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TOPOGRAPHIC AND CADASTRAL DOCUMENTATION FOR THE EXTENSION OF THE WATER SUPPLY AND SEWERAGE NETWORK IN CĂTUNELE COMMUNE, LUPOAIA VILLAGE, GORJ COUNTY

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Abstract. *The present paper focuses on the development of a topographic and cadastral documentation required for the extension of the water supply and sewage network in Lupoaia village, Cătunele commune, Gorj County. The project aligns with the broader objectives of sustainable development and modernization of public infrastructure in rural areas, with the main goal of improving living conditions and ensuring access to essential public services, in accordance with national legislation and European standards. The thesis systematically presents the stages involved in creating the topo-cadastral documentation – from field surveying and geospatial data collection to their processing and digital representation. The topographic surveys were conducted using modern GNSS and total station equipment, and the collected data were integrated into the national Stereographic 1970 coordinate system and processed using TopoLT, AutoCAD, and GIS software. The resulting documentation enabled precise identification of the network's alignment, delineation of affected properties, and provided the technical foundation for the network extension project. Beyond its technical scope, the work also addresses the administrative, legal, and social aspects related to the approval and implementation of public utility projects. Furthermore, it highlights the importance of digital cadastre and GIS integration in enhancing efficiency, transparency, and sustainability of public infrastructure development. This paper thus demonstrates the essential role of topo-cadastral documentation in the planning and modernization of rural infrastructure.*

Keywords: *topo-cadastral documentation; topographic surveying; water and sewage network; GIS; Stereographic 1970 coordinate system; ANCPI; AutoCAD; rural development; public infrastructure; geospatial data.*

INTRODUCTION

The project aims to prepare the topographic and cadastral documentation for the extension of the water supply and sewerage network in Lupoaia village, Cătunele commune, Gorj County. Its main purpose is to improve living conditions, protect the environment, and support local economic development. The documentation will determine the locations, property boundaries, topographic surveys, and technical solutions required for the implementation of the utility networks. The project complies with current legislation and contributes to attracting European funds, representing a major investment in modernizing infrastructure and enhancing the community's quality of life.

Cadastre – Definition and Role: Cadastre represents a technical and legal database of real estate properties, including data on surface area, configuration, land use, and legal status.It is essential for spatial planning, property protection, and the development of infrastructure projects.

Land Management: Cadastral data ensures precise boundary delineation, prevents overlaps and disputes, supports urban planning, and allows tracking of property changes (sales, subdivisions, construction, or land-use change).

Public Utilities

Accurate cadastral data helps reduce delays in obtaining permits, avoids conflicts with landowners, and minimizes route reconfiguration costs for infrastructure networks.

Types of Cadastre

- General Cadastre: includes technical, economic, and legal components.
- Specialized Cadastre: for specific sectors such as forestry, agriculture, and utilities infrastructure.

Utility Cadastre: The utility (urban) cadastre records pipeline and cable routes, diameters, installation depths, manholes/valves/hydrants, stations, connections, year of construction, and technical condition — all key elements for coordinating network extensions.

Technical vs. Legal Aspects: Technical cadastre: measurements, topography, boundaries, and networks. Legal cadastre: ownership, mortgages, easements, and restrictions.
Both components must be consulted in all public utility works to ensure compliance and data consistency.

Main Regulations

- Law 7/1996 – Cadastre and Land Registry: eTerra platform, mandatory technical documentation.
- Law 241/2006 – Water and sewerage services: delineation between public and private connections.
- Government Decision 1591/2002 – Technical norms for pipe installation: depths, distances, and protection requirements.
- Order 700/2014 – Procedures for approval, reception, and registration with OCPI (National Agency for Cadastre and Land Registration).

Water and Sewerage Procedure: Project authorization**,** Preparation of topographic–cadastral documentation**,** Approvals from authorities (OCPI, City Hall, Environmental Agency, Water Utility Operator, Romanian Waters, etc.)**,** Building permit – Law 50/1991, Project reception
Registration in the Land Registre.
Expropriation

According to Law 255/2010, expropriation is permitted for public utility purposes, provided there is fair compensation and legal justification.

Case Study

Runcu: outdated cadastre ⇒ delays exceeding 1 year, 12 km of unauthorized networks, legal disputes, and a 20% cost increase.

Cătunele: digital GIS-based systematic cadastre ⇒ approvals in under 3 months, optimized planning, positive citizen relations, and a 15% reduction in administrative costs.

Table 1

Comparation between Runcu and Catunele communes

Criterion	Runcu Commune	Cătunele Commune
Cadastral status	Incomplete, outdated	Complete, digitized, and integrated into GIS
Project duration	Extended by +12 months	Complied with according to the schedule

Approvals and permits	Delayed,missing for 12 km of the network	Issued promptly
Legal issues	Litigations with private individuals	No legal disputes
Administrative costs	Over budget by +20%	Optimized, under control
Public acceptance	ScLow, with distrust	High, with support from residents

Digitalization & GIS : Vectorized maps, correlated with databases such as eTerra and urban planning systems, enable rapid updates and efficient data management. Benefits: improved planning and traceability, shorter approval times, prevention of overlapping data, and enhanced institutional interoperability. Challenges: limited resources within local administrative units (UAT), outdated data formats, and delays in the implementation of the systematic cadastre.

Future Directions (Smart Systems): The next stage involves the use of drones for cadastral updates, AI for risk analysis, public online access, and real-time network monitoring, within the framework of ANCPI’s e-Cadastre projects.

Specific Aspects of Water and Sewerage Network Extensions

These projects have significant health, environmental, and economic impacts. They require detailed topographic surveys (contour lines, existing networks, property boundaries) and GIS integration.Positive examples have been recorded in the counties of Gorj, Mehedinți, and Dolj.

Topographic Instruments & Methods

- Direct distance measurement: pacing, tape, steel measuring band (±3 cm / 100 m), invar wire.
- Angle measurement: goniometers, theodolites (Theo 010 / 020 / 080; telescope, graduated circles, levels, optical centering, tripod).
- Indirect distance measurement: stadimetric, parallax-based, or electromagnetic (electro-optical tachymeters, precision up to ~1 cm).
- Leveling: geometric, trigonometric, or barometric methods; instruments include Ni 030 / 025 / 007 / 002 and LFG-1 laser levels.
- Procedures: instrument setup (stationing), angle measurements (single, repeated, or reiteration methods), distance techniques, and error management (systematic/accidental errors, horizontal plane corrections).

The theodolite must be periodically inspected: checks include vertical alignment of the axis, collimation, reticle line position, and optical centering. Errors may be of two types: Construction errors – cannot be corrected in the field, Adjustment errors – can be rectified on site.

Presented Theodolites: Theo 010 – precision 2cc, magnification 28× , Theo 020 – medium precision, optical scale, magnification 25× , Theo 080 – underground model, precision ~2c, magnification 18×

Indirect Distance Measurement

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- Dahlta 020 with Dahlta stadia rod (stadimetric method, engraved lines).
- Redla 002 (parallax-based, 2 m rod, rotating prisms).

Electromagnetic Measurement Instruments: EOT-2000 – laser-based, automatic corrections,

Recota – ±1 cm accuracy up to 3 km, readings in ~5 seconds, MRA-4 / Distomat DI-50 – radio-wave telurometers, 1–3 cm/km precision.

Essential Corrections for Steel Tape Distance Measurements: Temperature: standardized to 20 °C, Calibration: $Ce = -e \cdot D/50$, Tension: ≈ 2 mm per 10 kg variation, Reduction to sea level: applied for triangulation measurements.

Extension of the Water Supply and Sewerage Network – Lupoaia Village, Cătunele Commune, Gorj County

The area is located between the Getic Plateau and the Motru Depression, characterized by slightly undulating terrain favorable to public works. The existing infrastructure is inadequate:

Water supply is provided through individual wells. There is no centralized sewerage system, only individual septic tanks. The local cadastre is only partially updated, making it necessary to prepare complete topographic–cadastral documentation to ensure accurate and efficient project planning.

Stages of the Topographic–Cadastral Documentation

Stage I – Preliminary Documentation

- Consultation of the OCPI Gorj database and the e-Terra system;
- Analysis of orthophotos and verification of restrictions (easements, protection zones).

Stage II – Topographic Survey in the Field

- Total surveyed area: approximately 28 ha (urban and non-urban zones);
- Measurements: performed using GPS and total station;
- Coordinate determination: in Stereo 70 reference system;
- Marking of structural elements: buildings, roads, drainage ditches, fences.

Stage III – Data Processing

- Use of TopoLT, AutoCAD, and GeoGraph software;
- Generation of maps at 1:5000 scale, definition of the expropriation corridor, preparation of cadastral sheets and the technical report (memoriu tehnic).

Stage IV – Approval Process

Verification by an authorized specialist and submission to e-Terra for final approval, to be used in the technical design phase.

Methods and Equipment Used

- GNSS Method (Global Navigation Satellite System): Used for coordinate determination and georeferencing in the Stereo 1970 system, with centimeter-level precision.
- Tachymetric Method (Total Station): Applied in areas with obstacles. The Leica TS06 Plus total station was used to measure angles and distances accurately.

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- Mixed Method and Network Adjustment: Combination of GNSS and tachymetric measurements to achieve optimal speed and precision through network compensation techniques.

Equipment

- Trimble R10 GPS with RTK connection;
- Leica TS06 Plus total station with prism and remote control;
- Laptop equipped with TopoLT / AutoCAD Civil 3D;
- GIS tablet for real-time verification in the field.
- Cadastral Plan and Project Approval

The cadastral plan consolidates all surveyed and processed data, ensuring accurate representation of property boundaries, construction elements, and public utility corridors.

Following verification and approval through OCPI and e-Terra, the documentation becomes the official reference for the technical design and implementation of the water and sewerage network extension project in Lupoaia, Cătunele Commune.

Figure 1. Location maps

Cadastral Plan

The cadastral plan represents both the physical and legal situation of the affected properties. It includes:

- Parcel outlines, cadastral numbers and land registry (CF) references, property boundaries, pipeline routes, and protection zones;
- Digital maps (DWG, PDF formats) at a 1:5000 scale;

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- Longitudinal profiles and cross-sections used to determine slopes and installation depths of the pipelines.

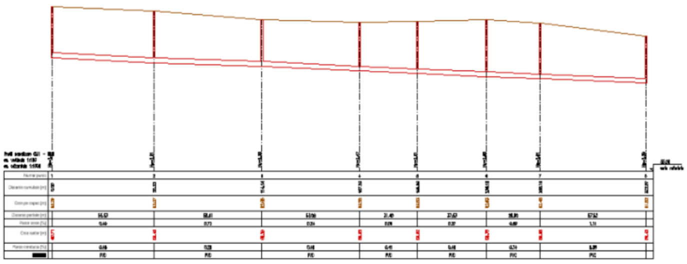

Figure 2. Longitudinal profile

Permits and Required Documentation

For the authorization of the works, the following approvals were obtained:

- OCPI approval – for land geometry verification and registration in the Land Registry; Urban Planning Certificate – issued by the Cătunele Municipality;
- Utility network approvals – from DEER, Distrigaz Sud Rețele, Aparegio Gorj, and telecommunications operators; Fire Safety (PSI) and Environmental approvals;
- Construction permit – issued in accordance with Law 50/1991.
- The technical documentation included: the technical report (tehnical report), site plans, land registry extracts (CF), cadastral sheets, ownership tables, and ANCPI forms.

Problems Encountered

a) Missing or Outdated Land Registry Records: Non-registered properties and unresolved inheritance cases.

b) Property Boundary Overlaps: Discrepancies between old plans (1:2000 scale) and actual field conditions required neighboring agreements (procese-verbale de vecinătate).

c) Missing Cadastre for Roads: Certain access roads were not registered in the public domain.

d) Extended Institutional Response Times: Delays in obtaining utility and environmental approvals.

Despite these difficulties, the project was completed and favorably approved, providing the legal and technical foundation for implementing the water and sewerage network extension in Lupoaia village. Common Problems and Solutions in Preparing Topographic–Cadastral Documentation for Public Utility Projects

Technical Field Issues:

- Absence of boundary markers or physical property limits; Overlapping property boundaries in the eTerra database due to inconsistencies between old maps and current field conditions;
- Lack of systematic cadastre in rural/extravilan areas;

- Property owner refusal to grant access for field measurements; Unregistered buildings requiring plan updates.

These factors lead to delays and repeated field measurements, affecting the overall project schedule.

Administrative and Bureaucratic Issues:

Extended processing times for approvals from OCPI, Romanian Waters (Apele Române), Environmental Agency, Electrica; Requirements for multiple document formats (physical, digital, electronic signature); Staff shortages in certain institutions; Inconsistent interpretation of Order 700/2014 and difficulties in approving partial works.

These challenges reduce process efficiency and delay the authorization of works.

Technical and Legal Solutions Adopted in Other Administrative Units (UATs)

- Municipality–OCPI partnerships to prioritize public utility projects;
- Use of drones and LiDAR systems to reduce measurement time and increase precision;
- Systematic registration and parcel updates financed through PNRR or local budgets;
- Citizen information campaigns prior to fieldwork to prevent conflicts;
- Integration with the General Urban Plan (PUG) to ensure the spatial development.

Implications of Project Delays on the Community

- Delayed access to essential public services (water, sewerage);
- Reduced economic attractiveness and youth migration;
- Loss of funding opportunities under national or European programs;
- Additional costs due to rescheduling, rework, and penalties;
- Public dissatisfaction and loss of trust in local administration.

Proposed Efficiency Measures

Creation of a joint working team (designer, surveyor, municipality); Implementation of a local GIS database containing updated utility and cadastral plans; Full digitalization of the approval process and online tracking of documentation status; Partnerships with universities of geodesy/topography for internships and technical consultancy; Establishment of an annual budget dedicated to updating cadastral plans, especially in rural areas; Periodic revision of local urban planning and infrastructure regulations.

Implementation – Key Stages

- Implementation workflow: Feasibility Study (SF) + Technical Design (PT) → Topographic surveys & cadastral plans → Approvals / permits (OCPI, Environmental Agency, Romanian Waters, etc.) → Network construction → Acceptance & cadastral updates.
- Technical design: based on topographic–cadastral documentation (Stereo 70 / 1970), topographic and geotechnical studies, capacity calculations, route and depth design, connection points, and pumping stations.
- Materials: PEHD, PVC/PVC-U (for water and gravity sewerage), fittings, valves, and hydrants in compliance with EN ISO 1452.

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- Execution: layout marking on cadastral plans, excavations, pipe installation, household/institutional connections, manholes/pumping stations, and road restoration.

- Modern methods include directional drilling, mechanized compaction, and GIS integration for network monitoring.

- Inspection & Acceptance: pressure and leakage tests, compliance verification against the technical design, final acceptance report, and Land Registry update.

Challenges & Solutions:

- Challenges: lack of updated maps, unregistered land parcels, underground obstacles, and restricted property access.

- Solutions: new topographic surveys, continuous dialogue with local authorities (UAT) and residents, adjustment of pipeline routes, and preparation of notarial documents or land partition agreements.

Legal Framework

The project complies with the following regulations:

Law 50/1991 – Construction authorization; Law 51/2006 – Community services of public utilities; Government Decision 930/2005 – Technical norms for water and sewerage networks;

Law 7/1996 – Cadastre and Land Registry; NTPA/STAS standards – Technical and environmental quality norms.

Impact on the Community

Social & Health Impact: Improved living comfort and hygiene; Reduction of waterborne diseases; Better working conditions for public services such as schools and medical facilities.

Economic Impact: Increased property value and attractiveness for investments; Easier access to funding programs (PNDR / POIM); Support for agriculture and small-scale industry.

Ecological Impact: Protection of groundwater and soil quality; Controlled treatment of wastewater; Compliance with EU environmental requirements.

Social Cohesion: Reduction of urban–rural disparities and greater social inclusion;

Addressing community reluctance through public information, subsidized household connections, and involvement of local leaders.

Potential Indicators: Satisfaction surveys: e.g., ~78% of residents report improvements;

Reduction in water losses; Increase in connection rates: +25% within 3 years (based on local examples).

CONCLUSIONS

The project's success depends on updated technical data, multi-actor coordination (engineers, surveyors, and authorities), and compliance with all legal and procedural standards.

The project's positive impact is both visible and measurable, and it can serve as a replicable model for similar rural infrastructure programs.

Strategic Directions: Development of a Local Water Management Plan; Creation of Intercommunity Development Associations (ADI) or Public–Private Partnerships (PPP) for network operation and expansion; Digitalization of monitoring systems (GIS integration, smart meters, automated alerts); Use of drones for inspection and mapping.

Operational Proposals: Support programs for connecting vulnerable households; Digitalization of cadastral documentation; Periodic maintenance plans for networks and pumping stations;

Environmental and civic education campaigns; Monitoring of consumption and resource efficiency; Continuous updating of infrastructure projects according to demographic and development trends.

Possible Extensions: Connection of isolated households through micro-treatment systems;

Development of new water catchments (springs, streams); Reuse of treated wastewater for irrigation where feasible.

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