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BLENDER TUTORIAL APPLIED TO BIM METHODOLOGY

September 2024

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01.// PURPOSE OF THE DOCUMENT

Blender is an open-source program for 3D modeling, widely used in the field of graphic design. Thanks to its open nature, Blender allows the incorporation of extensions and add-ons, add-ons developed by professionals from various sectors that provide additional functionalities to the software.

This manual provides a **basic guide** for the use of Blender 3D in conjunction with the Bonsai extension and other useful add-ons in the context of BIM methodology.

The aim is to encourage the use of open source tools in the implementation of the BIM methodology, thus promoting flexibility and accessibility in the design and modelling processes.

02.// SOFTWARE VERSION

The specifications of Blender used in the drafting of this document are as follows:

BLENDER	
Full Name Software	Blender 3D
Version	4.2.0
Date of writing the tutorial	September 2024
Name of developer company	Blender Foundation
Web developer company	https://www.blender.org/
Community Support Forum	https://www.blender.org/community/
Development Team	https://www.blender.org/about/people/

It is recommended to work the program with the English interface

The specifications of Bonsai used in the drafting of this document are as follows:

BONSAI	
Name extension	Bonsai
Version	0.8.0
Date of writing the tutorial	September 2024
Powered by	ifcOpenShell
Website	https://www.bonsaibim.org/
Community Support Forum	https://community.osarch.org/ https://bonsaibim.org/community.html

The versions in use, both Blender and Bonsai, appear in the lower right corner of the screen:

03.// INSTALLING BLENDER AND EXTENSIONS

To install Blender, first access the official download site (https://www.blender.org/download/) and select the version you need.

Starting with version 4.2 of Blender, add-ons have been renamed "extensions". These are available on the official Blender extensions page (https://extensions.blender.org/add-ons/). However, some add-ons are not yet listed on this site.

The following extensions and add-ons are recommended below:

Node Wrangler: new shortcuts to improve workflow with tools that include visual programming such as Geometry Nodes and the Shader Editor.

https://www.youtube.com/watch?v=XTVWy4IIH3A

MeasureIt: tool to generate precise measurements leaving graphics very similar to the dimensions of the planes with which you work in reality.

https://www.youtube.com/watch?v=7hKCDfYOsC8

Align Tools: new parameters that are used to align objects with respect to each other in location, scale or rotation. If we click on advanced options it will let us align these objects with respect to the pivot of the object itself or the global cursor.

https://www.youtube.com/watch?v=XicAUZ3GAA8

Loop Tools: Additional options to editing Edge Loops.

https://www.youtube.com/watch?v=o4LopQs2bBQ

Bool Tool: new interface that makes it easier to create pours, joints and intersections.

https://www.youtube.com/watch?v=A7LpZKCjF7k

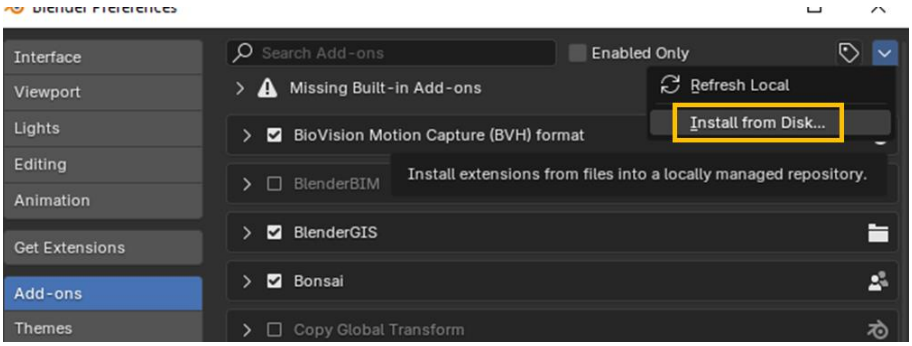
Bonsai: https://extensions.blender.org/add-ons/bonsai/ Add-on that allows you to generate ifc, export and import ifc, as well as edit ifcs without any restriction.

Blenderkit: https://www.blenderkit.com/ Add-on that acts as an Assets library to import them into the 3D model, from objects, textures to displacement maps and EXR.

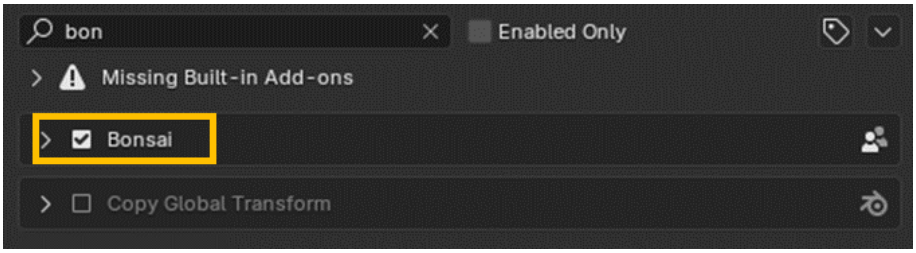
Sverchok: https://github.com/nortikin/sverchok add-on whose use is the parametric design that serves as an alternative to the function integrated in blender Geometry Nodes. Sverchok nodes can be integrated directly into the IFC file allowing direct generation and is perfectly compatible with BlenderBim

Blender GIS: https://github.com/domlysz/BlenderGIS Addon Add-on to work with GIS elements, allows the import of ascii, tiff, shp files... This way we can import the terrain where we work, facilitating the visualization and calculations of the result of the project.

To install the extensions from the browser, simply drag them directly into the Blender window. In the case of add-ons that are not found on the extensions page, they must be loaded directly from the file saved on your computer.



Once installed, it searches in the browser of the add-on window and activates:



04.// OPTIMISATION

To optimize the performance of Blender, we recommend that you make the following configurations:

1. System Preferences

Go to *Edit* > *Preferences* and access the System section .

Select **OptiX** and check all the available boxes under **Cycles Render Devices**, including those where the CPU and GPU are listed. This allows Blender to use the maximum capacity of its available hardware for rendering.

2.Undo Steps Settings

Set the value of **Undo Steps** to 256. Having multiple backsteps is always helpful for reverting unwanted changes more flexibly.

3. Online Access

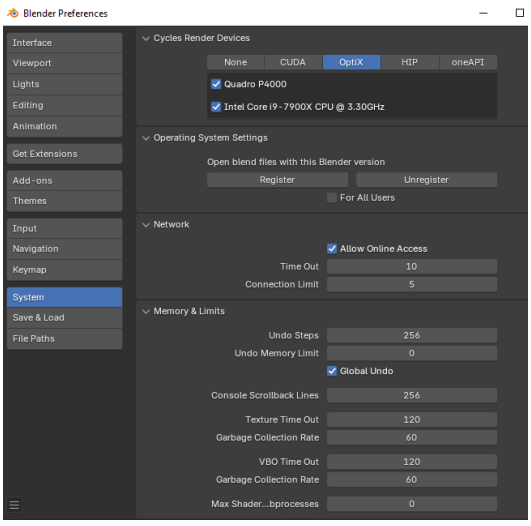
Enable the **Allow Online Access** option to allow Blender to access online resources that could improve its operation.

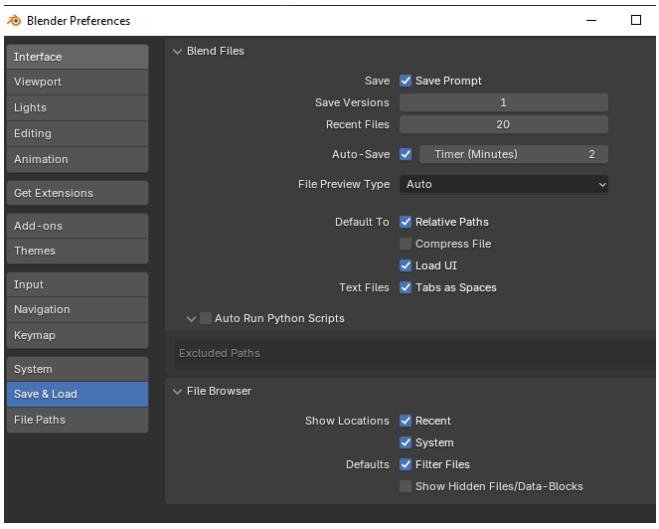
4. Auto-Save

In the **Save & Load** section, enable the **Auto-Save** option and set the auto-save time interval that you think is appropriate for your work pace. Note that this autosave is stored in the temporary folder and not in the location of the original file, serving as a backup in case of an unexpected program closure.

It is recommended to save your work regularly using the shortcut **Ctrl + S** to ensure that the changes are preserved in the desired location.

These settings will help improve the stability and performance of Blender, as well as minimize potential work losses.





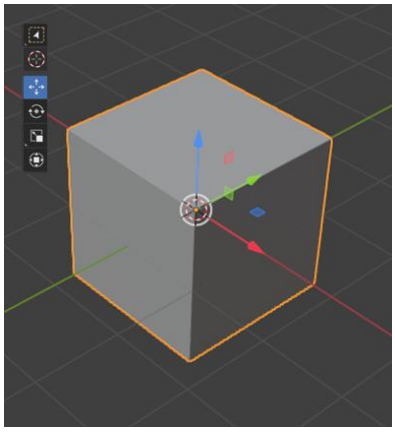
05.// OBJECT MODELING AND MODIFICATION

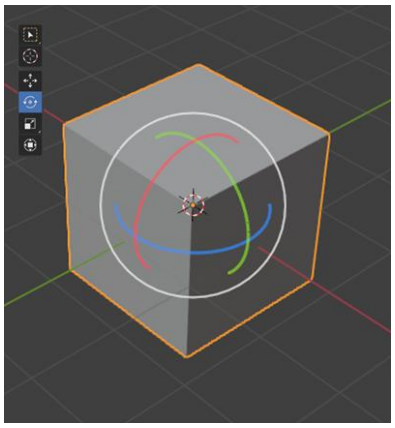
This section deals with the creation of geometry and its modification to adapt it to the specific needs of the project in which you are working.

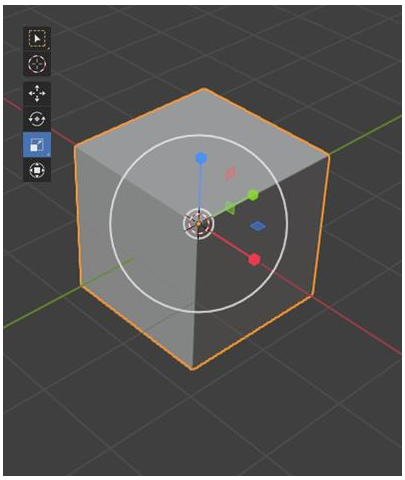
5.1 GETTING STARTED, TOOLS AND SHORTCUTS

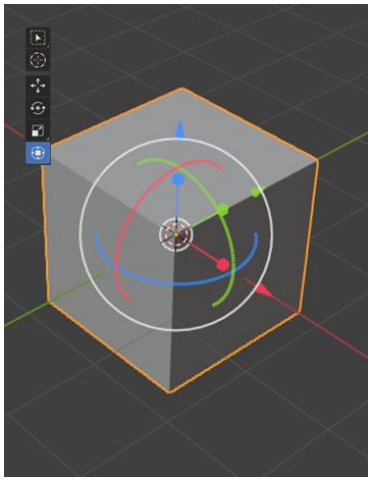
The letters **G** (Grab), **S** (Scale), and **R** (Rotate) are critical in Blender, as they allow you to move, scale, and rotate objects respectively. It's important to familiarize yourself with these shortcuts. In addition, these parameters can be restricted to one of three axes: **X** and **Y** (horizontal axes from north to south), and **Z** (vertical axis of height). Pressing the **Shift** key together with the axis makes an exclusion selection. For example, when using **G+X +Shift**, the object will move in the **Z** and **Y axes**, excluding the X-axis.

In the Tool Bar on the left, you will find the *gizmos* of each tool to make the work easier. If they are not displayed, they can be displayed by pressing the **T key**.

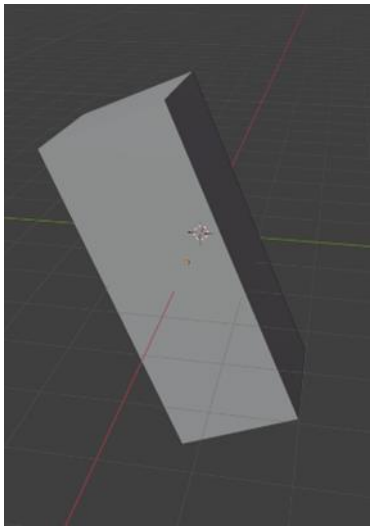


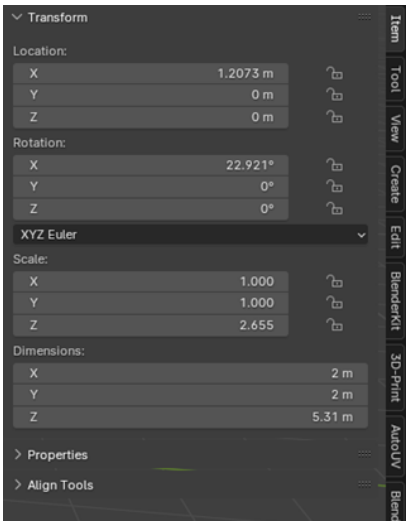






To view changes numerically, the **Item** tab on the right displays the object's location relative to the global cursor, its rotation, and scale. This menu can also be opened with the **N key**.



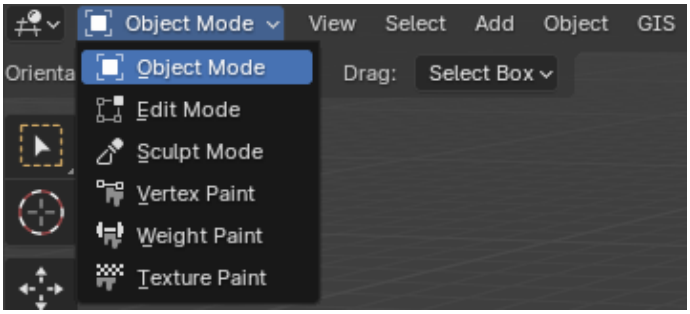


These modifications will be applied to the object we have in the scene, in its entirety

Under the options bar (**File, Edit, Render, Window, Help**), you will find the options: **Workspace**, **Mode Selector**, **View**, **Select**, **Add,** and **Object**.

In the **Add** section , all the options for creating different types of geometries, curves, and other elements that can be added to the scene are available. The shortcut **Ctrl + A can also be used**.

To modify the geometry of the different elements that make up an object (vertices, edges or faces) it must be done in **Edit Mode.**



The tools that exist in **Edit Mode** are the following:

Inset **I**: Creates a new face within the selected one and scales it to a smaller size.

Extrude **E**: Allows you to extrude the geometry according to the normal ones or lock the extrusion to the three coordinate axes. Alternatives to normal ones can be explored with **Alt + E**.

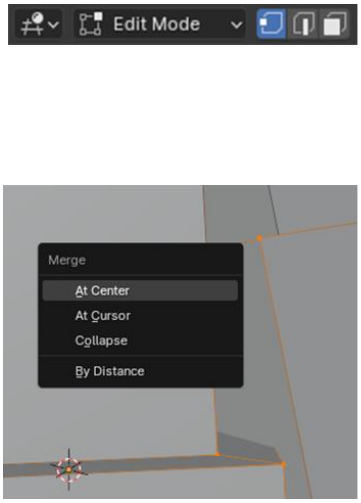
Loop Cut **Ctrl + R**: Create cuts in the part using adjacent quads as a reference, being able to distribute them evenly or adapt the shape to the edges of the quads.

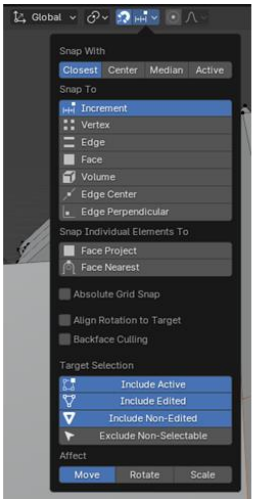
Bevel **Ctrl + B**: Truncates selected edges, allowing them to be rounded or given specific shapes with a custom profile.

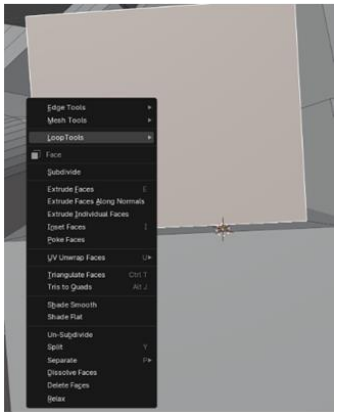
Spin (Tool Bar): Duplicates an object radially around a reference point.

Knife **K**: Cut the faces of the geometry to create new shapes or clean up the mesh.

In **Edit Mode**, you can change the type of selection (vertices, borders, faces) using the top icons or the numbers 1 (vertices), 2 (edges), and 3 (faces) on the numeric keypad. Right-clicking opens a menu with useful options for each selection mode. To access vertex options in other modes, the shortcuts **Ctrl + V** (vertices), **Ctrl + E** (edges), and **Ctrl + F** (faces) are used.







The **Merge** tool allows you to merge elements by selecting at least two faces, edges, or vertices, and pressing the **M key**.

Links to tutorials on these tools are attached:

https://www.youtube.com/watch?v=B0J27sf9N1Y&list=PLjEaoINr3zgEPv5y--4MKpciLaoQYZB1Z&pp=iAQB

https://www.youtube.com/watch?v=At9qW8ivJ4Q

5.2 SPECIFIC TOOLS

In addition to the tools mentioned, there are additional options such as:

Pivot Point: Defines how transformations are applied.

Snap: Moves elements along fixed increments of the grid or to surfaces/edges of other objects.

Proportional Editing (Fall-off): Allows geometry to be edited proportionally and smoothly with different mathematical parameters

https://docs.blender.org/manual/en/latest/editors/3dview/controls/snapping.html#snap-to

https://docs.blender.org/manual/en/latest/editors/3dview/controls/proportional_editing.html#proportional-editing

5.3 MODIFIERS

Here are the most relevant modifiers in the common workflow:

Geometry Nodes: Allows totally procedural and parametric designs and animations.

https://www.youtube.com/watch?v=8L9fV8P_HAM&list=PLgO2ChD7acqHzccBuhAGw8dTPLnR1E3QB&pp=iAQB

https://www.youtube.com/@Erindale

https://docs.blender.org/manual/en/latest/modeling/geometry_nodes/index.html

Generate: Modify the geometry as in **Edit Mode**, with non-destructive tools.

Array: Duplicates an object in a specific direction.

https://docs.blender.org/manual/en/latest/modeling/modifiers/generate/array.html

Bevel: Rounds edges globally.

https://docs.blender.org/manual/en/latest/modeling/modifiers/generate/array.html

Boolean: Performs mathematical operations (intersection, union, difference) between objects.

https://docs.blender.org/manual/en/latest/modeling/modifiers/generate/booleans.html

Mirror: Creates a duplicate on the selected axis.

https://docs.blender.org/manual/en/latest/modeling/modifiers/generate/mirror.html

Screw: Duplicates an object in a helical shape.

https://docs.blender.org/manual/en/latest/modeling/meshes/editing/edge/screw.html

Solidify: Generates a solid edge on hollow objects.

https://docs.blender.org/manual/en/latest/modeling/modifiers/generate/solidify.html

Wireframe: Creates a profile based on the edges of the object.

https://docs.blender.org/manual/en/latest/modeling/modifiers/generate/wireframe.html

Deform: Warps geometry based on external parameters.

Displace: Shift geometry using a black and white map.

https://docs.blender.org/manual/en/latest/modeling/modifiers/deform/displace.html

Simple Deform: Deforms geometry by twisting or bending it according to controllable parameters.

https://docs.blender.org/manual/en/latest/modeling/modifiers/deform/simple_deform.html

With these tools and modifiers, great versatility can be achieved in 3D modeling, adapting to various needs and projects.

The following link explains all the modifiers offered by Blender: https://www.youtube.com/watch?v=ov0F3cEJWoI

06.// METHODOLOGY OF WORKING WITH THE BONSAI EXTENSION

6.1 INTRODUCTION TO BONSAI EXTENSION

Bonsai is an add-on designed specifically for Blender that allows the creation and modification of IFC models natively, facilitating workflows typical of the BIM environment in a single software. Among its main functionalities are:

IFC Model Viewing and Exploration: Allows you to view and explore IFC models, as well as access all their properties.

IFC Data Editing and Extraction: Provides the ability to edit and extract attributes, properties, and metadata directly from IFC data.

Creation and Modification of Geometries: Facilitates the creation and modification of the geometries of the model, adjusting them to the requirements of the project.

Generation of Plans, Sections and Elevations: Provides tools to generate graphic documents such as plans, sections and elevations of the 3D model.

Creation of Schedules: Allows you to develop schedules for project planning and monitoring.

Conflict Detection: Offers tools for detecting conflicts within the model, improving coordination and avoiding construction errors.

Non-Geometric Data Integration: Facilitates the integration of additional data such as costs, asset management, and other aspects relevant to project management.

Bonsai optimizes workflow by bringing together in a single environment capabilities that normally require several programs within the BIM methodology.

For optimal use of this tool, it is recommended to use the documentation generated on the website of the application itself https://docs.bonsaibim.org/

6.2 EXPLORING THE BONSAI INTERFACE

The **Bonsai** extension in Blender is organized in an interface that makes it easy to work with IFC models. The essential elements of this interface are explained below:

To open an existing IFC file, you need to head to the **File** tab and choose the **Open IFC Project option**. When you open the file, you will be presented with three distinct zones in the **Bonsai interface**.

Zone 1: IFC Entity Tree

This zone shows a hierarchical tree of all IFC entities present in the model. It functions as a navigation panel, allowing the user to explore and select different parts of the IFC model as needed.

Zone 2: 3D Geometry Visualization

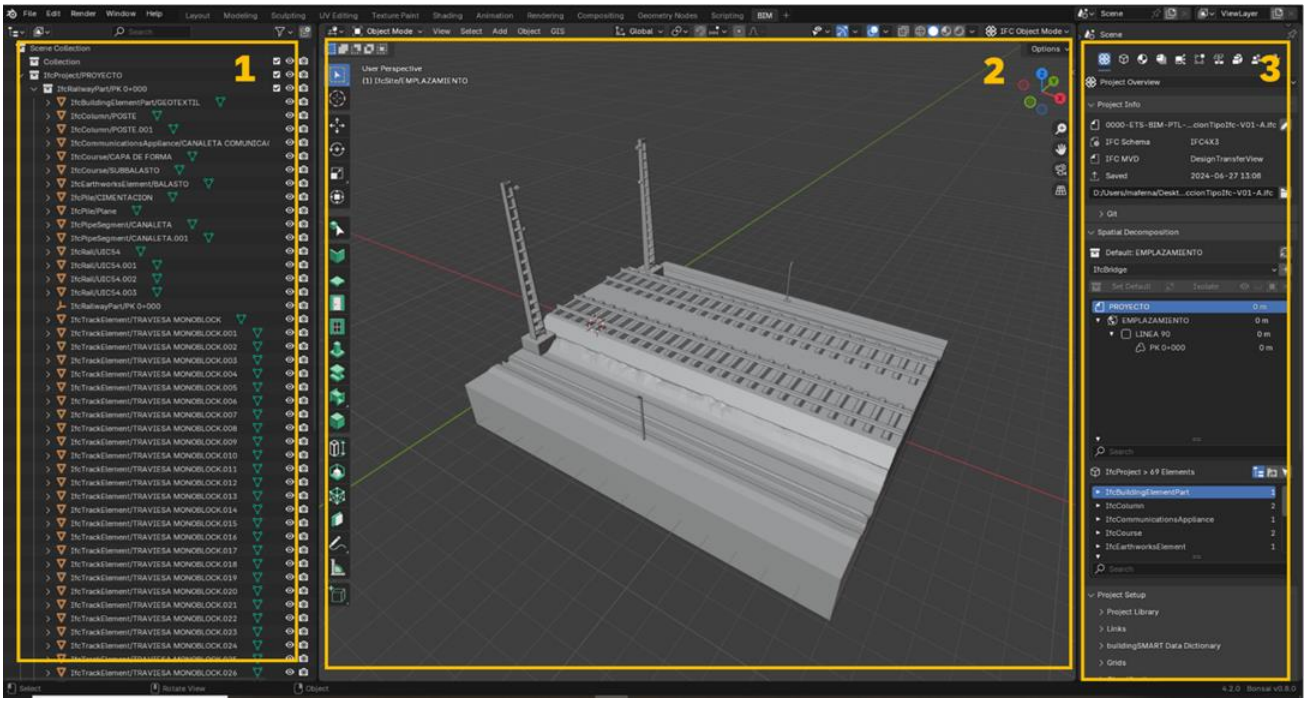
The geometry of the IFC model in a 3D environment is shown here. This view allows you to visualize and manipulate the graphical representation of the model, facilitating interaction with its physical structure.

Zone 3: Non-Graphical Data of the 3D Model

This is the area where Bonsai work is mainly focused. It presents the non-graphical data of the IFC model, such as attributes, properties, metadata, and any additional relevant information. This area is

critical for editing and managing information that is not directly represented in 3D geometry, such as material properties, construction data, and asset management details.

The Bonsai interface is designed to provide efficient and direct access to both the geometry and associated data of the IFC models, optimizing their handling and manipulation within Blender.



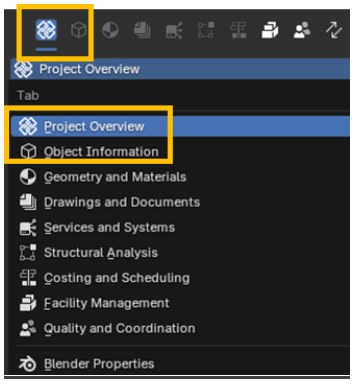
In Zone **3** of the **Bonsai interface**, a series of tabs are presented that allow you to navigate through the different properties and uses of the IFC model. Each tab provides access to different types of information and functionality related to the non-graphical data in the model.

For this manual, we will explain only the use of the first two tabs, which are the most relevant for basic handling of an IFC model:

Project Overview: This tab allows you to view and edit the basic properties of the elements of the IFC model. Here are attributes such as name, identification, object type, material, and other essential metadata that describe the general characteristics of each entity within the model. Their use is essential to make quick adjustments and ensure that all elements are correctly documented.

Object Information: This tab accesses the specific attributes of the selected elements, such as dimensions, technical parameters, and other detailed properties that depend on the type of entity (such as walls, windows, structures, etc.). This tab is key to customizing the model according to the needs of the project, allowing you to modify specific aspects and guarantee the accuracy of the data.

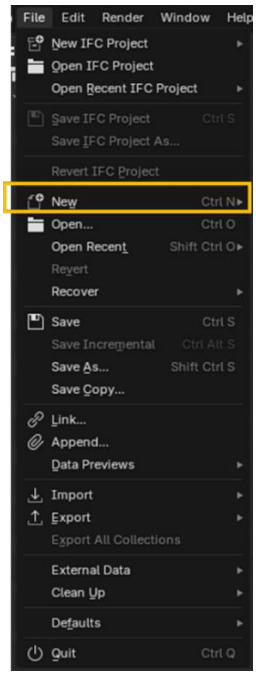
This manual will focus on guiding the user through the handling of these two tabs, providing the foundation for efficiently exploring and using the properties and attributes of the IFC model in Blender using Bonsai.

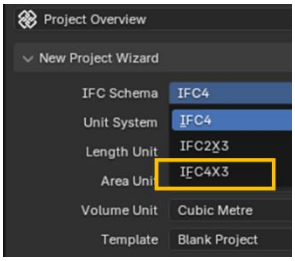


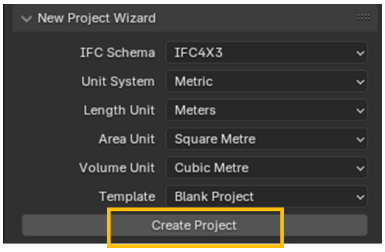
To generate a new IFC model with the Bonsai extension, a new Blender file must first be created. To do this, head to the **File** tab and select **New** to open a blank Blender file.

Next, on the **Project Overview** tab of the Bonsai extension, choose the **IFC 4x3** scheme. This ensures that the new project conforms to the most up-to-date standard for IFC modeling.

Note that if you decide to open a new IFC file directly from the **File** tab, Blender will default to the **IFC 4** scheme. For this reason, it is preferable to first create a new Blender file and then manually select the **IFC 4x3 schema** in **Project Overview**.







6.3 ORGANIZATION OF THE STRUCTURE

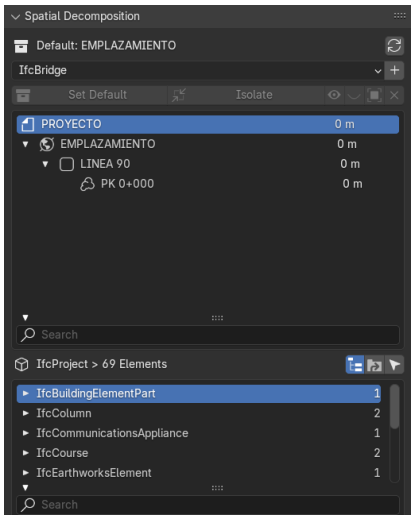
To manage IFC models efficiently with the Bonsai extension, it's important to familiarize yourself with the features of the **Project Overview** and **Object Information tabs**.

Project Overview

Some of the functions of this section are described below:

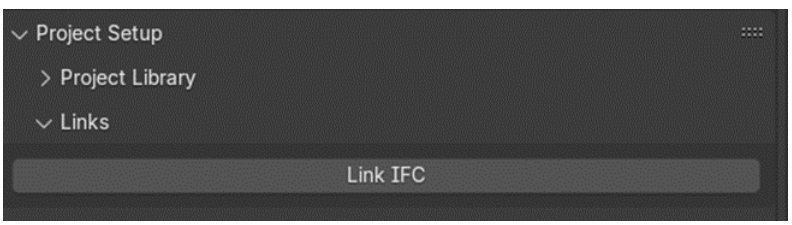
Project Info: Provides access to the general data of the project, allowing you to consult and manage the basic and fundamental information of the project.

Spacial Decomposition Allows you to visualize the structure of the IFC schema and make modifications to that structure. (For details, see point 6.5).



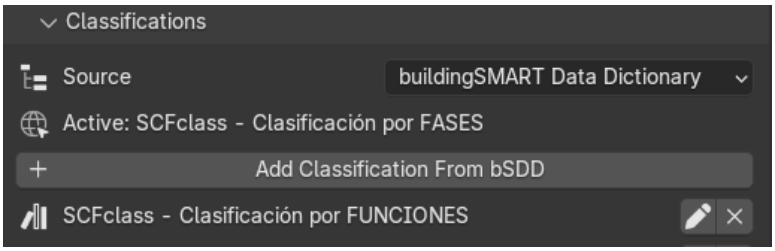
Project Setup

Links: Allows multiple IFC models to be combined and integrated into a single work environment, facilitating federation and coordination between different parts of the project.

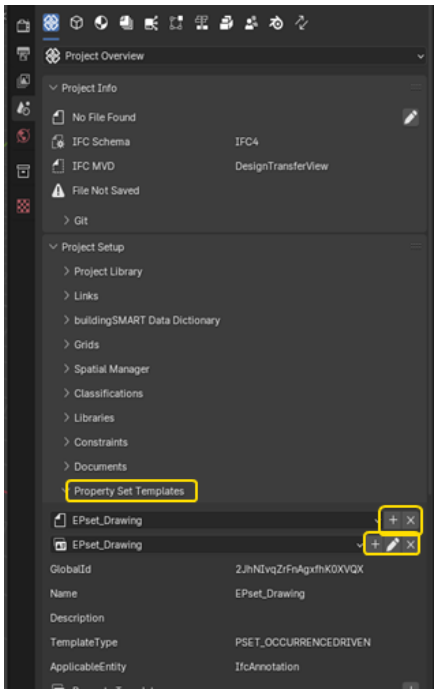


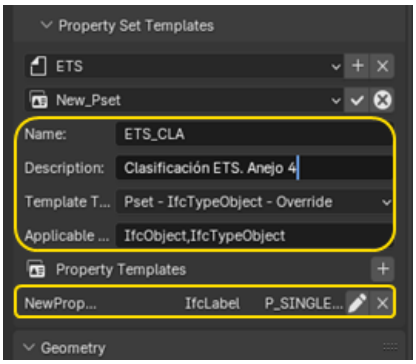
buildingSMART Data Dictonary: is a tool that provides a standardized way to define and describe terms, concepts, and attributes in the construction field. It allows you to choose different dictionaries in order to classify the different elements.

Classifications Activates the classification that you want to use on the different elements. The classification of each element is explained in point 6.6.



Property Set Templates: Allows you to create a custom property set template (Pset) to fit each user's needs. These properties can be reused in other projects that require them.





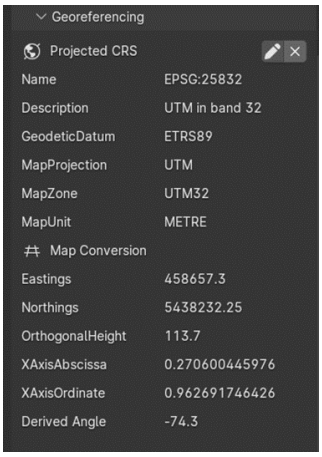
To generate a pset template, see the following tutorial https://www.youtube.com/watch?v=nlSM593swZY

As for ETS-specific Pset, such as the 'pSet_ETS.ifc' file, these can be added to different projects. To be available, they must be saved to the following location in the system:

C:\Users\usuario\AppData\Roaming\Blender Foundation\Blender\4.2\extensions\.local\lib\python3.11\site-packages\bonsai\bim\data\pset

Geometry

Georeferencing: Allows the incorporation of the necessary data for the georeferencing of IFC models



Object Information

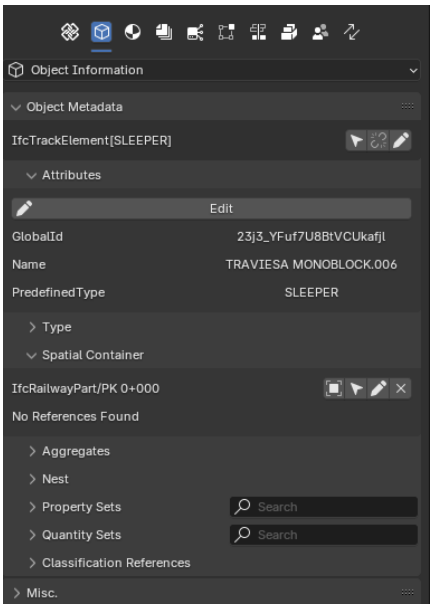
Some of the functions of this section are described below:

Object Metadata: Displays the IFC entity assigned to an object, as well as its metadata. The assignment of the entity type can be modified as necessary (see point 6.5).

Attributes: Displays the object's own attributes, such as the *GlobalID,* object name, *PredefinedType*, and more. These attributes can also be modified (see point 6.5).

Spatial Container: Indicates which spatial entity the object is located in and allows it to be reassigned to another spatial entity, if necessary (see point 6.8).

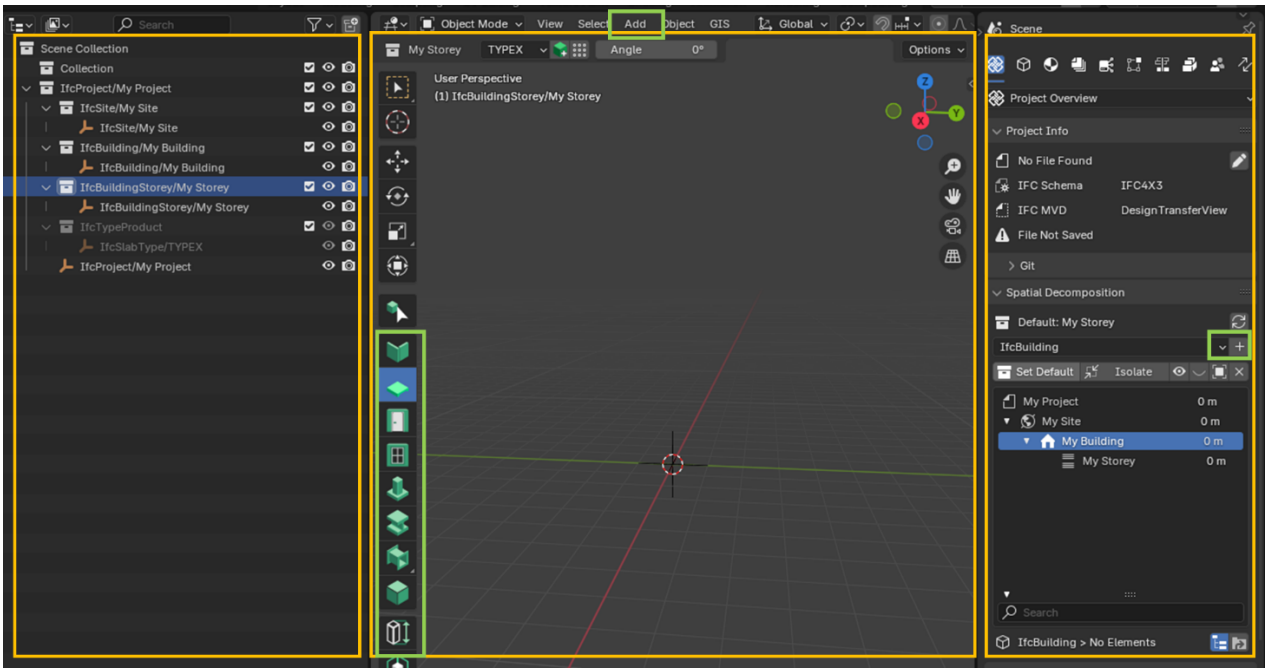
Property Sets: This section lists all the properties associated with the object. Section 6.7 explains how properties can be added.



6.4 GENERATION OF GEOMETRY

Bonsai allows you to generate IFC files natively. Section 6.2 of this document explains how to create a new IFC file and select the schema you want to use.

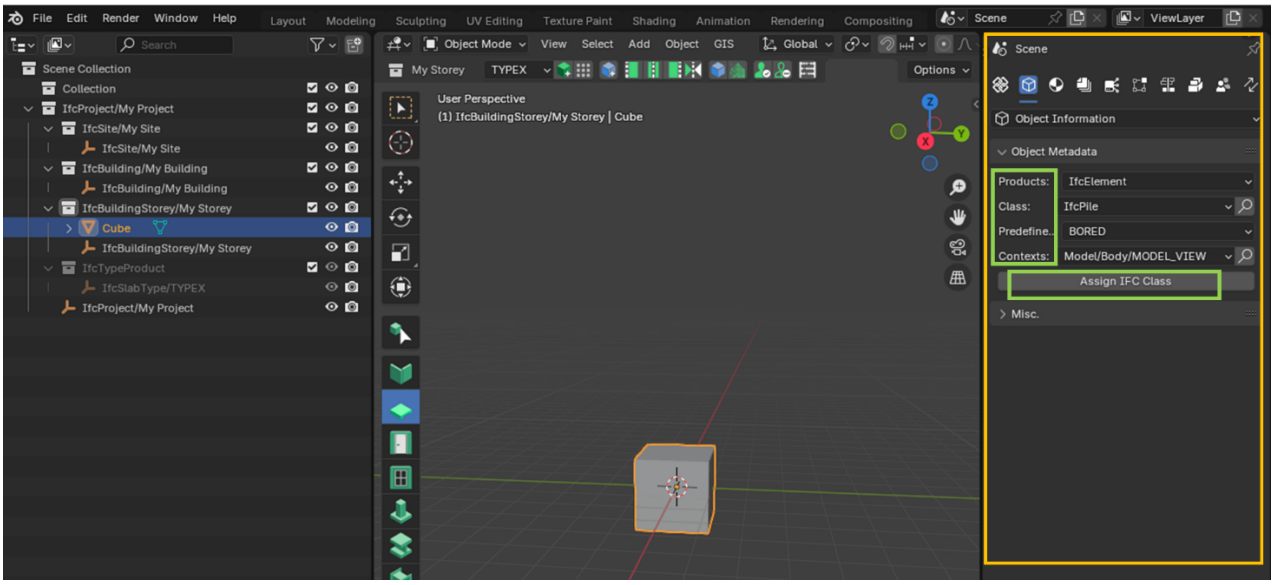
By default, Bonsai creates a schema with a number of entities that can be modified, as detailed in point 6.5 of this document.



Spatial entities can be modified and added from the **Project Overview/Spatial Decomposition tab.** This process is explained in section 6.5 of this document**.**

The different objects can be added using the drop-down available in the Bonsai extension, which is mainly designed for building elements, or through Blender's own **Add** tab .

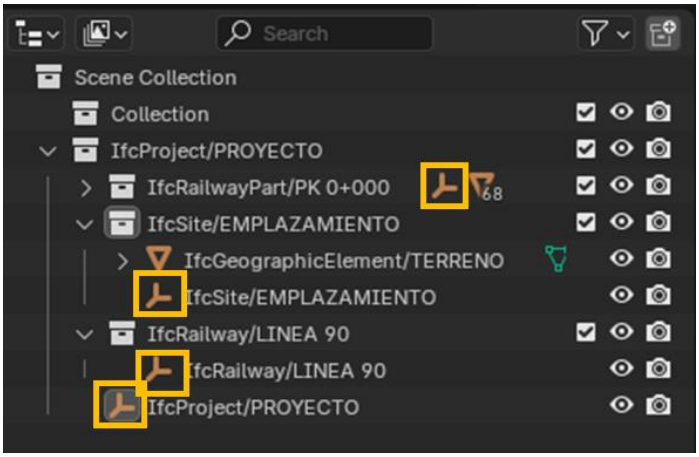
Objects added using the Bonsai extension are already assigned their corresponding IFC entity by default. However, objects added through the **Add** tab of Blender must be manually assigned to an IFC entity.



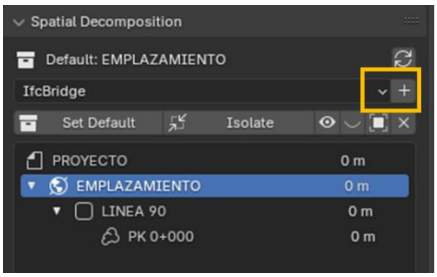
6.5 MAPPING IFC ENTITIES OF GEOMETRY

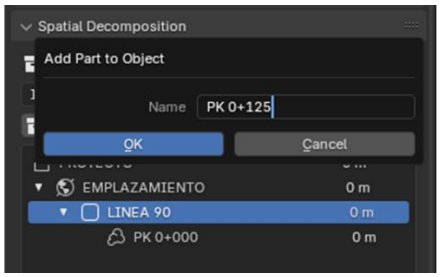
Bonsai allows you to map and adjust the entities of an existing IFC file.

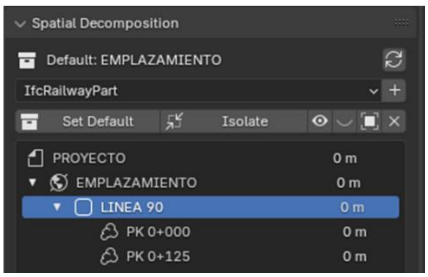
To make changes to any entity, the corresponding null object must first be selected in Zone **1** of the dashboard.



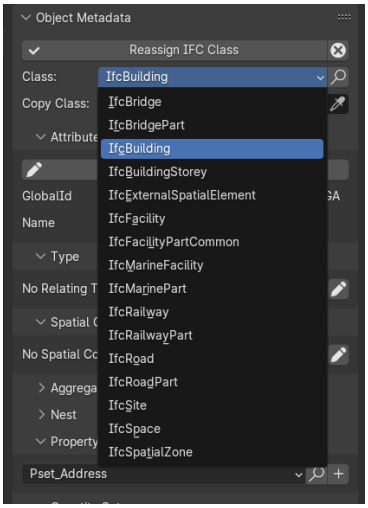
The hierarchy tree is located in the **Project Overview / Spatial Decomposition** tab, from where levels can be added or removed according to the needs of the project.



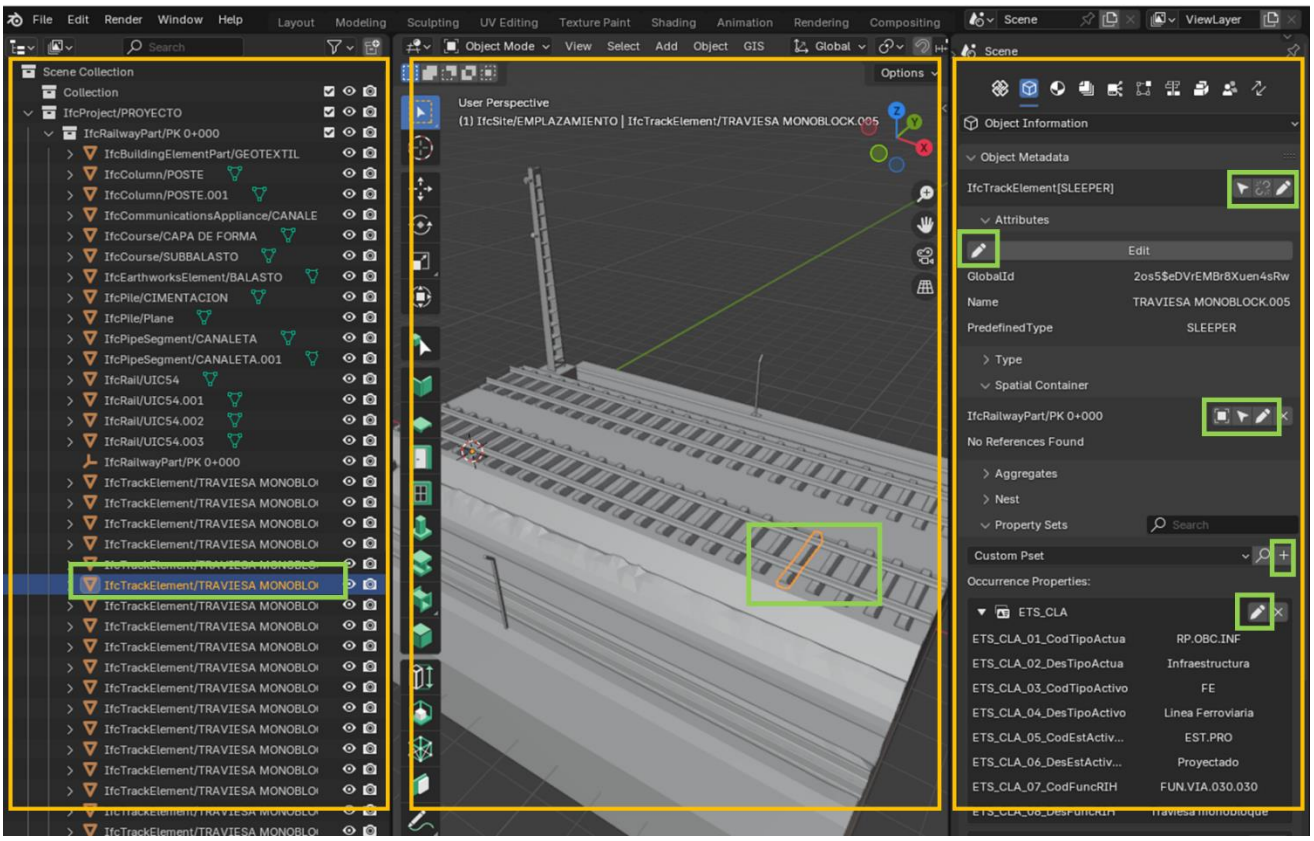




To change the entity type of tree structure, you use the **Object Information/Object Metadata** tab, selecting the entity with the null object symbol. The name of the entity within the hierarchy tree can be edited in the **Attributes section**.



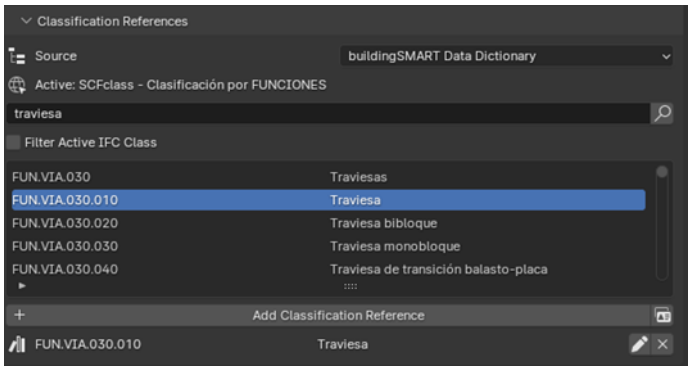
If you need to map the IFC entity of a 3D object, select the object with the "▽" symbol in Zone **1** of the panel. This will make the object stand out in Zone **2**, allowing Zone **3** to make all the necessary modifications: reassign an IFC class, rename it, define its location in the hierarchy tree, and add or update its properties.



6.6 CLASSIFICATION AGGREGATION

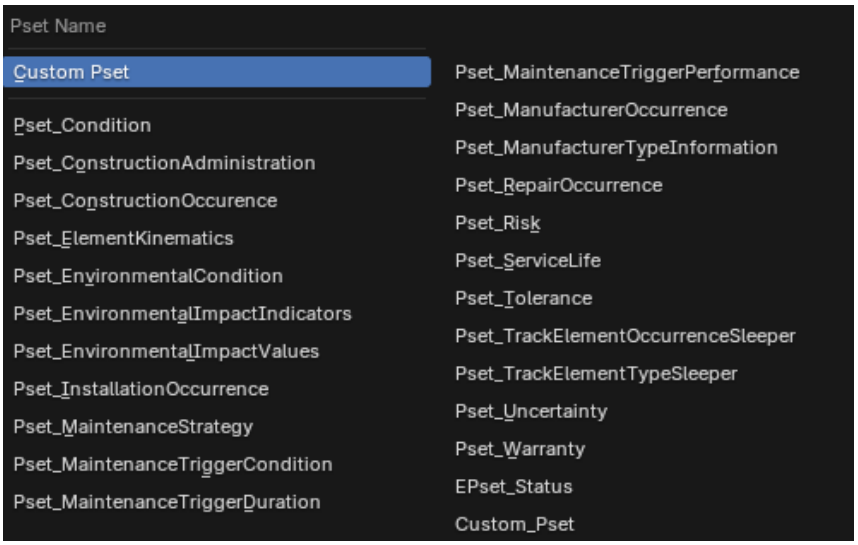
To effectively manage IFC models with the Bonsai extension, it is important to apply classifications to objects using Classification References, especially if you have enabled the buildingSMART Dictionary (bSDD) option in the Project Overview section. This ensures that objects in the model are classified according to established classification standards and dictionaries.

It is recommended to work without having the Filter Active IFC Class option enabled. This will allow you to view and manage all the elements of the model without restrictions, facilitating a more complete and flexible handling of the IFC model.



6.7 PROPERTY AGGREGATION

Bonsai allows you to include in each object the properties that are considered necessary, by default it includes the following psets:



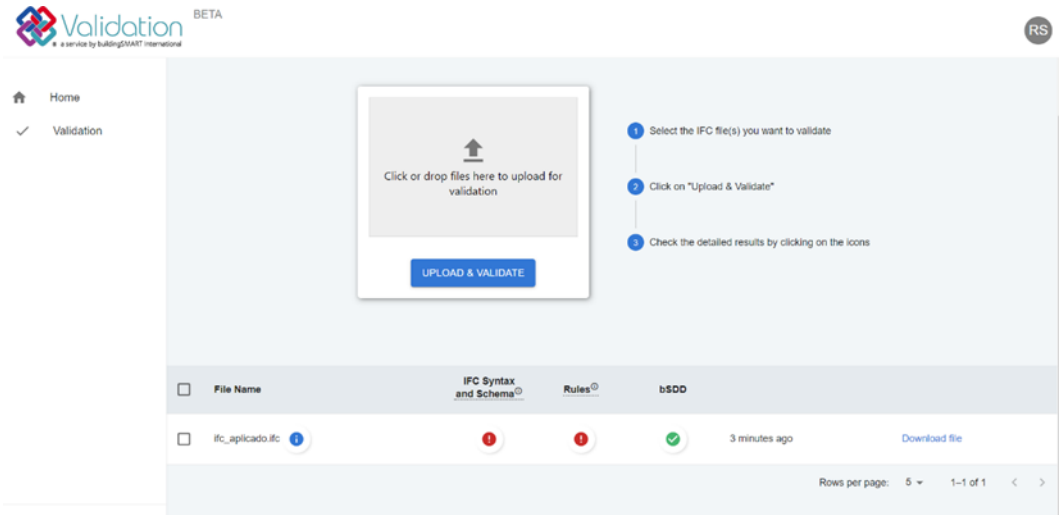
You can add user-defined pset by first generating a template as explained in point 6.3. Next, in the **Object Information/Object Metadata/Property Sets** tab , select the template you want to complete, which can be edited at any time.

6.8 EXPORT TO IFC

In the same section where it has been shown how to import an IFC file, the option to save it also appears. If we select this option, a dialog box appears that will show the location where it will be saved and if, additionally, we want a json file from the IFC.

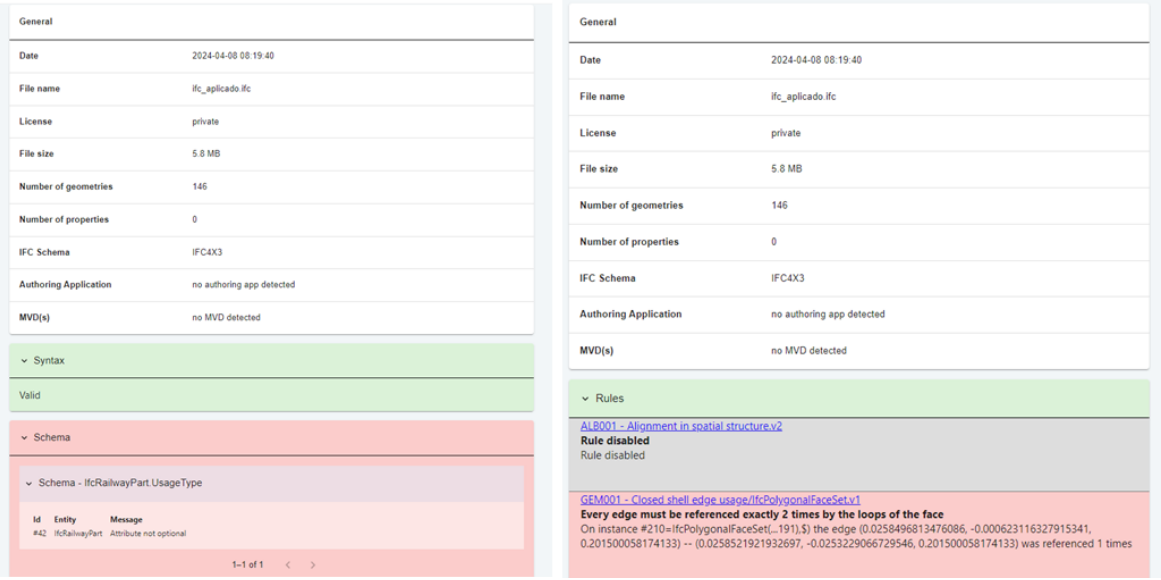
6.9 BSI VALIDATOR CHECK

For this process, only the BIM validator is used.



To check our files we will use the service that provides us https://authentication.buildingsmart.org. It will allow us to upload the file and see if it has any errors. When uploaded, it will display three error fields, the schema, the rules in the hierarchy, and the buildingSmartDataDictionary.

Selecting the errors will bring up a new tab with a file summary and with the errors of each section (there is no section that shows all 3 fields at the same time).



There are two errors in this file; one on syntax in the IFC scheme and another in the Rules.

6.10 CORRECTION AND ADJUSTMENTS

If you want to correct the errors that are detected through the validator, as it is open source software, it is recommended to ask in the following forums:

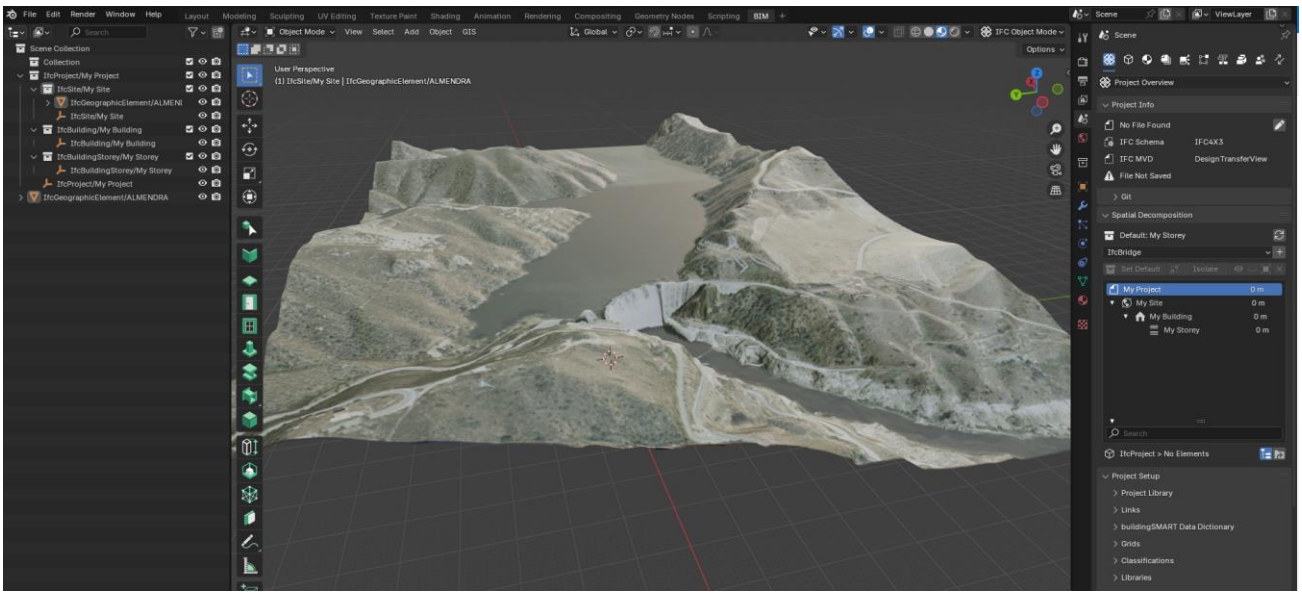
https://bonsaibim.org/community.html

https://community.osarch.org/

07.// METHODOLOGY OF WORKING WITH THE BLENDER GIS ADDON

7.1 INTRODUCTION TO BLENDER GIS ADDON

One of the advantages of using Blender in the GIS field is its ability to visualize terrain in 3D along with its corresponding orthophoto. This allows the areas of work to be geographically contextualized, facilitating a more complete and detailed analysis of the environment.



Blender-GIS is an add-on for Blender that facilitates the import of commonly used GIS (Geographic Information Systems) data formats, such as vector Shapefile, raster images, DEM in GeoTIFF format, and OpenStreetMap XML files. Among its main functionalities are:

- **Import** of vector contour lines, creation of faces by triangulation and application of topographic textures in raster format.

- **Obtaining geodata** directly from the web, allowing the visualization of dynamic web maps within the 3D view of Blender.

- **Extraction of OpenStreetMap data**, including information on buildings, roads, and other elements.

- **Management of** the georeferencing information of a scene.

- **Generation of terrain meshes** by means of Delaunay triangulation and placement of objects in these meshes.

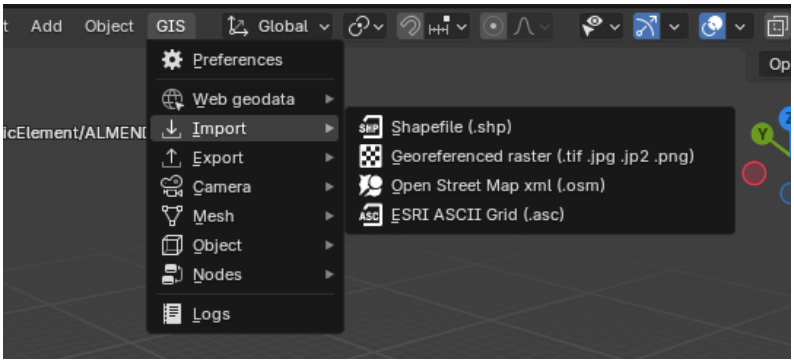
- Carrying out **terrain analysis** using shading nodes.

This tutorial will focus on explaining how to visualize terrain meshes using the data downloaded from the official pages, and using the supporting QGIS software.

To learn about other functionalities and uses of Blender-GIS, it is recommended to consult the following tutorial: https://github.com/domlysz/BlenderGIS/wiki/Quick-start

7.2 EXPLORING THE BLENDER-GIS INTERFACE

The interface of this plugin is very simple to use. To work with data downloaded from sites such as PNOA or GeoVisor Euskadi, you only need the **Georeferenced raster** and **ESRI ASCII Grid** commands.If you want to include buildings in the scene, you must also import files in Shapefile format.



7.3 QGIS-BLENDER WORKFLOW

The steps to follow to visualize terrains in 3D with Blender-GIS are as follows:

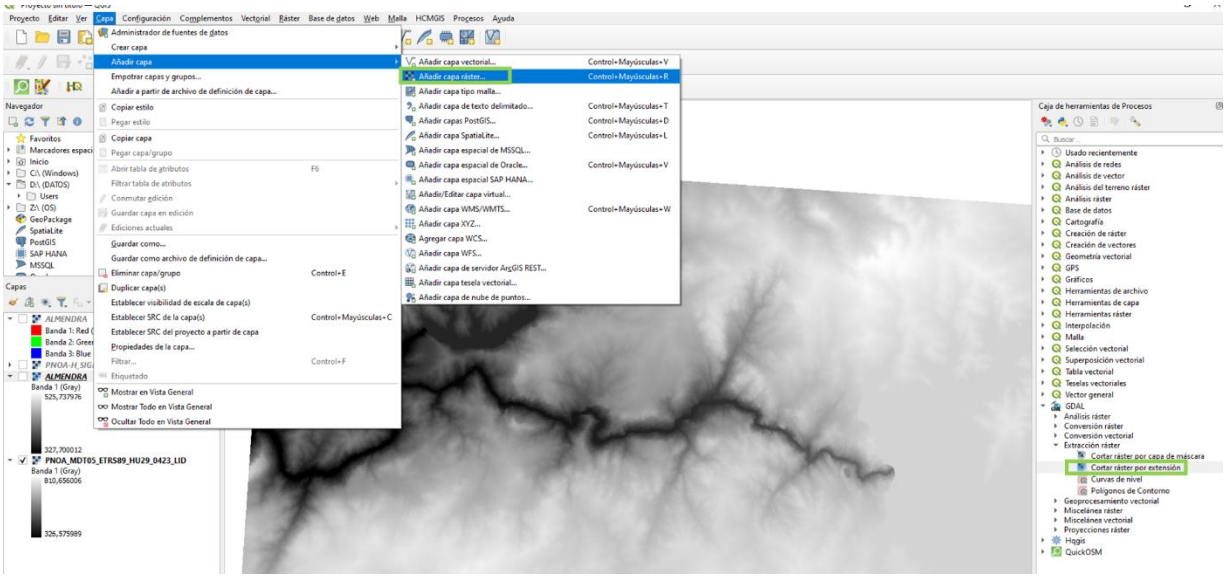
1. **Downloading the terrain and orthophotos**

Get the Digital Terrain Model (DTM) or Digital Surface Model (DSM) depending on the needs of the project, along with their corresponding orthophotos:

CNIG Download Center

GeoVisor Euskadi

2. **Trimming the project area in QGIS**



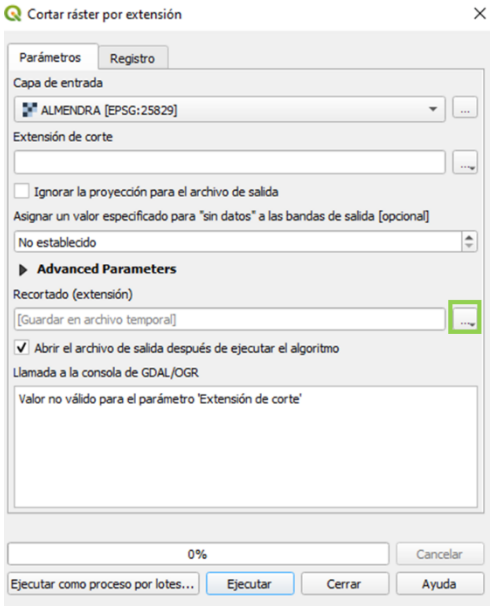
Open the downloaded files in QGIS to trim the area of interest.

Add both as raster layers and select the area you want to work on.

Use the "Cut raster by extension" option to delimit the work area.

During the trimming process, select "Save to File."

Choose **ASCII** format for terrain mesh files and **TIF** for orthophotos



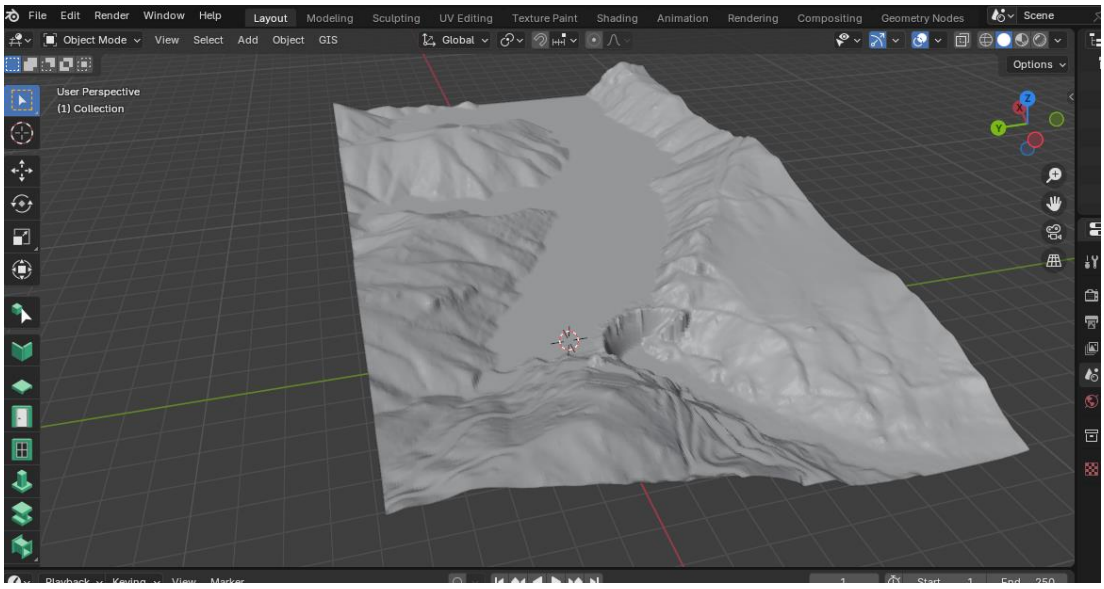
3. Preparing the environment in Blender

Open Blender and delete the elements that appear by default in the scene.

4. Importing the ground mesh

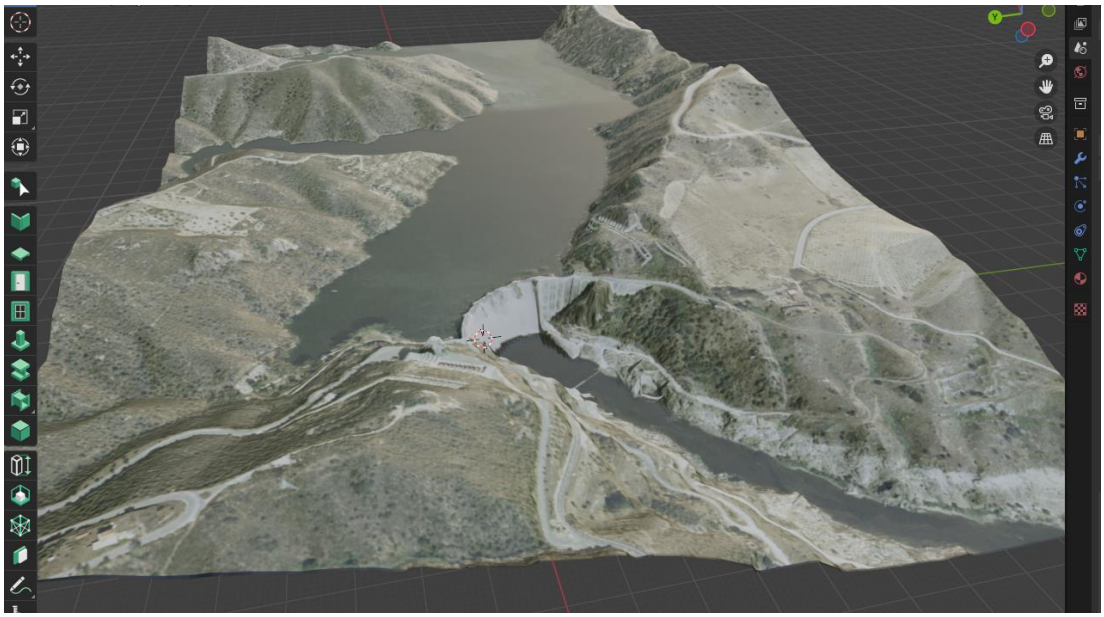
Go to the **GIS/Import** tab and select **ESRI ASCII Grid**

Choose the previously trimmed workspace in QGIS



5. Orthophoto overlay

On the same **GIS/Import** tab, select **Georeferenced Raster**



Make sure to check the **Base on Mesh** option so that the orthophoto "sticks" correctly on the ground.

These steps will allow you to visualize and work with the terrain in 3D and its orthophoto in Blender, providing a detailed geographic context for your project.

It can also be selected as an ifc file and exported with a corresponding entity

08.// LINKS OF INTEREST

This section compiles the main links of interest.

8.1 BLENDER & BONSAI

BLENDER

https://www.blender.org/

Blender 4.2 Manual

BONSAI

https://bonsaibim.org/

https://docs.bonsaibim.org/

FORUMS

https://www.blender.org/community/

https://osarch.org/

Manual Bonsai

8.2 OTHER

VIDEO TUTORIALS

https://www.youtube.com/watch?v=B0J27sf9N1Y&list=PLjEaoINr3zgEPv5y--4MKpciLaoQYZB1Z&pp=iAQB

https://www.youtube.com/watch?v=At9qW8ivJ4Q

https://www.youtube.com/watch?v=8L9fV8P_HAM&list=PLgO2ChD7acqHzccBuhAGw8dTPLnR1E3QB&pp=iAQB

https://www.youtube.com/@Erindale

https://www.youtube.com/watch?v=ov0F3cEJWoI

https://www.youtube.com/watch?v=nlSM593swZY

09.// ANNEXED

9.1 IFC FORMAT EXAMPLE MODEL