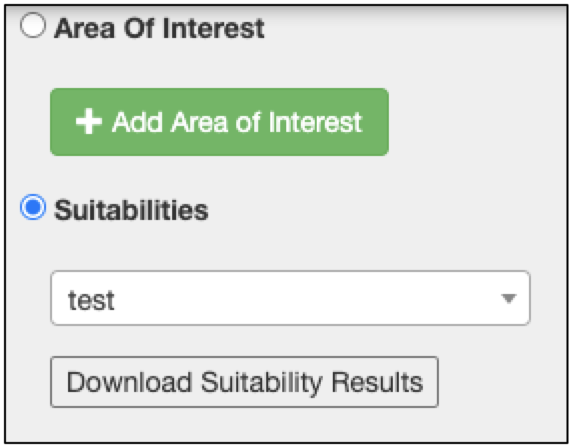


Figure 16. Table view of underlying data and analysis results.

	Lon	Lat	DTM	DSM	LC	VertDelta	SteepSlp	InflSlp	Plane	Obstacle	MaxClimb	Rough	Suitability
1	-116.839143406997	35.4955435624087	1123.68493652344	1123.67114257812	1	20.444580078125	7.68958604626518	6.38059968424985	-0.111831487268903	1	7.6381612759883	2000	2000
2	-116.83914339161	35.495318234861	1125.62719726562	1125.59692382812	1	21.06201171875	8.87383159498552	7.15305257326212	-2.1349679608255	1	6.23717503621095	2000	2000
3	-116.839143376223	35.4950929073133	1125.31140136719	1125.26062011719	1	26.868408203125	7.64365764529065	7.20173887785481	-1.36941602322259	1	6.80644475881034	2000	2000
4	-116.839143360837	35.4948675797656	1124.22216796875	1124.21520996094	1	24.82275390625	8.22486410186472	7.55010200782225	-1.36899062072462	1	7.03193124065046	2000	2000
5	-116.83914334545	35.4946422522179	1120.45275878906	1120.43884277344	1	26.061279296875	10.6347120500562	3.35921532793826	4.41483756315465	1	9.56773614610623	2000	2000
6	-116.839143330064	35.4944169246702	1121.38110351562	1121.36145019531	1	28.314453125	9.81704700840402	2.68507121714039	2.57586337068823	1	9.76814613531074	2000	2000

2.6 Capabilities

This application provides areas of suitability for HLZs, incorporating surface roughness and FARP terrain suitability assessment capabilities. The workflow is in a four-step process.

The first step is to ensure that the data are loaded correctly in a folder in the server. The data must be three data sets that all must line up: a digital surface model (DSM), a digital terrain model (DTM), and the National Land Cover Database (NLCD) land cover data set.

Next the user, must select an AOI limited to an area in which data have been loaded onto the map. Analyses function only where underlying data have been uploaded. The user can specify the central domain point longitude (degrees), central domain point latitude (degrees), cardinal direction distance (meters), and the maximum macroslope threshold (meters).

Third, a script based on GOAT is run on the parameters from the previous step and the data from step one. GOAT is a tool that incorporates surface roughness into HLZ and FARP terrain suitability assessment capabilities (see Ekegren and LeGrand 2021). It uses high-fidelity terrain elevation data, terrain suitability thresholds generated from extensive interviews with aviators, and circular sampling techniques to assess potential HLZs and their surroundings. Figure 17 shows the output of the script.

Figure 17. Transparency in data and subsequent analysis allows engagement with and validation of the process

	Lon	Lat	DTM	DSM	LC	VertDelta	SteepSlp	InflSlp	Plane	Obstacle	MaxClimb	Rough	Suitability
1	-116.839143406997	35.4955435624087	1123.68493652344	1123.67114257812	1	20.444580078125	7.68958604626518	6.38059968424985	-0.111831487268903	1	7.6381612759883	2000	2000
2	-116.83914339161	35.495318234861	1125.62719726562	1125.59692382812	1	21.06201171875	8.87383159498552	7.15305257326212	-2.1349679608255	1	6.23717503621095	2000	2000
3	-116.839143376223	35.4950929073133	1125.31140136719	1125.26062011719	1	26.868408203125	7.64365764529065	7.20173887785481	-1.36941602322259	1	6.80644475881034	2000	2000
4	-116.839143360837	35.4948675797656	1124.22216796875	1124.21520996094	1	24.82275390625	8.22486410186472	7.55010200782225	-1.36899062072462	1	7.03193124065046	2000	2000
5	-116.83914334545	35.4946422522179	1120.45275878906	1120.43884277344	1	26.061279296875	10.6347120500562	3.35921532793826	4.41483756315465	1	9.56773614610623	2000	2000
6	-116.839143330064	35.4944169246702	1121.38110351562	1121.36145019531	1	28.314453125	9.81704700840402	2.68507121714039	2.57586337068823	1	9.76814613531074	2000	2000

Finally, the user can see the results of the suitabilities from the script on the map where green circles represent areas of suitability that are less than or equal to 1.4; yellow circles, which are between 1.4 and 4; and red circles, which are greater than 4. These numbers are defaults and can be changed on the user interface. The user can also see specific details of each point from the GOAT script (see Figure 18).

Figure 18. All aspects of analysis results can be examined—no “black boxes.”

Suitability (index): 3.31
Vertical Delta/Initial Roughness (meters): 8.96
Steepest Slope (degrees): 2.58
Influential Slope (degrees): 2.36
Roughness (meters): 3.31

3 Technical Implementation

The RRSS Tethys app utilizes the Tethys Platform, Python, HTML, JavaScript, OpenLayers, Django, and PostgreSQL to implement its functions. Installing the Tethys Platform will install Django, Python, and PostgreSQL along with it. Python, Django and PostgreSQL are components that operate on the server side of the app to handle initializing the page or returning values to the user's browser for the interface. HTML, JavaScript, and OpenLayers are the front side components of the app that handle the GUI portion of the app.

3.1 Installing the app

Assuming the user has the source code, run "Tethys install" inside of the source code's directory to install the app. There should be a few prompts asking for the custom settings called "workspace," "user_workspaces," and "R." The directory "workspace" holds the three TIF files needed for the GOAT analysis to run. The directory "user_workspaces" holds a folder for each user. These folders contain an AOI ID–named folder that will contain the results of the analysis. The install then prompts for the name of the persistent store setting for handling the PostgreSQL database for the application. If a persistent store setting has not been made yet, one will need to be made using the Tethys Platform interface.

3.2 Opening the app

When the user goes to the RRSS Tethys application, the "home.html" file will be rendered using Django. The "home.html" file is an extension of the "base.html" file. The base file is a default HTML file that loads in components of the app that will usually be a part of every page on the app, such as the header portion. The home file specifies JavaScript and CSS files to load into the user's browser. The CSS files will mostly control how things look on the page while the JavaScript files will add interactions between the interface and the server. After the page loads, the OpenLayers JavaScript API will load and display the map on the page.

3.3 Making the AOI

This involves sending the necessary variables that make up the AOI (width and center) to the server. These variables are calculated when the user draws the square via the OpenLayers "Draw" interaction. The center and width values are sent back to the server to be saved to the PostgreSQL database via an AJAX jquery request.

3.4 Submitting the AOI

The submission occurs once the user clicks on "Run Suitability Analysis". When the user submits the AOI, the server will then take the parameters entered by user, which consists of the longitude, latitude, width, and max slope, and run the "GOAT.R" script that calculates the suitability values inside of the AOI and exports them out as a CSV file. This file contains the columns for Longitude, Latitude, DTM, DSM, Land Cover (LC), Vertical Delta, Steep Slope, Influence Slope, Plane, Obstacle, Max Climb, Roughness, and Suitability.

3.5 Viewing AOI results

Once submitted, the user has the option to view the data. Viewing the AOI results is when the user selects the desired suitability analysis from the available options. These options consist of any analysis names submitted by the current user. Making the selection will send an AJAX request to the server for the CSV results. After the browser receives the results, OpenLayers will draw the results on the map using the longitude and latitude columns, zoom into the location where the data are located, and keep the metadata stored in memory for each location. Clicking on a data location will call a JavaScript function that will find and display the selected feature's suitability, vertical delta and initial roughness, steepest slope, influential slope, and roughness.

4 Conclusion

This research effort has yielded a successful operational prototype of the Geomorphic Oscillation Assessment Tool (GOAT) as a part of the US Army Corps of Engineers' Model Interface Platform (UMIP). The purpose of this prototype tool is to incorporate surface roughness into terrain suitability assessment tools used in the forward arming and refueling point (FARP) site-selection process. The prototype tool in UMIP represents the science embedded in GOAT while providing a user-friendly interface and spatially referenced result viewing. It also includes user access control, data storage, and integration with a long-term data management system, enabling users to access, share, and interrogate past analyses through profile management and result persistence.

UMIP is a web-based software platform designed to enable rapid construction and deployment of spatial planning and analysis capabilities. It can both store data for future use or import and export data to other engineering planning tools. The software also provides close control of user access, ensuring adequate training can be provided before the full use of a software tool. Additionally, UMIP offers flexibility for future integration with a long-term data management system.

By incorporating surface roughness into the terrain suitability assessment tools, the prototype tool can provide a more accurate representation of suitable sites for the FARP process. This tool can help identify areas that are appropriate for helicopter landing zones (HLZs) and can help optimize the selection process for these sites. With the ability to access, share, and interrogate past analyses through profile management and result persistence, this tool will help to streamline the process of selecting suitable HLZs in the future. Overall, this research effort has been successful in developing a tool that is both useful and user friendly, offering an innovative solution to an important military planning challenge.

References

Ekegren, Michael, T., and Sandra L. LeGrand. 2021. *Incorporating Terrain Roughness into Helicopter Landing Zone Site Selection by Using the Geomorphic Oscillation Assessment Tool (GOAT) v1.0*. ERDC/CRREL TR-21-11. Hanover, NH: US Army Engineer Research and Development Center. http://dx.doi.org/10.21079/11681/42162.

Hoch, Brendon, and Samantha N. Cook. 2023. *A 10-Year Monthly Climatology of Wind Direction: Case-Study Assessment*. ERDC SR-23-2. Hanover, NH: US Army Engineer Research and Development Center. http://dx.doi.org/10.21079/11681/46912.

Abbreviations

AOI	Area of interest
CAC	Common access card
CSV	Comma-separated values
DSM	Digital surface model
DTM	Digital terrain model
FARP	Forward arming and refueling point
GOAT	Geomorphic oscillation assessment tool
HLZ	Helicopter landing zone
LC	Land Cover
NLCD	National Land Cover Database
RRSS	Rotorcraft resupply site selection
UMIP	USACE Model Interface Platform
USACE	US Army Corps of Engineers

REPORT DOCUMENTATION PAGE

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED START DATE	END DATE
November 2023	Final Report	FY19	FY21

4. TITLE AND SUBTITLE
Rotorcraft Resupply Site Selection (RRSS) v1.0 and the USACE Model Interface Platform (UMIP): Documentation and User's Guide

5a. CONTRACT NUMBER	5b. GRANT NUMBER	5c. PROGRAM ELEMENT
5d. PROJECT NUMBER	**5e. TASK NUMBER**	**5f. WORK UNIT NUMBER**

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
See reverse.	ERDC SR-23-12

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)	11. SPONSOR/MONITOR'S REPORT NUMBER(S)
US Army Corps of Engineers Engineer Research and Development Center 3909 Halls Ferry Road Vicksburg, MS 39180-6199	USACE	

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A. Approved for public release: distribution is unlimited.

13. SUPPLEMENTARY NOTES
Funded by FLEX-4 (2363/FIF)

14. ABSTRACT
This research effort aimed to create an operational prototype of the Geomorphic Oscillation Assessment Tool (GOAT) v1.0, developed by the US Army Engineer Research and Development Center, as a part of the US Army Corps of Engineers' Model Interface Platform (UMIP). This platform is a web-based software that allows for easy and rapid construction and deployment of spatial planning and analysis capabilities. The prototype tool in UMIP represents the science embedded in GOAT while providing a user-friendly interface for interaction and spatially referenced result viewing. It also includes user access control, data storage, and integration with a long-term data management system, enabling users to access, share, and interrogate past analyses through profile management and result persistence. The prototype tool incorporates surface roughness into terrain suitability assessment tools used in the forward arming and refueling point (FARP) site-selection process.

15. SUBJECT TERMS
Computer programs; Military geography; Military helicopters--Landing; Military planning; United States. Army--Aviation

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	C. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
Unclassified	Unclassified	Unclassified	SAR	26

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