Building National Data Infrastructure

ADB-LX Corp. Joint Workshop

31 October - 4 November 2022 I Seoul, Republic of South Korea

ADB

EAKPF
Republic of Korea

LX
Korea Land and
Geospatial InformatiX Corporation

Knowledge Series No. 12

Building National Data Infrastructure
Seoul, Republic of South Korea
31 October - 4 November 2022

Co-Organized by:
Asian Development Bank
Republic of Korea e-Asia and Knowledge Partnership Fund
LX Corporation

Contents

Workshop Overview

Rapid changes in land use associated with economic development, urbanization, and the need to feed a rapidly growing population have significantly increased demand for policies and systems that can help guide proper land management, land use and land-related services.

In developing countries, poorly managed land processes and the lack of clarity on land rights have long been hampering economic development. Developing countries need to have functioning land administration system and clear land policies.

For overall land management in developing countries to improve, there is a need for proper land laws and policies, land governance structure, institutional capacity, sustainable financing for land management covering the costs of surveys using modern technologies, as well as land management information systems, to name a few.

For the efficient and effective management of land, governments and private developers need to make decisions on the development choices about land use. Sound land management itself is critical for development.

From the public sector management point of view, it is more important as it is a key foundation on which various government functions can be built on.

The history of rapid industrialization through powerful economic development policies since the 1960s in the Republic of Korea serves as a good case study. The large-scale migration of rural populations to cities, as well as various land use and development projects in Korea, have led to so many land-related affairs including a wide range of areas such as policy, possession, transaction, use control, expropriation, resettlement, development, and management. The Government developed an integrated land information system and has been able to remove room for injustice and corruption in handling land-related affairs successfully.

Against this backdrop, ADB, and LX Corporation co-organized a workshop on "Building National Spatial Data Infrastructure" on 31 October-4 November 2022. The workshop was supported by the Republic of Korea e-Asia and Knowledge Partnership Fund in the context of Smart Geo Expo 2022 in South Korea.

Highlights

Participants

55 participants from governments, development partners, academia, and private sector from the selected developing member countries (DMCs), in addition to ADB staff working in public sector management and urban development sector

Speakers

More than 20 speakers from the public and private sectors in the Republic of South Korea, ADB and partner organizations with expertise in geospatial data management, land administration and planning using digital technology

Objective

The workshop aimed to promote an integrated approach in building national spatial data infrastructure under a systematic e-governance framework in DMCs.

Programme

DAY 1 (31 October 2022) I Venue: Sonocalm2 Goyang	
09:00-09:30 a.m.	**KOREA'S GEOSPATIAL INFORMATION & DIGITAL TWINS** Opening Address **Ms. Xiaohong Yang,** Chief Thematic Officer, Sustainable Development and Climate Change Department, ADB Welcome Remarks with Keynote Speech **Mr. Song-wook Choi,** Head of the Geospatial Information Division/Chief Executive Director, LX Corporation
SESSION 1: NATIONAL SPATIAL DATA INFRASTRUCTURE	
10:30 - 12:30	Moderator: **Thomas E. Abell,** Advisor, SDCC and Chief of Digital Technology for Development, ADB Geospatial Information Management: Implementing the Integrated Geospatial Information Framework Strategy and Planning for Managing City Growth **Andrew Coote,** Counsel, Norton Rose Fulbright LLP Introduction of Korea National Spatial Data Infrastructure **Daejong Kim,** Managing Director, Korea Research Institute for Human Settlements Country Case Presentation: NSDI in Republic of Kazakhstan **Lyailya Satybaldina,** Head of the Spatial Data Development Department of the Committee for Geodesy and Cartography, Ministry of Digital Development, Innovation and Aerospace Industry
SESSION 2: SPATIAL DATA COLLECTION AND GIS TECHNOLOGIES	
14:00 - 15:30	Moderator: **Yoonee Jeong,** Senior Digital Technology Specialist, ADB Trends on Spatial Data Collection, Survey and Maps Making **Won Kuk Lee,** Deputy Director, Geographic Information Institute Introduction of K-Geo Platform (Web GIS platform) for Geospatial Data Exchange and Sharing **Kwon Woseok,** Executive Director, WAVUS corporation Earth Observation Services Support for National Data Portal **Paolo Manunta,** Senior Infrastructure Specialist, ADB Country Case Presentation: Republic of Nepal **Karuna KC,** Deputy Director General, Survey Department
SESSION 3: SPATIAL DATA UTILIZATION AND GIS	
16:00-17:30	Moderator: **Arndt Christoffer Husar,** Senior Public Management Specialist (Digital Transformation), ADB Geospatial Information Distribution System for Data Sharing and Utilization **YoungJoo Lee,** Research Fellow, Korea Research Institute for Human Settlements Futureproofing the Past: Spatial Data for Digital Heritage Archiving **Siro Kim,** Deputy Director, Asean-Korea Cooperation Fund Country Case Presentation: Kyrgyz Republic **Zhakshylyk Toktosunov,** Director of SOE "Cadastre" under the State Service for Land Resources, Ministry of Agriculture of the Kyrgyz Republic
19:00-20:30	Seoul Workshop Welcome Dinner by ADB

DAY 2 (1 November 2022) I Venue: Sonocalm2 Goyang	
SESSION 4: INTEGRATED LAND INFORMATION SYSTEM	
09:00-10:30	Moderator: **Yoonee Jeong,** Senior Digital Technology Specialist, ADB Korea's Cadastral Management Information System **Simon Jeon,** Manager, Global Business Department, LX Corporation Global Trends of Integrated Land Information System **Patrick Stimpson,** Project Manager, GIS Country Case Presentation: Cadastral Mapping and Land Records in Mongolia **Bayantumen Purevdorj,** Head of Land Cadastral Division Agency for Land Administration and Management, Geodesy, Government Implementing Agency
SESSION 5: LAND USE PLANNING	
14:00 - 15:30	Moderator: **Jung Ho Kim,** Senior Urban Development Specialist, ADB National Land Use Planning System in South Korea **Jeong Ho Moon,** Senior Research Fellow, Korea Research Institute for Human Settlements and Construction **Seoul Urban Planning Information System** **Taehyun Kim,** Assistant Professor, Center for Technology Innovation, Seoul Institute of Technology Country Case Presentation: Cambodia **Iv Lim,** Deputy Director General, General Department of Land Management and Urban Planning, Ministry of Land Management, Urban Planning, and Construction **Yeang Dane,** Minister of Land Management, Urban Planning & Construction, Government of Cambodia **Chantha Mengly,** Ministry of Economy and Finance, Government of Cambodia **Keo Vibol,** Ministry of Economy and Finance, Government of Cambodia
SITE VISIT: National Geographic Information Institute (NGII)	
18:30-20:00	Smart Expo 2022 Welcome Dinner by LX Corporation

Programme

DAY 3 (2 November 2022) I Venue: KINTEX	
SESSION 6: LAND TENURE MANAGEMENT	
10:30 - 12:30	Moderator: **Yuji Miyaki,** Public Management Specialist (Taxation), ADB Innovative Directions in Land Registration Practice in the 21st Century: From First Registration to Interoperability of Systems, with Case Studies of Turkey and Colombia **Malcolm Childress,** Member, Global Land Alliance Land Registry Computerization Project **Korean National Supreme Court** Lightweight Type Digital Twin **High Speed Computer Vision for Remote Sensing** **Gwihwan Moon,** Founder and CEO of Omnis Labs Company, Creator of Deep Block INFOCAR SI Imaging Services **Next Generation Mobile Mapping** **Danny McGinn,** Assistant Sales Manager, WIPCO Ltd.
SESSION 7: LAND VALUE ASSESSMENT SYSTEM	
16:00 - 17:00	Moderator: **Stephane Gil,** International Land Administration & Property Tax Management Specialist, ADB Global Trends on Land Property Valuation **Stamatis Kotouzas,** Senior Land Administration and Geospatial Specialist, World Bank **Korean Experiences on Land Valuation** **Bong Joon Kim,** Manager, Korea Real-Estate Board
DAY 4 (3 November 2022) I Venue: KINTEX	
SESSION 8: KOREA'S ODA CASES SUPPORTING NSDI	
09:00-10:30	Moderator: **Yoonee Jeong,** Senior Digital Technology Specialist, ADB What We Have Learned from the National Spatial Big Data Project of Korean Government **Junyoung Choi,** Research Fellow, Seoul Institute of Technology The Government of Korea's ODA Cases in Supporting NSDI **Jongmin Lee,** Senior Manager, LX Corporation
SESSION 9: PROPERTY TAX MANAGEMENT SYSTEM	
09:00-10:30	Moderator: **Go Nagata,** Public Management Specialist (Taxation), ADB Global Trends on Property Tax Management and Valuation Systems **Paul Bidanset,** Consultant, ADB Property Tax and its linkage to NSDI **Stephane Gil,** Senior Manager, International Land Administration & Property Tax Management Specialist, ADB

SESSION 10: SMART CITY AND NSDI	
14:00-15:30	Moderator: **Arndt Christoffer Husar,** Senior Public Management Specialist (Digital Transformation), ADB WB's Approach for Climate-Smart Cities **Gyongshim An,** Senior Urban Development Specialist, World Bank Policy Framework of Climate Change of the Government of Pakistan **Syed Ashar Abbas Zaidi,** Deputy Secretary (Climate Change), Ministry of Climate Change of Pakistan **Slum Upgrading & GHG Emission Reduction Using the Business Model of CDM: Pilot Project in Pakistan** **In-Hyun Jeon,** General Manager, Global Business Office, LH **Korean Cities' Smart Response to Climate Change** **Jung Hoon Lee,** Professor, Technology & Innovation Management, Yonsei University
DAY 5 (4 November 2022)	
SESSION 12: COUNTRY PRESENTATIONS	
16:00 - 17:30	Moderator: **Arndt Christoffer Husar,** Senior Public Management Specialist (Digital Transformation), ADB Cambodia Kyrgyz Republic Republic of Kazakhstan Lao PDR Mongolia Nepal Philippines Tajikistan Timor Leste Viet Nam
SITE VISITS: Seoul Museum of History Smart Geo Expo 2022 Venue	

Opening Remarks

For centuries, countries have relied on maps (in printed form) for decision-making and other applications. Technological advancement over the years has made it possible to capture, store, process, and display an unprecedented amount of geographical and spatial information about society and a wide variety of environmental and cultural phenomena.

Spatial Data Infrastructures (SDIs) now play a vital role as location information is becoming essential in managing everything that governments manage — from roads and sewers, to education and public health.

In her opening address, **Ms. Xiaohong Yang**, Chief Thematic Officer, Sustainable Development and Climate Change Department at ADB, said a National Spatial Data Infrastructure (NSDI) is now "very, very critical for all development activities" as it serves as a "foundational infrastructure for the digital economy."

She said an NSDI is "not just a technology or an IT solution, but it needs very good institutional structure, data management, (and) sharing policy. Technical solutions, data and information services, operational and business models — all these are important elements of an NSDI."

As NSDI is built on spatial data and information services and maintained by a variety of public authorities as well as private entities, this means it demands a robust government coordination mechanism. And this is where the problem lies.

"Many countries have the national GIS in place but in most cases, they are operated in silos — i.e., the data don't talk among themselves, not integrated with other related information systems," she said.

This is where ADB could contribute. "At ADB, we recognize the value of NSDI for development activities. We want to be very much focused and provide more support to build NSDI in our DMCs," she explained. "Why is it important for ADB to do it? Because it is fundamental for the data economy."

She said ADB can use the Integrated Geospatial Information Framework (IGIF) developed by the United Nations and the World Bank for the management and development of geospatial resources. "For the transformation of digital economies, we support this framework, and we will collaborate closely with the UN, the World Bank, and other development partners," she added.

Through this workshop, she said DMCs, ADB and other international development partners will be able to find and promote integrated solutions in building NSDI.

As NSDI is built on spatial data and information services and maintained by a variety of public authorities as well as private entities, it demands a robust government coordination mechanism.

Ms. Xiaohong Yang, Chief Thematic Officer, Sustainable Development and Climate Change Department at ADB

Keynote Speech

Korea's Geospatial Information & Digital Twins

"Geospatial information is like air; you can't touch, you can't see it but without it, it's impossible to sustain life."

Dr. Song-wook Choi, Head of the Geospatial Information Division and Chief Executive Director, LX Corporation

In the 1950s, South Korea suffered a major blow when a tragic war broke out between South and North Korea. After the Korean War ended, the Republic of Korea's major infrastructure were more than 80% destroyed.

The nation, however, pulled out of the rubble and experienced remarkable growth in a short period of time, thanks to its heavy investment in key infrastructure in every generation: from logistics and automobiles in the in the 1970s to an expressway from Seoul to Busan to aid an export-led economic growth.

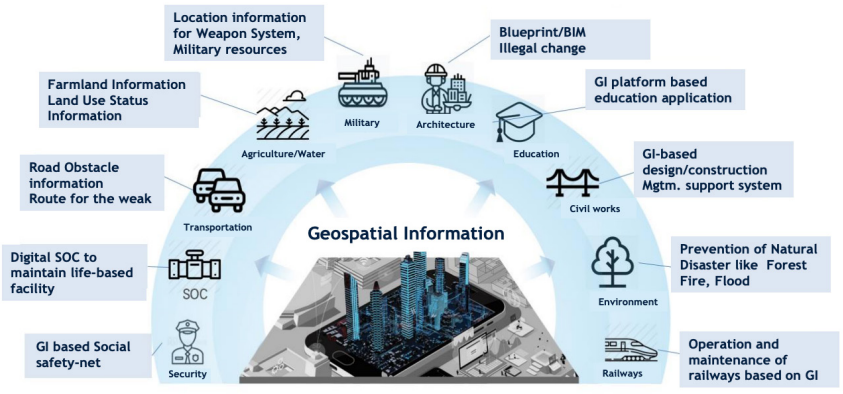
To overcome an IMF crisis in 2000, it invested in high-speed internet network. Now, the country is investing in geospatial information to support the development of a digital economic era, what it calls the New Future Industry.

Why We Breathe and Live GI

In his keynote speech, **Dr. Song-wook Choi**, Head of the Geospatial Information Division/Chief Executive Director of LX Corporation, likened geospatial information (GI) to air: "You can't touch it, you can't see it. But without it, it's impossible to sustain life." He cited these reasons:

- Over 80% of all information used in decision making is now based on geospatial information (GI).
- A combination of location and attribute information, GI provides understanding on the location and characteristics of natural or constructed features and boundaries on or about the earth.

Over 80% of all information for decision making is based on geospatial information.



- GI plays a role as "an engine and fountain for the 4th Industrial Revolution," enabling the safe and efficient operation of unmanned vehicles, the connection between virtual and real, the solution to urban problems (smart city), design, construction and maintenance, high-precision based location information (AI-IoT), GI-based convergence (Big Data).

Keynote Speech *(continued)*

Birth of Digital Twins

Dr. Choi said GI was only focused on people and activities in the past but as technology evolved, it gave rise to applications that move, not only people, but also machines and robots that people use and interact with. This led to the evolution of maps from paper-based to 2D to 3D which are becoming more experience-based.

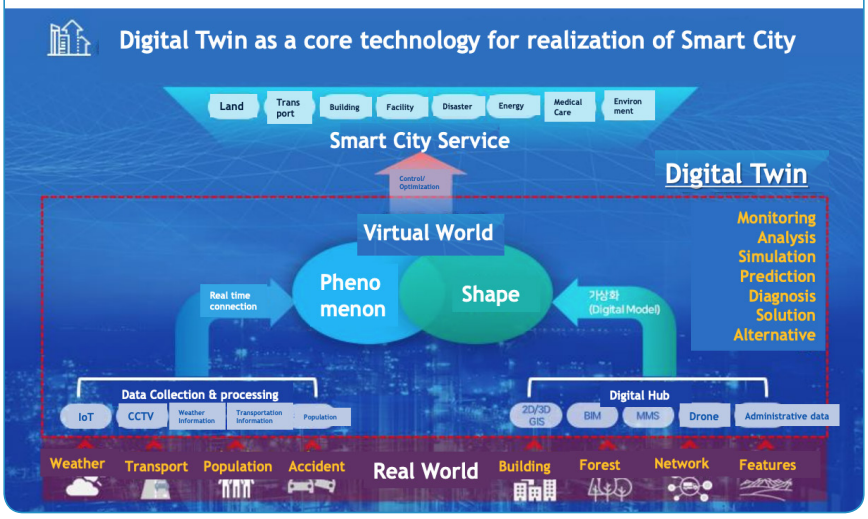
"GI-related technologies in the past were low capacity, low accuracy, and mostly 2D. In the future, the trend is moving towards 3D, high accuracy, and full-capacity maps and experiences. It takes full advantage of the latest ICT, making it possible to have multiple applications even more. With the Digital Twin, that's the direction forward," he added.

Digital Twin (DT) is defined as "technology that accurately models the real world in digital space (2D/3D) and then expresses changes that occur in real time, and predicts reality through analysis and simulation."

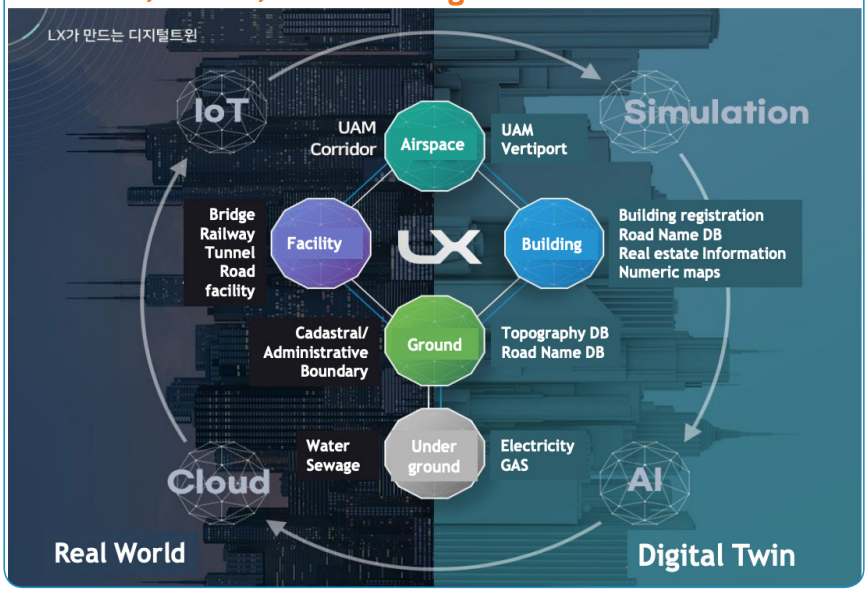
For the realization of Smart City, DT is used as a core technology. He said three things are needed to develop the DT: 1) data; 2) platform; and 3) services.

LX Corporation looks at three types of data: on the ground, underground, and airspace data. In the past, ground data for roads were analyzed in analog. With DT, it is now possible to study the traffic signal, billboards, road network length, slope or elevations, even the trees on streets. Underground data on water, sewage, electricity, and gas facilities can also be collected. Airspace data can be gathered using drone and urban air mobility technology.

Digital Twins is a core technology for a Smart City.



Data on, under, and above ground



A platform serves as a vessel for all this ground, underground, and airspace data collected. Using DT, the government can perform critical services such as building and infrastructure management; disaster response (by monitoring water levels and issuing alerts); and safety services, among others.

"Data collection is key and you have to be prepared to process all the data collected. Simulation, visualization and report generation are also important aspects," Dr. Choi said. Currently, LX is working with the Republic of Korea to use DT in managing industrial parks and complexes. LX is also devising a multiverse platform using the DT.

National Spatial Data Infrastructure (NSDI)

As the world becomes increasingly complex and interconnected, managing and addressing rapidly evolving economic, environmental, and social issues poses a challenge. Thankfully, there are now sustainable and innovative solutions that can guide informed decision making and issue management.

Using spatial data can help in intuitively understanding and interpreting conditions, events, relationships, and patterns. It provides key information and context that helps define, influence, and guide decisions and actions . From determining the best route to a destination, to performing long-term planning to enhance community resilience, a National Spatial Data Infrastructure (NSDI) serves as a place-based framework for connecting public and private data for understanding and decision making to deliver data, tools, and information to people.

In this session, moderated by **Thomas Abell**, advisor and chief of Digital Technology for Development at ADB, resource speakers presented the NSDI and its various applications to tackle today's challenges.

Using NSDI to Meet UN SDGs

In his presentation, **Andrew Coote**, Counsel of Norton Rose Fulbright LLP and member of the Geospatial Team of the World Bank, presented the implementation of the Integrated Geospatial Information Framework (IGIF) which was adopted by the United Nations Committee of Experts on Global Geospatial Information Management in August 2018.

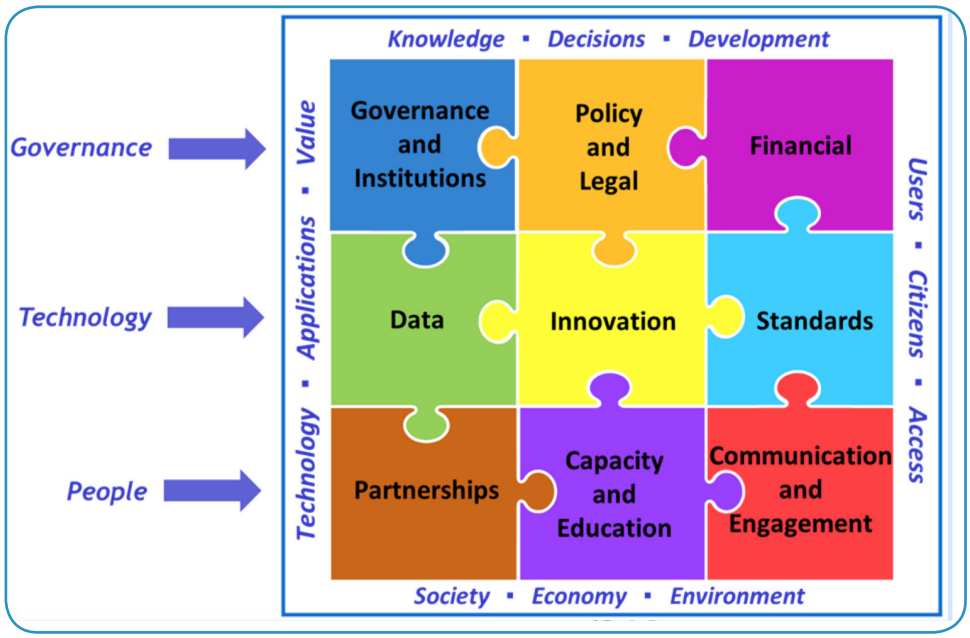
The IGIF was designed to aid in meeting the United Nations Sustainable Development Goals (SDGs) using geospatial technology and information. "UN SDGs rely on geospatial technology to achieve the targets and use location as an information integrator. In the national and local level, it is used for e-government/ digital twins, climate change adaptation and mitigation, smart and resilient cities, crisis response and preparation, precision agriculture — all requiring accurate and current geospatial data," said Mr. Coote.

In 2017, prior to the creation of the IGIF, the UN and the World Bank forged a partnership "to bridge the geospatial divide," he added. To strengthen national geospatial information management arrangements in countries, an integrated approach to geospatial information management is needed. This has to be aligned with national strategies and arrangements, and anchored into national development priorities.

This led to the creation of the IGIF which acts as a catalyst for economic growth and opportunity, and stimulates improved decision-making for national development priorities and the SDGs.

As an intergovernmental blueprint, the IGIF comprises three components:

1. The Overarching Strategy: Why geospatial information management needs to be strengthened and why it is a critical element of a nation's national priorities and development. It focuses on the role of geospatial information in



IGIF Strategic Pathways

The diagram shows the analytical tools (in orange), key inputs (in blue), the IGIF in purple, outcomes (in green). Arrows show the different types of information flows.

the digital age and how that information is integral to government functions at all levels.
2. Implementation Guide: What actions can be undertaken to integrate geospatial information with any other meaningful data to solve societal and environmental problems, and to provide understanding and benefit from a country's national priorities and development and the SDGs.
3. Country-Level Action Plans: How to build an IGIF for the nation, beginning with specific plans that align with a country's national priorities and circumstances. This details how the guiding principles, options, and actions recommended in the Implementation Guide will be carried out, when and by whom. It can be viewed as the "requirements document" for national implementation.

Mr. Coote said the World Bank is currently developing an action plan using IGF for the marine sector in the Philippines, Ho Chi Minh City's Smart City program, the Framework for Effective Land Administration (FELA) project in Viet Nam, Moldova, and Georgia.

Korea's NSDI Forged in Fire

In his presentation, **Dr. Daejong Kim**, Managing Director at the Geospatial Digital Twin Research Center of the Korea Research Institute for Human Settlements (KRIHS), shared the experience of the Republic of Korea in building its NSDI.

The nation's NSDI was born following a harrowing experience with two gas explosions that led to a devastating fire in Seoul in 1994 and in Daegu in 1995. These incidents resulted from poor management of information on underground pipes. The disasters prompted the Korean government to accelerate its efforts to update and integrate spatial data, such as underground maps. This meant removing bureaucratic silos and forging collaboration among agencies to establish a fully integrated geospatial data system.

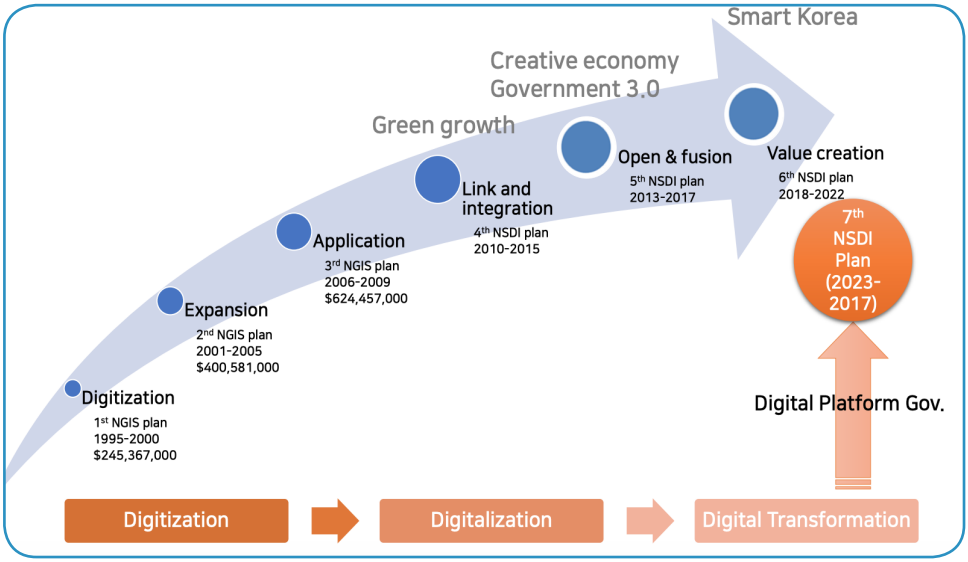
In 1996, the Ministry of Land, Transportation and Information (MOLIT) started with the development of an underground facility information management system and the development of a Public Land Information System. This proved to be challenging as various ministries were involved and there were too many regulations for land use. Reaching a consensus on how land-related information should be collected, managed, and shared was key to getting the projects off the ground. MOLIT, however, overcame these challenges by seeking mediation or windows of opportunity through higher bureaucratic channels.

By 2016, Korea's NSDI had not only prevented further disasters, but also dramatically reduced administrative costs and inefficiencies in the public sector. The integrated data system also enabled government officials to make better-informed policy decisions. About 90% of Korean government services is now related to geospatial information.

Over the years, investments in NSDI by Korea's central and national governments have been on a steady climb except during the IMF crisis in 2017. From US$4.9 million in 1995, investments jumped to US$210 million in 2021 by the central government and from US$81.5 million in 2007 to US$98.7 million by the local government in 2021.

Masterplan for NSDI

The Republic of Korea developed its first masterplan for national GIS between 1995-1999. The government publishes an NSDI strategic plan every five years and an action plan every year. The 1st NGIS plan (digitization) started in 1995. Korea is now moving to its 7th NSDI plan for digital transformation (digital platform government).



Currently, the Republic of Korea is developing an environmentally sound land use plan for Jeju Island using NSDI to protect underground water resource and the ecosystem, and conserve the natural landscape of the popular island.

To guide other countries in the pursuit of their own NSDI development, Dr. Kim shares some lessons from Korea's experience in NSDI implementation:

- Collaboration among state agencies is very critical.
- An institutional system is required for sustainability.
- Data accuracy and consistency with others is important.
- The NSDI has to be independent of commercial or specific software; otherwise, the financial cost can be high. When Google changed to a pay policy for its Google Maps services, Korean companies shifted to VWORLD which provided 3D data-based open platform service with many other spatial data, past aerial photos, indoor data, visual analytics tools and Open APIs.
- Strong political will and confidence are demanded from leaders.

"Our vision for the future is the convergence of the real and the digital world. The future of NSDI is probably NDTI (National Digital Twin Infrastructure)," said Dr. Kim.

Country Experience: Republic of Kazakhstan
Lyailya Satybaldina, Head of the Spatial Data Development Department of the Committee for Geodesy and Cartography, Ministry of Digital Development, Innovation and Aerospace Industry in the Republic of Kazakhstan presented the country's experience in building an NSDI.

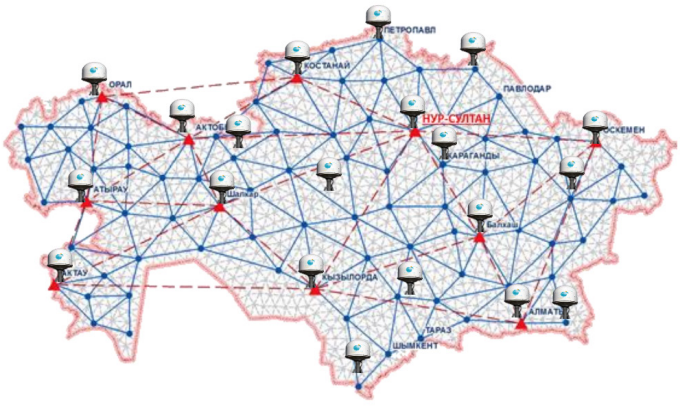
Currently, Kazakhstan has no satellite geodetic network and modern coordinate system. The coordinate base is represented by the coordinate system of 1942 which has no connection with international positioning systems in which modern geodetic instruments work.

This situation poses various challenges to the nation, including: outdated geobase, different coordinate systems, spatial data of various formats, land border overlays, and differences in standards and low levels of data accuracy.

The country plans to build an NSDI by 2021-2024. The project involves establishing a modern coordinate system and providing the territory of the country, including cities and district centers, with open maps. The government's "Digital Kazakhstan" action plan for 2018-2022 and the national project "Technological breakthrough through digitalization, science and innovation" for 2022-2025 include an NSDI. With an NSDI in place, Kazakhstan will be guided in its decision making on land relations, real estate, architecture and urban planning, forestry, subsoil use, agriculture, wildlife, ecology, and nature management, among others.

Establishment of a modern state coordinate system in Kazakhstan

The Republic of Kazakhstan plans to modernize its state geodetic networks, leveling networks, and gravimetric networks. It will have 86 reference stations comprising its modern state coordinate system.



QTRS
(Qazaqstan Terrestrial Reference System, state coordinate system of Kazakhstan)

Spatial Data Collection and GIS Technologies

If COVID-19 upended the world and accelerated digitalization at an unprecedented speed in 2020, extreme weather events and climate change altered the planet faster than ever before. This spawned a new set of requirements for spatial analysis, with geospatial technologies playing a more critical role in managing the pandemic and climate events, and in efforts to build a better world.

In this session, experts shared the rapid evolution of on location-based technologies and solutions that will enable countries to address the emerging challenges of the time.

NSDI Implementation in South Korea

In his presentation, **Mr. Won Kuk Lee**, Deputy Director, Planning and Policy Department at the National Geographic Information Institute (NGII), talked about the role and development of the NGII in South Korea.

As early as 1962, the country already put in place a Survey Act, but it took nearly four decades for a law providing for a National Geographic Information System to be enacted in 2000. This was followed by the passage of several laws until the NSDI was completed with the Framework Act on National Spatial Data Infrastructure created in 2015.

In 2014, the country's National Assembly passed three laws providing for a national spatial data policy: the Framework Act on National Spatial Data Infrastructure, an Act on the Establishment and Management of Spatial Data, and the Spatial Data Industry Promotion Act. These laws contain policies on generating synergy through a convergence of related areas (survey, cadastral, etc.) and promoting industrial development to foster the spatial data industry as a core industry of the creative economy. The three acts each requires a five-year plan (2021-2025). Currently, South Korea is implementing the 2nd Basic Plan for the National Survey Policy towards the realization of safe and convenient land management through smartification of survey.

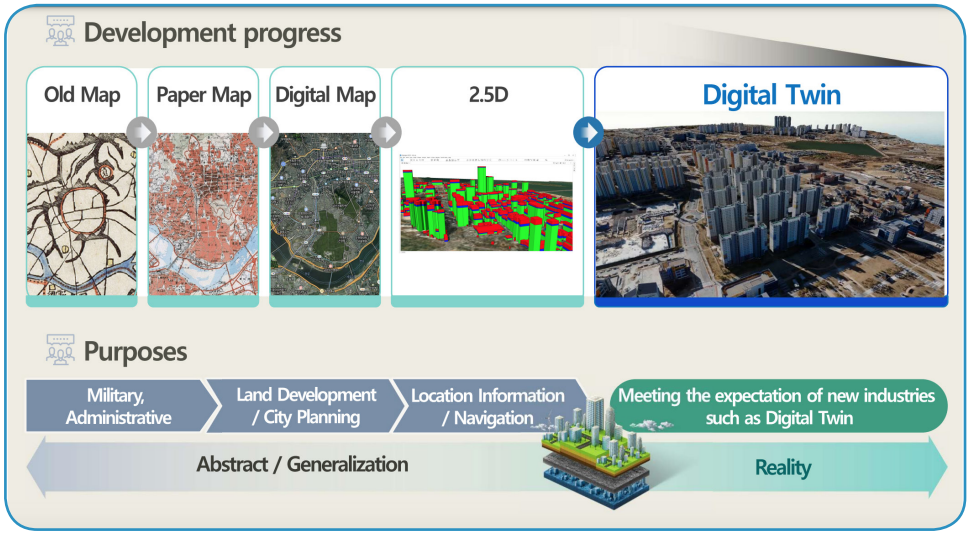
Tasked to implement the basic plans and masterplans is the National Geographic Information Institute (NGII). Founded in 1958 under the Ministry of Defense, NGII has an annual budget of US$120 million for 2023, 30% more than the previous year.

The vision for NGII is for the "realization of geospatial convenience for the people anytime, anywhere." Its mission is "to establish national datum and geospatial data." NGII's mains tasks also include the construction and management of national imagery data, a national spatial data database, national land survey and management of geographical names, and international cooperation.

NGII produces national geospatial imagery information system essential for mapping, recording changes in the national landscape through topography; providing high-resolution satellite images that can be used immediately for mapping, aerial photography and orthogonal imagery; and creating 3D spatial data. The data can be used for creating a national base map that guides administrative decisions such as building licensing, managing underground facilities, national land planning, large scale construction, and navigation.

Evolution of NGII

NGII produces old maps converted into 3D maps that can contribute to the digital twin of the future.



Since 2019, NGII has been operating the National Land Satellite Center to collect, produce, process, manage, and provide information acquired from the satellite and support land use and management tasks.

A high-definition road map is also being created to aid the commercialization of autonomous or self-driven cars. By 2025, all roads in the country are expected to have this map, said Mr. Lee.

K-Geo Platform

In his presentation, **Mr. Kwon Woseok,** Executive Director, Business Division, WAVUS Corporation, discussed the development of a cloud-based geospatial information platform in South Korea called the K-Geo Platform.

The country started collecting geospatial data 40 years ago through the Korea Land Information System (KLIS). KLIS gathers spatial data from 45 institutions and 85 information systems. All these go to a Real Estate Information System (REIS) and a National Geospatial Data Integration System (NSDI) which collect and provide the data to end-users. Cadastral and real estate data received by the REIS flow into the Spatial Information Dream, a platform for content creation and utilization. Spatial data received by the NSDI go to a National Spatial Information Portal and a Spatial Big Data Analysis Platform for public use.

Despite this system, Mr. Kwon said there are still challenges in data utilization, including aging system and lack of scalability, and the mindset of users that spatial data can only be used with the presence of professionals due to its complexity.

Institutions sharing the spatial data also maintain different database management systems so "collaboration is impossible," said Mr. Kwon. The cost of purchasing and maintaining foreign software have also been increasing, in additionto scalability issues.

"Twenty-five years since we started the National Geospatial Data System but users still cannot customize the data for their own purpose," said Mr. Kwon.

This led to the development of the K-Geo platform which took three years to complete from 2020. The platform provides free use of spatial information and conversion of administrative services. In 2021, the REIS and NSDI were converted into open source (cloud). A Developer Support Center was also launched so users can customize the data. In 2022, a 3D analysis tool was added to enable local governments and other users to study and customize 3D maps.

"Before the K-Geo platform, we were only focused on data collection. Now, we can play freely and do anything on the 'playground' and use the K-Geo platform easily for any purpose," said Mr. Kwon.

Once the K-Geo platform has been opened, the Ministry of Land, Infrastructure and Transport will use it as a base system for administrative processes. Vendors of the Ministry have to use the system to provide a platform, thus shortening the development time and save costs. Vendors can also add their system to the K-Geo platform.

Play and Do Anything

The K-Geo Platform provides free use of spatial information and conversion of administrative services. It was designed so administrative agencies can "play freely and do anything on the 'playground' using the K-Geo platform easily for any purpose.

Spatial Data Collection and GIS Technologies *(continued)*

Earth Observation Technologies

On September 28, 2018, a 7.5-magnitude earthquake and tsunami hit the island of Sulawesi in the Republic of Indonesia. The natural disaster had far-reaching effects as it destroyed homes and claimed hundreds of lives. The disaster left thousands of people seeking access food, water and shelter.

The 2018 disaster and the need to rebuild back better in the aftermath turned the spotlight to the development of a National Data Geoportal for Disaster as Indonesia sits on the Pacific Ring of Fire, a region around much of the rim of the Pacific Ocean where many volcanic eruptions and earthquakes occur.

In his presentation, **Paolo Manunta,** Senior Infrastructure Specialist (Earth Observation) of ADB and the European Space Agency, talked about the role of satellite sensing capabilities integrated with geographical information systems that Indonesia needed to manage future disasters and rebuilding efforts.

He said Indonesia's initial strategy is to utilize geospatial data derived from comprehensive statistical activities and comprised of periodic information on the structure and growth of the economy, social changes and development. These were collected by the Statistics Indonesia office. "Although not providing maps, the office provides information to elaborate on more maps that were usually geocoded," he explained.

In June 2019, a Presidential Decree was issued to create Satu Data Indonesia (One Indonesia Data), a government data management policy to generate reliable, accurate, up-to-date, integrated, and easily accessible data that can be shared and used by the stakeholders.

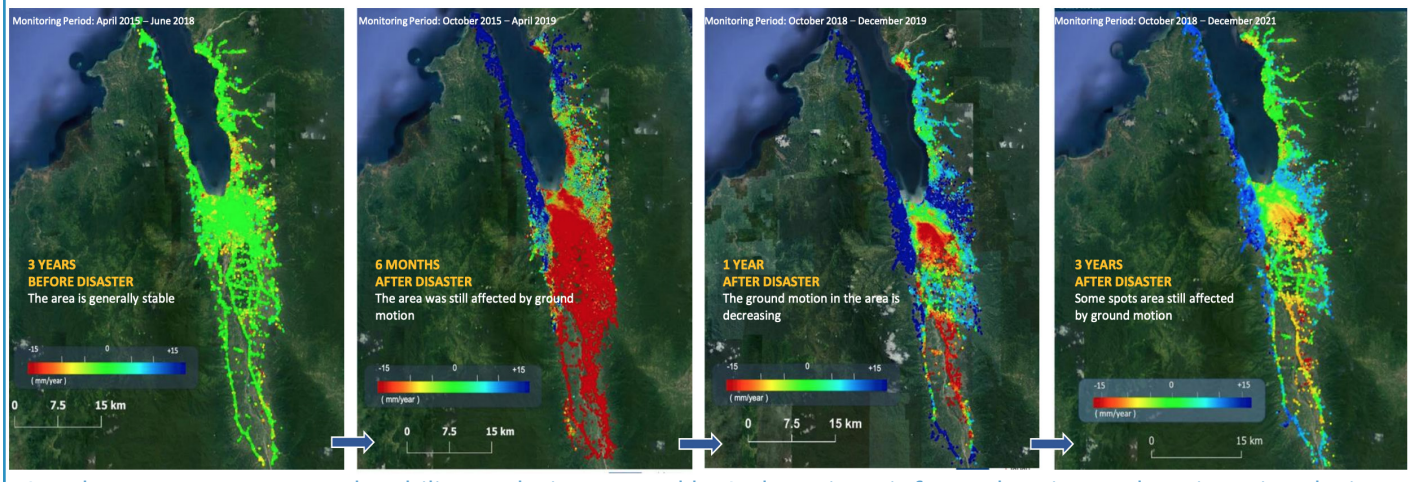
Portal Satu Data Indonesia, Indonesia's official open data portal, was also created to improve data governance management to support the implementation of government transparency and accountability, as well as support national development.

The government also built the INA-Geoportal as a national geoportal that connects various ministries, institutions, provinces, and regions that are partners in connecting the National Geospatial Information Network (JIGN) node. Users can use data analysis, geoprocessing, geotagging, drag-and-drop data files with open source-based map viewer technology.

Agencies involved were divided into two groups: the information providers and the decision makers. The Ministry of Public Works and Housing was put in-charge of reconstruction efforts after the disaster and the development of new information and web maps on disaster management.

Under the National Data Geoportal for Disaster were three groups: BRIN space agency for satellite imagery, InaRISK under the National Agency for Disaster

Earth Observation Application



Land movement maps and stability analysis are used by Indonesia to inform planning and engineering designs and to support reconstruction and rebuilding efforts.

Countermeasure (BNPB) for data analytics, and the Meteorology, Climatology, and Geophysical Agency (BMKG) for tabular data, web map, and tsunami early warning.

Indonesia started with a localized undertaking to produce a proof of concept before rolling out its national geoportal system on a national scale. It also partnered with private firms and international agencies with expertise on remote sensing. The target outputs are to have better data, better project design and solution, an earth observation-based platform, and an improved national data portal.

Mr. Manunta said Indonesia also successfully integrated the geospatial component as part of a bigger US$200-million ADB loan.

It also realized "there was no need to recreate what BRIN can provide but just complement it with powerful solutions. So we tapped a cloud solution for all land disasters, flooding, and building monitoring," he added.

The government utilized Rheticus®, an automatic, cloud-based, geoinformation service platform that proved extremely useful in analyzing land movement and stability. Rheticus was extensively used to inform planning and engineering designs and to support the implementation of the government's "Build Back Better" reconstruction program. The Rheticus Building Check was also used for constant monitoring and predictive analysis of building movement patterns that allow local authorities to quickly detect structural instability.

"The Rheticus Building Check can discriminate which buildings are in good shape and which ones require further inspection. Buildings get an ID that shows building stability and movement over time. This same approach is applied to roads and railway operators," Mr. Manunta explained. "Through this, we can understand ground movement trends, pinpoint areas with high levels of stress, and plan and prioritize inspection activities — move from reactive to proactive."

By 2030, the Government of Indonesia expects to develop, launch and begin operations of a national earth observation satellite to include optical cameras. Mr. Manunta said the challenge now is injecting earth observation into the national data system.

Country Experience: Republic of Nepal

In her presentation, **Ms. Karuna KC,** Deputy Director General, Survey Department of the Ministry of Land Management, Republic of Nepal, shared the agency's role as a national mapping organization.

The Survey Department is tasked with:

- Standardizing surveying and mapping authorization specifications for maps and data prepared by various state agencies;
- Regulating surveying and mapping activities of agencies; and
- Serving as Secretariat of the Surveying and Mapping Committee.

In line with the UN-World Bank's Integrated Geospatial Information Framework (IGIF), Nepal created an NSDI Clearing House which informs the general user about the data by creating metadata. This is expected to pave the way for data accessibility through the website, *www.nationalgeoportal.gov.np.* Currently, around 50 of the 126 survey offices have already been linked to the system.

The Survey Department has also completed land use mapping at the rural and municipality levels for all 753 local levels. Data have been turned over to respective local authorities who are now implementing the country's Land Use Act and related rules based on these maps. However, only cadastral maps are currently being shared with the cadastral department, tax administration, and land registration offices.

Future plans of the department include:

- System deployment to all survey offices
- Production of multipurpose maps and data for infrastructure development
- LiDAR survey of whole country
- Large-scale mapping
- High-resolution digital terrain model, orthophotography or orthophoto generation
- Establishment of Continuously Operating Reference Stations (CORS)
- Enhancement and strengthening of clearing house and metadata
- Exploring usability of unmanned aerial vehicle (UAV) for cadastral surveying
- Application of UAV for large-scale topographical mapping
- Application of UAV for disaster mapping supporting post-disaster activities

Spatial Data Utilization and GIS

Spatial data provides information that identifies the location of features and boundaries on Earth. The most common way that spatial data is processed and analyzed is using a geographic information system (GIS). These are programs or a combination of programs that enable users to make sense of their spatial data. This includes management, manipulation and customization, analysis, and creating visual displays.

In this session, experts shared how spatial data and GIS are used for various applications and how these can guide in decision making and development planning.

GIDS: Beyond Information System

Dr. YoungJoo Lee, Research Fellow at the Korea Research Institute for Human Settlements, presented the role of a Geospatial Information Distribution System (GIDS) and shared his expertise on how to set up policies on GIDS.

GIDS is not only about an information system but more about data distribution. "Not sharing geospatial information data might lead to duplication and inconsistency so it will just be a waste of budget and lead to reduced national competitiveness," said Dr. Lee. In many countries including South Korea, legislations focus on the exclusiveness of geospatial information as a semi-public good.

However, "treating geospatial information as a semi-public good limits its use to the public sector. In order to develop the industry, geospatial information should be treated as a public good and non-exclusive which means everyone can have access, not just government," Dr. Lee said.

A typical GIDS model involves collection, processing and management, and provision of data.

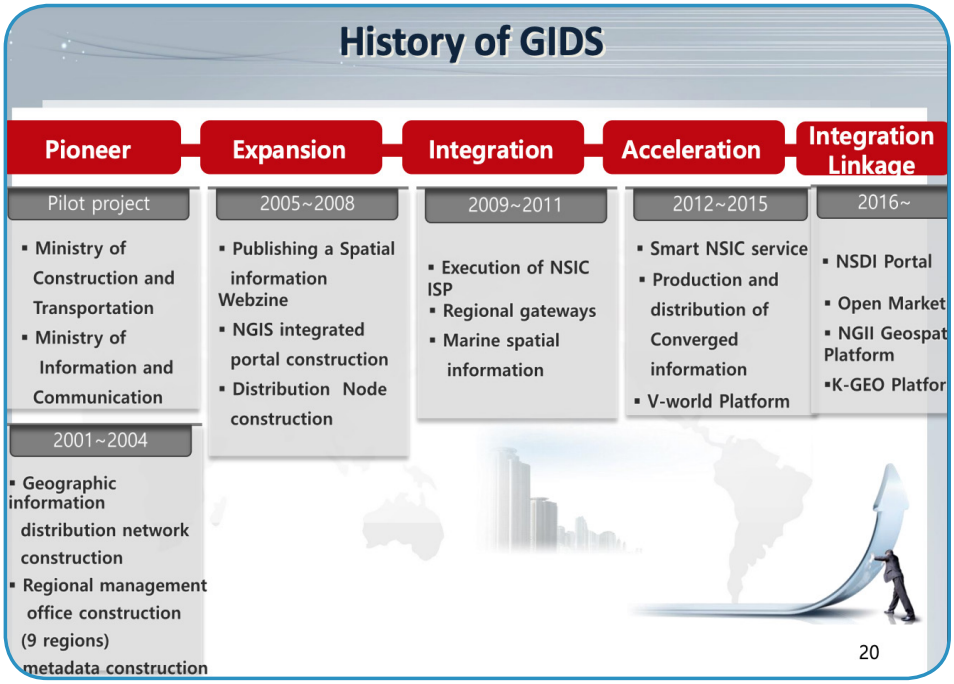
There are three types of GIDS: 1) Clearing house: Search Metadata to locate and get details of geospatial information — i.e., Library Catalogue; 2) Portal (Geospatial One Stop or GOS): Direct provision of data and service; and 3) Geospatial Platform: Comprehensive service and data provision combined with user participation.

In the case of South Korea, map distribution started when the National Geographic Information System (NGIS) commissioned survey companies to produce the maps then consigned outside organizations to sell them.

Map digitization started in 1995. However, there was no information exchange among state institutions that produce the spatial data so the data were repeatedly created. Users also did not know where to get spatial data and how to use it. This led to the creation of the National Spatial Information Clearinghouse (NSIC).

Evolution of GIDS in South Korea

The lack of information exchange among institutions that produce the spatial data led to the creation of the National Spatial Information Clearinghouse (NSIC).



Created in 2000 by the Ministry of Construction and Transportation, the NSIC served as a central institution to manage and distribute the spatial data produced by NGIS and others.

In its initial stage of development, the NSIC set up one central office and nine regional gateways for data collection. It then created a software to serve as a linkage for collecting data from the local government. Previously, only the public sector can provide data to NSIC. This evolved to include the private sector and individuals which can distribute data through NSIC and make it their geospatial information marketplace.

For countries establishing their GIDS, Dr. Lee recommended:

- Addressing the shift from analog to digital for the GIDS to be relevant to technological development;
- Recognizing that GIDS is an integrated system of hardware, software, spatial data, user/supplier, legislation, and policy — and not as information system — to come up with a concrete distribution policy; and
- Select a type of distribution system suitable for the country's social circumstances.

Future-Proofing the Past

Mr. Siro Kim, Deputy Director of the ASEAN-Korea Cooperation Cooperation Fund, presented the use of spatial data for preserving cultural heritage through digital archiving.

In his presentation, Mr. Kim discussed the Heritage Digital Archive Center which was established in 2012 as a non-profit organization whose purpose is "to research, optimize, and systematize digital methods for the archiving and preservation of cultural heritage."

With funding from the ASEAN-Korea Cooperation Fund, the Center embarked on a UNESCO World Heritage Digital Content Development Project that aims to develop content based on the major UNESCO World Heritage Sites in 10 ASEAN countries. By sharing digital archiving methods and technologies and establishing cooperation network for the exchange and utilization of cultural heritage digital archive material, the Center will help strengthen ASEAN-Korean relations. The Center is also developing content for a Virtual Reality Room in Busan's ASEAN Culture House.

To create the digital archive, the project team used aerial drones and DSLR camera to capture every inch and surface of the cultural heritage sites. The spatial data and 3D coordinates obtained enabled the Center "to create a true digital twin with dimensions identical to the physical structure. Photos were used to color and we used 3D modelling to supplement finer details," Mr. Kim explained.

From 2017 to 2019, the Center was able to produce thousands of photos, laser scans, and videos of the UNESCO World Heritage Sites in all 10 ASEAN member countries.

Preserving UNESCO World Heritage Sites

Ten ASEAN member states are participating in archiving and producing VR of their cultural heritage sites.

Spatial Data Utilization and GIS *(continued)*

To build this digital archive, the project team used photogrammetry to stitch together the photos and create polygons. The heritage sites were reconstructed with accurate textures, colors, and dimensions by utilizing real-world 3D data from laser scans and photogrammetry.

Aerial drones were used to quickly capture high-resolution footage of vast areas of UNESCO sites, both for the 360° virtual reality content and 2D mapping purposes. "Aerial photography was also crucial for filling in 'blind spots' in our scan data," said Mr. Kim.

Surveying techniques also enabled the project team to identify specific locations in terrestrial and aerial photography in three dimensions. "From there, we were able to combine the data and create point clouds and mesh models of the exterior and interior of each heritage site," he explained.

Incorporating the scan, photographic and floor-plan data of each World Heritage Site, the project team developed high-quality models that are not mere visual representations, but contain real-world topographical and spatial data.

These data will significantly contribute to efforts in protecting and managing heritage sites under the ASEAN Tourism Strategic Plan (ATSP) 2016-2025, Mr. Kim added.

Country Experience: Kyrgyz Republic

In his presentation, **Mr. Zhakshylyk Toktosunov,** Director of SOE "Cadastre" under the State Service for Land Resources, Ministry of Agriculture of the Kyrgyz Republic, shared the establishment of an NSDI in Kyrgyzstan.

The country's goal for setting up an NSDI is to have standardized and uniform rules for the presentation of data, metadata, and services.

In 2019, a government decree led to the creation of a roadmap for the implementation of the Digital Transformation Concept called "Digital Kyrgyzstan 2019-2023." The roadmap included: the phased establishment of the NSDI to create Kyrgyz Republic's geo-information portal; the creation of a cartographic base and a system of geodetic support; and the application of geospatial data for statistical purposes such as the population and housing census, statistical maps, and dissemination of statistical information.

To establish a geoportal, the government needed to:

- collect existing maps to support statistics across the country;
- develop principles, standards, and procedures for data exchange between relevant data holders in Kyrgyzstan;
- set up an online portal (geoportal) for data dissemination;
- generate photomaps and line charts to support the preparation and publication of statistical data;
- use aerial photography results as a base map in the geoportal.

In creating the NSDI, the government identified how it can optimize the use of existing spatial data to avoid wasting resources. It also established uniform conditions and tariffs for the provision of spatial data.

Spatial data to be made available in the Geoportal are the following:

- Cadastral data (Digital terrain models, primary and orthorectified data from aerial and space surveys, unified address system, administrative boundaries, and cadastral information)
- Geological data
- Water resources data
- Natural disasters data
- Forest resources data
- Static data

This spatial data will be useful in producing land use maps; an address register; databases for the Ministry of Emergency Situations, State Agency for Forest Resources, and State Agency for Water Resources; and an Open Data Cube.

The Open Data Cube provides an efficient means for storing and accessing satellite data and derived products. It contains a historical archive of data and is continually growing as new satellite data is automatically acquired and processed.

The Cube is at the heart of the SIBELIUS project, which provides improved pasture monitoring capabilities in Kyrgyzstan to support the country's large and economically significant herding community. Through satellite earth observation, Kyrgyzstan is able to efficiently monitor pasture, snow and drought over inaccessible regions, aiding in pasture management decisions and preventing the degradation of pasture regions in the hills and mountains, a growing problem in Kyrgyzstan.

Integrated Land Information System

Today's world is vulnerable to climate impacts such as flooding, drought, water scarcity, and heat stress. To manage these risks, countries turn to integrated land use planning as a strategy for mitigation as well as for national development.

Integrated land use planning entails having an efficient and effective land information system (LIS) that will inform legal, administrative, and economic decision making and policy creation in government, including taxation and revenue and security of land tenure for the citizens of a country.

In this session, experts share how countries can reap and maximize the gains from LIS and aid in their climate change strategy.

Integrating LIS

In his presentation, **Simon Jeon**, Manager, Global Business Department of the Korea Land and Geospatial Informatix Corporation, discussed the LIS of the Republic of Korea.

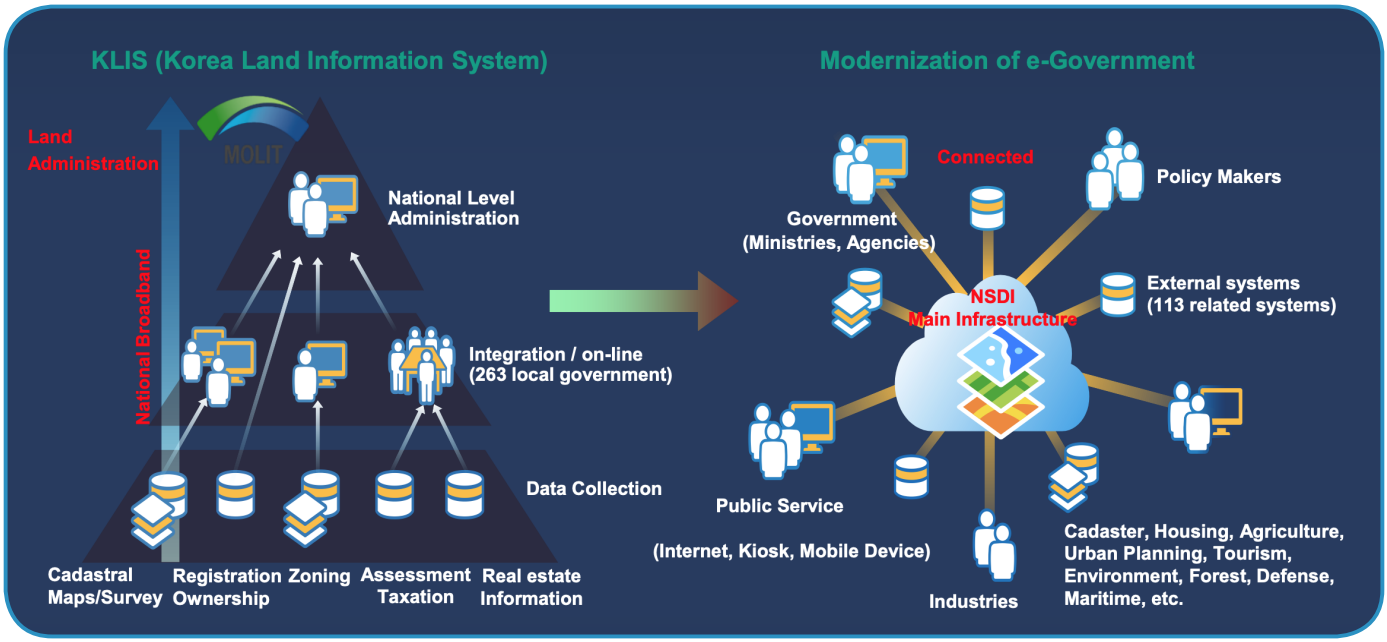
Currently, there are two land administration authorities in South Korea. The Ministry of Land, Infrastructure and Transport (MOLIT) is in-charge of the cadastral sector, i.e., land-related policy making, guidance and supervision, cadastral administration and services, topographic mapping, property valuation. The Supreme Court oversees the land registry sector, i.e., property registration (titling) and property information management.

Korean citizens have access to land information service, both online and offline through kiosks located in community centers, bank and marts. They can get their real property certificates printed anywhere, anytime.

However, South Korea's land sector was still besieged by problems such as having heterogeneous data, informal processes, duplicated systems, and different views from different departments, said Mr. Jeon. This prompted the creation of the Korea Land Information System (KLIS) in parallel with the evolution of Korea's e-government which started in 1996 and was launched in 2000 (KLIS Phase 1 also started in 1996 and its online service in 2010.)

After Korea undertook map digitization in 2003 and established a database, two systems were created: the parcel-based Land Information System in 2001-2008 and the Land Management Information System. These systems led to the creation of the KLIS by MOLIT. KLIS was eventually integrated with the Supreme Court's registry system to form the Korea Real Estate Administration Intelligence System.

KLIS is a national system infrastructure supporting 14 administrative processes such as land, cadastre, property, and urban planning. It provides 48 kinds of information services online.



Integrated Land Information System *(continued)*

Using KLIS, there is no duplication of work, saving time in public service; no conflict of interest; increased transparency and tax revenue, thus promoting transactions and utilization.

Most importantly, KLIS supports the modernization of e-government in South Korea, making transactions seamless and efficient. Currently, a total of 263 local governments are integrated online.

Global Trends in Integrating LIS

In his presentation, **Mr. Patrick Stimpson,** Project Manager, Land Administration Specialist, of the French company IGN FI, a global geographic information company, shared his insights into the global trends on integrated land information systems (LIS).

LIS is the main tool and source of information for land data management, which includes land registration, cadastral survey and mapping, land adjudication and titling, physical planning, and land valuation. To differentiate from a Land Information Software, the integrated LIS is a multi-component system involving system monitoring, IT infrastructure, people, data, software and hardware, security, legal framework, and communication.

As multi-component systems, LIS have considerably evolved during the last decades, particularly in terms of legal framework and institutional reform, digital spatial data capture/conversion, and technological aspects.

"One of the main issues for LIS is an outdated legal framework which doesn't recognize digital documents and doesn't support digital procedures and new technologies," said Mr. Stimpson. To address these issues, some countries have adopted modern land administration that allows digital documents and digital processes including digital security policy, a robust IT infrastructure, digital signature, and cloud hosting.

A modern LIS also requires up-to-date spatial data as the spatial basis for all land records and information. "LIS without accurate and reliable data is like a car without fuel," Mr. Stimpson said.

This need gave rise to the utilization of various technologies for data capture and conversion, including mobile solutions (GNSS-enabled tablets with orthorectified imagery), crowdsourcing (OpenStreet Map, Wikimapia), and emerging technologies based on AI such as automatic feature extraction and change detection.

However, converting legacy data into digital spatial data poses some challenges. Print-based documents have to go through a physical or manual process of rehabilitation or reconstruction, for one. So before converting legacy data into digital spatial data, Mr. Stimpson advised to first find out the data model used in the LIS. Information captured during this digitization will feed the LIS. If possible, use dedicated transactions for data conversion which will directly populate LIS databases. This will facilitate the integration in the LIS, he said.

Web-based and workflow-driven LIS is also becoming a trend. These enable the conversion of client/server applications into web services and applications, off-the-shelf software into open source platforms, data model into web map and layers, custom applications into customizable templates, stand-alone desktop into web client with browser, and static data into real-time data.

Another trend is the use of workflow engines and business rules engines to standardize procedures even among different offices. Decentralization enables users access to land services, the transfer and sharing of responsibilities to the local level (regional offices), and the creation of a "one-stop shop" for land services as part of other administrative services.

The use of blockchain technology (BT) has also led to improved transparency and reduction of fraud and forgery, easier auditability, and speed and efficiency of transactions. However, land administration authorities are still not prepared to use BT due to challenges related to the codification of legal operations into standard digital contracts, among others.

As proven in the case of the Republic of Uganda, having an LIS boosts economic development in terms of land revenues. LIS increases the security of land tenure, promotes access to finance and investments, efficiency in land market dynamic, and contributes to infrastructure development, said Mr. Stimpson.

Land Use Planning

Country Experience: Republic of Mongolia

In his presentation, **Mr. Bayantumen Purevdorj,** Head of Land Cadastral Division Agency for Land Administration and Management, Geodesy, and Cartography, talked about the current state of the unified land cadastre system in the Republic of Mongolia.

In 2001-2009, the Government of Mongolia implemented the "Cadastre Mapping and Land Registration" project using ADB loan. This led to the creation of a land cadastre database which is used for the cadastral mapping and land registration, covering 132,497 units.

The government invested in improving the National Land Cadastre database between 2013 and 2016 using modern techniques and technologies. This gave birth to the Unified Electronic Cadastre System which is used by 22 provinces and 339 sub-provinces in Mongolia. This system forms part of the Land Unified Classification Management Online System (LUCMOS) which covers geodesy and cartography, basic research, address, monitoring, planning, land exchange, evaluation and payment, cadastre, and urban development. The LUCMOS is integrated with Mongolia's National Spatial Data Infrastructure, making the system easily accessible to the public and private sectors.

Among the benefits of having an integrated national land management system are the improved productivity of state departments, reduced costs, greater transparency, and faster resolution of land disputes and other legal issues.

Around 57% of the land on earth is uninhabitable. As land is a finite resource, land use planning plays a critical role in developing habitable spaces for use now and to sustain future generations.

Without a proper land use plan, cities and communities would be in disarray. Communities would be unsafe, the environment would be damaged and resources wasted. Thus, land use planning ensures the orderly development of land in a way that protects the environment, conserves resources, enhances a community, and provides for transportation, industry, and economic needs.

In this session, speakers shared their insights into land use planning system and why it is vital to economic and social development.

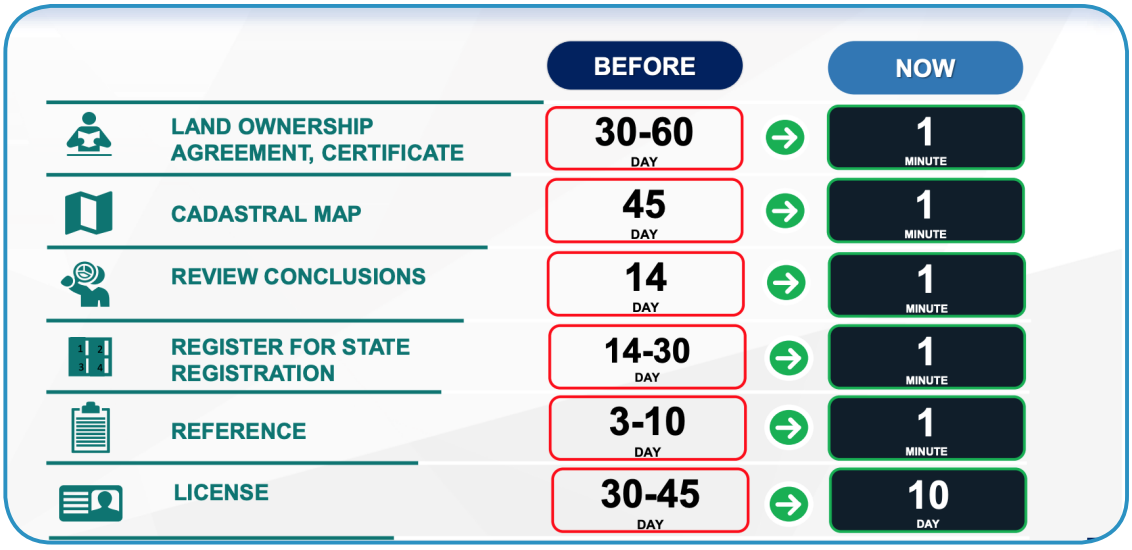
Global Trends in Integrating LIS

Mr. Jeong Ho Moon, Senior Research Fellow, Korea Research Institute for Human Settlements and Construction, presented the state and evolution of land use governance in the Republic of Korea over the years.

In the context of territorial planning, the country's land use policies were largely dictated by the rapid growth of urbanization and the expansion of urban areas in the 1960s and 1970s. National territorial development during this period mainly focused on economic growth and regional development through developing resources and fostering key industries such as steel, automobiles, and machinery.

Mongolia's Land Unified Classification Management System

Making public services fast and more efficient



Land Use Planning *(continued)*

To support its policy of export-led economic growth, the Government of Korea built a massive logistics infrastructure. This led to the construction of the Kyungbu Expressway in 1968-1970 that linked the nation's capital Seoul to the second-largest port city Busan, which became the symbol of Korean success.

Over the years, Korea's Comprehensive National Territorial Plan (CNTP) evolved with the demands of the times:

- 1st CNTP (1970s) > Maximization of growth potential with limited resources: Developing large industrial estates and metropolitan regions and investing in high-priority Infrastructure (expressways, ports) and links to major industrial estates
- 2nd CNTP > Spreading growth across the nation: Limit overconcentration in Seoul, develop multiple growth poles in the nation, reduce regional disparity, consider environmental aspects on territorial development
- 3rd CNTP > Establishment of "multi-centered" territorial structure: Focus on development of the west coast industrial sites and local cities, a comprehensive transportation network, expand South-North Exchanges, prepare for a unified Korea
- 4th CNTP (2000) > Balanced regional development and open and integrated national territory: Build π-shaped territorial axis to serve as "strategic gateway," promote regional competitiveness through industrial clusters and regional innovation system, build a high-speed transport network

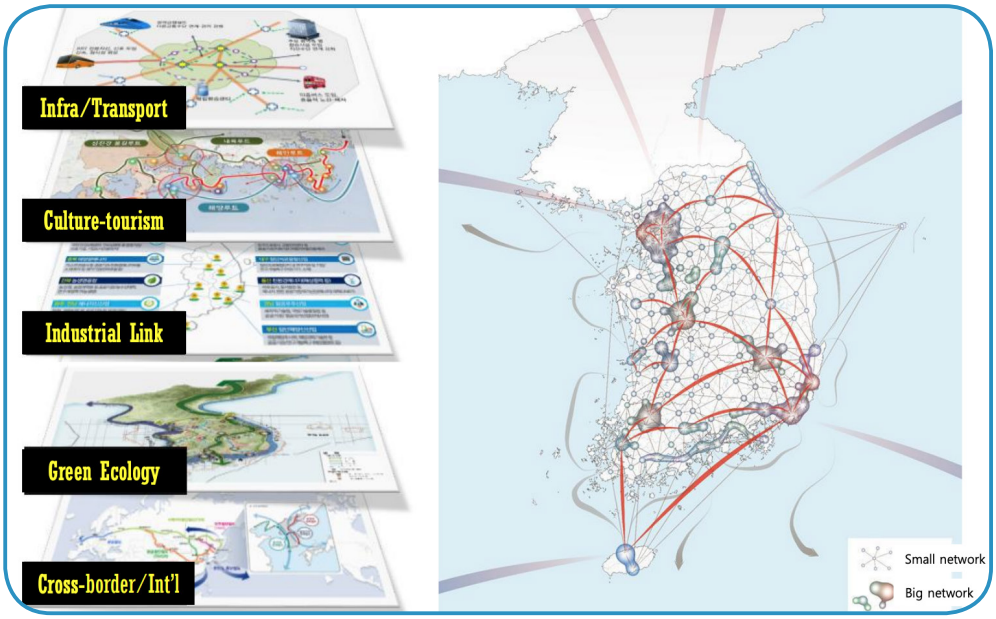
After South Korea became a member of the OECD and became a mature economy, enhancing regional competitiveness became the main thrust of the CNTP. By 2008-2012, spatial planning shifted to making Korea "global" and "green" by identifying areas for competitiveness, eco-friendly development, high quality of living, and for the global market.

The 5th CNTP will serve as a long-term territorial (spatial) policy and plan for 20 years (2020-2040), as the nation faces emerging challenges in the future such as climate change and increasing demand for quality of life, the 4th industrial revolution, weakened economic potential, uncertainty over the South-North Korean relationship, and growing decentralization and intensified desire for public participation in state affairs.

The state's vision under the 5th CNTP is "The Territory for all, enjoying space together." To achieve this, the CNTP will focus on creating flexible spatial units and forming smart territories, institute changes in its legal framework and territorial-spatial administrative hierarchy.

5th Comprehensive National Territorial Plan

Flexible spatial units and formation of smart territory in South Korea



It also called for a land use planning scheme that is more complex as it is based on patterns of urban growth, development axis, transportation axis, preservation axis, population forecast, among others.

Forecasting future land demand will be based on land use (residential, commercial, industrial), future population, development density, characteristics of the city, and higher level industrial policy, among others.

To determine all these requires generating a lot of data. Good thing Korea has developed a robust Land Information System over the years. In the early 2000s, National Geographic Information Institute (NGII) completed the digitization of the national land map. A land image database (containing aerial photographs, ortho-images, and digitized altitudes) has been completed since 2010 and is being updated annually since 2021.

A National Land Information Platform also offers services such as digitized maps, aerial photographs, historical maps, satellite images, emergency geographical information, open API, national land survey report and much more.

Since 2007, the Ministry of Land, Infrastructure and Transportation (MOLIT) has been providing the public a Land Use Regulation Information Service, which enables ordinary citizens as well as public officials to find and use land use regulation information.

Since 2011, urban planning information, public notices, and GIS-based map service have also been made accessible through a mobile app.

Information System for Urban Planning in Seoul

Dr. Taehyun Kim, Senior Research Fellow, Center for Technology Innovation, Seoul Institute of Technology, shared the experience of establishing the Urban Planning Information System (UPIS) in Seoul.

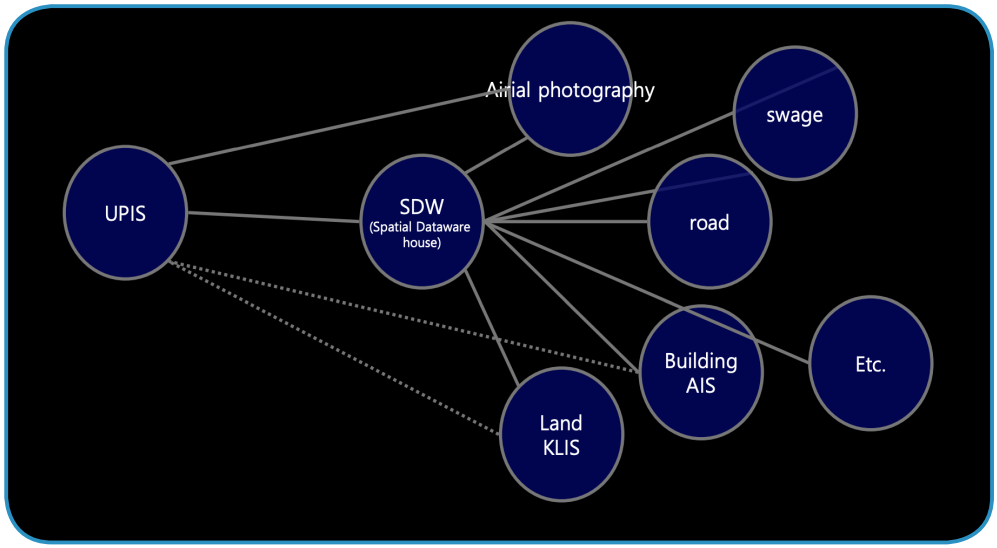
The planning and establishment of the UPIS started in 2000, with the aim to provide the urban planning information of Seoul promptly and accurately and support officials' decision making in urban planning.

Before the UPIS was launched, informing Korean citizens on the plans or decisions regarding urban planning were only posted on bulletin boards in front of government offices or on various websites. These proved too difficult and abstract for citizens to understand.

Along with the rapidly increasing population was the growing demand for more urban planning information. This prompted the City Government of Seoul to set up an Urban Planning Information System (UPIS) based on GIS and the urban planning portal. This made public disclosure of information transparent and efficient.

UPIS of the Seoul Metropolitan Government

Spatial data provided



Land Use Planning *(continued)*

The establishment of UPIS also made IT-based planning and processes essential. As some of the urban planning cases of Seoul take around 10-20 years to complete, recording and preserving a vast amount of administrative documents took longer due to the physical limitations of retaining and managing paper-based documents. The UPIS also harnessed various multimedia and contents such as 3D models and videos to make the visualization of information easier to understand. To address disruptions from frequent personnel changes, vertical and horizontal knowledge sharing was employed.

With this, the Seoul Metropolitan Government is now able to provide information on aerial photography, roads, water and sewage systems, buildings, land, and other aspects vital to urban planning.

Country Experience: Kingdom of Cambodia

In their presentation, officials of the General Department of Land Management and Urban Planning in the Ministry of Land Management, Urban Planning, and Construction, talked about the state of land use planning and future directions in the Kingdom of Cambodia.

Land use planning is currently governed by a policy and legal framework that focuses on four key priority areas: human resource development, economic diversification, promotion of private sector development and employment, and inclusive and sustainable development.

Spatial planning, while a rather old discipline, is relatively new to Cambodia. To promote political decentralization and administrative de-concentration that started in the early 2000s, the Royal Government of Cambodia has developed a set of legal documents and policies to serve as foundations for spatial planning at sub-national levels (province, district, and municipality).

Laws, implementation sub-decrees and detailed procedures for spatial planning have been drafted and approved to support the development of sub-national spatial planning at provincial, district and municipal levels. Various ministries govern land use and addressed in sector policies and plans.

To provide for a sustainable territorial development, the government, through the Council of Ministers, approved the National Policy on Spatial Planning in 2011. The National Committee for Land Management and Urban Planning (NCLMUP) served as the lead agency to implement spatial planning in Cambodia.

While NCLMUP and the respective sub-national committees are established, existing experiences on spatial planning are still limited in the country.

The government's future direction is towards integrating land use planning and management into the National Spatial Data Infrastructure to achieve economic growth, sustainability, and social stability in Cambodia.

Development of infrastructure and 37 urban roads in Cambodia

Land Tenure Management

Strengthening land and property rights plays a central role in efforts to end poverty, reduce hunger, and promote resilient communities. Land tenure management determines who has rights to use what resources, for how long, and under what conditions. Clear and secure land rights aid in food security, economic growth, and sustainable development.

In this session, speakers showed the latest developments and technologies in land registration and land tenure management.

Land Registration in the 21st Century

In his presentation, **Malcolm Childress**, Member of the Global Land Alliance, discussed innovations in land registration. He said property rights, public goods like infrastructure and environmental management, and local finance are critical areas of government services, and also key elements of economic and social stability.

With technological advances, there are now new ways of capturing and managing data and making them multifunctional and interoperable. He cited digital mapping and GIS which serve as basis for integrating data on ownership rights with spatial information on locations and boundaries.

"Integrated digital systems also permit additional layers to be overlaid, including valuation, with interoperability with other systems such as property tax," he added.

But the transition to e-governance is not usually easy. Acquiring data on the ground, digitizing records, putting it into a structure for permanent use and updating, and managing the system is a complex undertaking that entails a large investment, said Mr. Childress. It also involves multiple institutions and multiple years of implementation, which can have social, environmental, and political implications.

Citing the cases of the Republic of Turkey and the Republic of Colombia, he said governments are seeking to modernize property registration and cadastre through integrated solutions which offer the promise of supporting economic activity, local finance and social stability.

While interoperability through data capture and standardization of data models could boost efficiency for both states and citizens, it is neither a simple nor a quick solution, he added. Field acquisition through new survey is an expensive and complex process, and new records must be maintained to make systems legally and financially sustainable, he explained.

Thus, governments that seek to carry out national-level, system-wide modernization must be prepared for the long-term process — i.e., 20-year time horizons. This "calls for deep political commitments, planning for career paths and technological change, and a wide variety of inter-agency partnerships. This process is as much about management as it is about technology," he added.

Korea's Land Registry Computerization Project

In his presentation, Mr. Seok-Yong Yoon, Principal Public Management Specialist (e-Governance) of the Sustainable Development and Climate Change Department at ADB, discussed the land registry computerization project of the **Supreme Court of Korea**.

The digitization project started in 1994 to solve the backlog in real estate transactions as real property registration was then manually processed on a paper-based infrastructure. Public services such as certified copy request had to be carried out manually, and the tedious procedure involved searching, copying, and retrieving of the registry. Those wishing to read the registry or be issued with a certified copy had to visit the registry office in person.

From 1994-1996, computerization of 212 registry offices and the conversion of 45 million land titles were done. The next phase of the project (2003-2007) entailed the computerization of company registration and the launch of a Real Estate Registry web portal which allowed for online inspection and application for registration.

The project resulted in the following benefits:

- Saves the Korean government around US$300 million a year and 30% of labor cost when all titles were converted in 2002
- Increases competitiveness of companies and financial businesses due to the faster processing of registry
- Provides concrete data for effective tax collection and useful information that helps to make strategic decisions
- Dramatic increase in service quality due to the faster registry processing
- Reduced the need for plenty of staff and improved working conditions in registry offices

Land Value Assessment System

Technological developments such as Big Data, blockchain technology, artificial intelligence, and automated valuation modelling have been shaping land value valuations on a global scale in recent years, along with changing client expectations and the rapidly evolving regulatory environment.

In this session, experts shared how countries are modernizing their system of land valuation to meet their development challenges.

Land and Property Valuation in ASEAN

In his presentation, **Mr. Stamatis Kotouzas,** Senior Land Administration and Geospatial Specialist at the World Bank, talked about the importance of land and property valuation in the ASEAN and related initiatives in the region.

He said the urban population in East Asian and the Pacific region in the next 30 years is expected to grow by 33%, as countries become increasingly middle income. There will also be an additional 600 million households requiring housing and an 80% expansion in urban land area.

The silver lining is that digitalization and new technologies are becoming more available and less costly, he said. This offers opportunities to improve the quality of life of urban dwellers and at the same time, a greater demand for quality services.
"Fair and equitable property taxation hinges on fair and equitable property valuation as well," Mr. Kotouzas said.

However, land and property valuation is not just about taxation. It is also about the reliability and transparency of the real estate market, the fairness of land acquisition, infrastructure and investment financing, public land and building management, and monetization, among others.

The World Bank is focused on creating enabling linkages between land and property valuation and downstream to taxation. Among the challenges are:

- Comprehensiveness of land and property records: incomplete digitization and lack of building data information; considerable investments to have all properties and characteristics registered;
- Availability of price data: failure to register true prices and under-declaration of prices (high registration fees, property transfer taxes, weak enforcement);
- Valuation standards: limited use of internationally recognized valuation standards by public sector;
- Institutions and political support: lack of political willingness to tax wealth and to stand up to losers of property taxes; reliance on inter-governmental fiscal transfers; lack of champions in government

On the other hand, there are opportunities available:

- Several countries in the region are completing systematic land registration;
- Growing potential for using multipurpose land databases and concurrent use of proxies (mortgage valuations, central bank data);
- Some countries are advancing valuation practices and dynamic private professional bodies, public
- sector picking up the pace; and
- Soaring need and desire for own-source revenue mobilization, crises create opportunity for reform.

"The cross-cutting issue is the overall quality of tax administration such as the reliability of tax billing and collection systems, costs of tax collection, culture or tax payment, and extension of tax exemptions that exist for property tax," he added.

To help address these challenges, the World Bank launched programmatic initiatives with these two-pronged objectives: (i) generate knowledge and build capacity on modalities and development impacts of property valuation and taxation in ASEAN countries; and (ii) pilot scalable approaches for digital mass valuation for property taxation.

The WB program has three components: 1) case studies and analytics; 2) property valuation and property taxation with the end-view of making a scalable model; and 3) knowledge sharing and dissemination.

The table on the next page summarizes the main findings and recommendations of the WB after conducting the case studies.

Main Findings	Challenges	Main Recomendations
Very few comprehensive land and property records	Significant investments to improve land and property records but a few are close to completion Weak linkages between land and property record systems Experiments with new technologies to improve efficiency	Complete land and property recording systems with priority areas Link systems such as land and property ownership, land use, property tax, etc. Share experience between countries to improve quality and linkages between land and property records.
Availability of land and property price data	Very few transparent markets with accurate declared price data recorded for transactions Lack of monitoring, analysis, reporting and understanding of the importance of accurate land and property market data Missing necessary accurate land and property market data to enable economically rational decision making	Design and implement measures to ensure accuracy of declared price data Make publicly available accurate land and property market data and implement monitoring ana analysis. Share experience between countries to improve availability and understanding of the importance of data.
Valuation standards and profession	Recognition of valuation as a distinct profession, but only some effectively regulate the profession Professional qualification standards at varying stages of development Valuation standards and practice at varying stages of development Some national property measurement standards but not in the context of IVS	Address effective recognition and regulation of the valuation profession through legislation Progressively move towards formal adoption of relevant international equivalent standards Share experience between countries to improve standing and quality of professional institutions and standards.
Valuation education and training	Established valuation education and training, some very long-standing Achieved minimum requirements for CPD for qualified valuers; in some it is a condition of continuing license to practice Inactive academic valuation development by making research funding available to university faculties for public policy	Encourage regulated professions to ensure appropriate education and training and improve standards. Earmark public research finding for university faculties' public policy land and property market-related research. Share experience between countries to improve quality of valuation and related education and training.

Land Value Assessment System *(continued)*

Korean Experiences on Land Valuation

In his presentation, **Dr. Bong Joon Kim,** Manager, Global Cooperation Department, at the Korea Real Estate Board, talked about the real estate public announcement system of the Republic of Korea.

The land policies of South Korea played a key role in supporting economic development during its industrialization period. Through its land policies, urban land was properly supplied for the construction of public infrastructure, houses and plants, while urban problems such as land price hikes, speculation, and urban sprawls have been mitigated.

It is necessary to establish a systematic land price assessment system, land compensation system, and land tax system for the country's sustainable economic development. As urban development usually triggers a sharp increase in land price and speculations, securing land required for urban development and public projects exacts a heavy toll on the state's finances.

With the establishment of the Public Announcement System of Land Price (PASLP), South Korea is able to address these challenges.

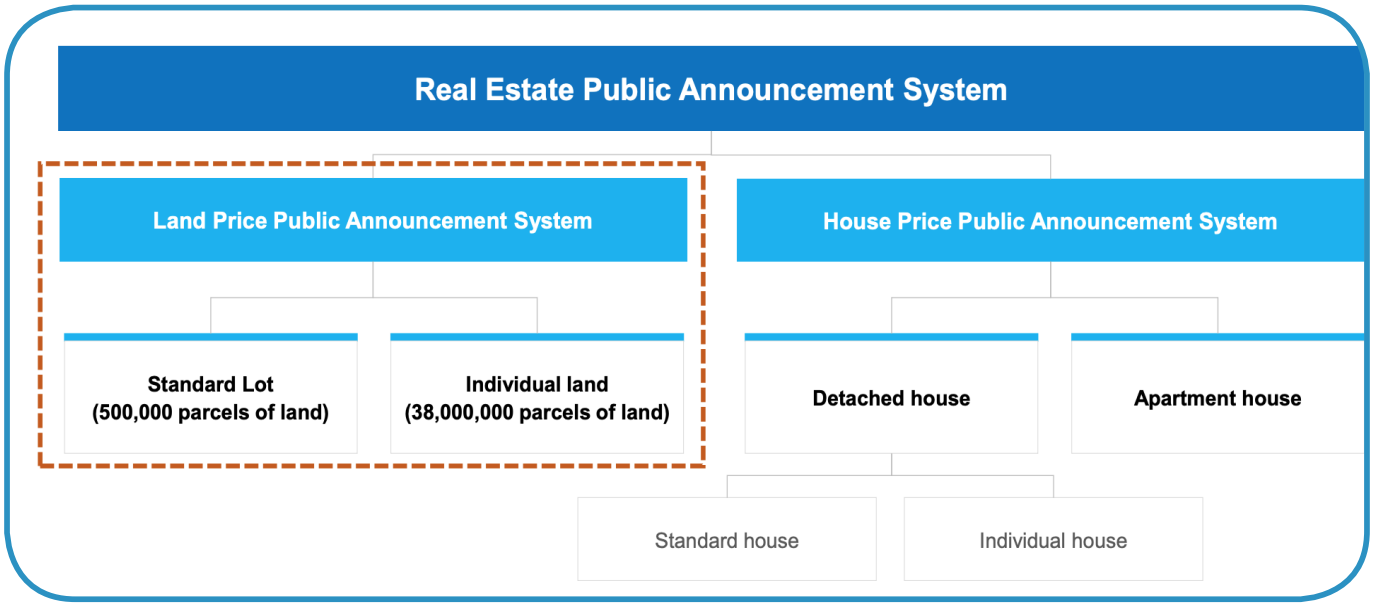
PASLP was introduced in 1989 to provide a unified land price standard for various administrative tasks, including taxation and compensation. Since its introduction, the PASLP has benefited from constant improvements through the development of ICT.

Technology brought major innovations in land assessment that reduce subjective judgments of assessors while enhancing the accuracy of site surveys.

After the 1989 land price public announcement system, the 2005 house price public announcement system was introduced to strengthen real estate possession tax and to realize fair taxation. The success of South Korea's PASLP inspired the development of a land price calculation model in the Republic of Viet Nam.

Dr. Kim shared these tips to promote sustainable urban development in developing countries by securing and supplying urban lands with the appropriate price:

- Construct a multipurpose land information system to manage the overall land market;
- Organize/Reform the taxation system for recapturing development gains and discouraging speculation;
- Prepare land expropriation and compensation system to provide development land smoothly;
- Establish a systematic land price assessment system for reasonable taxation and compensation; and
- Develop a national land use management plan to mitigate urban sprawl.



Strengthening land and property rights plays a central role in efforts to end poverty, reduce hunger, and promote resilient communities. Land tenure management determines who has rights to use what resources, for how long, and under what conditions. Clear and secure land rights aid in food security, economic growth, and sustainable development.

In this session, speakers showed the latest developments and technologies in land registration and land tenure management.

Korea's ODA Cases in supporting NSDI

Mr. Jongmin Lee, Senior Manager at LX Corporation, presented the development of an Integrated Information System for Real Property Registration and Cadastre (IISRPRC) in the Republic of Uzbekistan, an ODA-funded project supported by the World Bank.

The main objective for the project is to establish an efficient and accessible real property registration and cadastre system in Uzbekistan as part of the national e-government structure and services. To achieve this, business processes and customer orientation in the real property registry and cadastre must be improved and a fully digital real property registry and cadastre system (i.e., IISRPRC) must be created and made accessible online to the public.

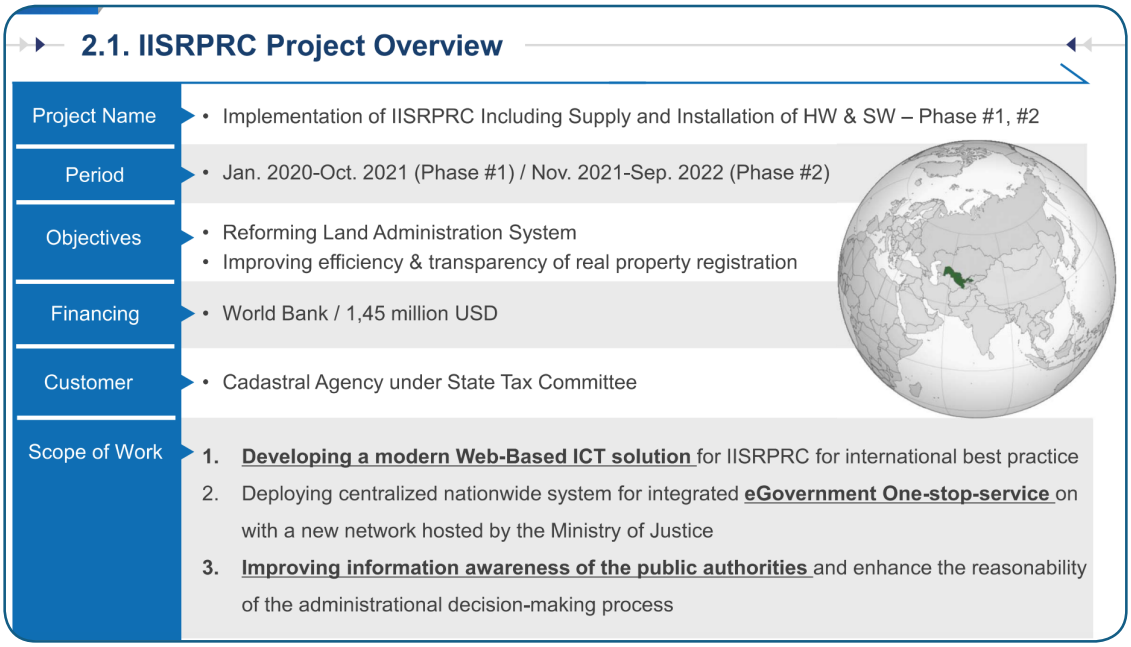
In addition, the project also aims to improve the regulatory and operational environment of the real property registry and cadastre in the country and facilitate spatial data access, exchange and sharing at the national level, as well as raise awareness on the importance of real property rights.

The IISRPRC project is part of Uzbekistan's NGIS/NSDI 10-year roadmap that started with the creation of an NSDI masterplan in 2016-2018. By 2023-2024, Uzbekistan expects to have its NSDI integrated with its digital government.

In detail, the project involves:

- Standardization of work processes: systematizing 53 regular administrative work processes and profiling international standard;
- Integrated real property registration system: having the capability to perform all work processes in one system; users from relevant departments use the same system; and integrate with e-government;
- Main Data Center and Reserve Data Center: securing availability, flexibility, scalability, and stability; dualization, virtualization, etc.

Once completed, the IISRPRC project is expected to reap benefits for the state, including optimized and standardized administrative work, improved reliability of land administration as property data will be secure and accurate, improved efficiency of government and public service, secure business transparency, and optimized investment by avoiding project duplication.



Korea's ODA Cases Supporting NSDI *(continued)*

National Big Spatial Data Project

Dr. Junyoung Choi, Research Fellow at the Center for Data Science Seoul Institute of Technology, presented the implementation of the National Big Spatial Data Project of the Republic of Korea.

The project grew out of a desire to find an efficient way to manage the increasing amount of geospatial information that has been accumulating from various sources as new technologies come onstream.

In addition to the common features of big data, the unique characteristics of spatial data make the treatment of big spatial data even more complicated. To help developers create big spatial data applications, new technologies must be developed to efficiently handle the massive amount of big spatial data.

This prompted the Government of Korea to embark on a five-year national project involving businesses, government, and the research community. Its goal is to develop a platform for efficiently storing, extracting, processing, and analyzing geospatial big data.

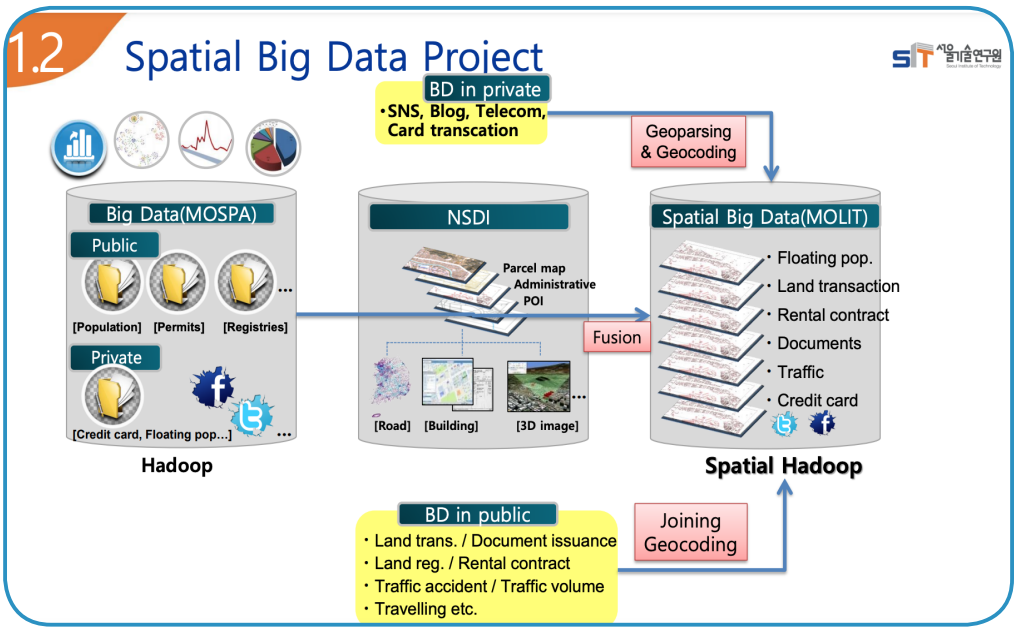
Dr. Choi shared the following key lessons from the project implementation:

- The National Spatial Big Data project will not exist without an NSDI. It must establish linkages with major e-government projects that can provide the attributes of spatial data along with spatial big data.
- Rather than providing complex analysis functions, shift towards providing common use modules and examples.
- Operate and manage integrated data with the latest data rather than building it.
- Set up a professional support group (Project Management Office or PMO) for business planning and management in state-owned enterprise or public institute. Expertise in system management and spatial analysis is needed in the PMO. It is necessary to share roles between the government and the PMO.
- Research in advance for system planning, but it is difficult for all of the R&D results to be utilized in financial projects.
- The national system is designed to be flexible in consideration of future technology and demand changes.
- Faithfully provide data with only basic functions as a minimum infrastructure (recognized as over-investment if under utilized).
- Create an environment for sharing analysis cases in which various cases analyzed through the system can be shared and new analyses can be made based on already analyzed cases.
- Public officials are not experts so it is important to train data scientists inside and outside the organization. One way to manage cost is to hold data analysis contests to stimulate data use and nurture data analyst talent.

How the Spatial Big Data Operates

An open source framework (Hadoop) is used to efficiently store and process large datasets ranging in size from gigabytes to petabytes of data. Instead of using one large computer to store and process the data, Hadoop allows clustering multiple computers to analyze massive datasets in parallel more quickly.

Source: www.aws.amazon.com



Property Tax Management System

Property tax management is undergoing a sea change, thanks to digital transformation. Property tax managers now have new and better ways to provide value to their organizations, become more efficient, and cost effective. Those willing to embrace advanced tax technology tools will be better positioned to meet the challenges that lie ahead.

In this session, speakers showed the latest trends in property tax management.

Global Trends on Property Management and Valuation Systems

Mr. Paul Bidanset, Founder & Executive Director of the Center for Appraisal Research and Technology (OpenAppraisal.org), shared best practices for land management and valuation software/computer systems in his presentation.

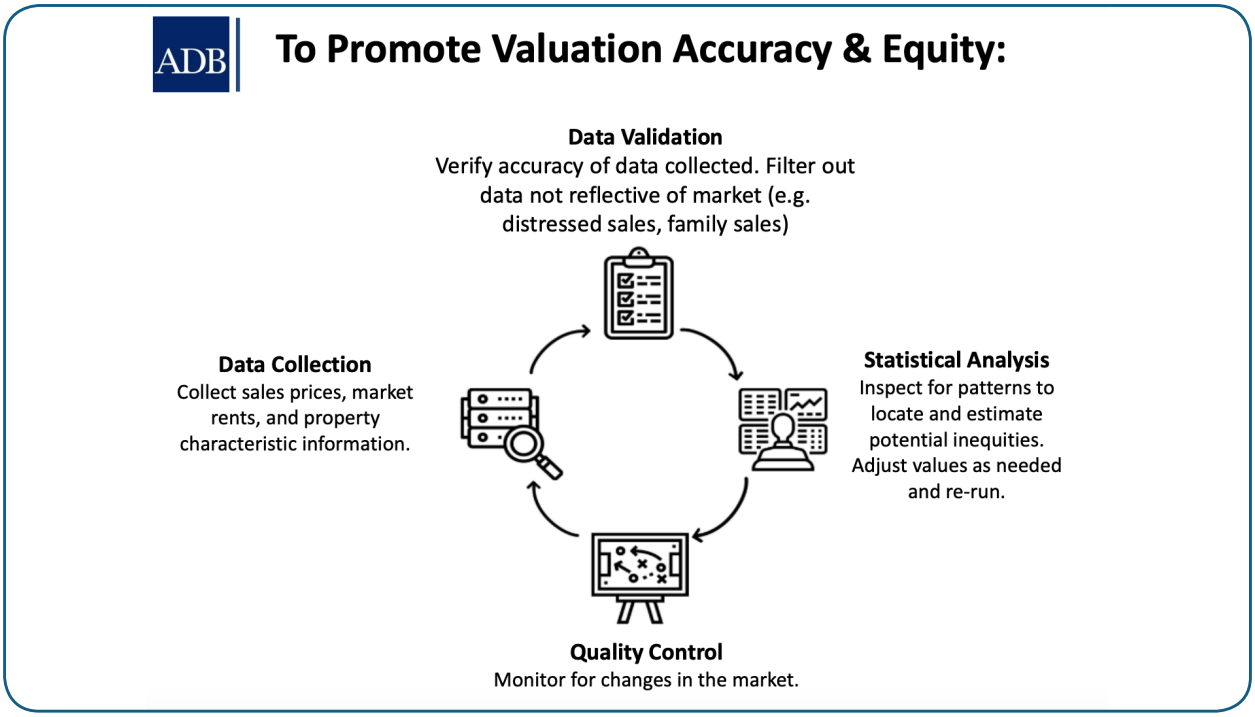
Assessing property values can be difficult to do without the right computer system and software for organizing important data. Mr. Bidanset said one way to do land management and valuation is by using software/computer systems referred to as "computer-assisted mass appraisal" (CAMA) systems. This software package is often used by government agencies to help establish real estate appraisals for property tax calculations.

There are also asset management systems that incorporate the property valuation component (mass and single property). These valuation algorithms are referred to as "automated valuation models" (AVMs). Real estate agents, brokers and mortgage lenders use AVMs as a starting point to evaluate properties. This service is used to provide accurate estimates on property values to commercial platforms and major consumer sites.

Mr. Bidanset said there should be cross-functionality between:

- Cadastral data (ownership records, property characteristics)
- Sales registries (deed information including price, date, parties, and characteristics)
- Geographic information systems (GIS)
- Mass valuation: table or regression-based AVMs
- Database (SQL Server, MySQL, Access) with output features (flat-file)

These computer systems and software must be used for data collection, data validation, statistical analyses, and quality control to promote valuation efficiencies, accuracy, and overall tax fairness. They must also be used in conjunction with international valuation standards (IAAO, IVSC, etc.).



Property Tax Management System *(continued)*

Property Taxation and NSDI

Mr. Stephane Gil, International Land Administration & Property Tax Management Specialist at ADB, discussed the issues that shape property taxation and how the system can be linked with NSDI to form part of e-government.

First, establishing or upgrading property taxation in a country requires a lot of political will and the necessary institutional support as the objective is to generate income for local governments. Engaging citizens through communication and decision making is key to understanding the rationale behind property taxation.

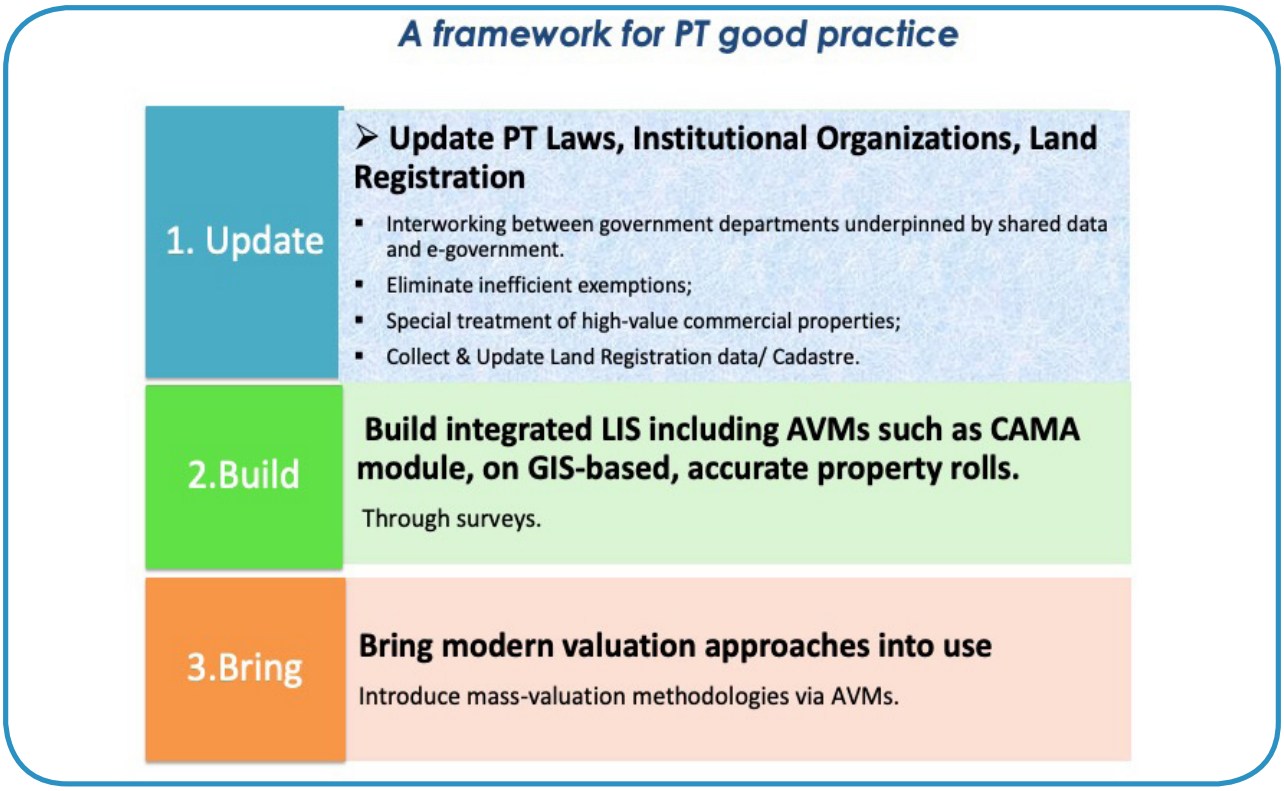
There are also technical issues involved in property taxation such as defining the tax base. In general, international best practices suggest the following:

- Broadly define the tax base to include all land and/or building (improvements) unless specifically exempted by law.
- Keep the tax rate structure as simple, transparent and accountable as possible.
- Use a value-based system that is correlated with differences in the relative value of properties as reflected in such factors as size, location, accessibility, land use type, construction type, quality and other property attributes.

In terms of organizational issues, there is evidence that fiscal decentralization may only impede reforms because it diverts attention away from revenue mobilization. However, there are suggestions to involve the local government more in the process by creating a Local Government Board (LGB), a single body that handles property registers/databases of all small cities through a unique IT platform.

In addition, governments could also put in place a state-level Property Tax Board tasked to assist all municipalities and municipal corporations to put in place an independent and transparent procedure for assessing property tax.

Lastly, there are also IT issues involved in property taxation. An integrated and comprehensive Land Information System including automated valuation models (AVMs module) can automatically generate property tax bills, ensure they are delivered to each property using GIS maps, or sent by mobile phone and e-mail, if needed bills can be printed at tax offices. It is recommended to have a property tax management system based on online GIS, which should be available to all municipalities.



The growing focus on smart cities and the use of emerging technologies in recent years has also drawn interest in national spatial data infrastructures (NSDI).

NSDI is seen to play a crucial role in urban development and has become an important platform for exchanging and sharing spatial data information to facilitate the availability of resources in the proper planning of smart cities and projects.

In this session, speakers discussed the critical linkage between NSDI and smart cities in tackling global challenges such as climate change.

Climate-Smart Cities

Mr. Gyongshim An, Senior Urban Development Specialist of the World Bank, presented the World Bank Group's Urban, Resilience and Land Global Practice (GPURL).

Urbanization is occurring at an unprecedented pace. Mr. Gyongshim said the WB findings show cities account for 80% of global GDP and are key to job creation and economic development. On the other hand, one billion people live in cities' slums today and this will balloon by 2.5 billion by 2050 due to urban migration. Land consumption outpaces population growth by 50% and this rapid expansion makes it difficult to provide services, housing, and transport.

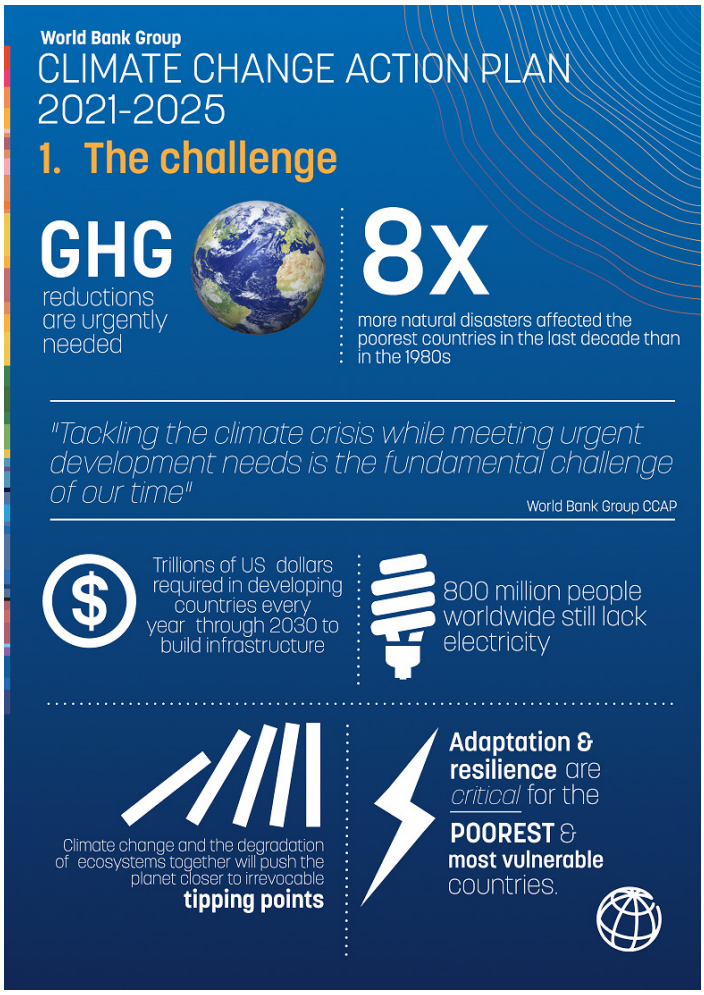
This also means around 1.5 billion people in large cities will be exposed to climate change impacts such as cyclones and earthquakes. Avoiding a 4-degree warmer world requires drastically reducing the carbon footprint of cities which generate 70% of greenhouse gas emissions and consume 70% of the world's energy supply.

As a result, many cities in Asia and Africa are dense, lack public space, and are now unlivable.

The WB is in a unique position to make a difference by helping governments tackle these challenges. Thus it created the GPURL that aims to promote more sustainable development patterns and address an increasingly complex set of development challenges.

The GPURL covers the following priority areas:

- Green Cities: developing low-carbon cities, urbanscapes and solid waste management;
- Inclusive Cities: upgrading slums, paving access to public services, participatory planning and citizen engagement, and tackling urban poverty;
- Resilient Cities: assisting in disaster risk management through issues of risk assessment, risk reduction (including flood management, urban drainage, coastal management, and retrofitting of infrastructure), disaster preparedness, etc.
- Competitive Cities: enhancing urban and rural



development through supporting and managing the urban-rural transition, assisting local development through developing land tenure, management and information systems, among others.

The WB's GPURL portfolio currently contained 215 projects worth US$30.69 billion operating in 2,969 locations across 91 countries as of fiscal year 2022. Forty-two projects amounting to US$6.6 billion are in the pipeline. In 2021, URLGP benefitted 14.3 million people with improved urban living conditions. Of this, 9.8 million live in Africa.

In addition to the GPURL , the WB is also pursuing a Climate Change Action Plan (CCAP) that aims to increase climate finance to reduce emissions, strengthen climate change adaptation, and align financial flows with the goals of the Paris Agreement. Since the first CCAP (2016-2020) which set a target of 28% share of climate-related finance in WB lending, there has been an increase in targets over the years as the WB ramped up country-level engagement and shifted from input-based to results-oriented commitments.

The CCAP 2021–2025 aims to advance the climate change aspects of the WBG's Green, Resilient, and Inclusive Development (GRID) approach, which pursues poverty eradication and shared prosperity with a sustainability lens. The new Action Plan represents a shift from efforts to "green" projects, to greening entire economies, and from focusing on inputs, to focusing on impacts.

In pursuit of these targets, the WB is implementing seven initiatives and programs on smart and green cities under the GPURL: Building Sustainable

Communities, Global Smart City Partnership Program, Smart Cities KSB, City Climate Finance Gap Fund, City Planning Labs, Global Facility for Disaster Reduction and Recovery, and Global Platform for Sustainable Communities.

To build a strong foundation to enable data-driven decision making across government, the WB also supports the development of smart city and green tools such as the following:

- **Advanced Practices for Environmental Excellence in Cities (APEX) App** — A data-driven app that allows city planners to make cities more sustainable in four key areas: energy, water, waste, and public transport. It harnesses data insights from advanced green practices around the world to create tailored solutions for cities.
- **City Planning Labs (CPL)** — A technical assistance program of the WB to help enhance the technical and institutional capacity of municipal governments to produce, share, and utilize geospatial data for evidence-led urban planning.
- **Climate Action for Urban Sustainability (CURB)** — An interactive planning tool designed specifically to help cities take action on climate by allowing them to map out different action plans and evaluate their cost, feasibility, and impact.
- **Unbreakable: The Resilience Indicator Toolbox** — Measures socioeconomic resilience in 117 countries and provides insights on what investments and policies drive resilience.
- **Think Hazard** — Provides a general view of the hazards, for a given location, that should be considered in project design and implementation to promote disaster and climate resilience.

The WB also provides knowledge sharing and dissemination through capacity building programs, e-learning courses and webinars, and research and guidance notes to generate wide-ranging insights for solving development challenges.

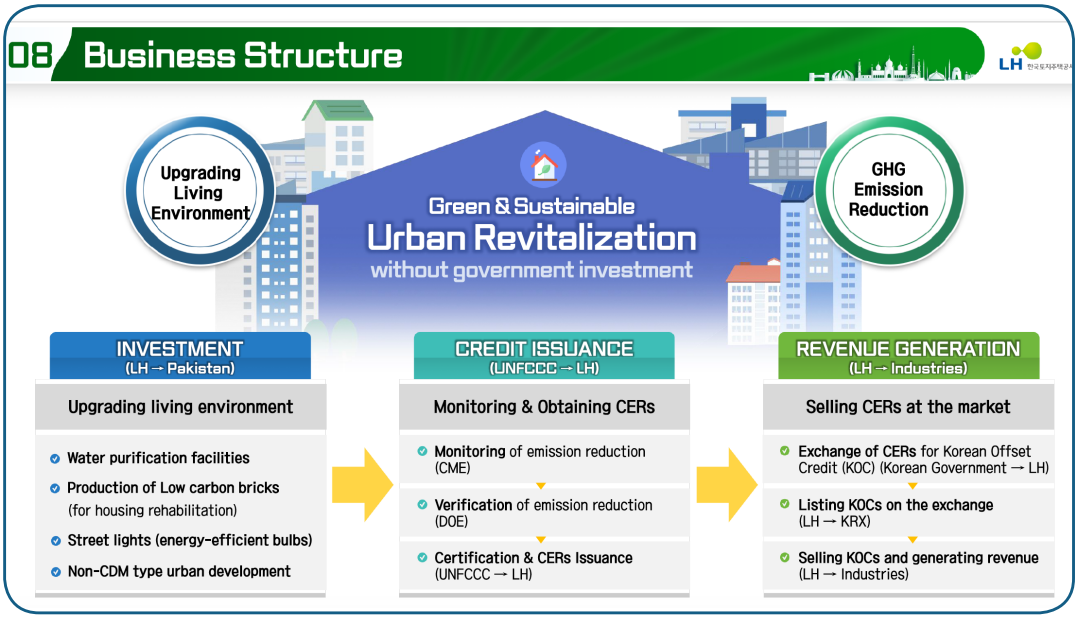
Slum Upgrading and GHG Reduction in Pakistan

In his presentation, **Mr. In-Hyun Jeon**, General Manager, Global Business Office at Korea Land and Housing Corporation (LH), discussed the use of the Clean Development Mechanism (CDM) developed by LH in a pilot project in the Islamic Republic of Pakistan.

Pakistan is the most urbanized nation in Southeast Asia with an urban population of nearly 100 million in 2022 and forecast to grow to 176 million by 2050 and account for 52% of the nation's total population.

More than a third of the population lives in informal settlements, known as Katchi Abadis. They face urban challenges such as waste management, clean water and sanitation, electricity and gas supply, environmental quality, and poor infrastructure. They are also more vulnerable to natural hazards such as flooding, heatwaves, landslides, and earthquakes.

Slum Upgrading and GHG Emission Reduction Without Government Funding



Smart City and NSDI *(continued)*

To address these urban challenges, LH, in collaboration with Pakistan's Ministry of Climate Change and Project Team ATR Inc. (ATR), piloted a project that aims to upgrade the country's slums and reduce GHG emission. The project involves the establishment of water purification facilities to supply safe drinking water, production of low-carbon bricks for housing rehabilitation, installing and replacing energy-efficient streetlights, and urban development.

As a signatory of the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), Pakistan contributes towards carbon mitigation in the form of the Clean Development Mechanism (CDM). This market-based mechanism is instituted to facilitate GHG reduction through carbon trading.

Using the CDM as business model, LH will track the carbon emission reductions (CERs) from the project activities and have them verified and certified by the UNFCC. The CERs will then be exchanged for Korean Offset Credit (KOC) by the Government of Korea and sold to LH, which will list the KOCs on the Korea Exchange to generate revenue.

The project will be implemented in three phases: after being piloted in 31 communities in Karachi and the province of Sindh in Pakistan, it will be launched in the other regions of the country.

As well as increasing the government's ability to address the issues of basic needs in the slums, the project will also help Pakistan, the Republic of Korea, and LH contribute to meeting four of the 17 UN Sustainable Development Goals, namely: SDG No. 6-Clean Water and Sanitation; 9-Industry, Innovation, and Infrastructure; 11-Sustainable Cities and Communities; and 13-Climate Action.

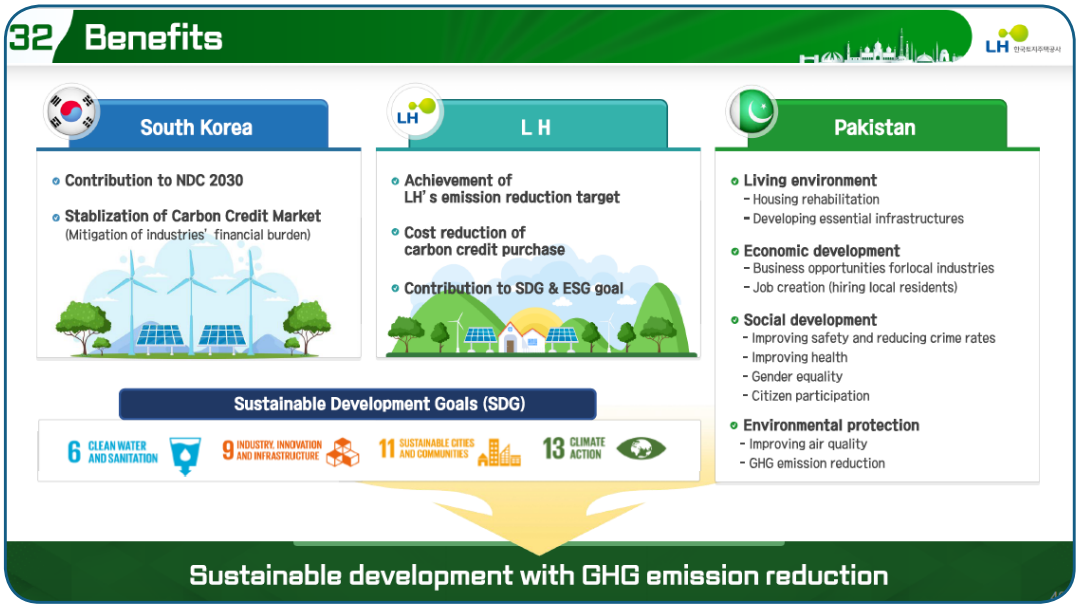
Korean Cities' Smart Response to Climate Change

In his presentation, **Dr. Jung Hoon Lee**, Project Manager of the Global Smart City Index Development Project, discussed how the Republic of Korea became home to some of the world's smartest cities and how adopting new technologies helps to create a more sustainable and livable present and future for its citizens.

The Smart Cities Index Report "examines the changes in cities that are rapidly growing with the 4th Industrial Revolution, suggesting the future of smart cities, and at the same time, helping to guide cities' participation in the changes that are leading towards global smart city establishment," said Dr. Lee. The report was published by Yonsei University's Digital Transformation Technology Management Center and IfM Engineering, a technology holding company at Cambridge University of England.

The 2022 report covers 31 smart cities which were analyzed based on eight assessment areas: service

Expected Project Benefits



innovation, urban intelligence, urban sustainability, urban openness, infrastructure integration, urban innovations, collaborative partnership, and smart city governance. For the first time, the report also ranked the smart cities based on the assessment areas.

Three Korean cities were among the 31 smart cities in the report: Seoul, Busan, and Incheon. All three cities received high grades for their integration of infrastructure resources to implement smart cities, even exceeding the average grade of the world's smart cities. The average of the three Korean cities, including Seoul, stood at 3.83 versus the world average of 2.54.

Seoul was selected as the top leading city in developing intelligence. It received high grades for its application and implementation of artificial intelligence-based data for public services. In support of the "2050 Greenhouse Gas Reduction Strategy through Green New Deal," Seoul has adopted a seven-pronged strategy to become a zero-emission city by 2050. The seven strategies include the Seoul Smart Mobility Reform that aims to increase the share of bus and subway riders and reduce car users to curb traffic woes. To do this, the city successfully utilized advanced intelligent transport system technology, a Bus Management System, and Global Positioning System for traffic management.

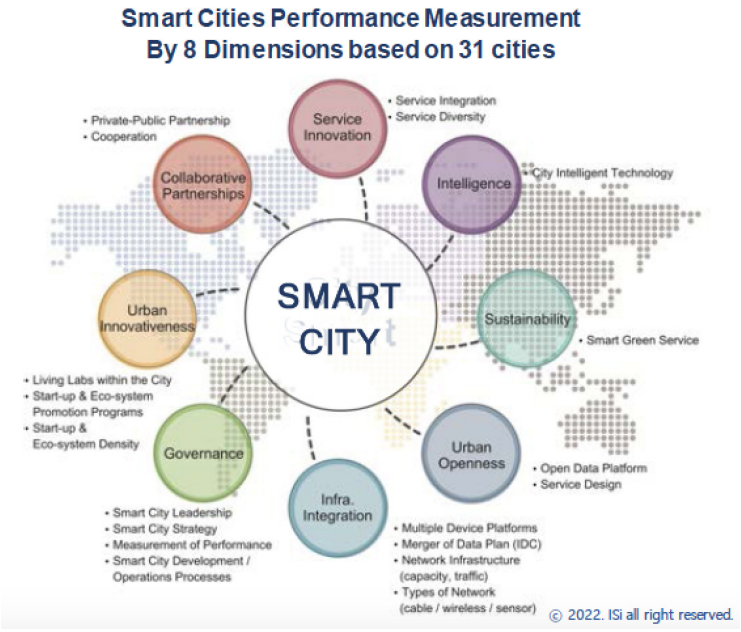
The report also ranked Incheon City high in in smart city governance for its systems and strategies that forged strong integration and specificity in urban planning related fields. The Government of Korea chose Busan as a test bed for its Eco Delta City pilot project in 2018. The project involves applying new technologies related to the 4th Industrial Revolution to establish an innovation ecosystem and present a leading model for future smart city developments. These include attaining complete energy sufficiency with 100% of consumed energy from renewable sources, using AI for managing the occurrence of marine debris that pollute its bodies of water, and establishing an environmental health monitoring system in traffic-congested areas of the city.

Meanwhile, Busan City was ranked first in the report in terms of infrastructure service diversity. This included the city's use of differentiated app services, digital treatments, and environmental energy services. Its Smart Green Industrial Complex is being established as a green energy cluster among industry, academia and research, capable of developing human resources, evaluating technology and providing the research infrastructure. The renewable energy-themed complex is also equipped with digital technology and green energy systems.

In addition to these three Korean smart cities, the Government of Korea is also transforming its electronic manufacturing hub and third-largest urban center, Daegu, into becoming the nation's first smart city data hub. Harnessing technology to make the city resilient, Daegu offers smart services to predict and issue alerts on landslides, monitor flooding, and reduce heat stress.

Before these cities become "smart," their urban innovations are tested in a "living lab" which serves as an open innovation platform for citizens, governments, companies, and research institutes to apply smart city technologies to solve specific problems in a city.

In South Korea, the living lab is intended to improve Public-Private-People Partnership to overcome the limitations of government-led urban development and create a new smart city innovation ecosystem. An example is the Sambang Water Living Lab in Gimhae, a city located in southern part of Korea. The Living Lab is a testbed for smart solutions to prevent flooding and drought, as well as for managing water resource with citizen participation.



Digital Twins and NSDI

Since the concept was born in 2016, "digital twin" (DT) has been gaining significant ground in the geospatial domain. While the basic features of a DT are known, there are significant gaps between DT and the national spatial data infrastructure (NSDI) that need to be addressed for these to be implemented to scale in tackling real-world problems.

In this session, experts discussed how countries and organizations can harness these intelligent and trustworthy systems for informed decision making.

Understanding the LX Digital Twin Platform

Mr. Chung Park, Deputy Director General of the Digital Twins Department at LX Corporation, talked about the DT concept and presented the LX DT platform.

Korea Land and Geospatial Informatix Corp. (LX) is a state-run agency affiliated with the Ministry of Land, Infrastructure, and Transport (MOLIT) that provides cadastral and spatial information. Established in 1977, LX has overseas projects in more than 30 countries around the world.

LX was born out of the need for Korea to respond to major accidents and various urban problems that could have otherwise been prevented if there were appropriate tools to simulate them in advance. As most of these constantly recurring problems are related to urban space, said Mr. Park, data based on multidimensional spatial analysis and digital urban space infrastructure can be utilized to diagnose, predict, and respond to them.

Mr. Park said a "digital twin" — a virtual representation of a real-world physical system, people or a process that serves as a digital counterpart — will help improve the accuracy of simulation models enabled by the fuller integration of the internet of things (IoT).

Using DT technology can aid in the effective management of state resources, leading to improved public safety and security, city planning, disaster prevention and capabilities to overcome environmental challenges.

The LX Digital Twin Project was developed to address the need for a virtual space that will integrate into one all spatial data that will be used for the operation and management of smart cities.

LX piloted the DT project in Wansan-Gu in Jeonju, the 16th largest city in South Korea and the capital of North Jeolla Province. LX has been recreating Jeonju's 200 square kilometers as a 3-D model since the project began in 2018. Two years later, a masterplan for the DT platform was established. In 2021, LX has completed the entire area data on Jeonju in 3D which will be used for creating service models for system application.

LX Digital Twin Platform Features

In 2022, a web-based DT platform was created to promote the use of the technology among local governments and other institutions.

NSDI and Digital Twin Policy in Korea

Mr. Kihwan Seo, Research Fellow at the Geospatially Enabled Society Research Division of the Korea Research Institute for Human Settlements (KRIHS), talked about the use of NSDI as a national policy in South Korea and its strategies for digital twins.

In his presentation, Mr. Seo said a Spatial Data Infrastructure (SDI) policy helps government to produce, manage, access, and share spatial data. As approximately 80% of all data has a spatial (location) component, SDI is particularly useful for various government services (e-government), disaster management, resource allocation, climate change mitigation, among others.

The Korean government started implementing a masterplan of SDI (National Geographic Information System) in 1995 to develop the information infrastructure for geospatial data management. This came as a response to a series of urban disasters such as the Ahyeon-dong, Seoul gas explosion in 1994, the Daegu underground gas explosion and the Kobe earthquake in 1995 which was partly blamed on lack of spatial data for monitoring and warning signs.

The master plan laid down the groundwork for the establishment of the NGIS Team under the Ministry of Construction and Transportation (MOCT), spatial databases and data standardization, assistance of GIS-related technical development, and the development of framework for utilization and application of the NGIS. Since 1995, the masterplan has gone through several revisions and its 7th iteration is in progress.

The key organization for the policy, planning, and implementation of the NSDI in Korea is the Ministry of Land Infrastructure and Transportation (MOLIT). Components of the NSDI were designed for greater interoperability of geospatial data and standards which are shared via an NSDI portal. Under MOLIT is the NGII which produces a variety of national geospatial imagery through high-resolution aerial photography technology. These 3D geospatial data (including digital maps, aerial photographs, ortho photographs) are uploaded and shared on the NSDI portal for users such as decision makers in the public and private sectors.

From the digitalization of topographic maps in 1995, the NSDI is now being used for a range of applications, including road and underground facility information management system, land information system, GeoPlatform, and urban planning, among others.

NSDI Progress in Korea

Phase	1st Phase (1995~2000)	2nd Phase (2001~2005)	3rd Phase (2006~2010)	4th Phase (2010~2013)	5th Phase (2013~2017)	6th Phase (2018~2022)
Objective	Initiating NSDI	Development of Application Systems	Expanding application systems	Integration of database & application systems	Government 3.0	Infrastructure for Smart Korea
Strategic Goals	• Enacting NSDI law • Organizing NSDI committee • Converting paper map to digital map • Managing and distributing spatial data	• GIS applications for government services (ex, LMIS, facility management) • Establishing clearing house	• System Integration • Strengthening partnership among all levels of government and private sectors	• Establishment of 3D data for representing real world • Expanding integration of application systems	• Open and share all public data • Establishment of Indoor spatial data • Provide on-demand spatial data • Convergence of spatial data with other data or contents	• Value added spatial data • Activating Geospatial platform for sharing spatial data • Promoting spatial industry • Reorganizing governance system

Country Presentations

Topics/Issues	Kingdom of Cambodia	Republic of Kazakhstan
1. Key Lessons from the Workshop	• What is NSDI and NDTI and importance • How to integrate spatial data for public services • Digital Twin concept • Case studies of other countries in NSDI, especially the Government of Korea	• Knowledge and experience of Korea in the implementation of the NSDI are very useful in the creation and implementation of such systems in Kazakhstan. • ADB-financed projects in other countries and explore opportunities and support provided by ADB.
2. Most Relevant Sessions	• National Spatial Data Infrastructure • Integrated Land Information System • Land Tenure Management System • Spatial Data Utilization and NSDI	• Introduction of Korea National Spatial Data Infrastructure • Introduction of K-Geo Platform (Web GIS platform) for geospatial data exchange and sharing • Spatial Data Sharing and Utilization Mechanism in South Korea • Korea Cadastral Management Information System • Seoul Urban Planning Information System • Global Trends of Land Registration System and Korea Land Registration System • Trip to NGII
3. Ongoing or Planned Government Project Related to the Workshop	• Establishment of five Continuously Operating Reference Stations (CORS) for Land Management and Infrastructure • Development (August 2021-December 2023) • Developing National Spatial Data Infrastructure in Cambodia	• Unified Geoportal of Infrastructure Data: a tool for continuous urban planning regulation and territorial development processes • Development of NSDI: for implementation from 2021-2024
4. Proposed Project/ Assistance from ADB, World Bank, Others	Unified Platform for National Data Portal • Develop Unified Platform • Data Center setup and data standardization • Data sharing and data security (laws and regulations, technical aspects of cybersecurity) • Services (Updating topographic map, modernization of the cadastral database system, property tax management system, urban planning information system)	• Assistance and support for the development of a strategy for building NSDI, master plans and support in the implementation of master plans • Digitization of available paper data, acquisition of necessary equipment • Training of specialists, increasing the potential of employees

Kyrgyz Republic	Lao People's Democratic Republic	Republic of Mongolia
• How Korea reformed to make the NSDI a basic accurate tool for all bodies and the population • How urban planners are able to access analytical data easily and how Korea identified one agency to coordinate all issues related to the development of the NSDI and avoided duplication • Insightful country experiences	• Legal framework • Sustainability funding • Fundamental datasets and standard • Capacity building	• Determine the current situation in establishing NSDI: what to do, what to focus on in the future • Integration of data from various providers • Spatial data utilization
• NSDI session because the experience on reform implementation in Korea was interesting. • Session 5 (Land Use Planning System) because we learned about the existence of two systems (internal – for civil servants and external for public use) • Session 8 on the development of legislative acts by LX, instruments on big data analysis for urban planning	All sessions are important but NSDI is most relevant to the case of National Geography Department in Laos. We have initiated to establish NSDI of Laos (refer to our law on survey and mapping 2021 and 5-year plan 2020-2025 of Ministry of Home Affairs).	• NSDI • Spatial Data Utilization and GIS
• Currently establishing an NSDI. The creation of a single body responsible for the creation of NSDI is necessary to coordinate the work among all institutions more closely and to strengthen their interest in further advancing the reform. • Plan: For better urban planning, we will request for data from mobile operators, transportation cards, and commercial banks.	Plan to initiate and assess NSDI of Laos	• Legal environment reform: Package laws on land and creating a NSDI Law • Introducing advanced technology (machine learning, AI, blockchain technology) • Capacity building
• Assistance and support for the development of a strategy for building NSDI, master plans and support in the implementation of master plans • Digitization of available paper data, acquisition of necessary equipment • Training of specialists, increasing the potential of employees	Need budget, capacity building and awareness to support and to implement NSDI of the country	

Country Presentations *(continued)*

Topics/Issues	Republic of Nepal	Republic of the Philippines
1. Key Lessons from the Workshop	• Digital twins technology • Enhance new ideas on 3D data on LIDAR Survey Mapping • Good coordination between government institution for providing One Door Service to the people • Getting more knowledge on Land Management and NSDI practices from expert as well as participants • Getting additional knowledge on Property Tax considering LBS, GBS, CAMA and more	• Integrated Geospatial Information Framework to develop and strengthen national geospatial information management • Establishment of the relevance of geospatial information systems to data users and stakeholders to ensure sustainability • Legal and institutional reform and established web-based workflow has driven Korea's integrated land information system • Strong will and confidence of the leaders as well as identifying champions in the development and implementation of NSDI • Collaboration, partnership and sharing
2. Most Relevant Sessions	• Land use planning • Completed land use zoning into ten categories • Nepal government finished LUM and delegated to LG for updating and implementation • LGs are facing more challenges in updating. • We have seen Korean and other countries practices which supports us to enhance our knowledge.	National Spatial Data Infrastructure: • Fundamental in building a strong economy • Establishment of a well-defined national GIS-governance structure Integrated Land Information System: • Legal framework upgrade and institutional reform • Problems in the land sector emanates from the duplication of data, varying views from different offices
3. Ongoing or Planned Government Project Related to the Workshop	• Ongoing: LiDAR Project, Implementation of Land Use Plan, Integrated NSDI, Cadastral Survey Application System • Important project: upgraded the Property Tax System •	• Philippine National Spatial Data Infrastructure • Geoportal Philippines • Philippine Land Administration and Management System (LAMS) • Enhanced Land Administration and Management System (eLAMS) • Establishment of National Natural Resources Spatial Database
4. Proposed Project/ Assistance from ADB, World Bank, Others	• ADB Study Visit in Kathmandu	Towards the development of the Philippines NSDI: • Revisit the draft Technical, Operational and Legal Framework of the Philippines • Fast track the development of eLAMS • Revisit and assess existing systems in place that create and manage NSDI-related data to see avenues of data integration • Establish the National Natural Resources Spatial Database • Strengthen coordination and data sharing across different national and local government offices

Tajikistan	Democratic Republic of Timor-Leste	Socialist Republic of Viet Nam
• Introduction of Korea NSDI • Korea Land Registration System • Spatial data for digital heritage archiving • Korea's ODA cases in supporting NSDI	• Cadastral Land Management System • Land Registration Management System • Property Tax Management • 3d Laser Scanner for 3D Cadastral Information System	• To build an e-government, it is necessary to have a national database system and that building an e-government requires a legal framework with clearly defined responsibilities of departments or ministries in building and developing an NSDI system. • The components of databases in NSDI need to be built synchronously and in an openly shared among departments to provide public services. • There is a need for a long-term strategy in the development of the country's NSDI when software technologies are obsolete. • Considering public-private partnership (PPP) for private companies to be involved in building some component databases to reduce the financial pressure on the government and increase efficiency.

	• Permanent GNSS Cors Station to be installed in eight municipalities
	• Land registration for land ownership certificate
	• Terrestrial Border Demarcation
	• Geodetic Network Control Point
	• Land Rent Information System
	• Future Plans (2011-2030)
	  • Framework and policy for geospatial information
	  • Property tax management system
	  • Implementation of AI-based system for land cover classification and smart city
	  • Vessel Management System	

Provide technical assistance for a Pre-Feasibility Study (PFS) for the creation of a modern Land Information System (LIS) in the form of spatial base-maps, metadata, standards, etc., which is critical to ensure that the NSDI interacts with other sectorial information systems in Tajikistan.	• Capacity building for system developer • Capacity building on NSDI and Big Data • Assistance to future SDI project	• Continue organizing annual workshop so that member countries of ADB can have opportunities for learning and sharing experiences. More technical focus of the workshop such as planning, tax, evaluation. • Enhance experience sharing activities of countries that have succeeded in building, operating and exploiting NSDI. • ADB, LX can cooperate with Viet Nam to build projects related to spatial planning and land use planning (planning the use of different types of land for socio-economic development).

Site Visits

National Geographic Information Institute (NGII)

The National Geographic Information Institute (NGII) of Korea contributes to the national development by setting up the national geodetic datum and sharing system of geospatial information.

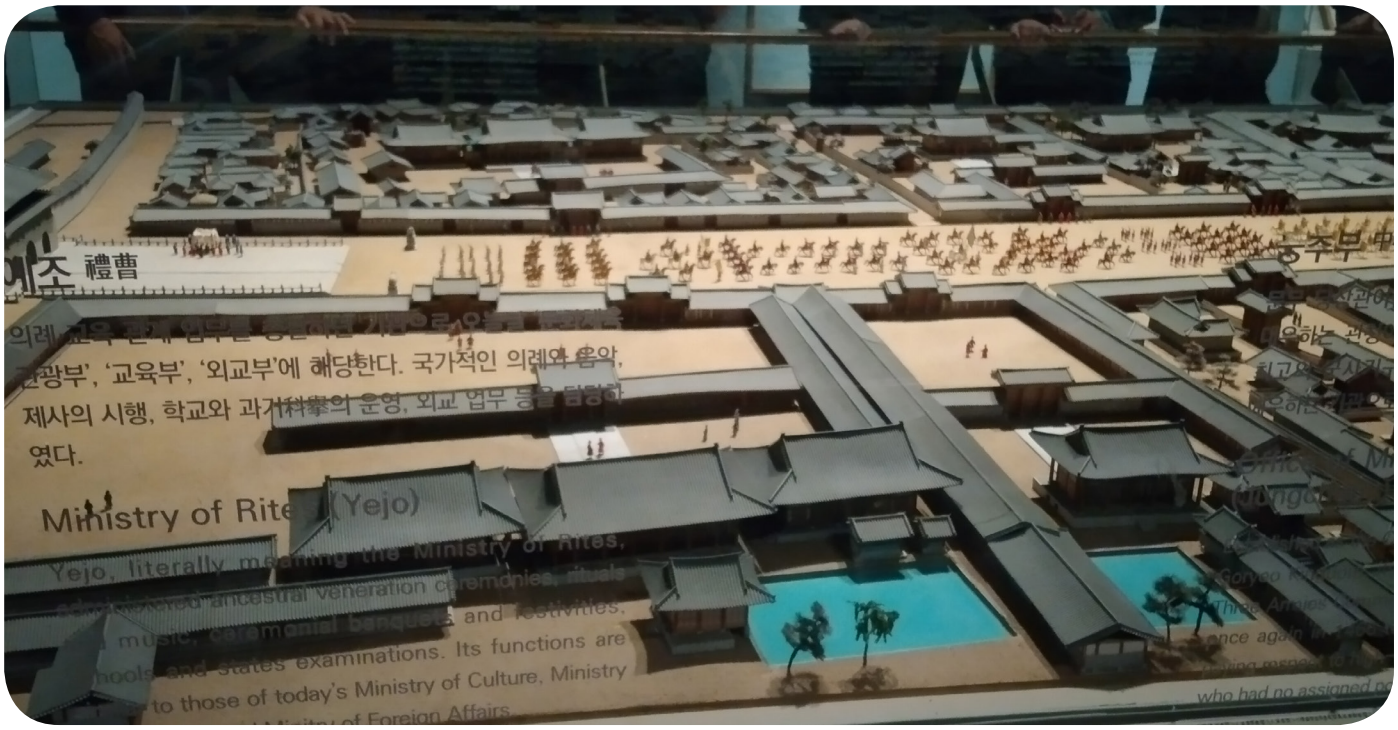
The site visit gave workshop participants an overview of NGII's vast operations. Among others, it manages the space geodetic observation center, national geodetic control point, and national base maps. NGII also conducts national land surveys, and operates the geospatial information application support center.

Smart Geo Expo 2022

The workshop coincided with the Smart GEO Expo 2022, touted as Asia's biggest geospatial information technology exchange expo.

In its 14th year, the Expo ran from Nov. 2-4, 2022 and was held offline for the first time in three years since the COVID-19 pandemic started. The Expo presented the future vision of the geospatial information industry brought over by new geospatial information technologies and its convergence with other fields of industry.

Seoul Museum of History



The Seoul Museum of History is the only museum in South Korea that represents the city's history and culture.

Since its establishment on the former site of Gyeonghuigung Palace in 2002, the museum has offered visitors the chance to experience 600 years of Seoul's history and culture through interactive exhibitions. The three-story museum is divided thematically into three exhibition areas, including a special exhibition area, a permanent exhibition area and a hall that exhibits collections donated by the public. The building covers everything about Seoul's history and culture from the prehistoric era to modern times, focusing especially on the Joseon era.

The museum aims to raise cultural awareness and build a strong bond within the community by collecting, preserving, researching, and displaying artifacts and materials related to Seoul, as well as promoting the city's history and culture to an international audience.

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