

GreenLand2 application

User manual

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1. Introduction

Our society needs and environmental predictions encourage the applications development, oriented on supervising and analyzing different Earth Science related phenomena. Satellite images could be explored for discovering information concerning land cover, hydrology, air quality, and water and soil pollution.

The main objective of the GreenLand2 application is the generation and execution of workflows, based on satellite images. The GreenLand2 application development is based on simple, but powerful, notions of mathematical operators and workflows that are used in distributed and parallel executions over the Grid infrastructure. The nodes of the graph could take the form of a simple operator or a sub-workflow. Multiple nested levels are allowed within the GreenLand2 application.

All the time consuming operations are executed over the Grid infrastructure. Such a mechanism offers a better use of available distributed resources in a transparent way. Especially when considering the size of geospatial data and the amount of processing time required to rectify, extract relevant features and make available for viewing.

The GreenLand2 application offers a friendly user interface for viewing and editing workflows and operators. The description involves the basic operators provided by GRASS library as well as many other image related operators supported by the ESIP platform. The processing workflows are represented as directed graphs giving the user a fast and easy way to describe complex parallel algorithms, without having any prior knowledge of any programming language or application commands. Also this Web application does not require any kind of install for what the house-hold user is concerned. It is a remote application which may be accessed over the Internet.

For more information regarding the GreenLand2 application you could consult the department page (<http://cgis.utcluj.ro/applications/greenland>) or contact us at the following emails: dorian.gorgan@cs.utcluj.ro, vasile.mihon@cs.utcluj.ro.

2. User interface presentation layer

The GreenLand2 user interface presentation layer is highlighted in Figure 1. The entire application is divided into 6 main modules that perform the following:

1. User information

When first accessing the application it displays a sign in form and waits for the user to authenticate with the right credentials (username and password). After this step the user information is displayed within the GreenLand2 application. By clicking on the user name or the down arrow a list appears and offers the user the possibility to logout;

2. Application logos

Represent the GreenLand2 and the enviroGRIDS project within the application was developed. Both images are linked to other web pages that contain detailed information about the objectives and the attributes that they refer to;

3. Menu options

It contains the most needed operations on a regular usage of the application. A detailed description of each option is provided below, in the following paragraphs. It is worth to mention that the GreenLand2 application offers much more features, that are not part of the general menu and that will also be described later within this document;

4. Projects list

The project represents the basic notion of the GreenLand2 framework. It contains a list of resources (basically input data: satellite images, text files, numerical values, strings, etc.) and a group of workflows that will be executed over the Grid infrastructure. Projects name are unique within the list of a user. When a user registers the GreenLand2 application a default project is automatically provided by the system;

5. Workflows list

A workflow represents, in its simplest form, a basic operator. More complex workflows could be created by connecting the existing operators and current workflows in different ways. One of the main objectives of this application includes a Workflow Editor that will assist the user in building such complex workflows. Adding two satellite images, extracting bands from a Landsat image, computing vegetations indices (NDVI, EVI, GEMI, etc) represent a few of the basic operators included within the GreenLand2 application;

6. General information window

All the users' actions results are displayed in this application module. Basically it contains a large set of features that will activate based on the users' requests (e.g. allows the user to specify the inputs for all the workflows included in a project, displays the Grid execution progress, output result management, etc).

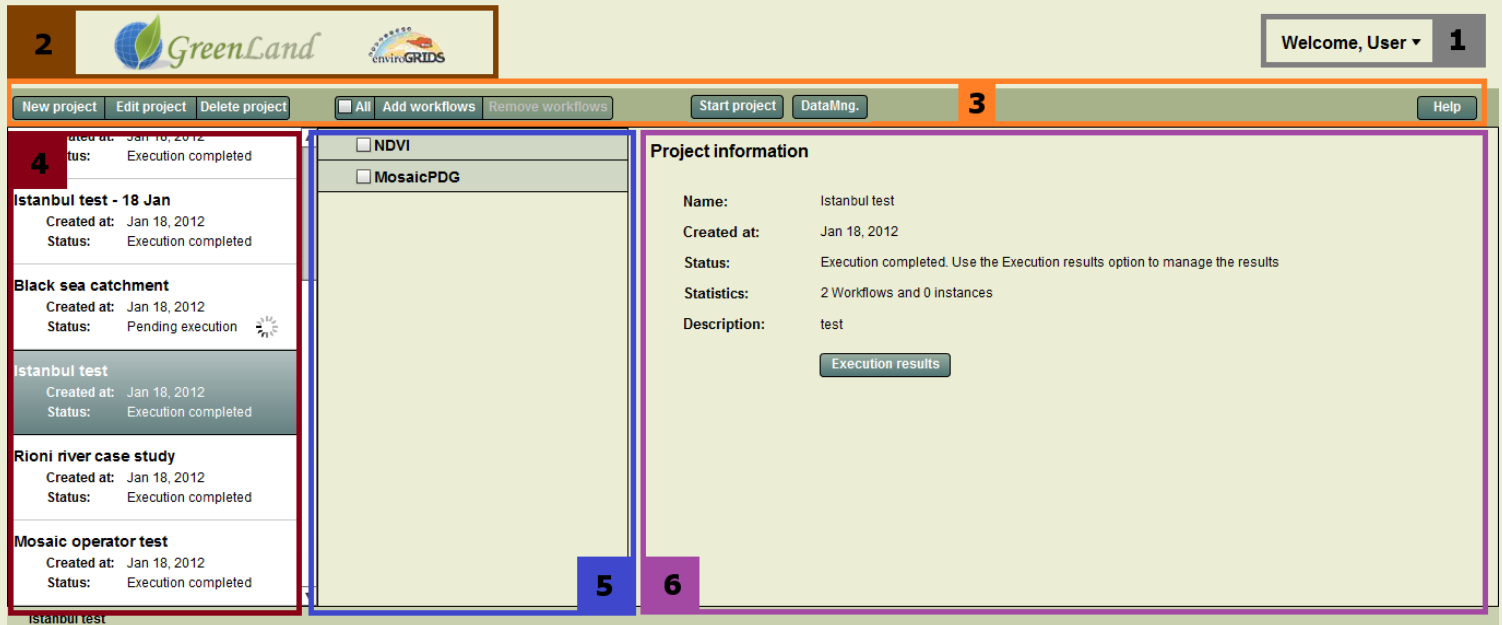


Figure 1. GreenLand2 graphical user interface modularization

3. Menu option features

This section contains the short description of the menu bar options, provided by the GreenLand2 application:

- **New project:** it allows the creation of a new project. A project is one of the key concepts of the GreenLand2 application, that stores one or more workflows;
- **Edit project:** useful for changing the name or the description of an already existing project;
- **Delete project:** allows the user to delete an existing project. This action is triggered together with a warning popup message, just to clearly notify the user regarding this aspect;
- **All:** it could be used to check/uncheck all the expandable workflow (together with their child items) in the workflows list;
- **Add workflows:** opens a table populated with existing workflows inside the GreenLand2 database. Using this feature the user is able to attach a list of workflows to the current selected project;

- **Remove workflows:** in order to remove a workflow the user has to select it first. The selection is made by checking the combo box module, positioned on the left side of the workflow's name;
- **Start project:** by using this option the user triggers the Grid execution, related to the current selected project. Several pre-processing validations are performed, such as:
 - Check if the project contains at least one workflow;
 - Check if all the workflows inputs are properly specified;
 - etc.
- **DataMng.:** allows the user the possibility to manage its own resources uploaded into the GreenLand2 data repositories. Downloading and uploading represent two of the operations provided by this feature.

4. Use case scenario 1 – Use an already existing project

The following section highlights what are the steps required for performing a valid Grid processing, using the features provided by the GreenLand2 application. This use case contains an already defined project, called (Istanbul_project_imported). In this case, the project contains two workflows: NDVI and EVI.

Step 1: Sign in your account


A screenshot of a 'User sign in' form. The form has a title bar with the text 'User sign in'. Below the title bar, there are two input fields: 'Username' and 'Password'. The 'Username' field is a simple text box, while the 'Password' field is a text box with a small eye icon on the right side, indicating a password field. Below the input fields, there is a blue button labeled 'Sign in'.

Figure 2. Sign in GreenLand2 application

Step 2: Open the project content

The process step was already completed for this project using the Grid infrastructure. Click the project name to open its content (Figure 3).

It is important to mention that you could not execute a project that has the “Executing project” status. This status is displayed just under the project name, in the projects list.

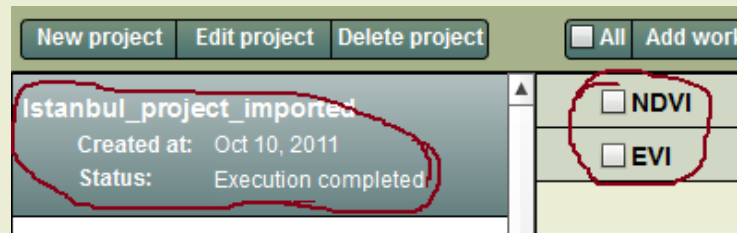


Figure 3. Identify the project and open its content

Step 3: Output results management

In order to handle the output results, just select the project from the project list, and use the **Execution results** option (Figure 4).

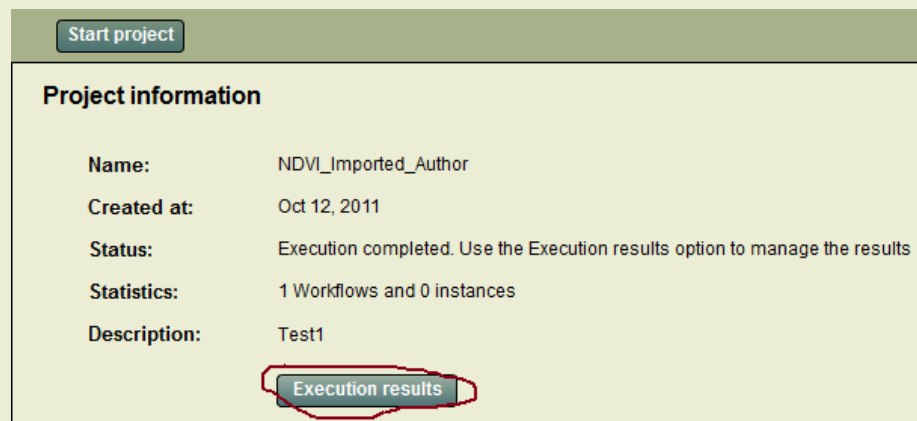


Figure 4. Visualize the process results

Once this step completes, a new table will appear that contains all the output results for the two specified workflows (NDVI and EVI). At this moment the results analysis could be performed only on the user local machine, by downloading the results, using the **Download** option (Figure 5).

Project execution details

Workflow name	Start time	Status	Result
NDVI	2011-10-13 10:43:50.0	Completed	5a6ac4f8-ba84-4a43-a211-5a6ac4f8-ba84-4a43-a211 Download
EVI	2011-10-13 10:43:50.0	Completed	5a6ac4f8-ba84-4a43-a211-5a6ac4f8-ba84-4a43-a211 Download
			5a6ac4f8-ba84-4a43-a211-5a6ac4f8-ba84-4a43-a211
			5a6ac4f8-ba84-4a43-a211-5a6ac4f8-ba84-4a43-a211

Figure 5. Output result management and analysis

After a project finishes its execution, the workflows list could be modified (add new items or remove some of the existing ones). Also, you could specify new inputs for the workflows, and start a new process, based on the values that you specified (follow the steps 3, 4, 5 and 7 described in section 5. *Use case scenario 2 – Create/execute your own project*).

5. Use case scenario 2 – Create/execute your own project

This section highlights all the necessary steps used for executing a new project that contains a list of workflows, specified by the user.

Step 1: Sign in your account

User sign in

Username

Password

[Sign in](#)

Figure 6. Sign in GreenLand2 application

Step 2: Create a new project

Use the **NewProject** menu bar option.



Figure 7. Identify the New project option

In this step both the name and the description fields are mandatory. Please take care when naming your project. All the projects in your projects list should have unique names.

Create a new project

Name

Description

Figure 8. Create a new project

Step 3: Add new workflows to the current created project

Use the **Add workflows** menu bar option.

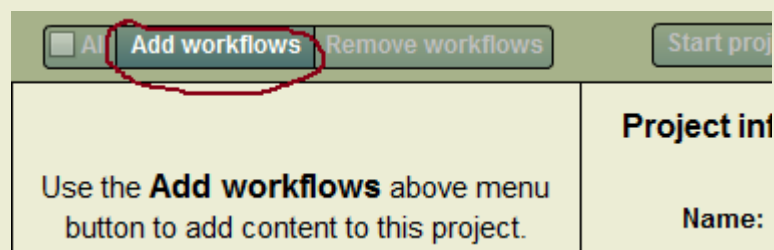


Figure 9. Identify the Add workflows option

At this time a table should appear, in the right of the workflows list, populated with all the workflows that exist in the GreenLand2 database, and are available for this user. In order to attach an operator to the current selected project you should first select it, by using its corresponding check box, located in the first column of the table. Multiple workflows could be selected, and after that use the **Add workflows** button under the table to finish the attachment action (Figure 9).

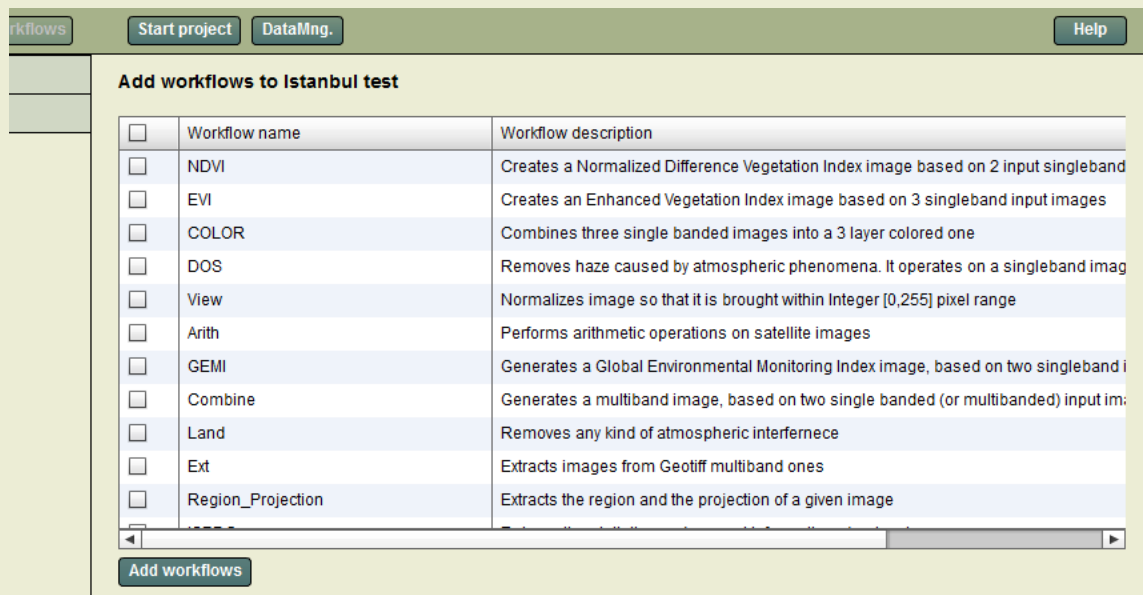


Figure 10. Select workflows list

It is worth to mention that the same workflow could be multiply within the same project (Figure 11), but each of its instances will have a different name (contains the workflow's name and an index, that represent the number of instances for this workflow). For example if the NDVI workflow is added, it will be inserted under the NDVI name. If a second insertion is made, then the NDVI_1 name will be used, and so on.

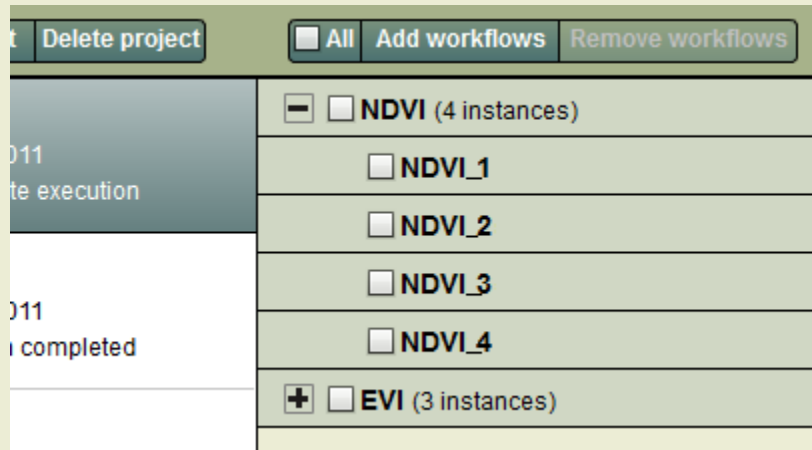


Figure 11. Create multiple instances of the same workflow

Step 4: Remove workflows

At any time you could add new workflows by following **Step 2**, or remove workflows from a project by using the **Remove workflows** menu bar option.

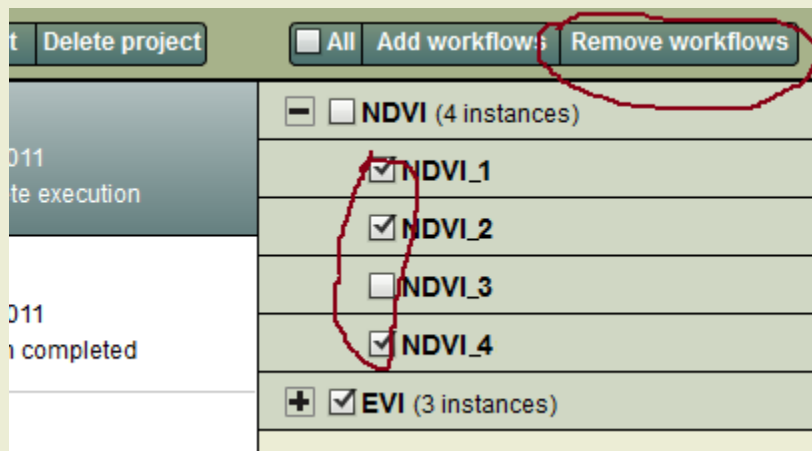


Figure 12. Remove workflows from the current selected project

Step 5: Upload external files

Use the **DataMng.** menu option (Figure 13) in order to upload your own images or files. A popup window will be displayed and the **Upload files** section will automatically be selected.

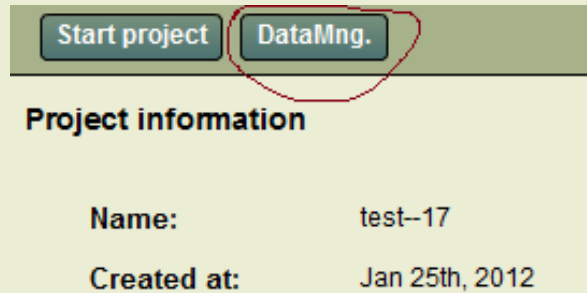


Figure 13. Upload external resources

Once you manage to reach to this step, the **Attach files** button will allow you to browse through the system files and directories and load the resources that you desire. Be careful at the files types, because only geographically referenced images validate the GreenLand2 internal format. All the selected files will appear in a table, as described in Figure 14.

Here you have the possibility to add new files or to remove some of the existing ones. The file transfer to the server will not start until the **Upload list for** button will be use. It is important to set the privacy attribute for these files. For example the **Private use** attribute means that only you could use these resources after they are uploaded to the server. By applying the **Public use** settings other users will also be able to use them freely (but they have no administrative privileges to delete them).

If the uploaded image is a multiband one, it will automatically be divided into several single-band images, equal to the number of bands contained in the multiband image. For further processing over the Grid infrastructure only the images' bands could be used. If you select an operator that deals with multiband images, you should use the Combine operator first. This operator generates a multiband image that you could use as input for other GreenLand2 operators.

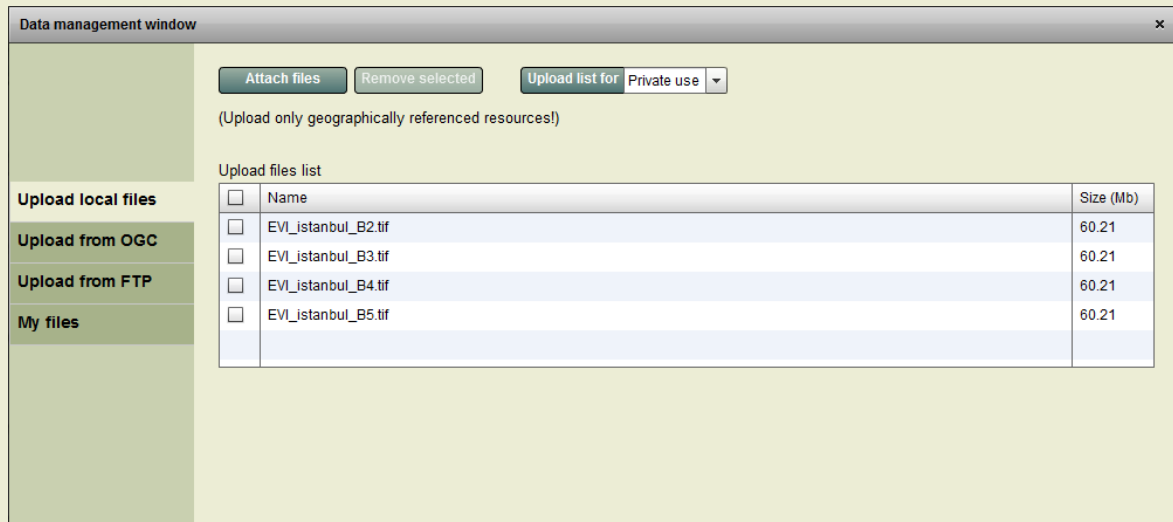


Figure 14. Upload files list

The *Step 5* section describes only the operation of uploading files from your local machine. But the GreenLand application offers two more possibilities (retrieve data from OGC or FTP servers) that will be presented in chapter 6. *Resources management*.

Step 6: Specify workflow inputs.

In order to accomplish this step, simply click on a workflow. This action will display all the primary inputs of that workflow and for each input a list of possible values (e.g. satellite images) are provided to the user. The user could specify for each input a single value that will be used further on in the Grid based execution process.

Using the **Save** button all the values you specified for these inputs will be save, and there is no undo possibility. The **Resume last saved** option play the undo role, but only if it does not immediately follows after a save action (Figure 15).

Figure 15. Remove workflows from the current selected project

Also you could change the name and the description of the workflow.

Step 7: Start the Grid processing

After all the workflows inputs were properly specified, the execution process could begin, using the **Start project** menu bar option.

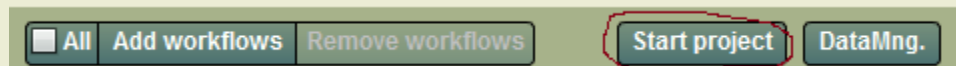


Figure 16. Identify the Start project option

After this action, a monitoring table will be display that highlights the processing progress (Figure 17).

Project execution details

Workflow name	Start time	Status	Result
NDVI	2011-10-13 10:43:50.0	Running	
EVI	2011-10-13 10:43:50.0	Completed	5a6ac4f8-ba84-4a43-z Download

Figure 17. Monitor the project execution

Step 8: Output results management

When a workflow finishes its execution a list of results will be available, together with a download option (Figure 18). Using this option the user is able to download the result on its local machine and analyze its different aspects. It is worth to mention that the execution process may take some time, depending on the workflows complexity.

[Start project](#)

Project execution details

Workflow name	Start time	Status	Result
iGr1	2011-09-16 14:40:36.0	Completed	eb7ddd1d-69d8-4a07- Download
Test	2011-09-16 14:40:36.0	Completed	eb7ddd1d-69d8-4a07- Download
G1	2011-09-16 14:40:36.0	Completed	eb7ddd1d-69d8-4a07- Download

Figure 18. Output result management

6. Resources management

Each user is able to manage its' own resources as he desires. The resource management option activates by using the **DataMng.** menu option. The general overview of this module is presented in Figure 19.

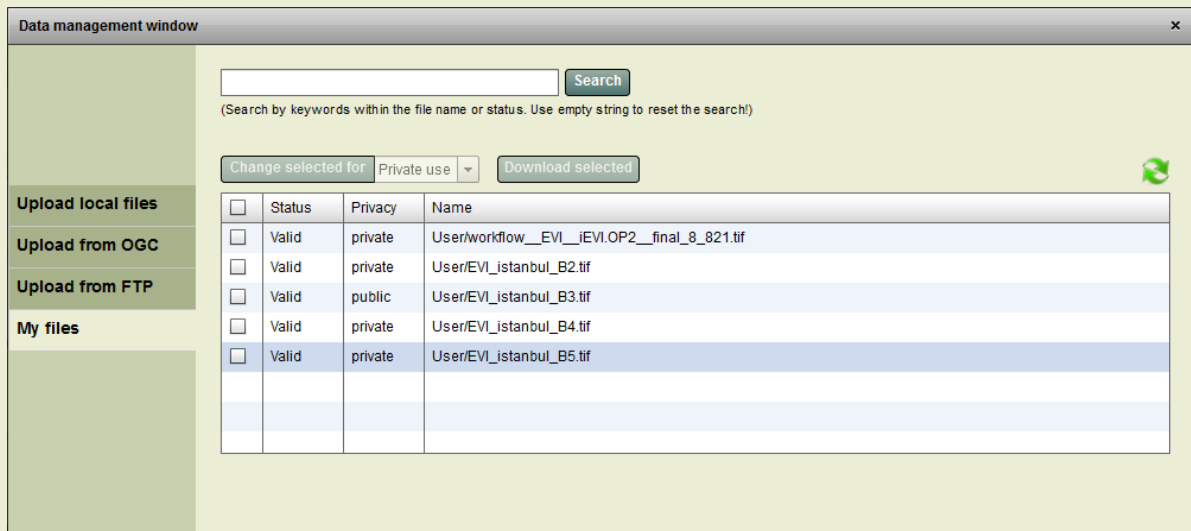


Figure 19. User resource management module

There are four operations that could be performed by the logged in user through the **DataMng.** menu option. In each situation the data retrieving process consists of two phases:

- Data transfer to the GreenLand repository;
- Data analysis and conversion. This phase tries to convert the current uploaded image into an internal GreenLand format (GeoTIFF). This operation has the effect of breaking multi-band images into several single-banded ones. The conversion result is displayed to the user in the **My files** option panel.

6.1 Upload local files

The user is able to use in the Grid processes its' own satellite images. These files could be located onto its physical machine, so a local files upload would be required in this case. Specifying the files that are going to be uploaded, the user should click on the **Attach files** button. By this time the files table should look like the one presented in Figure 20. The files privacy attribute is by default set to private, but it could be adjusted

by using the Private/public combo box. If some of the files listed in the data table are not suitable for the upload operation the user has the possibility to remove them though the **Remove selected** button.

All the previous mentioned operations are performed before the actual upload. In order to start the data transfer the **Upload list for** button should be used. At this time a progress bar displays the upload status.

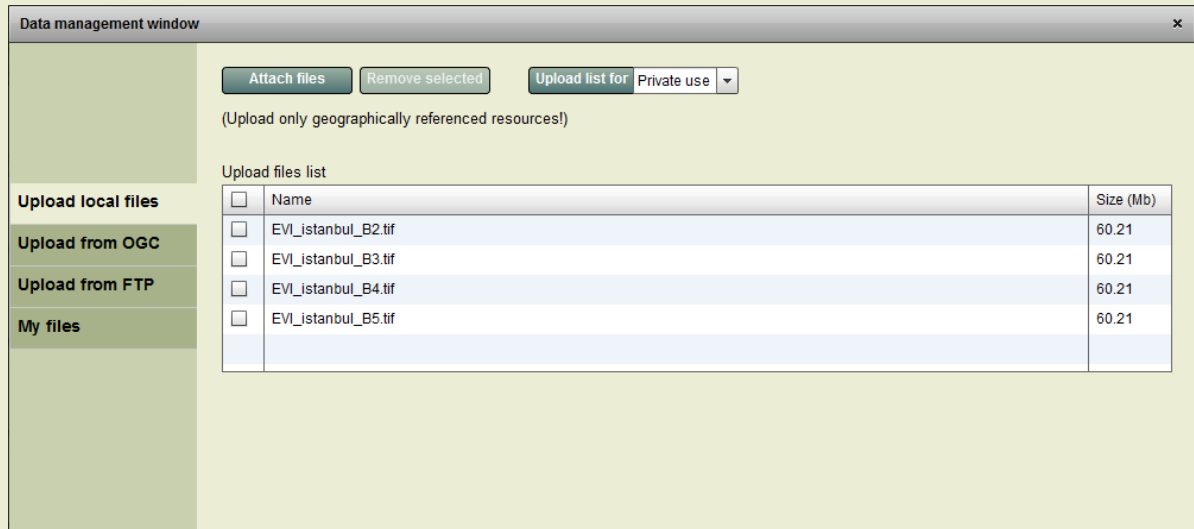


Figure 20. Upload local files panel

6.2 Use OGC services to retrieve data

Another convenient way to import data into the GreenLand repository is through the OGC (Open Geospatial Consortium) services. The Upload from OGC option implements the WMS and WCS services. The WMS is used to display different layers onto an interactive map, while the WCS service is used in order to retrieve data that correspond to the user's needs (Figure 21).

First of all the user needs to input the web address of the server that hosts the OGC services. In order to have access to the data, the Connect button should be used. The information displayed in the graphical interface is stored in the GetCapabilities xml file. This file is then analyzed and its information organized within the Layers combo box. Each time a new item is selected from the layers list the interactive map will overlay it over the proper geographical region, specified by the GetCapabilities file. All these steps represent the WMS implementation of the OGC services and offer only the visual effect of the OGC capabilities.

Data management window

Uri for the OGC service

Service version

Layers

Image width

Image height

Image projection

Coordinates points of the selected area (lat., lon.)

A:	<input type="text" value="-40.95703125"/>	<input type="text" value="53.26171875"/>
B:	<input type="text" value="-40.95703125"/>	<input type="text" value="-3.33984375"/>
C:	<input type="text" value="16.69921875"/>	<input type="text" value="-3.33984375"/>
D:	<input type="text" value="16.69921875"/>	<input type="text" value="53.26171875"/>

The geographical selection will ALWAYS have a rectangular shape based on the min. and max. latitude and longitude values of these points!

Map view showing a rectangular selection area over the Atlantic Ocean. The map is powered by ESRI.

Figure 21. Data retrieval based on OGC services

In order to retrieve data, the WCS implementation was required. By default, when a new layer is selected the **Image width**, **Image height**, **Image projection** are automatically determined from the GetCapabilities file. If this file does not contain such information the standard values are displayed: 10 pixels for the width and height of the image and the EPSG:4326 projection.

It is worth to mention that the image width and height should not exceed the [10; 10 000] pixels interval. A validation form will notify the user when wrong information is specified (Figure 22).

Map selection is used to specify the geographical area coordinates that will be use in the WCS get data requests. Only rectangular selections are allowed and they could be described with the use of the mouse (by selecting the rectangular shape on the right of the zoom slider) or with the use of the keyboard (by setting the latitude and longitude coordinates for the A, B, C and D points). Resizing and moving an existing map selection is another feature implemented within the OGC data retrieval.

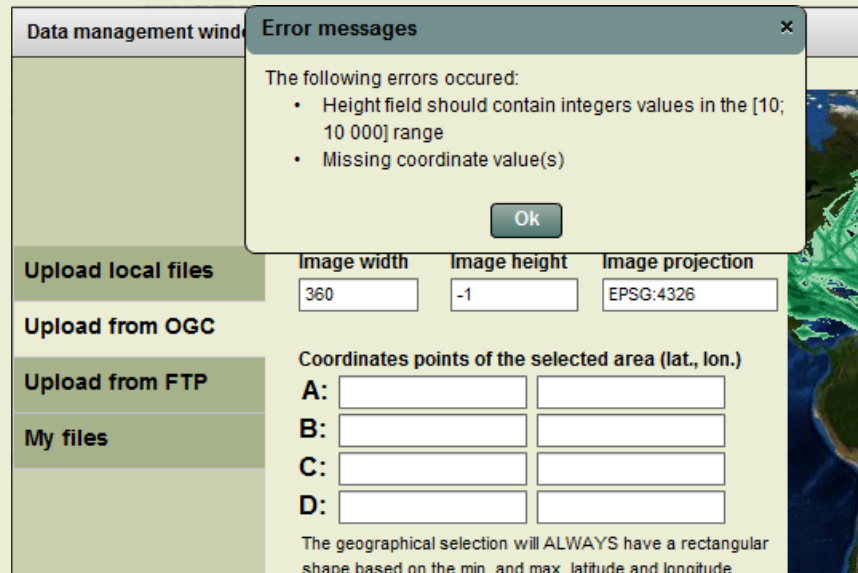


Figure 22. System message when using wrong inputs

After all the inputs were properly specified the next step will be to download the data through the use of the WCS service. In order to achieve this functionality use the **Upload to GreenLand repository**. After that a popup window will be displayed that will ask the user to name the image that will be downloaded. A privacy attribute could also be specified. Using the **Save image to GreenLand repository** enables the data transfer (Figure 23).

Use this name when saving the image

image_from_wcs

Use this privacy attribute when saving the image

Private use

Save image to GreenLand repository Cancel

Figure 23. Save OGC data form

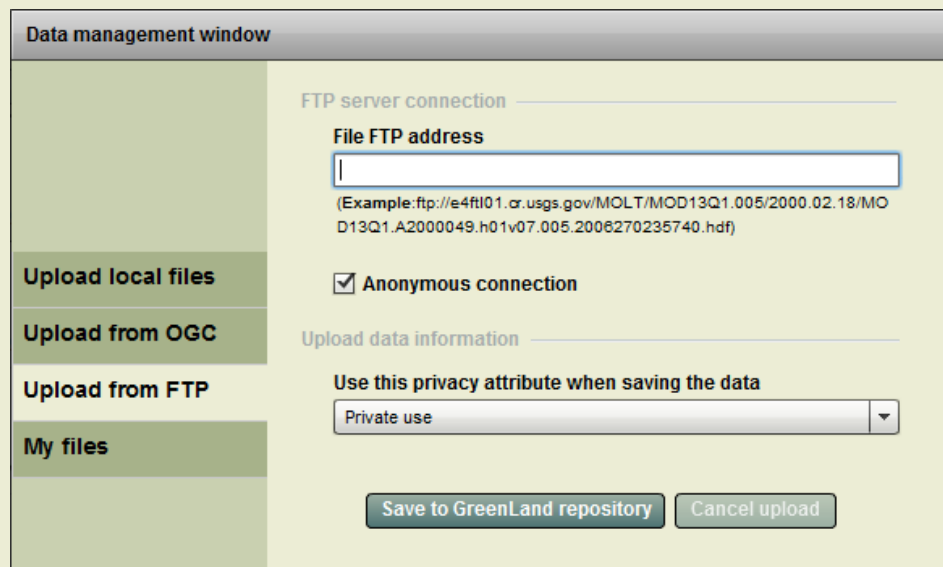
Within the data transfer process a spinning wheel animates in order to show the transfer progress. At any time the user has the possibility to cancel the download. The same conversion principal is applied as in the case of uploading local files.

6.3 Use FTP protocol to retrieve data

The third method of uploading data into the GreenLand repository is through the use of the FTP protocol. The Upload from FTP option allows the usage of data from remote FTP servers that support anonymous connections or connections based on username and passwords (Figure 24). Until now the GreenLand application does not provide support for secure FTP, but will be one of the future work features. Also browsing through the FTP server folders is not yet implemented.

The **File FTP addresses** should contain a valid ftp, that could also include the port used by the server in the data exchange process. An example of how this address should be formatted is given bellow this text input. The next step is to specify the FTP connection type: anonymous or password based. By un-checking the **Anonymous connection**, two text inputs will be displayed where the user should enter the username and password.

It is worth to mention that the name of the remote file will be preserved when saving the image to the GreenLand repository. An extra attribute for the data transfer service is the privacy of the file: private or public. Using the **Save to GreenLand repository** button the upload from the FTP server begins. A progress bar indicates throughout the whole process the data transfer status. At any time the user is able to stop the uploading by using the **Cancel** button.



The screenshot shows a software window titled "Data management window". On the left is a vertical sidebar with four buttons: "Upload local files", "Upload from OGC", "Upload from FTP", and "My files". The "Upload from FTP" button is highlighted. The main area of the window is titled "FTP server connection" and contains a text input field for "File FTP address". Below the input field is an example URL: "(Example:ftp://e4ftl01.cr.usgs.gov/MOLT/MOD13Q1.005/2000.02.18/MOD13Q1.A2000049.h01v07.005.2006270235740.hdf)". Below the input field is a checkbox labeled "Anonymous connection" which is checked. Below the checkbox is a section titled "Upload data information" which contains a dropdown menu labeled "Use this privacy attribute when saving the data" with "Private use" selected. At the bottom of the main area are two buttons: "Save to GreenLand repository" and "Cancel upload".

Figure 24. FTP data retrieval panel

6.4 My data management

Allows the user to monitor and manage its own uploaded data (Figure 25). Here you can perform search operations, download files, change privacy attributes, etc.

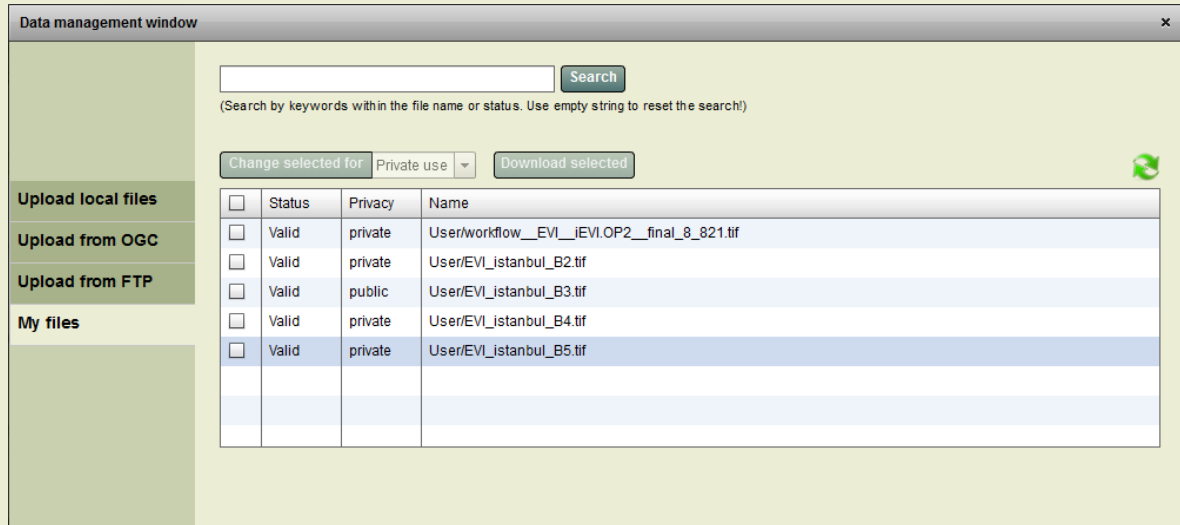


Figure 25. My files management panel

All the results that correspond to the search pattern will be displayed in the bellow resources table. In order to disable the search effect just set the text input to empty string and hit the **Search** button. **Download selected** will create an archive with all the selected images that you could download on your local machine.

The flow applied to each resource (satellite image in particular) that you want to upload is the following:

- You should first select it from your local machine;
- Start the upload to the GreenLand2 data repository by following the step 5 in the *Use case scenario 2 – Create/execute your own project section*;
- Once the upload finishes, the resource will be set with the **Checking** status. This means that an internal algorithm analyzes the image and tries to convert it into a standard GreenLand2 format. If the uploaded image is a multiband one, it will automatically be divided into several single-band images, equal to the number of bands contained in the multiband image. For further processing over the Grid infrastructure only the images' bands could be used. If you select an operator that deals with multiband images, you should use the Combine operator first. This operator

generates a multiband image that you could use as input for other GreenLand2 operators;

- If the image is properly formatted it will have the **Valid** status, otherwise the **Error** one;

7. Conclusions

This is the first version of the GreenLand2 application, and there are some things to be improved or added as new functionalities:

- Extend the GreenLand2 database with new workflows;
- Allow the user the possibility to create its own workflows using a WorkflowEditor module;
- Implement the online result analysis module;
- Support for the OGG services.