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Leveraging Land and Geospatial Information to Support Urban-Rural Resilience

The critical role of land and geospatial information in enhancing community resilience to disasters and fostering climate-smart development.

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The University of Melbourne



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CENTRE FOR SPATIAL DATA
INFRASTRUCTURES AND
LAND ADMINISTRATION



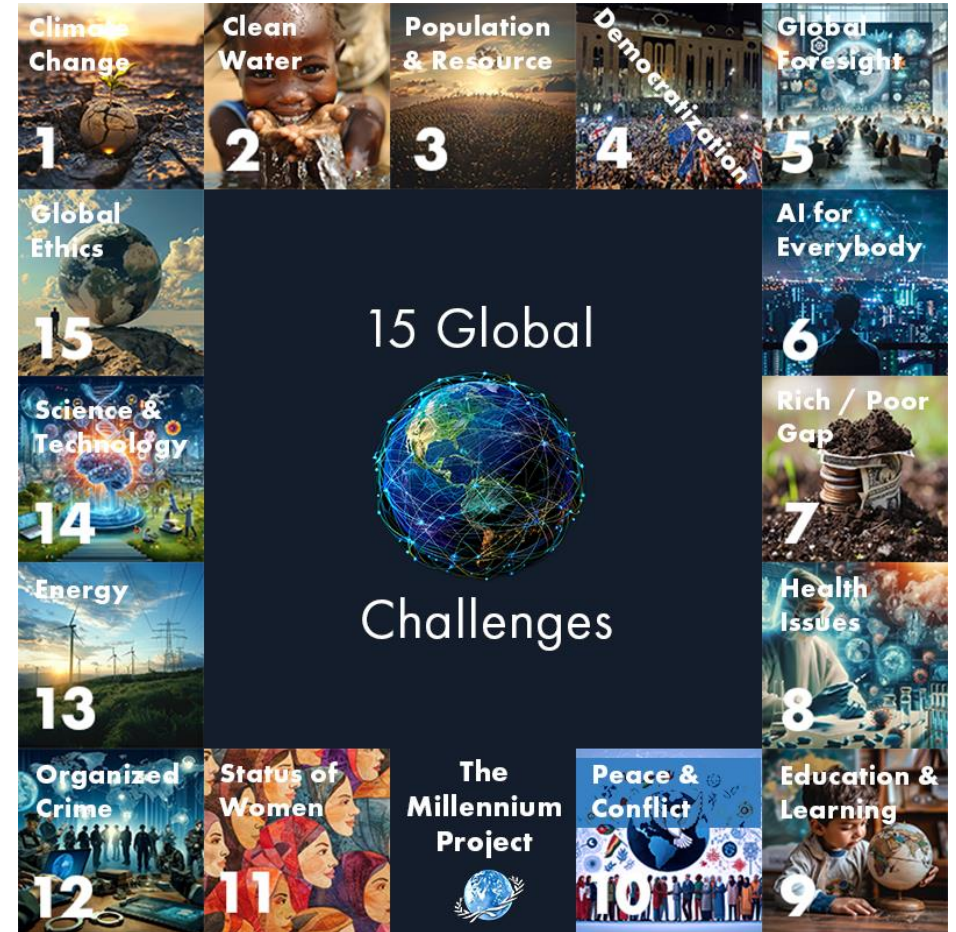
Global Challenges



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- ✓ Population growth and rising complexity
- ✓ **Climate change** and environmental sustainability
- ✓ **Digital economy** and smart, inclusive societies
- ✓ Global trade, emerging markets, and resilient supply chains
- ✓ **Future cities**: adaptive, regenerative, and sustainable
- ✓ Digital infrastructure with **open ecosystems**, IoT, and sensors
- ✓ Ageing assets and the need for integrated digital upgrades
- ✓ Connected, automated, and shared services
- ✓ Growth in open data, 3D models, AR/VR, digital twins, and urban analytics
- ✓ AI and Large Language Models are changing everything!



<https://millennium-project.org/challenges-overview/>

- ✓ **Land Information** and Geospatial data are **critical infrastructure**.
- ✓ **National resilience depends on land and geospatial trust**.
- ✓ We face a choice:
 - ✓ Collaborate now to elevate land and geospatial intelligence.
 - ✓ Or allow poor-quality data to undermine national systems, resilience and disaster preparedness.
- ✓ The time to act is now.

Broad Application Domains



Disaster Management



Environment Monitoring



Transport & Energy



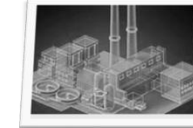
Smart City & Urban Planning



HealthCare



Land Administration



Infrastructure & Construction



Manufacturing & Industry 4.0



And more ..

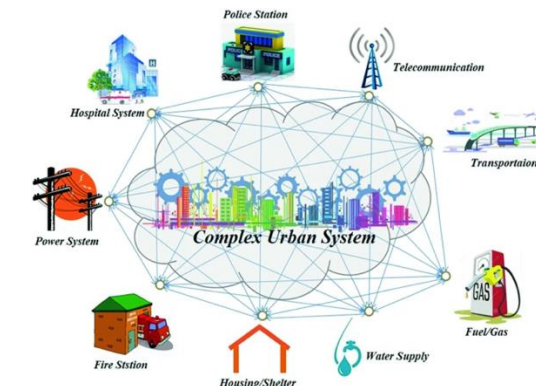
Making the strategic case for treating:

Land Information and Geospatial Data as critical National Infrastructure, essential to building Resilient, Sustainable, and Inclusive Communities in the face of climate risks, technological disruption, and economic uncertainty.

Why Resilience?



- **Resilience** is about **improving** the **ability** of systems to proactively and positively manage change. It underlines **preventive** (sustainable pathways), **anticipative** (understand), absorptive (withstand), **adaptive** (adjust), and **transformative** (fundamental shift) capacities in planning (Davoudi, 2018; Manyena et al., 2019; Meerow et al., 2016; UNDRR, 2017).
- **Resilience** underscores the importance of **systems thinking** and the role of **governance, people, and technology** in making solutions **place-based, inclusive, and future oriented** (Hölscher et al., 2019; IPCC, 2022; Rajabifard et al., 2021; UN, 2015; UNISDR, 2017).
- **Resilience** has the ability to **engage multiple actors** based on multi-level collaboration (**top-down** and **bottom-up**) and provide a **common ground** for planning and practices (Asadzadeh et al., 2022; Bene, 2017; Cutter, 2016).



Uddin et al., 2019

Resilience includes Sharing Benefits.

Climate Change



Urbanization



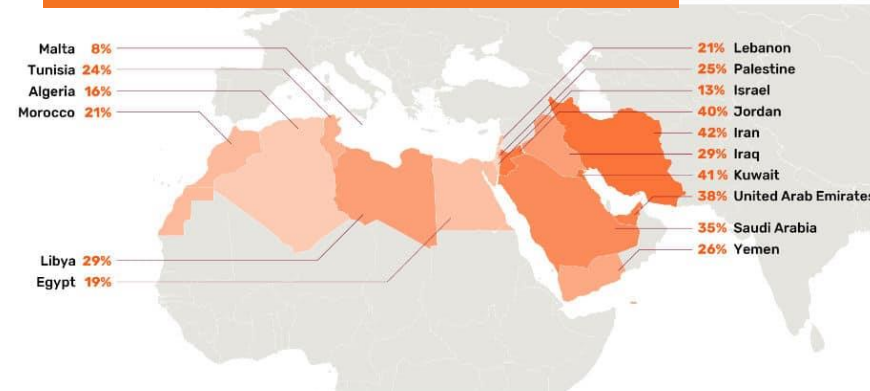
Land Degradation



Gender Inequality



Land Tenure Insecurity



Land Use Conflicts



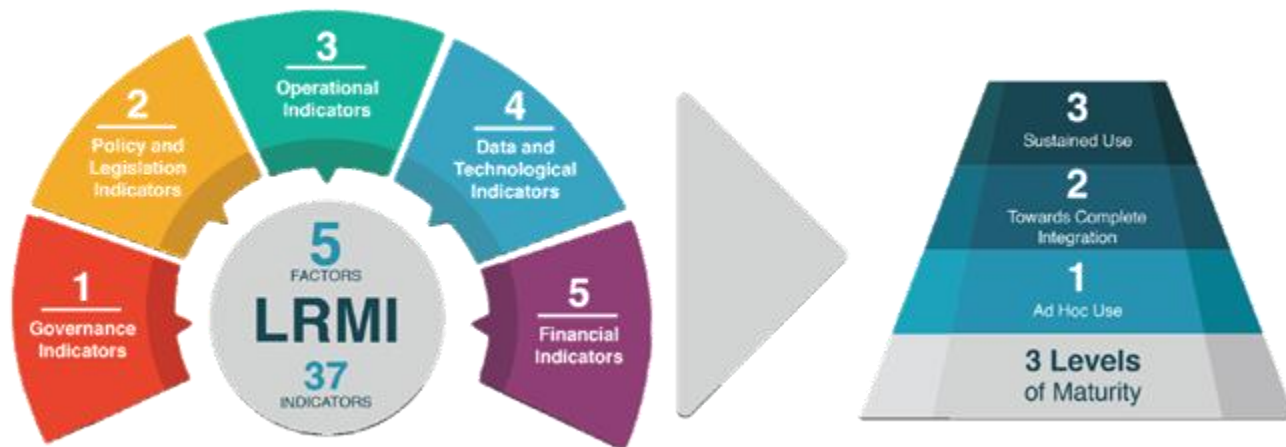
The Importance of Land



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- **Land and geospatial information** are key to ensuring that land records are **comprehensive and secure** - informing the **what, who, where, and how much**.
- **Without this information**, it is **almost impossible** for countries to develop **proper planning and disaster response** or preparedness plans.



26 M

People displaced by
disasters in 2023

When disasters displace people, land records and geospatial data are key to protecting their property rights and building resilience

Access to Land for Efficient Planning, Climate Action, and Infrastructure is critical.

Aim

Today 2025, the number of connected devices worldwide is over 75 billion, up from ~15.7 billion in 2015.

purpose land data and geospatial information so they can sustainably manage human-kind relationship to land and climate resilience in the face of existing and emerging

*This is a call to **move from fragmented efforts to coordinated systems** —
with policy, talent, and trust as the foundation for disaster-ready,
spatially enabled futures.*

innovation, and end-to-end land administration modernisation and geospatial processes to achieve improved climate resilience and sustainable land management across scales in line

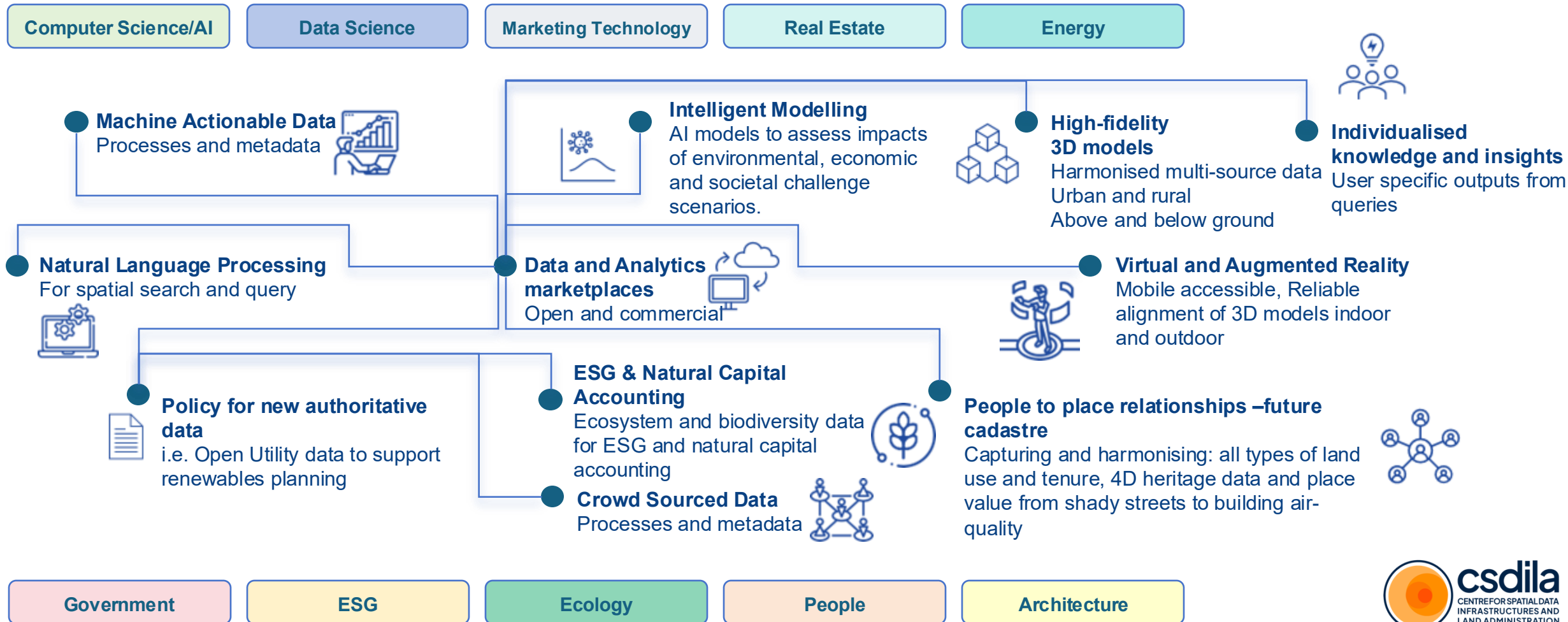
Access to land facilitate **tenure**, **land use**, **land valuation**, and **zoning** information for planning, monitoring, and implementing responses before, during, and after any **incident, e.g., disasters**.

✓ *Land/geospatial Information is not just critical — it is Transformative.*

Complementary Domains

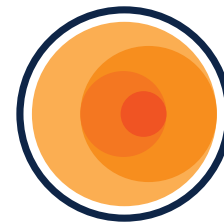


If we consider the innovations required to advance the capture, visualization, discovery and use of land and geospatial data, for *Disaster Ready and Spatially Enabled Communities* – **the geospatial industry need to grow our collaborations with complementary domains.**

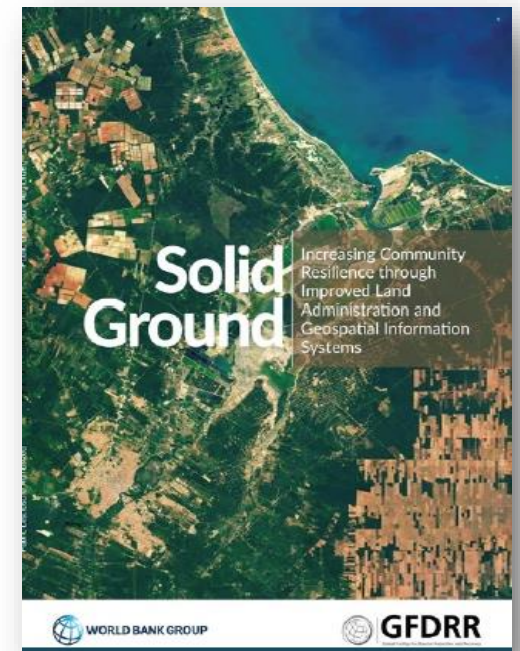




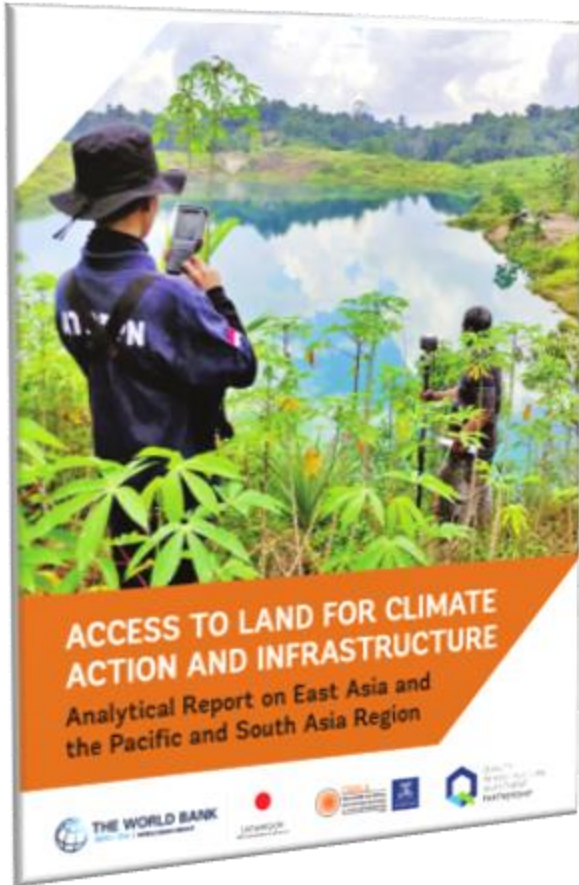
Improving Resilience and Resilience Impact of National Land and Geospatial Systems 2023



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“Global Guide for Access to Land for Climate Action and Infrastructure”



Almost **1 in 2 Climate Actions** will require accessing **Land** with actions related mainly to: **Forestry, Infrastructure (Energy, Transport,..), Environment, and Agriculture.**

Currently, **3% of GDPs on Infrastructures.** But for Climate Action **requires 8% investment** on infrastructures.

WB has agreed to double its investments in access to land.





- The **Paris Agreement** is a historical document that **legally binds the whole World to participate in climate change fight**
- The Agreement urges speeding up **clean tech development** and international technology transfer
- Countries have submitted their **Nationally Determined Contributions (NDCs)**, which contain targets, policies, and measures for **reducing national emissions and adapting to climate change impacts**.

Addressing Climate Actions requires **1.2 bh** of new land...

THE AGREEMENT: BY THE NUMBERS

195 countries adopted the Paris Agreement at the 21st Conference of the Parties in December.



At the core of the Agreement:



We must keep global temperature rise this century to **well below 2° Celsius** (that's 3.6° Fahrenheit).



189 countries representing **more than 99% of global emissions** have submitted their Intended Nationally Determined Contributions. These INDCs make up the heart of the Paris Agreement.



Countries must review and re-assess these pledges **every 5 years**, with “global stocktaking” starting in **2023**. Countries can't lower their targets - in fact, they are encouraged to raise their ambition and level of commitment with time.



Location

SES



Land Matters in SDGs



Sustainable Development requires an **integrated approach** that takes into consideration environmental concerns along with economic development.

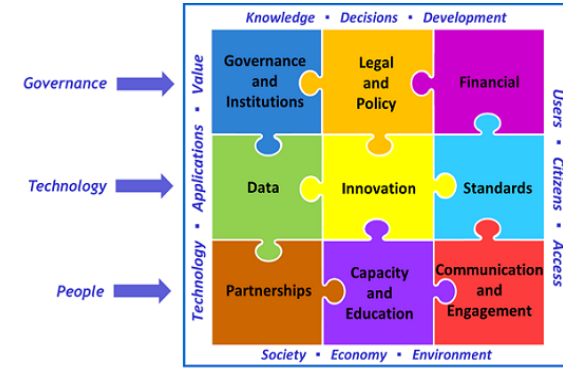
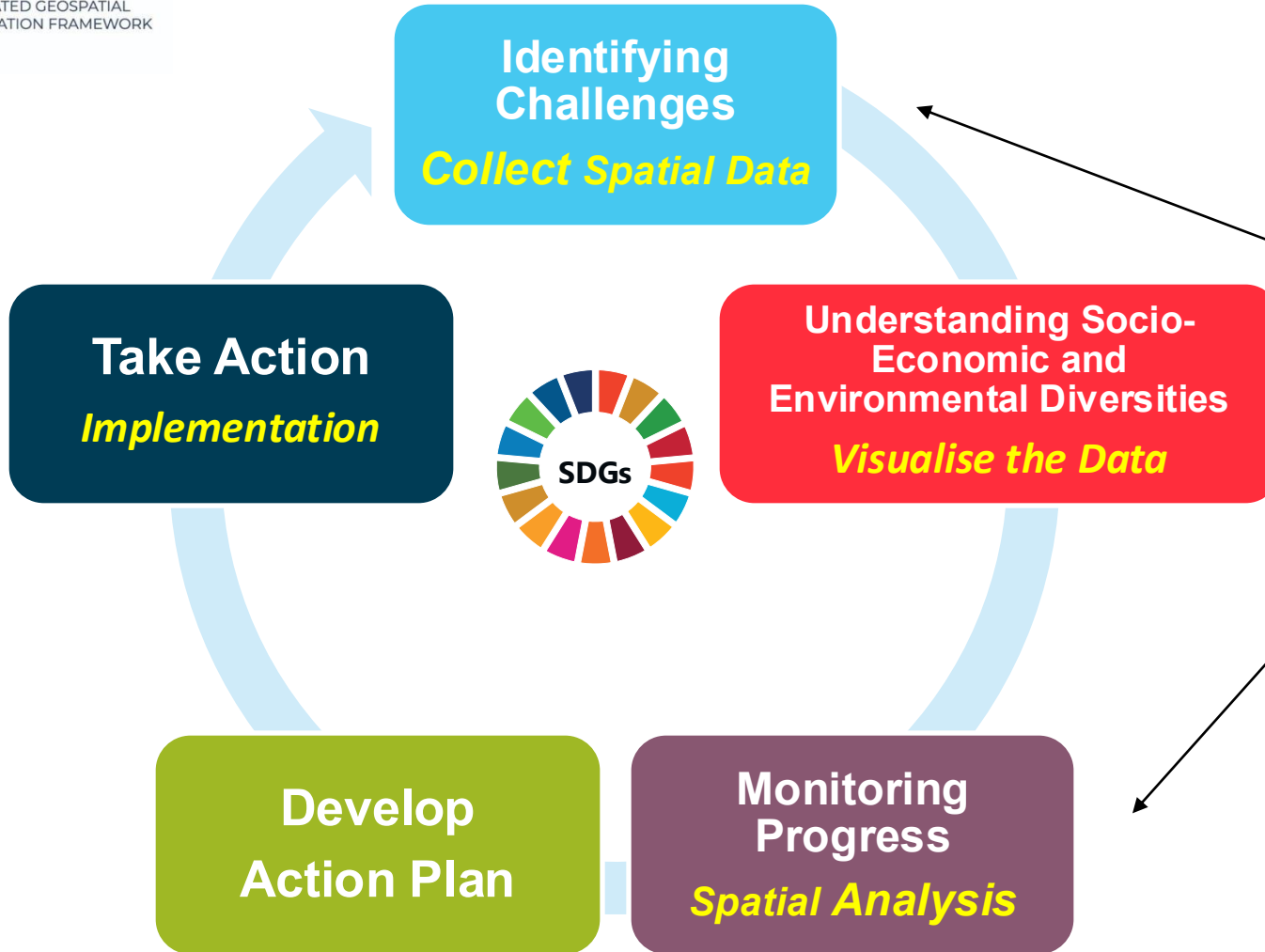
Process-Based Approach to Achieve SDGs



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UN IGIF
INTEGRATED GEOSPATIAL
INFORMATION FRAMEWORK

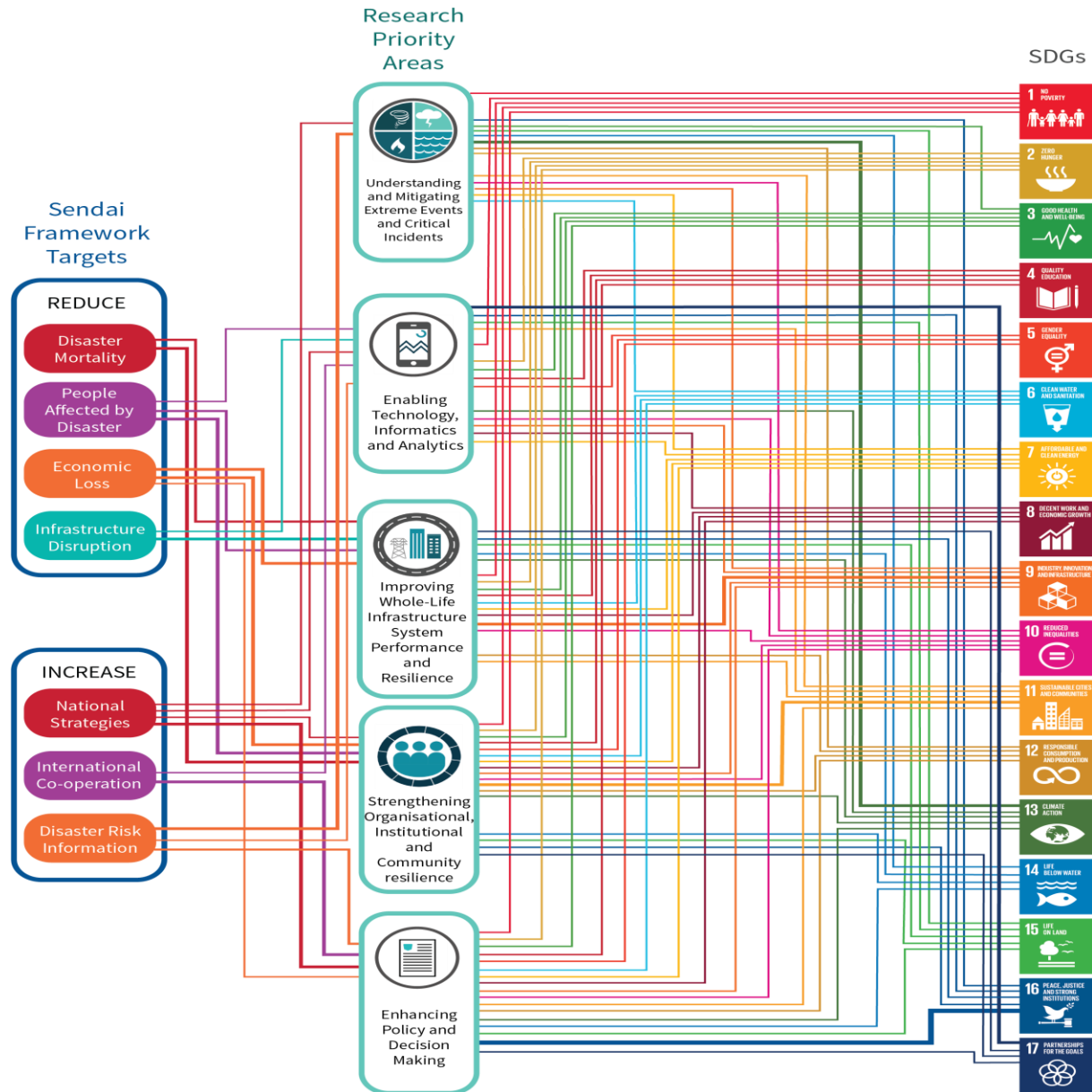


Interrelationships Mapping

SDGs Inter-Relationships



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Supporting Resilience- *From Real World to Digital World*



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Maximizing Return on Our Investments

Digital Economy

Digital World/ Digital Twin

\$1/3 Return Ratio

IoT/Linked Data

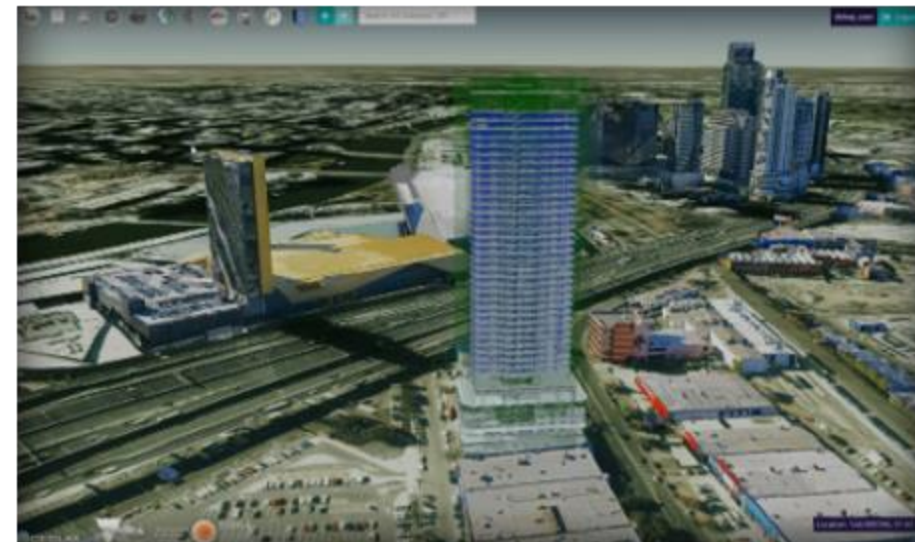
3D Digital
Cadastre

3D Parcel
Fabric

2D Spatially
Accurate Parcel
Fabric

2D Cadastre

**Connected
Platform**



Real World



Resilient and Intelligent Infrastructure Systems (RIIS)



TOWARDS PRODUCTIVE, CONNECTED, SUSTAINABLE AND SMART INFRASTRUCTURE

**UBIQUITOUS SENSING,
INTELLIGENT AND
ADAPTIVE SYSTEMS**

**DATA COLLECTION,
SECURITY, AND
INTEGRATION**

**MODELLING,
SIMULATIONS AND
PROGNOSTICS**

**INFRASTRUCTURE HEALTH
MONITORING AND
PREDICTIVE MAINTENANCE**

**SPATIAL DATA
INFRASTRUCTURES,
DIGITAL TWIN AND
DECISION SUPPORT**

Infrastructure protection utilising real time monitoring and predictive models during flash flooding events

- Analysed and processed IoT data for Townsville
- Integrated flood data in Digital Twin
- Multi-step ahead predictive flood model
- New sensor deployment
- Published an article in the high impact IEEE journal for building infrastructure.

Advanced point cloud segmentation for real-time infrastructure modelling, management, and resilience.

- Advanced AI for 3D Infrastructure point clouds
- Successful engagement with the industry partner
- Runner-up in the RIIS Presentation in Sydney (Nov 2024)
- Submission of a paper to IEEE's International Geoscience and Remote Sensing Symposium

Integrating Spatial Digital Twin with Automation System in Smart Infrastructure Asset Management

02

- AI-based 3D Asset Detection
- High Resolution Depth Estimation
- 3D Object Detection using GenAI (Vision Language Models)
- 3D Asset Localisation using GenAI (MLLMs)
- Conveyor Health Prediction
- 2 Articles published and 2 others in progress

Data Integration with Spatial Digital Twin for No Spill Network

03

- 3D Graph Database for Water Infrastructure
- 3D City Water Utility Network Model
- 3D BIM model for Water Treatment Plant
- Article Published and others in progress

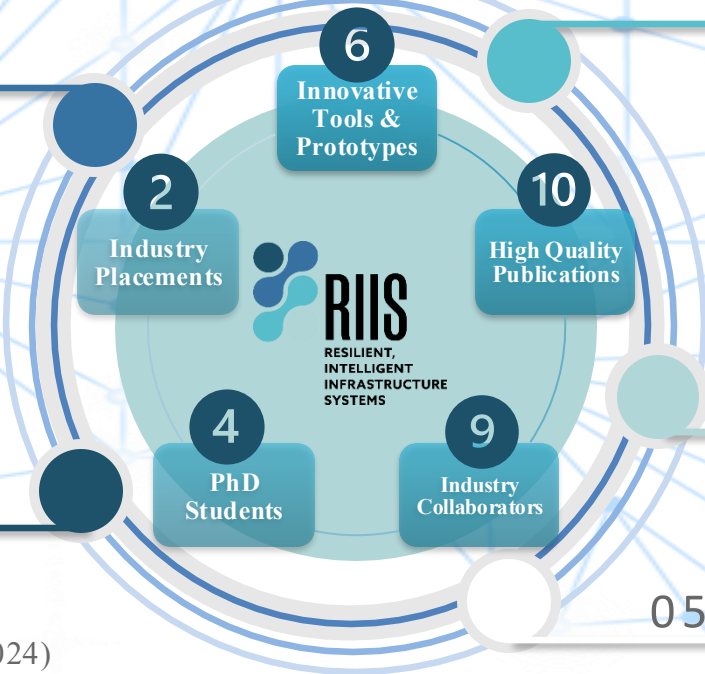
Structural Health Monitoring of Bridges: A Digital Twin Demonstrator

05

- Sensor Deployment & Testing
- Digital Twin for Bridge Health Monitoring
- 2 Research Article and 1 Conference paper in Progress

01

04



WHO WE ARE ?



Centre for Spatial Data Infrastructures and Land Administration

Established in 2001

**A WORLD CLASS
RESEARCH
CENTRE**

**EMPOWERING SOCIETY WITH
LAND AND LOCATION
INTELLIGENCE**



60+ Global Collaborations

Key Capabilities



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MODERN LAND ADMINISTRATION SYSTEMS

Modernisation of Land Administration Systems and development of digital and intelligent cadastres in the contexts of smart cities, indigenous lands and land for climate actions



BUILDING INFORMATION MODELLING (BIM)

Developing multi-dimensional land and property rights, restrictions and responsibilities

BUILDING ENERGY & IOT

Analysis and solutions in building energy management, energy ownership and decarbonisation



URBAN ANALYTICS

Enhancing urban design and planning practice applying big data science, simulations and geodemographics



REMOTE SENSING

Image and object recognition from remotely sensed data sources, from land tenure to vehicle and human movement, hierarchical modelling, mapping and optimal data utilisation



DIGITAL TWIN & AI TECHNOLOGIES

Developing leading-edge spatially enabled digital twin solutions and AI analytics to meet business and decision-making requirements.

ECOLOGY & LANDSCAPES

Designed experiments and digital twin solutions for climate-resilient land and landscapes
R & D capabilities include: Prototype Platforms, Tools and Applications; Modelling and Analytics Frameworks and Strategy and Policy Development, Consulting, Advisory Services and Training

DISASTER MANAGEMENT AND CLIMATE RESILIENCE

Developing Spatial Information ecosystems for climate-resilient land management and decision support

CSDILA strategic areas of core capability are centred on proven and emerging knowledge and technology relating to land administration, geospatial and location intelligence



LAND ADMINISTRATION, GEOSPATIAL and LOCATION INTELLIGENCE



STRUCTURAL HEALTH MONITORING

Integrating real-time IoT data, geometric information, and physics-based data via FEM to provide comprehensive insights into the health & performance of critical infrastructure.



EXECUTIVE TRAINING & CAPACITY BUILDING

Strategic training to embed innovation and geospatial capability in practitioners and executives globally



SUSTAINABLE DEVELOPMENT GOALS (SDGs)

Supporting the development of data infrastructures that implement the SDGs



SDI & DIGITAL INFRASTRUCTURE ENGINEERING

Enhancing governance and digital engineering capabilities in our societies via Spatial Data Infrastructures (SDI)



VISUALISATION & D-LAB

Cutting edge geospatial data collection, visualisation and analysis including lidar, drone, hologram, VR and AR

THE FUTURE IS BRIGHTER



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Thank You

We welcome new partnerships and collaborations



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