Remote Sensing, GIS, and BIM Tools As a Basis for Flood and Deforestation Strategic Actions

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Abstract- *The application of Remote Sensing technology has become increasingly important in addressing environmental and landscape challenges, especially for dynamic elements such as waterways and forests. The critical evaluation of multispectral satellite imagery provides valuable insights into the current status and changes in various environmental parameters, such as vegetation indices to monitor changes in vegetation health, land cover, and classification to monitor changes in land use patterns and soil moisture levels. At the same time, there is a need to integrate these data into a landscape project workflow. The digitalization of landscape context can be possible by creating a unique model capable of collecting all analysis data and using them in the decision-making process. The digitalization and design of the built environment are increasingly oriented towards the methodology of Building Information Modeling (BIM), an approach for a collaborative and dynamic design process.*

This study presents an examination of the use of Remote Sensing methodologies as an informative layer inside a digital BIM model for strategic territorial planning of environmental systems in the Finiq Municipality, South Albania. Located on the Greek border, it is a very heterogeneous environment where agriculture, forests, water basins, and rivers are surrounded by various gradient morphology. At the same time, it is a fragile territory due to flood events and soil pollution resulting from settlements and agriculture processes.

Remote Sensing (RS) and Geographical Information System (GIS) represent two proficient methodologies for spatially visualizing flood events and deforestation areas through the years. Starting from RS sensing data analysis about water and vegetation and the comparison to land use data of the actual condition (Agjencia Kombëtare e Planifikimit të Territorit AKPT, 2021), this study aims to create a direct collaboration between analysis and project tool. Through the use of Sentinel-2 satellite imagery maps about different parameters showing the actual conditions, the paper investigates how a digital model can be built and how it can collect all the data coming from the analysis phase. By a methodological case study, a new workflow for the creation of a Landscape BIM model is shown and different tools are used, each one for a specific objective.

The results of this study provide a valuable contribution to decision-makers and will contribute to addressing the environmental challenges in Finiq within a comprehensive, coordinated, and integrated approach involving all relevant stakeholders. The study demonstrates the potential of the collaboration of Remote Sensing technology, GIS analysis, and BIM models in addressing environmental and landscape problems, focused on flood and deforestation monitoring, and highlights the importance of considering these technologies as valuable tools in the planning and management of environmental systems.

Keywords:
Remote Sensing, BIM, Territorial Model, Finiq Municipality, Flood Risk, Deforestation.

Fig1 / Finiq Municipality landscape panoramic view
source / the author

Introduction - Finiq Municipality, part of the District of Vlora, is located 20 km from the city of Saranda, 8 km from the shores of the Ionian Sea, and it shares a border with Greece, appears as a heterogeneous system where agriculture, forests, rivers, and settlements coexist in a sometimes precarious balance. The particular morphology of the context shows human settlements developing on elevated areas that stand out amid the agricultural expanses, with only rivers and minor watercourses acting as separators (Fig1).

There are two main environmental issues affecting this area: flooding, caused by heavy precipitation, and deforestation, which reduces the forested area surface to accommodate livestock farming and expansions. Severe floods, a high intensities rainfall natural phenomenon in Albania (Selenica, 2004), have the potential to lead to loss of human life, as well as significant damage to infrastructure and agriculture, but, on the other hand, they can provide nutrients to the soil, vegetation, and water reservoirs. All rivers experience variations in flow, influenced by multiple factors during rainstorms, such as precipitation amount, intensity, duration, and storm area typically during the period from November to March, which accounts for approximately 80% of the total annual precipitation (Kamberi, Kamberi, & Xhillari, 2022). To protect the territory from floods and ensure proper water supply for agriculture and urban areas, strategic actions are required, considering the natural changes in the territory's conditions and the phenomena influencing it.

Deforestation in Albania is a concerning issue, impacting biodiversity and natural habitats. Uncontrolled clearing of forests threatens ecosystems, soil erosion, and exacerbates climate change effects. In the Finiq Municipality forests represent an important natural ecosystem, with a large area and rich biological diversity. Their surface is primarily located in the area of Dhrovjani and Mesopotam. This landscape must be preserved untouched by human activity in order for such a value not to be lost (Finiq Municipality, 2021).

In this scenario, in the Municipality of Finiq, floods occur from the Bistrica River, identified as a “Flood zone” with a high value (Selenica, 2004). The deforestation monitored in the Vlora district, where the Municipality of Finiq is located, has resulted in a loss of 4,590 hectares of tree cover, equivalent to a 13% decrease since 2000, as observed from 2001 to 2022 (Global Forest Watch, 2023).

Territorial planning and landscape projects should rely on continuously updated data concerning the events and changes occurring in a specific landscape in order to effectively manage and regulate these phenomena. Therefore, the development of interactive models capable of storing environmental data is a crucial challenge in assessing the potential risks of floods and deforestation and subsequently mitigating their impacts on landscapes and communities.

In a context characterized by a lack of landscape and urban planning, Remote Sensing (RS) tools can play a crucial role in generating maps depicting the current conditions by providing valuable data on water resources, land, and vegetation health status, and the spread of urbanization. RS analysis involves the use of sensors on satellites, aircraft, or drones to capture data from the Earth's surface (Cianci & Molinari, 2019). These sensors detect and measure electromagnetic radiation reflected or emitted by various objects and surfaces. The collected data, in the form of images or spectral data, is processed to extract valuable information about the Earth's features (Toth & Jóźków, 2015). By analyzing the patterns and characteristics of the reflected or emitted radiation, it can evaluate insights about environmental changes, natural disasters, land use, and other critical factors influencing our planet.

In recent years, there has been significant interest in integrating RS images with Geographical Information Systems (GIS) vector data. The importance of integrated software systems enables the combination of remotely sensed data with vector datasets for optimal results for users in environmental applications within both GIS and remote sensing domains (Hinton, 1996).

GIS analytical tools are employed to analyze and represent built and current contexts. In landscape, they depict the territory based on geological and hydrological features, soil, and topographic elevations. They facilitate various types of analyses but, despite their proven utility, GIS tools are not utilized in parametric design. There is a lack of connection between analyses or data related to a territory and the design process for a specific area. In traditional landscape practices, GIS data is set aside after the analysis phase and is no longer used as a valuable tool for designers.

RS and GIS together can provide a detailed and real-time reading of the current state of places that are generally not mapped or regularly updated. However, they are limited to representing the existing state. The creation of a useful digital model allows parametric modeling to incorporate external influences (terrain, water, sunlight, vegetation, etc.) as parameters, adapting the design to contextual conditions through information and representation. RS maps and GIS data should be integrated as parameters and used not only during the analysis phase but also during the design phase.

The digitalization and design of the built environment are increasingly oriented towards the methodology of Building Information Modeling (BIM), a method based on the concept of an informative design approach that allows the designer to enrich the geometric objects of the model, derived from traditional CAD systems, with specific information about the elements themselves. The construction model is not merely geometric but instead contains information essential to understanding and designing the existing environment, in this research, focusing on landscape discipline. Computation in landscape architecture requires designers to extract and establish abstract rules for landscape performance from ecological, formal, cultural, and material perspectives. Developing these rules, or the syntax of the landscape, already constitutes the planning of the project itself, demanding landscape architects to define how an environment is represented according to behaviors and relationships.

An interoperability development is necessary to achieve BIM models integrated with territorial GIS data that can collaborate with models from other disciplines.

Making RS mapping, analyses, and GIS data available during the design decision-making process is thus essential for a comprehensive project, aligning more closely with the territory and striving for the lowest possible environmental and landscape impact.

The article examines the advantages of this integration for users in environmental applications within both RS and GIS domains into a BIM model, making them an indispensable element for design choices in the case study of Finiq Municipality.

Specifically, in section 2, the context of the application is investigated through a state of art overview. In section 3 the materials, tools, and the workflow of the methodology used are presented. In section 4 the obtained results on the digital Finiq model are shown as results of the method and, finally, in section 5 there are limitations, possible future development, and stakeholders of the present study.

Research Question

The digitization of the landscape can occur through various methods and tools, but often these processes are performed separately in different project phases. The different phases should intertwine and influence each other, aiming to make these exchanges as seamless and direct as possible. Although Remote Sensing analysis and GIS data are integrated into landscape project processes, mostly as initial inputs rather than design choices, Building Information Modeling (BIM) is not widely adopted in landscape design practices (Landscape Institute, 2016). Modeling landscape projects with BIM tools may seem contradictory, as there might appear to be an incompatibility between these two domains. However, they are closely interconnected. The "B" of Building is not the most crucial aspect of BIM; rather, it is the "I" of Information and the "M" of Modeling. The primary goal of BIM is to create a three-dimensional model containing all the necessary information for designing, constructing, and managing. Collaborating models allow for an exchange of information among various disciplines, adapting to changes in either one. Hence, BIM is a dynamic tool capable of adjusting different elements to the evolving context, much like nature. The adaptability feature seen in an ecological system is mirrored in a BIM context, where each discipline coexists, coordinates with others, and adjusts according to specific characteristics (Ahmad & Aliyu, 2012).

The simulation and visualization tools offered by BIM can be utilized by landscape architects to design more realistically and efficiently. Plant properties and specifications can be used to determine optimal placements, with drought-tolerant plants being introduced in areas with limited water and specific species in areas requiring phytoremediation. By combining information with BIM design tools, landscape architects gain a comprehensive view of their working environment, harmonizing various aspects of an interdisciplinary field. This approach equips them with readily available tools and elements to complete projects, making informed decisions based on the provided information.

The present study investigates how the dynamism of the landscape and territory, represented through RS analysis and GIS data, can be transferred to the BIM project, enabling targeted work towards objectives and yielding improved benefits in terms of design quality and control, consequently influencing the transformation of the territory (Golberg, Holland, & Wing, 2012). Transferring the dynamics of the environment into a design tool will enable working smarter and achieving better outcomes in terms of performance, quality, and project control.

The research focuses on a new way to integrate analysis data inside design software to monitor, plan, and project inside a unique tool.

Methodology Used

In the scenario of a digital landscape, everything is aimed at achieving a representation that closely adheres to reality and the built context, resulting in a landscape architecture project that is seamlessly integrated and of high design quality.

The study area is a portion of the Finiq Municipality, 4x3 km square Located along the Bistrica River, it encompasses the urban settlements of Finiq, Mesopotam, and Krane.

This landscape segment is predominantly characterized by an agricultural vocation, separated from the main watercourse flowing east to west towards the Ionian Sea. Particularly, elevated morphological features host urban centers. The following analysis and methodology will focus on this small territory fragment with the aim of test and creating a workflow that could potentially be applied to other locations or areas (Fig2).

The study focuses on the creation of a digital informative model, which represents the actual conditions of the territory, capable of summarizing all the analysis data in order to give the landscape designer and urban planner the possibility to use analysis maps and layers to make project decisions and choices. The approach to the digital landscape theme involves several methodological steps, which were preparatory to each other, specifically:

1) Remote Sensing analysis;
2) GIS data overlap;
3) Creation of a territorial model;
4) Creation of BIM model.

1. Remote Sensing analysis: the first stage involves identifying suitable RS tools and raster maps to study and represent the phenomena under investigation, namely, flooding and deforestation in the present research. Through satellite imagery and aerial photography, these maps provide valuable insights into changes in land cover, vegetation, and hydrological patterns (Farhadi & Najafzadeh, 2021). For flood analysis, parameters such as humidity content, water extent, and water presence can be extracted from these maps to model floodplains and predict flood events. Regarding deforestation, remote sensing raster maps enable the detection of changes in forest cover over time, helping to identify deforestation hotspots and assess the extent of forest loss. Remote sensing maps are accessible through various sources, including government websites, research institutions, geospatial data portals, and online platforms. Many countries offer open data initiatives for freely accessible datasets. This research uses open-source data from the Sentinel Hub EO Browser, where data from Landsat and Copernicus satellites are available (Sentinel Hub, 2023).

2. GIS data overlap: a transformation from raster maps to vector data is necessary to

Fig2 / The study area of Finiq Municipality
source / author

compare and overlay the analyses with the Land Use layer (National Agency of Territorial Planning, AKPT, 2021) and to approach the initial variations and monitoring of the studied phenomena. The second step of the integration process involves bringing RS data into GIS software and aligning it spatially with other geographic layers. This georeferencing process ensures that RS data aligns accurately with the existing geographic information, enabling seamless integration and spatial analysis. Overall, the implementation and integration of RS data within GIS have enhanced the ability to understand and manage environmental resources effectively. This powerful synergy between RS and GIS has become an indispensable tool for monitoring, resource management, and informed decision-making in various domains. The open-source software QGIS 3.28 is used for the present research.

3. Creation of a territorial model: the third step aims to create a 3D model capable of reproducing the main features of the landscape. The creation of a territorial 3D model starts by gathering relevant data such as aerial imagery and terrain elevation data. This model can be created through drone flights using LiDAR or photogrammetry techniques that produce point clouds, but it requires specific tools that may not always be available. Through this study the software Autodesk Infraworks, in particular its Model Builder tool, is used for the creation of a territorial model. It generates a model based on GIS data that depicts the topographic surface, water features, infrastructure, and buildings, and overlays a satellite map of the area's current state.

4. Creation of a BIM model: the final stage involves transferring the RS analysis, now incorporated into GIS vector data, and the territorial model obtained, to the BIM model. The integration of these data into a 3D model is a powerful approach that enhances the design and management of projects. RS and GIS provide valuable geospatial data and analysis, the territorial model provides the context of application while BIM offers detailed 3D representations of landscape elements and it is the tool where the landscape architect can make decisions and design. BIM software varies depending on specific needs and uses. In this research, Autodesk Revit 2023 is utilized as it is the most widely used software, fostering enhanced collaboration between landscape and other disciplines. Revit stands out for its integration of Dynamo within the software itself. This tool provides a graphic programming interface that allows users to customize workflows and create connections with external files, presenting different design options alongside the designer's work (Schimdt, 2015). Through this tool, it is possible to transfer RS and GIS data to Revit elements, representing the geometry and containing the necessary information for RS analysis. "Floors" elements are particularly suited for this process due to their characteristics.

Results

After the methodological workflow, the steps are applied to the territory part of the Finiq Municipality case study. The research demonstrates how a digital model of a small portion of a wider territory can become a useful tool for the design decision-making process, regarding flood events, forest extensions, and settlements. The study's findings demonstrate how, through the integration of various expertise and tools, information can be contained within a single digital model, which is updatable and replicable, to obtain an overall picture of the current state.

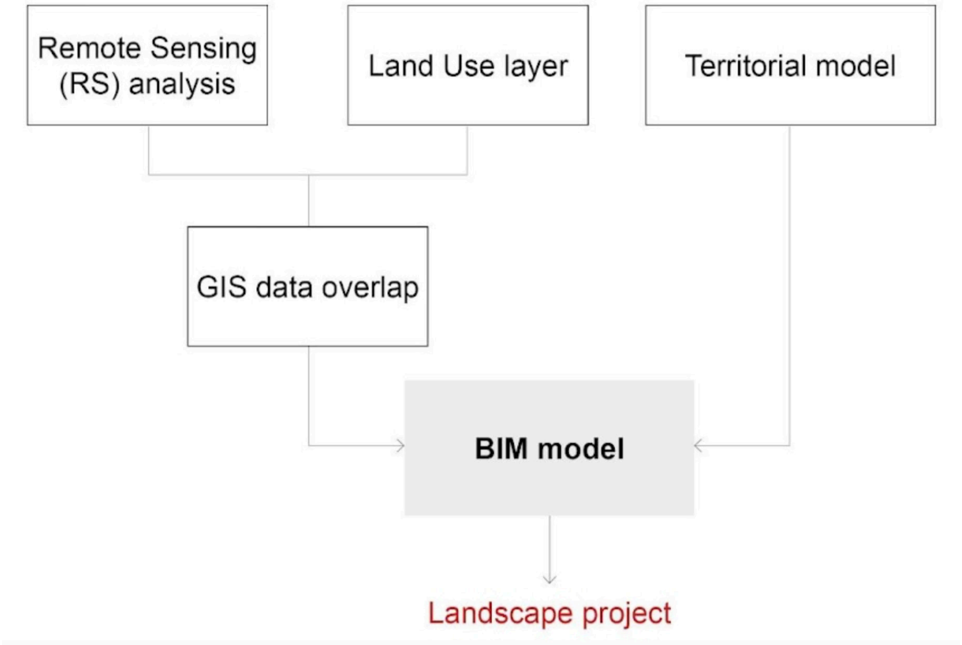

Fig3 / Methodology stages for the creation of a BIM model start from RS analysis, GIS data, and territorial model.
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Starting from the Remote Sensing analysis, parameters were considered to provide information about the current state of vegetation and the presence of water in the analyzed territory. The various visualizations were conducted using the Sentinel Hub EO Browser, specifically the Sentinel-2 L2A dataset, dated June 30, 2023. This date was chosen because, being open-source software, data visualization was sometimes unusable due to cloud cover masking the Earth's surface or data quality issues. Additionally, for flood mapping, it is ideal to base the analysis on data immediately after a flood event. However, due to the relatively short historical availability of open-source data, the analyses presented here will serve as a methodology test, applicable in the future with specific and non-open data.

The parameters used to monitor floods and deforestation complement each other, as areas with more water also have a higher probability of vegetation proliferation. Conversely, the absence of vegetation is sometimes due to poor soil characteristics, leading to insufficient retention of meteoric water.

To monitor water presence, two parameters were considered: SWIR and NDMI. The Short Wave Infrared RGB Composite (SWIR) measurements assist scientists in gauging water content in plants and soil due to water absorption of SWIR wavelengths (Fig4a). Vegetation appears green, soils and built-up areas display various shades of brown, and water appears black in the composite. SWIR bands are valuable for mapping water presence and fire damages, as newly burned land reflects strongly in these bands. The Normalized Difference Moisture Index (NDMI) assesses vegetation water content and drought monitoring (Fig4b). NDMI values range from -1 to 1. Negative values (approaching -1) indicate barren soil, while values around zero (-0.2 to 0.4) indicate water stress. High positive values (approximately 0.4 to 1) indicate a high canopy without water stress.

To monitor vegetation presence, two parameters were considered: Barren Soil Visualization and NDVI. The Barren Soil Visualization is useful for soil mapping, and investigating landslides or erosion in non-vegetated areas (Fig5a). It shows vegetation in green and barren ground in red. The Normalized Difference Vegetation Index (NDVI) is effective for quantifying green vegetation health based on light reflection at certain wavelengths (Fig5b). NDVI values range from -1 to 1. Negative values (approaching -1) indicate water and values close to zero (-0.1 to 0.1) correspond to barren areas like rock, sand, or snow. Low, positive values (approximately 0.2 to 0.4) represent shrub and grassland, while high values suggest temperate and tropical rainforests (values approaching 1).

Following the specific Remote Sensing analyses for the examined themes, an overlay and comparison with the Land Use and the vectorization of raster maps are necessary (Fig6). Using the open-source software QGIS, raster maps can be imported and georeferenced following the data's Reference System and location under analysis. In this study, specifically, SR: WGS84/UTM 34N, EPSG 32634 was used. The comparison between the vector representation of the current state and the RS analysis maps reveals that within a geometry indicating homogeneous usage, such as natural areas, there are many differentiations based on the analyzed field. To discretize and simplify the raster data for importing into BIM software, a 40x40 meter grid was created to represent and convert the satellite data analysis into vector data with associated geometry and information (Fig7a). Through the geoprocessing operation "Zonal Statistics," each grid pixel is attributed an average value from the underlying raster, providing a coherent visualization for the analysis in a more versatile format for transfer to the BIM model (Fig7b). The output of this stage is in Shapefile (.shp) format.

analysis; (b) the grid with the data of the NDMI analysis and simplification.

The last missing step for importing all elements of the current state into the BIM model is creating the territorial model for a purely morphological representation of the current conditions of the analyzed territory. Using the Model Builder tool within Autodesk InfraWorks software, it is possible to define the area for which a three-dimensional model of reality is intended. Using data from OpenStreetMap and Bing satellite imagery, a model adhering to the real-world location is created. This exportable model can be converted from .fbx to .dxf format and then imported into the BIM software (Fig8).

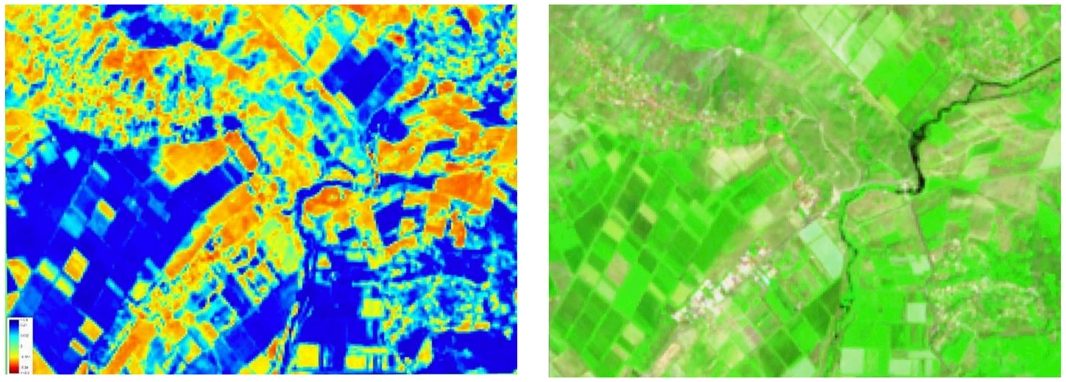

Fig4 / Remote Sensing analysis of water feature from Sentinel Hub EO Browser, dataset Sentinel-2 L2A; (a) Normalized Difference Moisture Index (NDMI) analysis; (b) Short Wave Infrared RGB Composite (SWIR) analysis
source / author

Fig5 / Remote Sensing analysis of vegetation and soil features from Sentinel Hub EO Browser, dataset Sentinel-2 L2A; (a) Normalized Difference Vegetation Index (NDVI) analysis; (b) Barren Soil Visualization analysis
source / author

The last step and ultimate goal of this study is to import all the data obtained through the previous stages into the BIM software to create a model useful for the designer, containing all necessary project information in one place. Autodesk Revit 2023 is used due to its wide usage in the fields of architecture and engineering, as well as the inclusion of the Dynamo tool. Through Python scripting, Dynamo allows for the importation of previously collected data. The territorial model is imported by creating a topographic surface, generating elevation points from the input data, resulting in a realistic, measurable, and sectionable surface for visualization and graphical representations (Fig9).

Importing vector data, derived from simplified RS analyses on a grid, requires the use of Dynamo with the DynamoGIS package to convert geometries and information from Shapefile (.shp) files into Revit elements. The "Floor" system family is the most suitable for this purpose. The objective is to transfer GIS data to the BIM environment using Floors that take on the geometry and information from the Shapefile. Geometry and information will be extracted from the source file, defining the perimeter of the Revit Floor and automatically attributing the associated parameter to the element. The land use layer is the first import from GIS data in order to give a characterization of the model and the topography (Fig10).

Through visualizations based on the transferred data, it is possible to reproduce the initial RS analysis maps with colors and gradations. In this case, analysis is useful for making immediate design decisions based on real conditions. Fig11 represents an example using the NDMI parameter, but this process can be applied to all parameters, as shown in Fig12, where all Remote Sensing analysis values previously displayed and analyzed are transferred

Fig6 / Comparison between land use and Remote Sensing analysis map; (a) Land use layer (National Agency of Territorial Planning, AKPT, 2021); (b) the overlay of the NDMI map on land use layer shows how within a single geometry there are different characterizations and data
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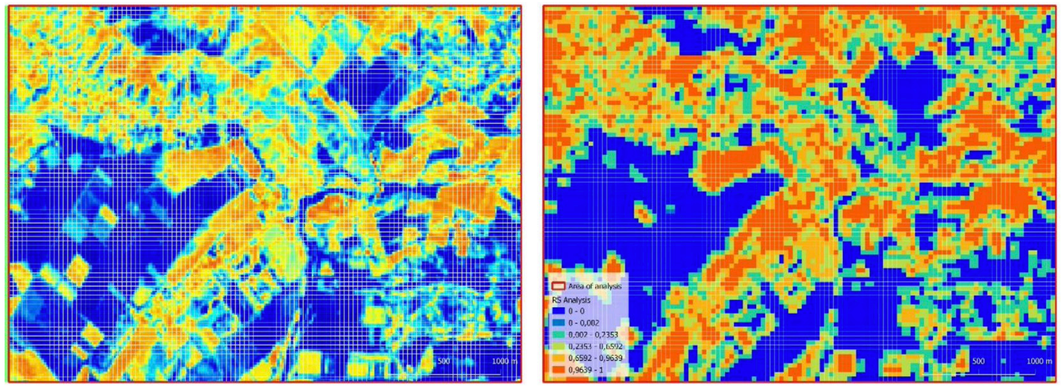

Fig7 / Results of Remote Sensing analysis overlaid on the 40x40 m grid; (a) grid overlapped on the NDMI analysis; (b) the grid with the data of the NDMI analysis and simplification.
source / author

to each Floor element.

Having this additional layer in the model enables the designer to draw upon specific rules and make decisions based on real-world information. Through the BIM software's tools, landscape architects can interpret and utilize the current state's data according to their own design approach, allowing for more informed and context-sensitive decision-making.

Conclusions and Recommendations

This study demonstrates how, by using different inputs, it is possible to create a single BIM model capable of containing and processing information derived from Remote Sensing and GIS analyses. The overlay and interpolation of various layers are no longer limited to geographical systems solely for the analysis phase but are directly related to the design phase, enabling the designer to have a complete view of the environment in which they are operating. The synergy between GIS (including Remote Sensing Analysis) and BIM enables better decision-making, efficient collaboration among various disciplines, and a comprehensive understanding of the project's context, resulting in more sustainable and informed construction processes (Freller, Gnaedinger, Mattos, & Schaller, 2017).

The methodology described and tested in this study can adapt to different contexts, modulate the grid based on the scale of the application and project, and incorporate additional analyses, research, and data related to the studied environment. GIS data and Remote Sensing analyses, along with their sources, will become increasingly important and must be more precise and specific. Indeed, the quality and diversity of data are fundamental aspects on which this research methodology is based. The abstraction of soil characteristics and their digitization allows for the control of countless information, previously confined to the GIS environment, now also integrated into the BIM environment.

The close relationship established between soil, vegetation, and any other quantifiable and measurable environmental information through this new approach is essential for fully understanding the dynamics and environmental impact of the landscape project with the territory and context. The discretization of the context through a grid can contain not only data related to soil, water, and vegetation -visible and tangible elements- but also information concerning air, pollution, and protected areas.

The use of the new methodology during the design phase accelerates and simplifies the overall vision of the project and its context. The availability of territorial information in the form of BIM parameters integrates the dynamism of nature into the model. The changes and updates in GIS data can be easily imported into the existing model, replacing only the information attributed to each element.

Several stakeholders can benefit from this new project approach. By combining RS and GIS into a BIM model, stakeholders can assess the impact of proposed projects on the surrounding environment, analyze site conditions, and optimize spatial planning. Municipalities can create models that encompass information related to the environment, soil quality, water, and air, obtaining comprehensive analyses and project insights, and providing a 360-degree view of their territory. By establishing new workflows, data quality for both Remote Sensing analyses and the creation of the territorial model can be increased and tailored to specific objectives, relying less on open-source data with a higher uncertainty index. The transition towards enhanced data quality constitutes a strategic initiative designed to mitigate dependence on open-source data characterized

Fig8 / Infraworks territorial model created by Model Builder tool, Bing data are overlaid on GIS data in order to create a realistic model with elevations and textures
source / author

Fig9 / Revit topography imported and created from Infraworks territorial model
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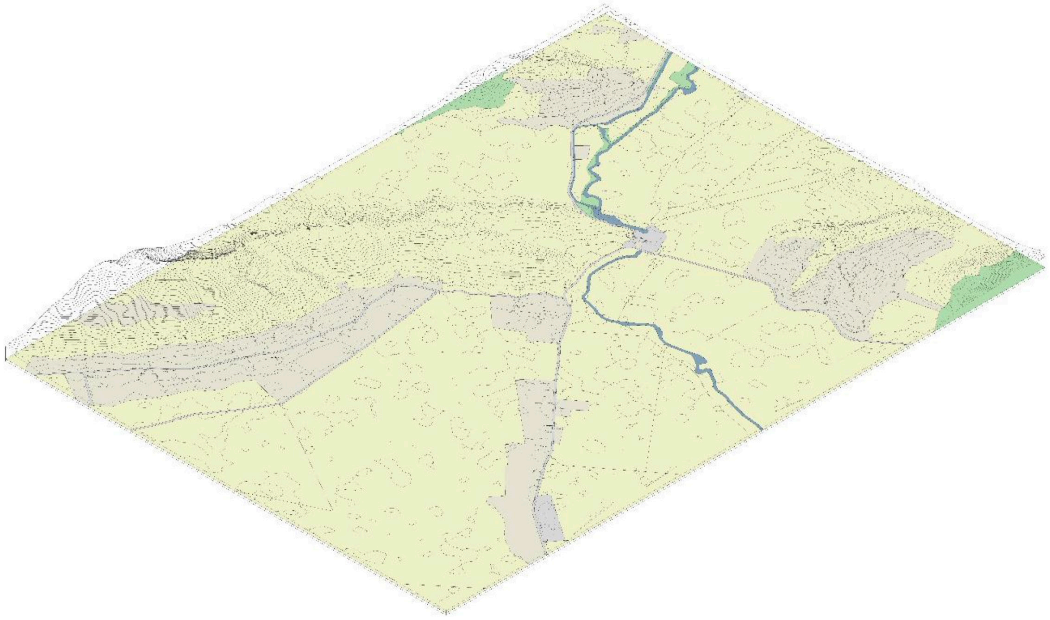

Fig10 / Land use layer imported through Dynamo workflow as Floor elements in Revit
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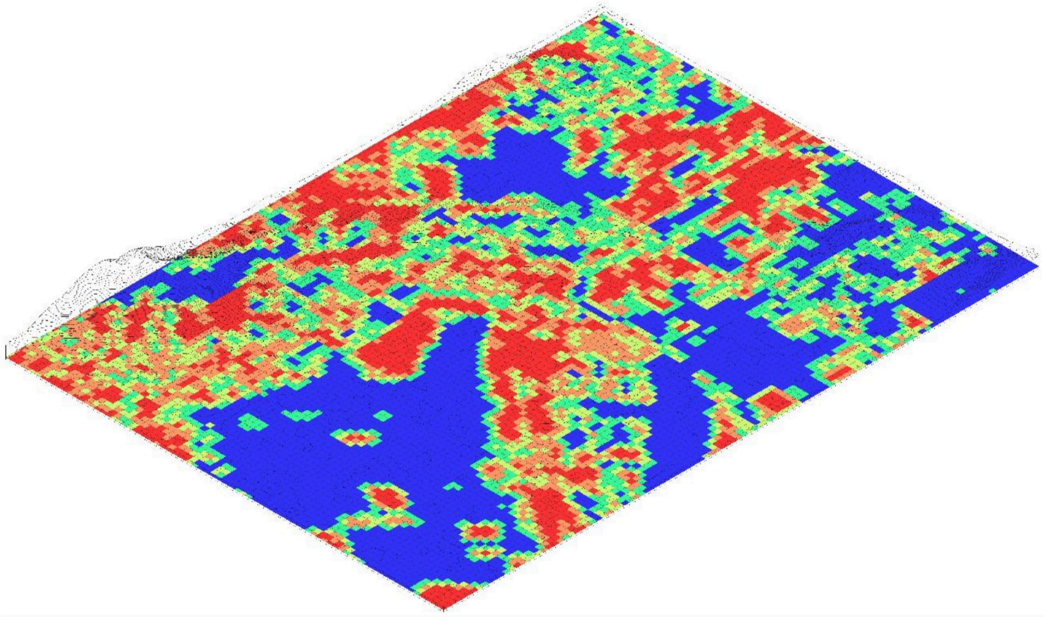

Fig11 / RS NDMI grid analysis into Revit model, the visualization is based on the information inside each floor which is the same as the GIS shapefile
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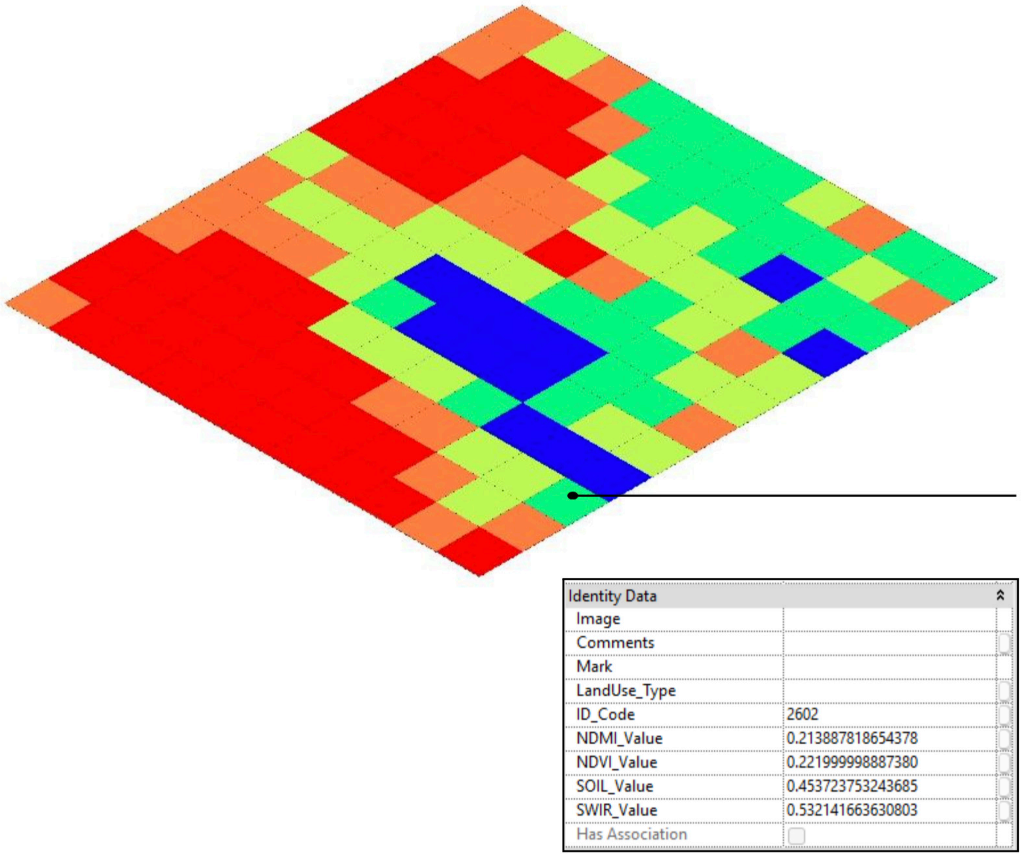

Identity Data	
Image	
Comments	
Mark	
LandUse_Type	
ID_Code	2602
NDMI_Value	0.213887818654378
NDVI_Value	0.221999998887380
SOIL_Value	0.453723753243685
SWIR_Value	0.532141663630803
Has Association	☐

Fig12 / Zoom to a little part of the RS NDMI grid into Revit model which shows all data inside the element regarding also other RS analysis parameters
source / author

by elevated uncertainty indices, thereby establishing a more resilient and dependable foundation. Landscape and territorial designers can access up-to-date information and gain a profound understanding of the project context. The application of the methodology to a wider and more complex area, such as Municipal territories, Provinces, or Regions, represents an opportunity for the development of the community and the knowledge of the territory itself. Expanding the results to the entire Finiq Municipality or the Vlora district can enhance and develop comprehensive mapping and planning, infrastructure management, and environmental control. The creation of different scenarios and immediate visibility of the environmental impacts of landscape projects make this RS, GIS, and BIM interoperability a necessary and essential tool for simplifying the complexity of the landscape, which offers Municipalities and other territorial stakeholders a powerful set of workflow for spatial analysis, planning, and decision-making across various domains, contributing to more efficient, informed, and sustainable urban management.

References

Ahmad, A., & Aliyu, A. (2012). The Need for Landscape Information Modeling (LIM) in Landscape Architecture. 13th Digital Landscape Architecture.

Cianci, M., & Molinari, M. (2019). Information modeling and landscape: intervention methodology for reading complex systems. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLII-2/W9.

Farhadi, H., & Najafzadeh, M. (2021). Flood Risk Mapping by Remote Sensing Data and Random Forest Technique. Water, 13, 3115. doi:https://doi.org/10.3390/w13213115

Finiq Municipality. (2021). General Local Plan. General Local Plan, Strategic Environmental Assessment. Finiq: Finiq Municipality.

Freller, S., Gnaedinger, J., Mattos, C., & Schaller, J. (2017). GeoDesign: Concept for Integration of BIM and GIS in Landscape Planning. Journal of Digital Landscape, 2-2107, 102-112.

Global Forest Watch. (2023). Forest Monitoring Designed for Action. Retrieved July 25, 2023, from https://www.globalforestwatch.org/

Golberg, D., Holland, R., & Wing, S. (2012). GIS+BIM = Integrated Project Delivery. @Penn State, 524-530.

Hinton, J. (1996). GIS and remote sensing integration for environmental applications. International Journal of Geographical Information Systems, 10:7, 877-890. doi:10.1080/02693799608902114

Kamberi, H., Kamberi, Z., & Xhillari, G. (2022). Assessment of the Water-Energy-Food-Ecosystems Nexus in Albania. Athens: Global Water Partnership – Mediterranean (GWP-Med) .

Landscape Institute. (2016). BIM for Landscape. New York: Routledge.

Nghia, B., Pal, I., Chollacoop, N., & Mukhopadhyay, A. (2022). Applying Google earth engine for flood mapping and monitoring in the downstream provinces of Mekong river. Progress in Disaster Science, 14, 100235.

Schimdt, L. (2015). Revit Sites and Landscape. Revit Technology conference Europe.

Selenica, A. (2004). Flood Potential In Albania. BALWOIS 2004. Ohrid, Republic of Macedonia.

Sentinel Hub. (2023). EO Browser. Retrieved from https://www.sentinel-hub.com/explore/eobrowser/

Toth, C., & Jóźków, C. (2015). Remote sensing platforms and sensors: A survey. ISPRS Journal of Photogrammetry and Remote Sensing, 115, 22-36.