

ISBN 978-4-9914075-0-5

ISBN 978-4-901668-37-8

PROCEEDINGS

International Symposium on GeoInformatics for Spatial-Infrastructure Development in Earth and Allied Sciences

Chiang Rai, Thailand, 11-13 December 2024



CONFERENCE CHAIRS : Venkatesh RAGHAVAN & Phaisarn JEEFOO

EDITORS : Natraj VADDADI, Sittichai CHOOSUMRONG & Chaiwiwat VANSAROCHANA



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Association of Geoinformatics Laboratories for Earth Sciences

Technical Document 1



GIS-IDEAS 2024

DECEMBER 11 to 13TH 2024

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CHIANG RAI, THAILAND

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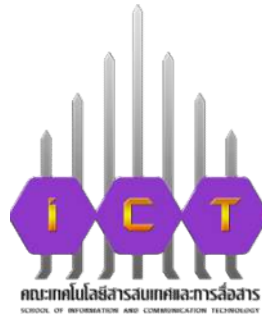
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Geoinformatics for Spatial - Infrastructure Development in Earth & Allied Sciences

The International Conference on Geoinformatics for Spatial-Infrastructure Development in Earth & Allied Sciences (GIS-IDEAS) provides a platform for sharing of knowledge and valuable experiences and help promote collaborations and scientific exchanges between not only between students, researchers and practitioners Japan, Vietnam and Thailand but also our other colleagues involved in developing and promoting Geoinformatics technologies. The conduct of GIS-IDEAS Conferences is based on the spirit of mutual cooperation and openness.

GIS-IDEAS is planned around a central theme which is decided in consultation with the host institution. Apart from Technical Sessions on Geoinformatics technologies and applications, Special sessions on different topics related to Geo-informatics are also held during the conference.

GIS-IDEAS is organized in collaboration with premier institutes located in Asia. GIS-IDEAS which was founded in 2002 to develop and promote Geoinformatics applications and foster cooperation in application of Information and Communication Technologies to problems and issues related to our natural and social environment. To achieve these aims, the conference aims to;

- ◆ support capacity building through organization of symposia, workshops and fieldwork.
- ◆ share information resources and know-how in Geoinformatics
- ◆ promote research collaborations and joint research in Geoinformatics
- ◆ promote exchange of information and academic publications
- ◆ develop a human resource network to support development and growth of Geoinformatics

Previous GIS-IDEAS Conferences were organized in collaboration with premier institutions like Can Tho University (VN), Danang University of Education (VN), Japan Geotechnical Consultant Association (JP), Japan Society of Geoinformatics (JP), Hanoi University of Mining and Geology (VN), Hanoi University of Natural Resources & Environment (VN), Ho Chi Minh City University of Technology (VN), Kyoto University (JP), Naresuan University Thailand, Osaka City University (JP), Osaka Metropolitan University (JP), Vietnam National University (VN) and others.

From the Conference Chairs

Our best wishes to the GIS-IDEAS Community for a Happy New Year! We are very happy to bring out this volume of the GIS-IDEAS 2024 Conference Proceedings, that was held from December 11–13 in the vibrant city of Chiang Rai, Thailand. As we look back at this exciting event, we feel immense satisfaction to continue the proud tradition of fostering global collaboration and innovation in geoinformatics that began with the establishment of the Japan-Vietnam Geoinformatics Consortium (JVGC) in 2001.

The GIS-IDEAS 2024 conference provided a unique platform to exchange ideas, share knowledge, and explore the latest advancements in spatial sciences, urban planning, and environmental sustainability. The beautiful and culturally rich Chiang Rai offered an excellent venue to discuss how Geoinformatics can address some of the most pressing global challenges. With a program that included inspiring keynote speeches, dynamic technical sessions, and hands-on workshops, GIS-IDEAS 2024 promises to deliver insights and solutions that will resonate well beyond the event.

We extend our heartfelt thanks to all the contributors whose research enriches the proceedings of this conference. Our deepest appreciation to our wonderful host the University of Phayao and to various conference committees, faculty, staff, and students who work tirelessly to ensure the event's success. Special acknowledgment is due to our sponsors and supporters, whose generous contributions enable us to create a collaborative and vibrant platform to showcase innovations and current trends in Geoinformatics research and application. We also express our thanks to the editors and manuscript reviewers and commend their hard work to bringing out the proceedings in a timely manner.

Together, we hope to kindle innovative ideas, foster meaningful collaborations, and deepen the connections that unite the Geoinformatics community worldwide. Your participation and support are integral to the success of GIS-IDEAS 2024, and we look forward to the insights, discoveries, and partnerships that this conference will inspire.

Thank you Chiang Rai!, and See you at GIS-IDEAS 2026!! Warm regards,

Phaisarn JEEFOO & Venkatesh RAGHAVAN

Chairs, GIS-IDEAS 2025

Dt: January 2025

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Dr. Pakorn Petchprayoon is the Director of the Geo-Informatics Product Innovation Office at the Geo-Informatics and Space Technology Development Agency (GISTDA). His research focuses on understanding the physical processes of energy exchange between the land and water surfaces and the atmosphere by integrating satellite data with direct field measurements. Dr. Petchprayoon has dedicated 23 years to GISTDA, contributing in various research and leadership roles. He has authored and co-authored several publications and was a lecturer on GEOG 4093 Remote Sensing of the Environment at the University of Colorado, Boulder, USA. Dr. Petchprayoon holds a B.S. from Burapha University, M.S. from Mahidol University, and M.A. and Ph.D. from the University of Colorado-Boulder, USA.

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PROF. SONG XIANFENG



Prof. Song Xianfeng is a distinguished expert in Geographic Information Sciences (GIS) and Remote Sensing Hydrology, focusing on geospatial data mining using vehicle GNSS trajectories, cellular network signalling, and DVR data. He holds an MS in Remote Sensing Geology (1995) from China University of Mining & Technology, along with a PhD in GIS from the Chinese Academy of Sciences (1998). He is presently serving as a Professor at the University of Chinese Academy of Sciences since 2011, following roles as Associate Professor and Assistant Professor there and at Kyoto University. His industry experience includes managing IT for the Chinese Investment Corporation for Sciences and Technology.

The Keynote speakers

DR TRAN VAN ANH



Dr. Tran Van Anh is a lecturer at Hanoi University of Mining and Geology (HUMG). She obtained her Master's degree in Surveying and Mapping Engineering from HUMG, Vietnam, in 2001 and her PhD degree in GeoInformatics from Osaka City University (Japan) in 2007. Her field of study is remote sensing and GIS. She has working interests in Radar Interferometry (InSAR) for land deformation detections and optical images for air pollution (PM10) determination. Besides that, she also works on geospatial data research and builds predicting models. She has had more than 50 works published in prestigious domestic and international journals.

DR NATRAJ VADDADI



Dr. Natraj Vaddadi, an Executive Member of the Governing Council at the Centre for Education & Research in Geosciences, is a geologist specializing in Urban Groundwater Recharge through Rainwater Harvesting. He holds a Master's degree in Geology from the University of Pune and a Ph.D. in Natural Resources and Environment from Naresuan University, Thailand. With over three decades of teaching experience, he serves as a Visiting Professor in Petroleum Technology at Nowrosjee Wadia College and teaches postgraduate courses in Drilling Engineering and Production Operations at the University of Pune.

Dr. Vaddadi has conducted numerous workshops on Open-Source GIS in India, Thailand, and Vietnam and is the author of the internationally acclaimed book *An Introduction to Oil Well Drilling*. As a founding member of the Centre for Education & Research in Geosciences, he advocates for geoscience education, promoting its integration into environmental conservation and sustainability initiatives.

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APPLICATION OF GIS TO BUILD A LAND DATABASE IN A MOUNTAINOUS DISTRICT OF SON LA PROVINCE, VIETNAM

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ABSTRACT

As a unique production resource, land is an invaluable national asset. The establishment of a database stands at the core of digital transformation. A land database consists of four key components: a cadastral database, a land statistical and inventory database, a land use planning database, and a land price database. This paper aims to create a land database to enhance the efficiency of land exploitation and management within the context of the Moc Chau mountainous district in Son La province. The study was carried out using various methodologies, including synthesis and analysis, field investigation and surveying, and notably, the integration of multiple software systems to develop the land database. Consequently, the necessary component databases have been successfully established, ensuring the requisite accuracy. These databases are compiled using the VBDLIS online software developed by Vietnam. This research holds practical significance, offering valuable insights for policymakers and aiding in effective land use planning. It establishes a robust data foundation, a crucial step towards operating within a digital government, a digital economy, and a digital society.

Keywords: Land database, GIS, VBDLIS, Moc Chau, Son La

1. INTRODUCTION

The land database is one of six national databases earmarked for prioritized implementation, aimed at enhancing state management, providing public land services, and facilitating the exchange of land information among ministries, branches, organizations, and individuals. Simultaneously, it plays a crucial role in the deployment and functioning of the e-government system.

Land serves as a unique means of production, an essential living environment, an area for residential settlements, and the foundation for economic, cultural, and national security and defense projects. The current challenges faced by the land management sector are to address the requirements for national development while concurrently ensuring the efficient and sustainable management and safeguarding of land resources.

The applications of GIS technology in land management is increasingly prevalent due to its highly effective spatial field management benefits, such as reduction in investment costs; rapid data storage and retrieval; efficient collection of large volumes of data in a short timeframe; swift and effective enhancement of the quality of public service management; increased accessibility for a wide user base, and others. The land database is systematically developed by provinces, cities, and districts, encompassing a range of components such as the cadastral database, a land statistical and inventory database, a land use planning database, and a land price database. It is structured for regular electronic accessibility, utilization, management, and updates.

The cadastral database encompasses essential information related to the establishment and modification of cadastral maps, land registration, issuance of certificates for land use rights, property ownership including houses and other assets tied to the land and associated cadastral files. The land statistical and inventory database comprises reports, tables, statistical data, land inventory, and land use maps at various administrative levels—communal, district, and provincial.

The land use planning database consists of comprehensive explanatory report data, land use maps, planning maps, land use plans, as well as adjusted land use planning and provincial and district-level plans. The land price database comprises data such as land price lists, adjusted and supplemented land price lists, land price adjustment coefficients, specific land prices, auction-winning prices for land use rights, and land price information recorded in the information collection form for land plots. All this database includes attribute and spatial database and scanned documents.

Across the globe, numerous studies address the establishment of land databases, primarily emphasizing the development of land cover and land use databases through diverse methodologies. Zahir Ali et al. meticulously outlined the constraints and challenges involved in integrating legal and geometric cadastral information to establish a novel digital cadastral system (Ali and Shakir 2012). In 2019, Benjamin Beaumont et al. conducted a consultation process to create a land cover and land use database for the Walloon region (Beaumont, Stephenne et al. 2019). In their 2022 study, Md. Zulfikar Khan and colleagues examined soil carbon stocks and documented land use changes in Italy, employing the LUCAS soil database (Khan and Chiti 2022). Matthew Mleczko et al. (2023) developed a national land use and planning database in the USA (Mleczko and Desmond 2023). Pei Yin and Jing Cheng analyzed the urban land planning database of Shanghai, China using a MySQL-based software system and proposed a conceptual model for the urban land planning database (Yin and Cheng 2023).

This multi-scale open database contains information on land use and land cover, supporting the DestinE program in creating a highly precise digital model of the Earth (Kepka, Hájek et al. 2022). Yindan Zhang et al. established the Fine-resolution, Large-area Urban Thematic information Extraction (FLUTE) framework (Zhang, Chen et al. 2022). A service-oriented GIS-based web system was developed to offer a viable solution, incorporating fundamental geographic features and benchmark land price-related information (Yang, Sun et al. 2015). A study developed a land management system using a Geographic Information System (GIS) (Yakubu and Asah 2023).

Several studies in Vietnam have explored land-related topics, employing a variety of technologies. Vo Quang Minh et al. (2004) specifically investigated land information management, integrating GIS and socioeconomic data approaches for effective land use planning (Minh, Tri et al. 2003). Huynh Van Chuong et al. (2010) conducted research to develop a database for land assessment and land use planning in Thua Thien Hue province (Chuong and Lân 2010). Nguyen The Cong and colleagues (2020) conducted research on establishing a statistical database and a land inventory in Dong Thap province (Công, Miễn et al. 2020). Tran Xuan Mien and colleagues (2022) utilized the ARCGIS API to construct a statistical land inventory database in Phu Luong district, Thai Nguyen province (Miễn, Công et al. 2022).

Mobile GIS technology has been employed in research to update market land price information in Phung town, Hanoi city (Cầm 2021). Le Thi Lien established a cadastral database in Bac Kan province by utilizing Microstation and gCadas software (Liên 2022). In Long Thanh district, the land management software (DNAI.LIS) was employed to establish and extract land databases. (Thảo, Hạng et al. 2023). Another study developed a ground spatial model and multi-objective attribute information for each land plot, emphasizing the challenges involved in creating a land database (Anh, Hải et al. 2017). The land price map database for Hoang Van Thu ward in Thai Nguyen city, along with an attribute database containing details such as the number of sheets, plots, areas, roads, state price, market price, and management system, was developed using MapInfo software (GIS) (Anh and Gầm 2020).

Building and updating the national land database is crucial, demanding completeness, accuracy, scientific rigor, and timely updates. The content, structure, and information types within the national land database follow the technical regulations outlined by the Vietnam Ministry of Natural Resources and Environment. The constituent databases within the national land system must be developed simultaneously, linked, and integrated. The organization and implementation scale of the cadastral database are determined by the administrative units at the district level.

Presently, fundamental survey data, maps, and publications related to land resources in Son La province lack uniformity, leading to cumbersome storage and difficult information retrieval. These obstacles significantly impede land management efforts at the local level, resulting in several issues and reduced effectiveness. Thus, establishing a land database for the experimental area (Moc Chau district, Son La province) becomes a matter of high urgency. This initiative will be crucial, providing essential insights to aid policymakers in formulating strategies, devising plans, and conducting land use planning to more effectively harness existing land resources for both political stability and economic development.

2. TECHNOLOGICAL PROCESSES AND SOFTWARE USED TO BUILD LAND DATABASES

2.1 Technological processes

The process of building the land database is detailed in Table 1.

Table 1. Technological process of building components of the land database.

Technological process	Steps
Cadastral Database	- Preparation
	- Collecting documents and data
	- Reviewing, evaluating, classifying, and organizing documents and data
	- Building spatial land data and cadastral spatial data
	- Scanning legal documents and processing files
	- Creating cadastral attribute data
	- Completing cadastral data
	- Checking and accepting the cadastral database
	- Verifying and integrating data into the system
Land Statistical and Inventory Database	- Creating cadastral metadata
	- Preparation
	- Collecting documents and data
	- Reviewing, evaluating, classifying, and organizing documents and data
	- Building spatial data for land inventory
	- Scanning legal documents and processing files

Technological process	Steps
	<ul style="list-style-type: none"> - Creating land statistical and inventory attribute data - Checking and completing land statistical and inventory data - Preparing documents for inspection and acceptance - Packaging and submitting statistical and inventory databases - Overall check and data integration into the system - Developing land statistical and inventory metadata
Land Use Planning Database	<ul style="list-style-type: none"> - Preparation - Collecting documents and data - Reviewing, evaluating, classifying, and organizing documents and data - Building spatial data - Scanning legal documents and processing files - Developing data for the land use planning database - Checking and completing land use planning data - Preparing documents for inspection and acceptance supervision - Packaging and submitting the land use planning database - Overall inspection of the land use planning database and integration into the system - Building land use planning metadata
Land Price Database	<ul style="list-style-type: none"> - Preparation - Collecting documents and data - Reviewing, evaluating, classifying, and organizing documents and data - Building spatial data for land price - Scanning legal documents and processing files - Creating land price attribute data - Checking and completing land price data - Preparing documents for supervision, inspection, and acceptance - Packaging and submitting the land price database - Overall inspection of the land price database and its integration into the system - Developing land price metadata

2.2 Main software used to build land database

The software used in the research is diverse and user-friendly. For the cadastral database, the following software and processes were employed: Microstation V8i software combined with Gcadas and LisediorTC for editing and standardizing spatial objects. Spatial data were then exported to GML.; Attributes were entered in Excel following Gcadas' Excel template; The cadastral database was packaged using ViLIS 2.0 software, encompassing space, attributes, and scanning records. Data from ViLIS 2.0 was subsequently converted to VBDLIS according to regulations. This is proprietary software developed by a IT unit in Vietnam, commissioned by the Ministry of Natural Resources and Environment for deployment across provinces and cities. Currently, only provincial land registration offices manage and access the system. In the future, local citizens may also be systematically granted access.

For other components such as land use planning, statistics and inventory, and land price databases, the primary platform used was the online VBDLIS software available at <https://vilg.vietbando.net/>. The exchange and distribution of land data were carried out using the GML geographic format language and the standard land metadata format via XML extended format language, facilitated through data storage devices and data transmission services.

MicroStation, a comprehensive geographic information system software, offers complete functionality for data acquisition, management, search, and display. Its latest version, MicroStation V8, fully supports all prevailing standard CAD formats, including AutoCAD's

DWG and MicroStation's DGN. This updated version resolves various file size limitations, enabling the integration of both 2D and 3D data within the same file while also supporting Unicode.

The advancements in MicroStation V8 are particularly significant in mapping, notably in the development of detailed topographic maps requiring grid construction and surface analysis. Notably, the previous method of dividing information layers within the 0-63 range has been replaced, allowing users to set the number of information layers according to their specific needs.

MicroStation V8 offers users enhanced flexibility, allowing for quick mounting of a 2D reference file onto a 3D terrain file. This version provides the option to display a background image for terrain from various perspectives, offering a versatile viewing experience. The introduction of Unicode support in MicroStation V8 is a significant enhancement, enabling internationalization of documents and designs, aligning with document regulations in Vietnam. MicroStation V8 now supports several Oracle database systems, including MS SQL, Sybase, Informix, and Access. Moreover, it serves as a comprehensive CAD-based application development environment by facilitating support for programming languages such as Visual Basic, MicroStation Basic, and MDL. Users can utilize the Visual C++ or .NET toolkit for coding and debugging programs.

gCadas is specialized software designed for cadastral and land management, offering a comprehensive set of tools within the Microstation V8i environment. Its functionalities include support tools for measuring and creating cadastral maps, such as registration, producing cadastral records, exporting technical records, index books, electronic cadastral books, registering for the issuance of land use rights certificates, managing land statistics and inventory, and constructing cadastral databases.

gCadas software incorporates tools that automate steps involved in creating cadastral and current status maps, significantly reducing field-work time and enhancing labor productivity. It integrates spatial processing (*.DGN) and land parcel attributes (*.GTP). For spatial data (*.DGN), gCadas software processes, detects conflicts, and offers automated tools, including converting seed files, establishing topology, editing map frames, labeling cadastral plots, and copying objects, among other functions. It supports single or multiple map files. Regarding attribute data (*.GTP), gCadas software facilitates the conversion of attribute data from software like Famis, Vilis, Elis, and TMVlis. It also enables data assignment from spatial data, direct importation into the land plot, exporting to Excel, and updating from Excel files, ensuring commonality and convenience in data management.

VBDLIS software, developed by the Viettel Military Industry and Telecommunications Group in Vietnam, is recognized by the Ministry of Natural Resources and Environment as suitable for constructing, managing, operating, and exploiting land databases. The software provides users with the capability to edit various types of maps, including traffic, urban, land, and thematic maps to highlight data models. It facilitates the connection of geometric objects with non-geometric data, enabling the editing, updating, and exploitation of digital map information. VBDLIS is a web-based software, accessible directly over the internet, offering ease and convenience in building, managing, operating, and exploiting land databases.

VBDLIS software possesses the capability to convert data from other popular GIS software, such as .mif from MapInfo and .shp from ArcGIS. Notably, VBDLIS is the sole software that

encompasses all database subsystems, including cadastral, land statistics and inventory, land use planning, and land price. The process of building a database with VBDLIS software can be accomplished in two ways: either building it online on the website or creating the database on the desktop and subsequently converting it online.

3. CHARACTERISTICS OF THE CASE STUDY

Moc Chau district is situated in the mountainous and highland region, serving as a border district in the southeast of Son La province (refer to Figure 1) (Administrative map of Moc Chau district). The central coordinates are 20°49'21 degrees North latitude and 104°43'10 degrees East longitude. The distance from Son La city center to Moc Chau along Highway 6 is approximately 115 km, while the distance from Moc Chau to Hanoi is around 195 km.

Geographically, Moc Chau district shares its borders as follows: to the east, it borders Van Ho district; to the south, it shares borders with Sop Bao district in Hua Phan province, Lao PDR, covering a common border stretch of 39,949km; to the west, it borders Yen Chau district; and to the north, it borders Phu Yen district.

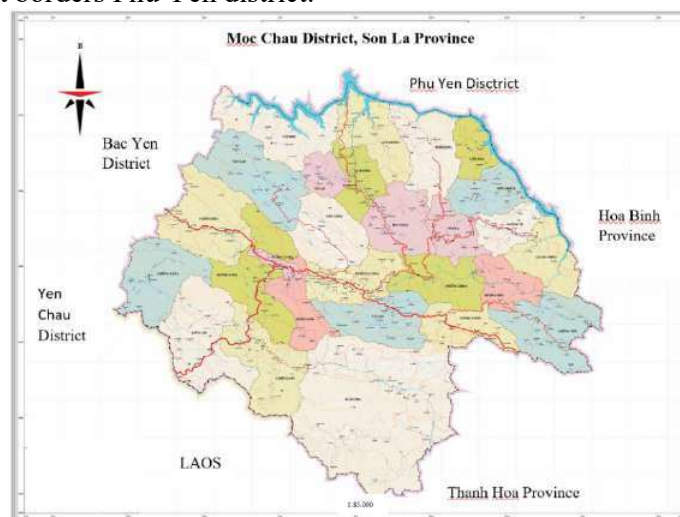


Figure 1. Administrative map of Moc Chau district, Son La province (Administrative map of Moc Chau district).

Moc Chau district comprises 15 commune-level administrative units, inclusive of two towns: Moc Chau (the district capital) and Moc Chau Farm, along with 13 communes: Chieng Hac, Chieng Khua, Chieng Son, Dong Sang, Hua Pang, Long Sap, Muong Sang, Na Muong, Phieng Luong, Quy Huong, Tan Hop, Tan Lap, and Ta Lai. The district covers a total natural land area of 1,081.66 km² and has a population of approximately 114,460 people. Among these, 42,364 reside in urban areas, while 72,096 live in rural areas, resulting in a population density of about 106 people/km² (General Statistics Office).

Moc Chau features a karst terrain dominated by limestone mountains, characterized by numerous high mountains and undulating hills resembling waves, aligning in the northwest - southeast direction. This vast plateau encompasses plains, basins, ravines, rivers, and streams, creating diverse topography. The average altitude is approximately 1,050 meters above sea level.

* Building and converting statistical land inventory databases



Figure 4. Result of land statistical and inventory database in the experimental area (Vietnamese language software).

* Building and converting land use planning databases:

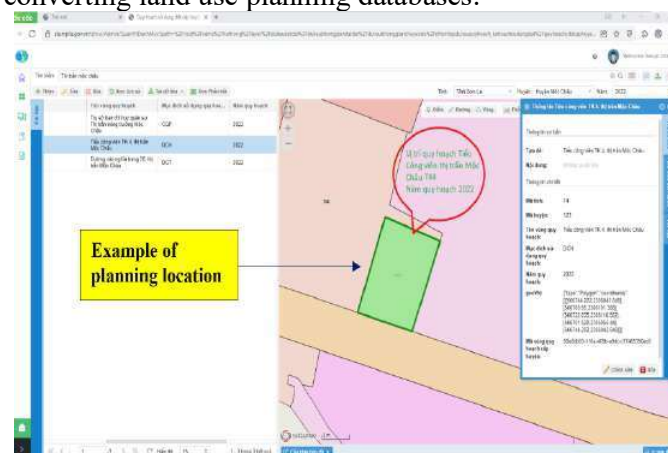


Figure 5. Result of land use planning and plan database in the case study (Vietnamese language software).

* Building and converting land price databases:

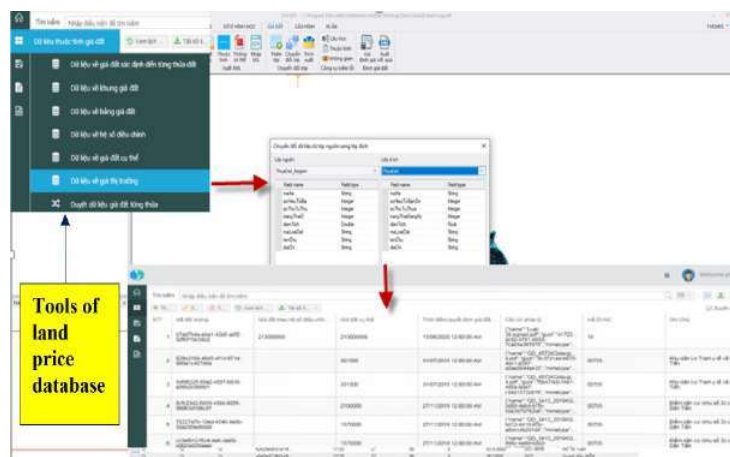


Figure 6. Build a land price database directly on VBDLIS (Vietnamese language software).

The research outcomes concerning the construction of a land database, encompassing the four components, fulfill the criteria for product quality, document completeness, input data, and operational functionality, making it fully exploitable and usable.

The quality of cadastral data is individually determined for each land plot, ensuring consistency among cadastral spatial data, cadastral attribute data, and cadastral records. The land use planning database maintains data consistency between spatial land use planning and attribute information. Land price data quality is established for each land plot, aligning with the regulations of competent state agencies and maintaining consistency with prevailing land prices. Additionally, the quality of land statistical and inventory data ensures the integration of information between statistical and attribute data.

The presentation of land attribute data aligns with the stipulations of land law regarding certificates of land use rights, property ownership, attached assets, cadastral records, land statistics and inventory, land use planning, and land pricing. The exchange and distribution of land data and metadata adhere to standard formats, specifically following the GML geographic format language and the XML extensible format language for metadata. Land data and metadata are exchanged and distributed through data storage devices and data transmission services in the form of data files.

It is evident that sustainable development necessitates well-considered planning closely aligned with local realities, avoiding indiscriminate land use, minimizing agricultural land reduction, and preventing wasteland. The district's land use planning should integrate all these aspects, thereby meeting the legal provisions and aligning with the district's natural and socio-economic conditions.

Once established, the land database will offer swift and precise land information and data, significantly enhancing state land management. It will aptly fulfill the growing demands of economic development, society, defense, security, scientific research, training, international collaboration, and the advancement of e-government in the natural resources and environment sector. Most notably, it will consistently provide essential information to the public and businesses, promoting transparency in land-related services.

The current land use data within the land database serves as the foundation for creating an updated land use map, crucial in annual planning. Leveraging the capabilities of Geographic Information Systems (GIS), spatial analysis facilitates the assessment of land use changes by overlaying map layers over specific time periods. This analysis, alongside statistical data, enables the prediction and guidance of various types of land use development. For the formulation of land use plans, quantitative evaluation of multiple criteria assists in locating optimal sites.

The land database not only supplies information for planning options and mapping but also allows for the application of multi-criteria analysis methods in conjunction with GIS to pinpoint optimal planning locations. Furthermore, it aids in evaluating the impact of land use planning on the economy, society, and the environment while providing support for compensation calculations and site clearance.

Beyond these primary functions, the land database significantly enhances the decision-making process of state management agencies, streamlines administrative services in document handling, and reduces transaction times. It ultimately improves access to land information, catering to the needs of both individuals and organizations.

Several proposed solutions aim to enhance the efficiency of land database exploitation and management within the study area and the country at large:

These include the necessity of planning a long-term strategy for the land data infrastructure, serving as the basis for implementing tailored solutions. Additionally, the proposal involves the creation and enhancement of a market-oriented land information service system. Moreover, it is essential to formulate a detailed and feasible roadmap encompassing aspects such as time, budget, and human resources for effective practical implementation.

Reform the investment policy concerning the construction of a land database by shifting from the current scattered and occasionally inconsistent investment approach to a more concentrated, definitive investment strategy. The focus should be on cultivating a diverse range of human resources, specifically individuals equipped with expertise in land data infrastructure. These professionals should possess comprehensive knowledge not only in land management but also in comprehending urban and rural infrastructure, as well as information technology and urban management.

Developing the information technology infrastructure is crucial, not only for the land management industry but also for the enhancement of the entire administrative system. Provinces and cities should conduct thorough reviews and implement necessary improvements to regulations governing the operation, exploitation, updating, and sharing of land data information under local management. Simultaneously, it is essential to establish and refine various databases, including the land database, cadastral database, land statistical and inventory database, land use planning database, and local land price database. Additional investments are required for the maintenance of connections and the operation of the land information system within the province. This system is crucial for managing, operating, exploiting, updating the land database, and ensuring its connection and sharing with the relevant departments and branches of e-government and smart cities at the local level.

Utilizing 4.0 technology in the development of land technology involves exploring and incorporating innovative technologies such as block chain in electronic transactions within the sector. Implementing open communication standards among information portals and establishing an integration platform for sharing data between information systems and land management databases aligns with cutting-edge global technology standards. Leveraging big data technology for the collection and analysis of data supports decision-making in land management. Furthermore, conducting research to provide open data for the business community encourages the development of applications that cater to the needs of the people.

Implementing robust solutions to ensure information and system security is crucial for managing and securely sharing data from the land database. One key solution involves building a new integrated land database, streamlining processes for measurements, adjusting changes in cadastral maps, and registering land while issuing certificates of use rights. This comprehensive database encompasses details related to land use, housing ownership, and other assets associated with the land.

Standardizing and converting the cadastral database into a system while developing additional component databases (planning, land use plans, land price, and statistical and inventory databases) in areas where a cadastral database already exists is essential. To achieve a cohesive national framework, it's imperative to consolidate cadastral data from provinces and cities along with land-related information provided by ministries and branches.

This consolidation includes compiling comprehensive data such as national land use planning, land price frameworks, and data on bordering areas between provinces and cities. Connecting and sharing these databases is crucial for the effective implementation of e-government initiatives and seamless integration with other national databases. This endeavor necessitates additional investments, upgrades, and the ongoing maintenance of the national land information system.

Implementing such a system would serve as an effective tool for environmental management by enabling better control over territorial planning. The modernization of the land management system represents a significant stride towards achieving the goal of establishing an electronic government through administrative reform. Moreover, a modernized land management system will facilitate an increase in financial revenues derived from land, including land use fees, rents, taxes, and associated fees. This influx of revenue will contribute not only to local budgets but also to state government budgets.

Upon the effective implementation of these solutions, the seamless connection and sharing of land data and associated information within a networked environment will serve as a foundational step towards the realization of e-government and the development of smart urban areas. Furthermore, the transparent handling of administrative procedures and land information will enhance openness and transparency. This, in turn, is poised to increase revenue, reduce costs, offer convenience for both the public and businesses, and foster greater trust among the people towards the government, thereby instilling confidence in both domestic and foreign investors. This progressive approach aims to gradually cultivate an honest government that ensures fairness for all members of society.

5. CONCLUSIONS AND PERSPECTIVES

The research applied the latest and most specialized software to build a land database, which includes components such as a cadastral database, a land statistical and inventory database, a land use planning database, and a land price database in the experimental area of Moc Chau district, Son La province. The land database is systematic and synchronous, achieving the required accuracy. Additionally, several solutions to improve the efficiency of land database exploitation and management have been proposed for localities.

The establishment of a land database in the case study of Moc Chau district offers numerous benefits, such as ensuring an accurate, secure, and transparent data system across management levels. It provides a centralized and consistent channel for accessing information, thereby preventing errors in source data management. This initiative enhances the quality of the decision-making process and advances state management in local land management. Furthermore, it improves the services of state management agencies by expediting document reception and processing, reducing transaction time, and enhancing access to land information to meet the needs of individuals and organizations.

The research's findings will be invaluable for managers, policymakers, and land use planners in an effective and scientific manner. It is recommended that the construction of land databases should continue to be carried out experimentally in various localities with diverse geographical and socio-economic characteristics, allowing the application of different methods and technologies.

For the land database of Moc Chau district and, by extension, the land database of Son La province, it's essential to further develop mechanisms and policies for information utilization. This step ensures that individuals, businesses, and organizations can conveniently, quickly, accurately, and promptly access information. Moreover, there's a need to continuously supplement, update, and refine the land database throughout its operational use and exploitation processes. Implementing clear policy mechanisms is crucial to enhancing the efficiency of use and reducing the time required for current land-related administrative procedures. People gradually gaining direct access to this database as an open-source resource would also be highly beneficial in the future.

The creation of land databases should persist across various localities with distinct characteristics, utilizing diverse methods and technologies. Effective implementation of these solutions is anticipated to facilitate the connection and sharing of land data and associated information within a networked environment. This interconnectedness serves as the foundation for implementing e-government and the development of smart urban areas. The information technology infrastructure links multiple sectors such as resources and environment, tax, banking, etc., enhancing the efficiency of information exploitation. This integration ensures accuracy, timeliness, and overall operational efficiency.

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