

Developing a LADM Part 5 – Spatial Plan Information country profile for Greece

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SUMMARY

Spatial planning is a critical element of Land Administration (LA), involving the assessment and management of land use, development, environmental protection, and the optimal utilization of land resources. Recognizing the significance of integrating spatial planning information into the Land Administration Domain Model (LADM) framework, LADM Edition II introduces a dedicated part for spatial plan information -Part 5. This paper delves into the conceptualization and development of the LADM Part 5 – Spatial Plan Information country profile for Greece (GR_SP_LADM). The development of this profile aims to enhance the applicability of LADM Edition II Part 5 and to support better planning, monitoring, and management of spatial data in alignment with Greek regulations.

Spatial planning in Greece operates on multiple levels—national, regional, and local/municipal—each corresponding to different scales of implementation. The national level offers broad spatial guidelines, while the local level focuses on community-specific planning, which may encompass one or more municipalities or even regional or hyper-local areas. Given the complexity of spatial planning processes in Greece, standardization is vital for ensuring interoperability across the different hierarchical levels of government and stakeholders. This paper aims to make the organization of spatial planning-related information in Greece more efficient and transparent, thereby promoting sustainable growth and urban development using consistent spatial data structures and clear legal and administrative procedures.

Therefore, the paper examines the country profiles of LADM Part 5 that have been developed (as in the case of Indonesia, Turkey and others), with a focus on the current state and evolution of spatial planning in Greece. It maps the existing spatial planning framework against the concepts and classes of LADM Part 5, resulting in the development of a tailored country profile for Greece. This profile is illustrated through UML diagrams and at the next step of this research, it will be implemented in a database and validated through instance-level diagrams and practical implementation using 2 case studies. Future work includes the comparison of the country profile for LADM Part 5 for Greece, with the profile developed for Turkey using corresponding use cases.

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1. INTRODUCTION

Land Administration (LA) has emerged as a critical concern in the modern world, with effective land management playing a vital role in ensuring sustainable land use and safeguarding the interests of both present and future generations. Spatial planning, a key component of LA, involves the systematic organization of land use across various scales and planning levels. To enhance the effectiveness of Spatial Planning, it is essential to standardize these processes, thereby ensuring consistent and sustainable development outcomes.

The international standard LADM (ISO 19152), particularly through its revised edition, provides a comprehensive framework for standardizing spatial planning. LADM supports interoperability in representing Rights, Restrictions, and Responsibilities, including the representation of spatial plans in four dimensions—3D space and time (ISO/ DIS, 2023).

The decision to publish LADM Edition II as a multi-part series has resulted in the development of six standards that are backward compatible with Edition I and together they form LADM Edition II. LADM Part 5 - Spatial Plan information includes a conceptual model that encompasses packages related to plan units, plan blocks, plan groups, and permits.

Defining the role and scope of spatial planning within the broader context of LA is crucial. As highlighted, spatial planning significantly contributes to the core objectives of LA, including the registration of property information, valuation, and land use management (UNECE, 1996). This paper aims to develop a country profile for Greece based on LADM Part 5. In developing this profile, legal, institutional, and technical considerations have been carefully examined (Kalogianni et al., 2021), with particular attention to Greece's three planning levels: national, regional, and local.

The rest of the paper is structured as follows: Section 2 discusses the hierarchy of planning levels in selected countries, chosen for their design similarities to Greece. Section 3 presents the development of country profiles based on LADM Part 5 (ISO 19152-5). Moreover, Section 4 outlines the methodology and process for creating the country profile for Greece, while Section 5 provides conclusions and discusses potential future work.

2. SPATIAL PLANNING IN SELECTED COUNTRIES

Spatial planning can be regarded "the soul of space optimization" (Liu & Zhou, 2021), given its role in guiding strategic interventions in spatial development (Giannakourou, 2022; Economou, 2008). The objectives set within spatial planning vary by country and are influenced by international and European policies (Wassenhoven, 2004 in Seitanidis, 2023;

Asprogerakas & Zachari, 2019; Asprogerakas, 2016) as well as by challenges that manifest on both global and local scales (Wassenhoven, 2009 in Wassenhoven, 2022). Additionally, local traditions, significantly impact these objectives (Vassi et al., 2022a), contributing to the diversity of spatial planning systems across Europe and globally (Wassenhoven, 2023; Vassi et al., 2022). Giaoutzi and Stratigea (2011) argue that spatial planning must address problems by considering their spatial context and impact, which requires identifying a cohesive spatial (residential) system. Furthermore, Vassi et al. (2022a) highlight that legal initiatives for spatial management differ across countries due to varying legal traditions. In Europe, these traditions are generally categorized into four "legal families" (Germanic, Scandinavian, British, and Napoleonic - with Greece falling under the latter) that correspond to five planning traditions: Germanic, Scandinavian, British, East European, and Napoleonic (Newman and Thornley, 1996).

It is important to note that a planning system encompasses all tools (plans, frameworks, or directives) applied across different spatial scales (Economou in Wassenhoven, 2022). Giannakourou (2022) suggests that a planning system primarily revolves around spatial plans, which can be categorized into four categories based on criteria such as objectives, content, spatial scale, and legal implications resulting from their institutionalization (Giannakourou, 2022; Silva & Acheampong, 2015):

- **Perspectives – Visionary Plans:** These plans include policy statements and long- or medium-term goals and visions for spatial development across various scales. They are typically indicative, programmatic in nature, and provide direction to administrative bodies, resulting in loose binding. An example is the Structuurvisies in the Netherlands. Countries like Australia, the USA, Canada, Spain, and Sweden do not have national policy and perspectives of this type.
- **Strategic Plans:** These plans provide integrated frameworks that coordinate the spatial impacts of various planning activities implemented by public bodies, ensuring vertical and horizontal coordination. Examples of such plans include regional plans in Japan, Korea, Turkey, Denmark, Estonia, and Slovenia.
- **Framework Plans:** These plans are further divided into structure plans and master plans, which are tools for socio-economic policy development and location-specific land use planning. They operate at either the municipal level or higher/lower levels (clusters of municipalities or municipal units). Municipal Structure Plans in Belgium and District Outline Plans in Israel are typical examples.
- **Regulatory Plans:** These plans regulate development and protect individual parcels of land, usually through detailed planning. Examples include planning permission in the UK and Ireland, Byggetilladelse in Denmark, Permis de construire in France, Baugenehmigung in Germany, and Licenciamento Municipal de Obras Particulares in Portugal. Similar tools exist in the USA, where land-use zones are defined.

Given this global categorization, studying Greek spatial planning is crucial to understanding its distinctive approach within this broader context. Exploring the Greek spatial planning framework provides valuable insights into how national legal, cultural, and administrative traditions influence the formulation and implementation of spatial plans, thereby building the foundations for the development of country profile for LADM Part 5, as presented in Section 4.

3. LADM PART 5 - ISO 19152-5: SPATIAL PLAN INFORMATION AND ITS IMPLEMENTATIONS

This section provides an overview of the recent advancements in the implementations of LADM Part 5- Spatial Plan Information. Although Part 5 has not yet been voted as ISO standard, several countries have developed country profiles for their spatial planning systems based on its structure and concepts.

LADM Part 5 supports planning hierarchies, plan units are organized through plan blocks, while spatial functions and spatial planning permit registrations are supported. This ensures a comprehensive approach to land management by linking land tenure with spatial information (Indrajit et al., 2020). The primary goal is to document the RRRs associated with spatial plans, ensuring compatibility with data from land tenure, value, and development activities (Indrajit et al., 2021).

The spatial planning package in LADM Part 5 includes five key classes, each with distinct attributes designed to represent different aspects of spatial planning. These classes are: SP_PlanGroup, SP_PlanUnitGroup, SP_PlanBlock, SP_PlanUnit, and SP_Permit. The SP_PlanGroup class plays a hierarchical role, representing different spatial planning levels, thereby facilitating the classification and distinction of planning levels, while the SP_PlanUnitGroup corresponds to areas associated with higher planning levels, representing larger planning areas. The SP_PlanBlock class is an integral part of LADM Part 5, composed geometrically of one or more SP_PlanUnits. The SP_PlanUnit class represents the smallest homogeneous area at the highest scale, offering the greatest level of detail among the classes. Finally, the SP_Permit class addresses various permits relevant to spatial planning processes (ISO/ DIS, 2023).

Indonesia was the first country to pioneer the adoption of LADM Part 5 at a conceptual level (Indrajit et al., 2019), aiming to effectively integrate RRR-related information from LA into existing LAS while embracing a participatory approach. This initiative led to the development and iterative enhancement of Indonesia's country profile, including the creation of a 3D planning data model for cities like Jakarta. The improvement of the LADM country profile was guided by the examination of three key aspects related to the incorporation of spatial planning information: additional data for land-use planning, the inclusion of parties related to land possession and spatial planning and RRR information. Furthermore, another notable application of LADM in Indonesia is the implementation by BPN (Badan Pertanahan Nasional), the national land agency, of a computerized land office system that leverages an interest-based system (Computerized Land Office) grounded in LADM principles.

Apart from Indonesia, several other countries have also applied the Draft International Standard (DIS) LADM Part 5 to meet their specific spatial planning needs. In Turkey, Yilmaz et al. (2024) analyzed the requirements of the Turkish spatial planning system and developed a corresponding country profile (Figure 1). The conceptual profile was validated through instance-level diagrams and technically implemented using Netcad. Additionally, Gruler (2023) extended the CityJSON schema based on the conceptual model of LADM Part 5 and tested it with real-world use cases for approved zoning plans in Turkey.

Furthermore, for the Netherlands, van Aalst (2023) based on the LADM edition I country profile that was already in place, followed the methodology of making a country profile (Kalogianni et al., 2021) and developed a country profile for LADM part 5. The Netherlands

has a comprehensive spatial planning system that divides land into various uses, including residential, industrial, agricultural, and natural areas. There are five different geoportals providing open data for them from different spatial plans, tailored to the needs of each managing institution, leading to ambiguities and interoperability issues when it comes to use them together for the LADM country profile.

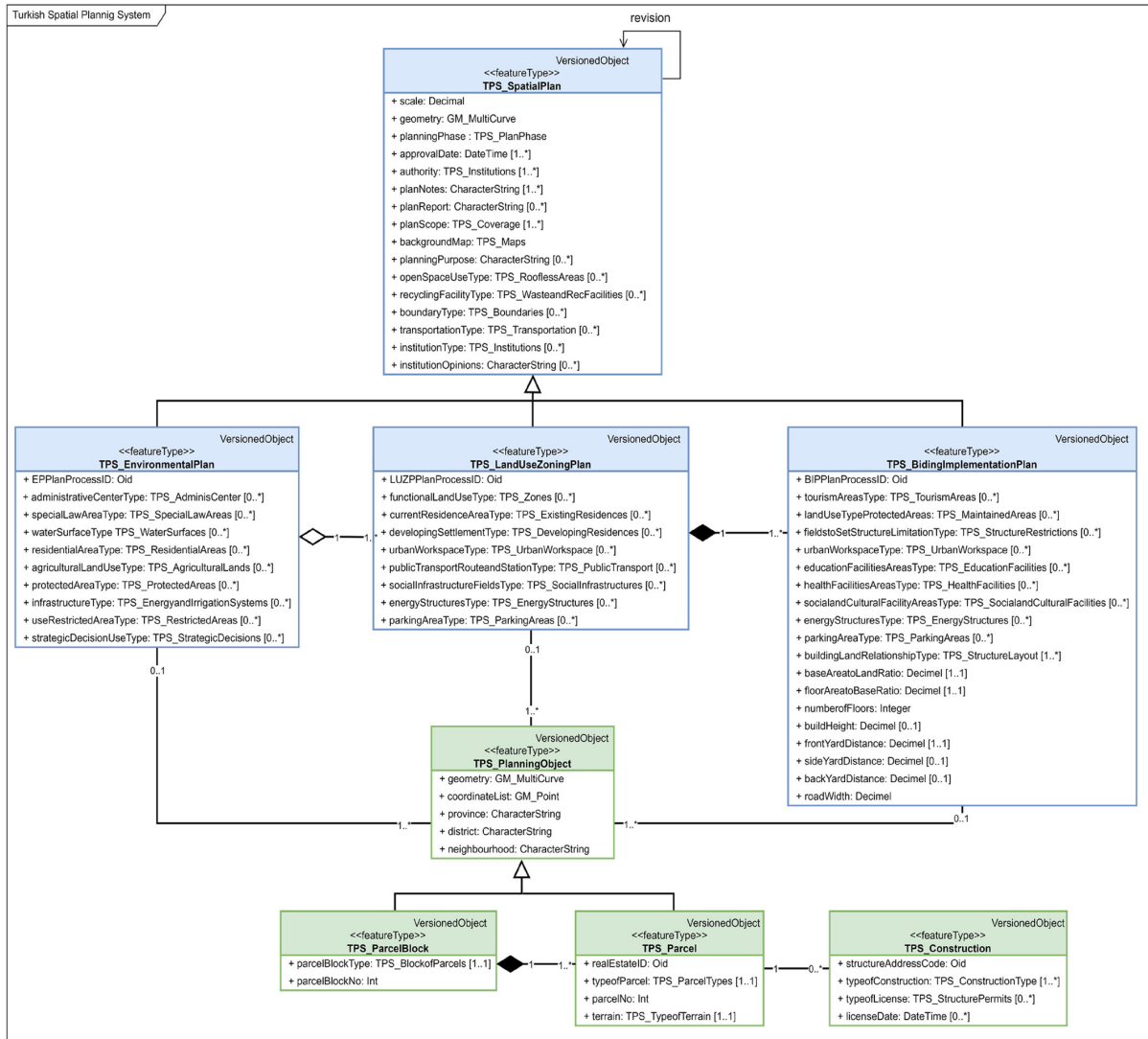


Figure 1. UML class diagrams of the Turkish LADM Part 5 country profile (Yilmaz et al., 2024)

Finally, Batum et al. (2024) proposed the integration of IFC with LADM Part 5 to standardize BIM-based permit checking processes, focusing on a case study from Estonia. An LADM Part 5 country profile for Estonia, integrated with the Estonian spatial planning database has been developed alongside a prototype solution for compliance checks among Estonian spatial plans, implemented with the software solution provided by Future Insight B.V. The Estonian LADM profile achieved Level 2 conformance according to the abstract test suite of ISO 19152:2012(E), demonstrating its ability to address both national requirements and international standards effectively.

4. DEVELOPING AN ISO 19152-5 PROFILE FOR GREECE

The intricate nature of spatial planning in Greece necessitates the creation of a country profile based on LADM Part 5. The LADM can effectively support this complex system, which is subject to frequent updates and changes, by offering a unified framework for LA, consistent spatial data structures, and clear legal and administrative processes. A well-developed profile will introduce the necessary legal and institutional data to govern the RRRs within Greece's Land Administration Systems (Kalogianni et al., 2021).

The development of the Greek country profile followed the methodology proposed by Kalogianni et al. (2021) for creating LADM-based country profiles. This process involved completing 'Phase I: Scope definition' and 'Phase II: Profile creation (modelling)'. The final phase, 'Phase III: Profile testing (implementation)', will be addressed as part of the future work in this research.

4.1 Phase I - Scope definition of the LADM Part 5 country profile for Greece

To establish a comprehensive and future-proof profile, it was essential to first define the scope to cover, not only the current situation of spatial planning in Greece, but also the anticipated changes stemming from recent legislative updates. The current and evolving legal framework introduces flexibility into the Greek spatial planning system, highlighting the need for standardization to facilitate a more adaptive approach to spatial planning. The structure and interrelations within the Greek spatial planning system are illustrated in Figure 2.

The Greek spatial planning system has undergone significant transformation, primarily due to Law 2742/2020, which amended Law 4447/2016. The revised framework introduces a three-tiered, top-down hierarchical system that is more adaptable than its predecessor. The first two levels—national and regional—focus on strategic plans coordinated by a visionary national strategy, known as the National Spatial Planning Policy (Nowak et al., 2023). This strategy also includes a guiding document addressing maritime space, although it is not classified as a formalized plan. However, due to delays in finalizing this strategy, the previously established General Framework for Spatial Planning and Regional Development (GFSPRP) continues to play a crucial role. Papageorgiou (2017) notes that this political decision effectively downgraded the GFSPRP, while elevating the status and thematic scope of Special Spatial Plans.

At the national level, Special Spatial Plans (SSPs) were first introduced by Law 2742/1999, to provide sector-specific directions in areas of critical importance (Gourgiotis et al., 2022), such as penal institutions (prisons), renewable energy sources, industry, aquaculture, tourism (this plan has been canceled by the Council of State) (Kyriakidis et al., 2022), and mineral raw materials (currently under implementation) (Gourgiotis & Tsilimigkas, 2021).

Alongside these, Regional Spatial Plans (RSPs) hold equivalent importance, with both being binding on each other. Since the reforms introduced by the Law 4447/2016, RSPs have been elevated in significance, allowing them to complement, specify, or modify SSP directions when permitted (Giannakourou, 2022; Stefani, 2021). Furthermore, Maritime Spatial Plans (MSPs) have been integrated at the regional level to manage marine spatial units, operating under guidelines set by the National Spatial Planning Policy for Maritime Space. These plans focus exclusively on marine spaces, avoiding conflicts with terrestrial plans (Gourgiotis & Tsilimigkas, 2021; Gourgiotis et al., 2023; Papageorgiou & Kyvelou, 2021).

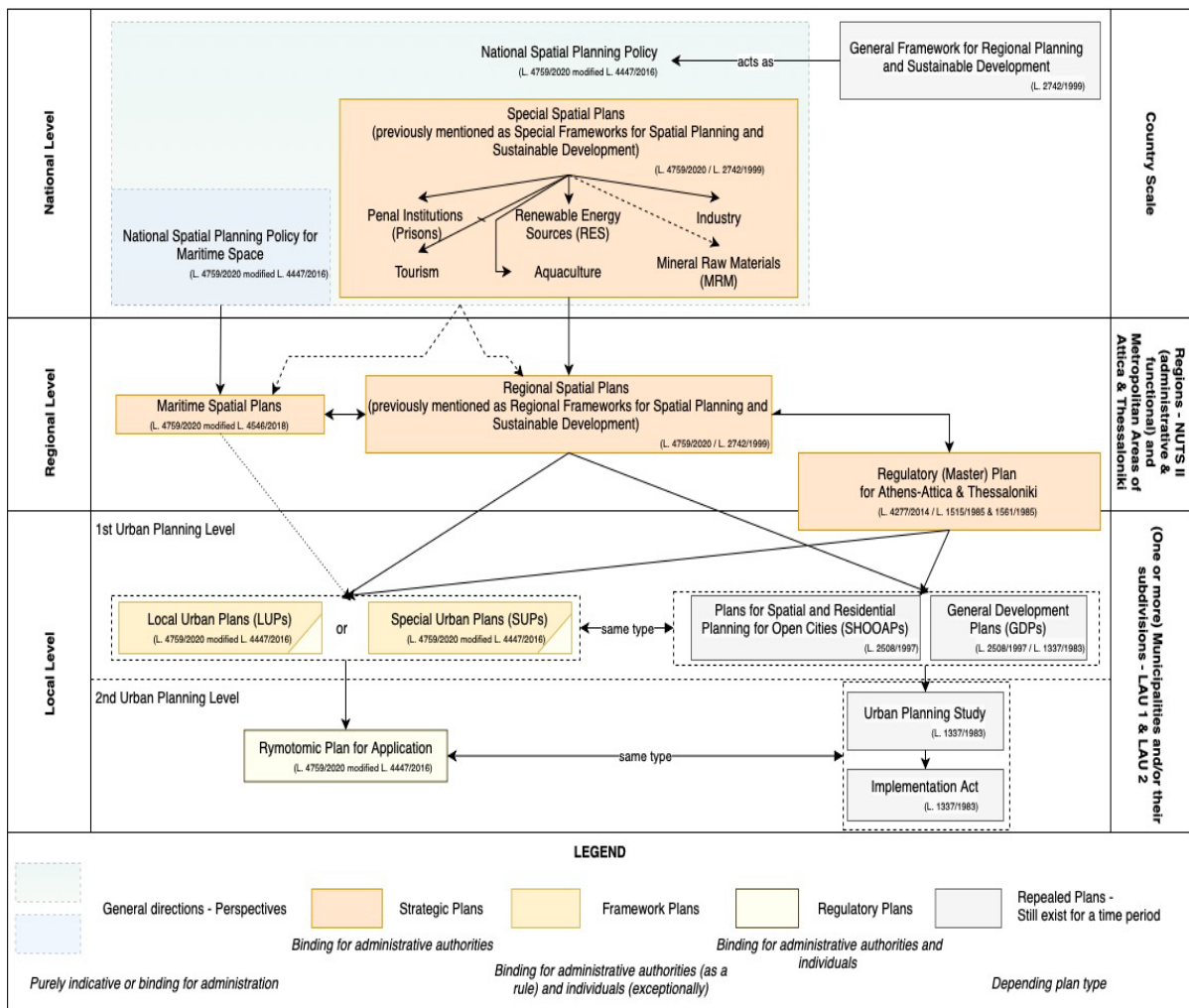


Figure 2. Structure and relationships of the Greek spatial planning system

Between the regional and local levels, a distinct category of plans addresses metropolitan areas, reflecting their strategic developmental role (Bakogiannis, et al., 2024). Regulatory (Master) Plans for the major metropolitan regions of Attica and Thessaloniki remain in effect, with those for other metropolitan areas repealed. These plans that have been institutionalized through ad hoc laws (Economou, 2007 in Siolas, et al., 2015), differ in their geographic scope: the Attica plan covers the entire region, effectively acting as a RSP, while the Thessaloniki plan covering selected parts, serves as an intermediary between regional and local spatial planning (Bakogiannis et al., 2024).

At the local level, the planning system adopts directions from the higher levels (Gourgiotis et al., 2022; Bakogiannis et al., 2021). This third level includes framework and regulatory plans structured into two categories: Local Urban Plans (LUPs) and Special Urban Plans (SUPs), which are intended to replace the older General Development Plans (GDPs) and Plans for Spatial and Residential Planning for Open Cities (SHOOAPs) that were institutionalized since 80s and 90s, respectively, for planning system to be more flexible (Asprogerakas, 2016). While LUPs and SUPs serve as flexible updates to the planning framework, GDPs and SHOOAPs remain valid until fully replaced. It is important to note that LUPs and SUPs are

not concurrent; each is designed to be implemented under specific circumstances. These plans, although primarily framework-oriented, also incorporate regulatory elements (Giannakourou, 2022). The approval process for LUPs and SUPs has been upgraded under Law 2742/2020, requiring a Presidential Decree, which contrasts with the past approval process through centralized or decentralized administrative bodies. This change makes the provisions more binding and directly enforceable.

Under the previous system, local planning was further detailed through Urban Planning Studies and Implementing Acts. These have now been replaced by Regulatory Plans for Application, which are explicitly regulatory in nature.

In Greece, spatial planning data availability is currently undergoing significant improvement, particularly through the development of geoportals at the local level. Given that much of the spatial planning information exists in non-digital formats, numerous local and regional authorities have taken initiatives to digitize their data and provide open access to spatial planning elements within their jurisdictions. However, the access rights, accuracy, and reliability of these open data services differ considerably across platforms. Additionally, it is common for similar or overlapping thematic categories to be represented across different sources, leading to inconsistencies in data presentation and usability.

4.2 Phase II - Profile creation

Phase II of the methodology for creating LADM-based country profiles, involves the conceptual standardization using UML, specifically focusing on aligning the existing spatial framework of Greece with the LADM Part 5 concept and classes. This phase is particularly challenging due to the difficulties in finding direct correlations between existing national spatial data and the LADM classes. In many cases, not all LADM Part 5 classes are applicable, and sometimes the classes provided by the international standard do not fully capture the specific characteristics needed for the Greek context. Therefore, this phase requires multiple revisions to refine the model and ensure it meets the intended objectives.

The primary goal during this phase, is to develop a conceptual model that includes as many relevant LADM classes as possible to achieve high level of conformance with the standard, while also simplifying the profile under development. This approach is aimed to optimize the profile's applicability by aligning it with the international standard and the needs and requirements of spatial planning in Greece.

To develop the Greek country profile, key design decisions were made. Notably, the LADM Part 5 did not explicitly model strategic framework documents like the General Framework for Regional Planning and the National Spatial Planning Policy for Maritime Space, as these provide high-level directions without detailed provisions suitable for standardization. Figure 3 presents the mapping between the core LADM Part 5 classes and the main classes that reflect the Greek spatial planning reality.

Based on the strategic hierarchy of spatial planning in Greece, as outlined by legislation, it appears that the Special Spatial Plans occupy the highest national level, followed by the Regional Spatial Plans and the Maritime Spatial Plans at the regional level. While these plans operate at different levels, in the context of planning and standardization, they are considered to be on the same hierarchical level. This is because Regional Spatial Plans are related to, but not subordinate to, the Special Spatial Plans and Maritime Spatial Plans; instead, they are developed in parallel.

Current Spatial Planning in Greece	ISO 19152-5 Spatial plan information
Special Spatial Plan for Tourism	SP_PlanBlock
Special Spatial Plan for Industry	SP_PlanBlock
Special Spatial Plan for Renewable Energy Sources (RES)	SP_PlanBlock
Special Spatial Plan for Aquacultures	SP_PlanBlock
Special Spatial Plan for Penal Institutions (Prisons)	SP_PlanBlock
Special Spatial Plan for Mineral Raw Materials (MRM)	SP_PlanBlock
Regional Spatial Plans	SP_PlanGroup
Maritime Spatial Plans	SP_PlanGroup
Regulatory (Master) Plan for Thessaloniki	SP_PlanGroup
Local Urban Plans (LUPs)	SP_PlanGroup
Special Urban Plans (SUPs)	SP_PlanGroup
Rymotomic Plan for Application	SP_PlanBlock
Implementation Act	SP_PlanBlock
General Development Plans (GDPs) & Plans for Spatial and Residential Planning for Open Cities (SHOOAPs)	SP_PlanGroup
Urban Planning Study	SP_PlanBlock

Figure 3. The use of LADM classes in the standardization of the project for Greece

The Regional Spatial Plans in Greece were established first, followed by the Special Spatial Plans, indicating their parallel development. To reflect this hierarchy and relationship in the country profile, the SP_PlanGroup class was used to represent the Regional Spatial Plans and Maritime Spatial Plans, capturing their hierarchical nature. On the other hand, the Special Spatial Plans were modeled using the SP_PlanBlock class, as these plans function independently and operate alongside the other two types of plans.

At the next planning level, LUPs, SUPs, GDPs, and SHOOAPs, along with the Regulatory (Master) Plan for Thessaloniki, were standardized using the SP_PlanGroup class to reflect their hierarchical position. These plans are directly related to the Regional Spatial Plans, inheriting regional directions and depending on them for their implementation. While the Regulatory (Master) Plan for Athens-Attica aligns with Regional Planning and is grouped with Regional Spatial Plans, the Regulatory (Master) Plan for Thessaloniki, due to its sub-regional nature, is categorized differently.

At the subsequent level, the Rymotomic Plan for Application and the Urban Planning Study are modeled with the SP_PlanBlock class and are associated with LUPs, SUPs, and GDPs/SHOOAPs. This relationship is one of aggregation, where a Rymotomic Plan for Application cannot exist without the associated Local Urban Plans or Special Urban Plans.

Similarly, the Urban Planning Study is dependent on the General Development Plans/SHOOPs.

Finally, the Implementation Act is linked to the Urban Planning Study through aggregation, meaning that without the Urban Planning Study, the Implementation Act cannot exist. However, the Implementation Act is considered part of the Rymotomic Plan for Application, and in cases where the Rymotomic Plan for Application is applied, the Implementation Act is not separate and thus has no independent correlation.

The UML diagrams of the LADM country profile for Greece, as shown in Figures 5 and 6, illustrate how these various spatial planning tools and plans are standardized within this framework.

Additional analysis was carried out for the LUPs and the SUPs to further refine their representation within the LADM framework. This analysis was particularly necessary given that these two plan categories form the foundation of a streamlined system designed to address long-standing urban and spatial planning challenges in Greece. These plans are part of a broader initiative currently funded by the Hellenic Recovery and Resilience Facility, set to be implemented between 2022 and 2026 under the supervision of the Hellenic Ministry of Environment and Energy (Vassi et al., 2022a; Vassi et al., 2022b).

The key components for both plan types include the classes: `Xoriki_Organwsi_TPS`, `Oikismos`, `Tomeas_Poleodomikou_Kanonismou`, `Poleodomiki_Enotita`, and `Genikes_Xriseis_Gis`.

These components are critical in the spatial planning process as they define the core spatial planning elements. Therefore, further modelling of them in their corresponding LADM classes was undertaken, as illustrated in Figure 6. This modelling effort ensures that the LADM-based profile accurately represents the current and future needs of spatial planning in Greece, allowing for better alignment with international standards and improved interoperability across different levels of government and planning authorities.

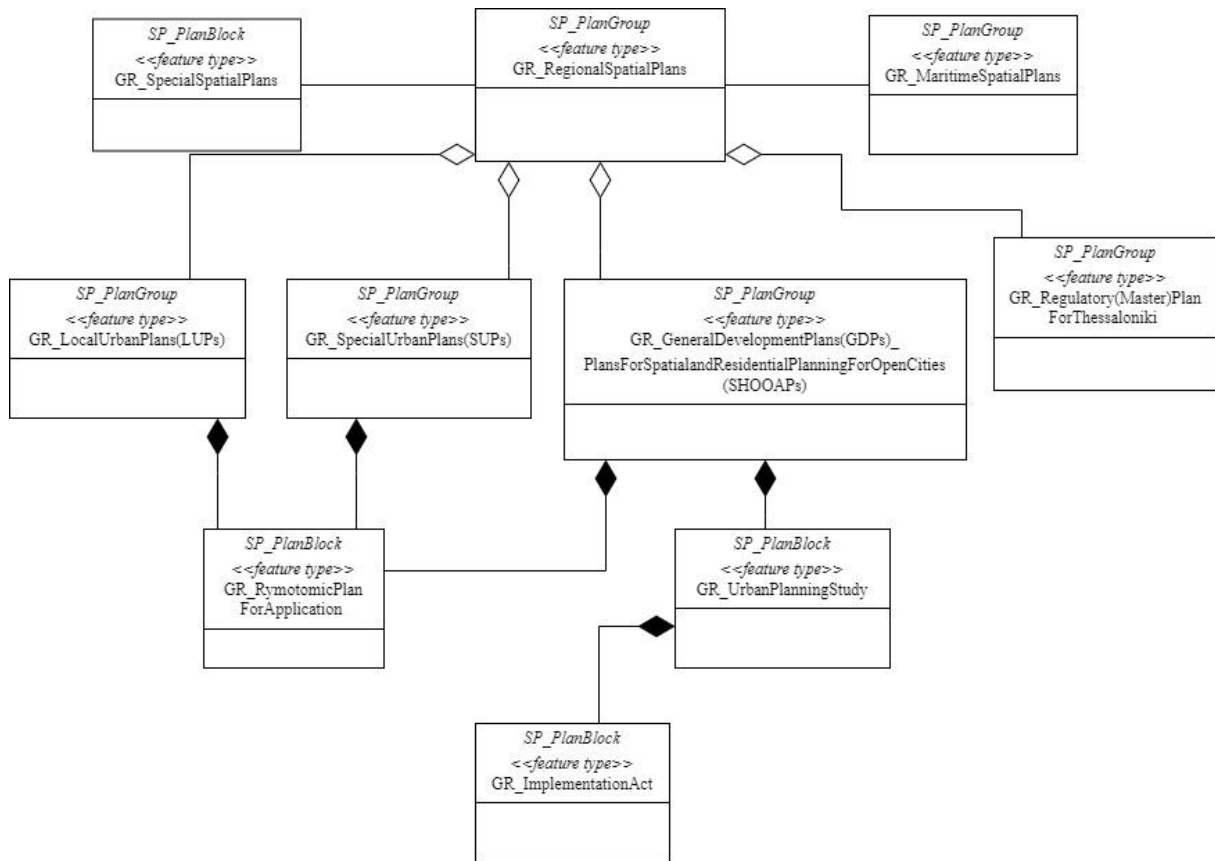


Figure 5. UML country profile of Greece -1

Upon closer examination, it was noted that Tomeas_Poleodomikou_Kanonismou is autonomous and independent of the other components. This element defines the limitations and building regulations within specific areas, making it appropriate to model it as an SP_PlanBlock in the LADM framework. On the other hand, Xoriki_Organwsi_TPS, Oikismos, Poleodomiki_Enotita, and Genikes_Xriseis_Gis are all represented as SP_PlanUnitGroup classes. These classes collectively capture the hierarchical organization of spatial units and land use designations as dictated by the LUPs and SUPs, ensuring that the framework accurately reflects the complexities of spatial planning in Greece.

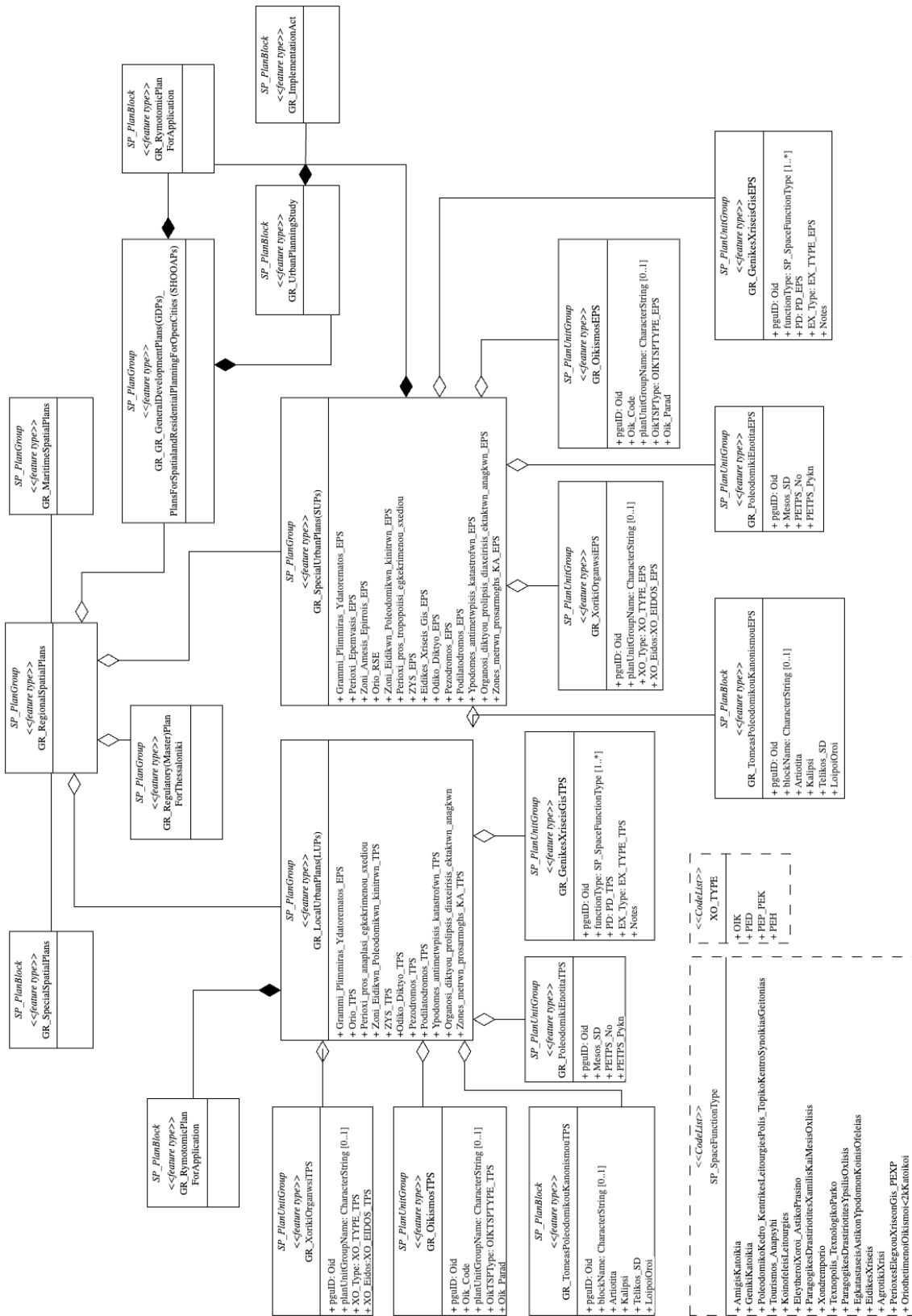


Figure 6. UML country profile of Greece -2

5. CONCLUSION AND FUTURE WORK

This study has developed an LADM-based country profile for Greece, focusing on Part 5, which deals with spatial planning information. This involved a thorough examination of Greece's spatial planning system, encompassing both the existing framework and anticipated changes driven by evolving legislation. The profile was designed to address the complex nature of Greek spatial planning, which operates across multiple levels—national, regional, and local—each with its own specific plans and tools. Given this complexity, standardization was essential to create a more flexible and efficient spatial planning system, while ensuring consistent spatial data structures and transparent legal and administrative processes. By standardizing spatial information, which is very important for a complex system like Greece's, the development of this model ultimately enhances the flexibility of the Land Administration System (LAS).

The next stage of the methodology, following the study of the Greek spatial situation and its challenges, involved correlating the standard LADM with its specific classes. The Greek plans/tools which were standardized based on the LADM classes were those containing objects for standardization, rather than general frameworks with broad directions. These plans and tools, which operate at national, regional and local spatial planning level, were standardized using basic classes of LADM-part 5, such as SP_PlanGroup, SP_PlanBlock, SP_PlanUnit and SP_PlanUnitGroup, depending on the requirements and content of each standardized element.

It is important to note that an additional phase should be incorporated into the existing methodology, to ensure the proper validation of the new model. Specifically, this phase III involves testing the developed country profile for Greece (Kalogianni et al., 2021). To advance to this phase, a repeated process must be followed, aiming to refine and improve the model through a pilot application. This approach will facilitate the transition from a conceptual model to standardized one, resulting in a well-defined final model. So, this phase III will involve examining two case studies to validate the model. The first case study is in the Attica region, focusing on an Implementation Act related to an Urban Planning Study. Relevant data will be provided by the Hellenic Cadastre, in compliance with GDPR regulations. The Implementation Act refers to the legislative and procedural framework that governs the detailed planning and execution of urban development projects, translating urban plans into actionable steps and ensuring adherence to regulations. The second case study concerns a municipal-scale project in the historic city of Chania, Crete. This study will assess municipal (local) plans and utilize the municipal WebGIS for spatial planning as the primary data source. Additionally, data captured through laser scanning will be used to create a 3D city model of the area. Both case studies will provide real-world data to validate and refine the model effectively. Further studies could explore the impact of the model on various stakeholders and assess its effectiveness in different contexts.

Finally, future work includes the comparison of the country profile for LADM Part 5 for Greece, with the profile developed for Turkey using corresponding use cases.

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