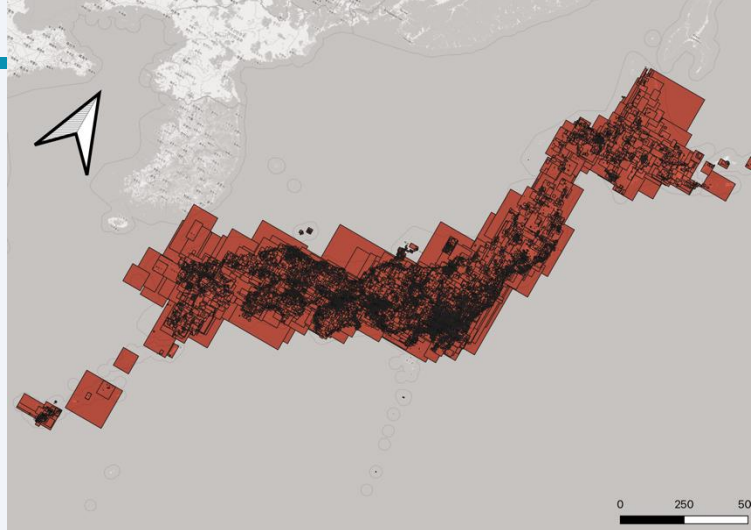
Research Introduction:
Overview activities during sabbatical research



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PART I

Evaluating Sustainability of Open SDI Using Multiple VGI Data Sources

OpenStreetMap, Mapillary, and Community-driven Geographic Data

Why VGI Matters for Sustainable Open SDI

Evaluating Sustainability of Open SDI Using Multiple VGI Data Sources

1 Future SDI: Open Data Commons

Spatial Data Infrastructures have historically been built and maintained by governments through centralized, top-down workflows.

2 Rise of Hybrid Geodata

As societal needs grow more complex and diverse, hybrid approaches that government open data with community-driven sources are essential.

3 High Cost of 3D & Precision Data

Maintaining high-resolution 3D geodata is extremely costly, making purely government-led approaches unsustainable at scale.

4 Need for VGI Assessment/Trust

Assessing OSM and Mapillary data coverage and update cycles is critical to reveal both the potential and the challenges of VGI as a complementary SDI .

→ **Goal: Evaluate sustainability of volunteer-driven geographic data to build resilient, open SDI**

Resent VGI Research & 3D City Models: Connecting the Dots

2019	2022	2023	2024	2025
OSM-Notes Quality feedback via user-posted Notes	**Mapillary + OSM edit** Street imagery as road data catalyst	**Corroborative OSM and PLATEAU** Overview PLATEAU and compare with central Tokyo data	**OSM Changeset analyze** Editing validation & Contributor action	**3D Attributes @ OSM** Building 3D coverage on OSM **3D Library Performance Evaluation** JS library + 3D Tile service

Overarching Theme: VGI Activity Sustainability

- Data Commons: How to evaluate, maintain, and improve the sustainability of volunteer-driven geographic data.
- From individual OSM-Notes to large-scale 3D building analysis — multiple scales of assessment.
- **Emerging challenges: AI-assisted mapping, data imports, contributor concentration, regional inequality.**

OSMCha: Editing Trends Validation

International Geographical Congress 2024:
https://speakerdeck.com/tosseto/20240828igc2024osmcha

OSM Changeset Analyzer (OSMCha)

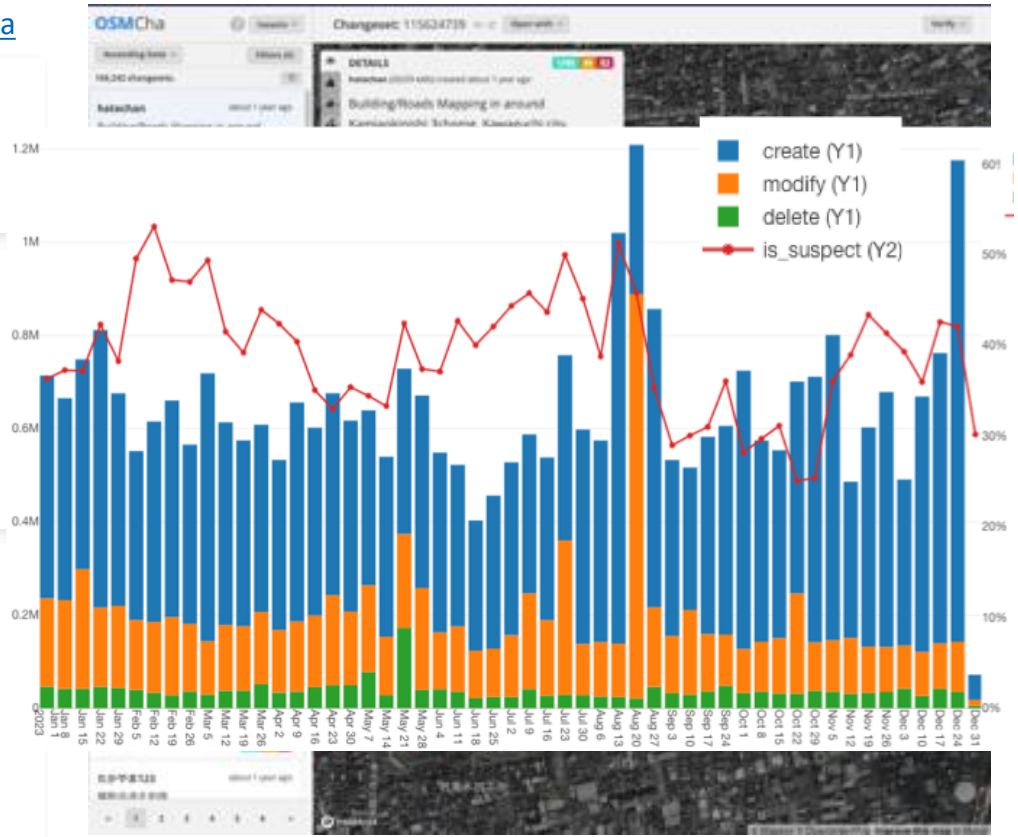
- Python package to automatically detect suspicious OSM changesets.

Methodology

- Target data: Changeset (195,416 records) whole one-year 2023
- A detailed survey of suspicious categories and percentages was conducted.

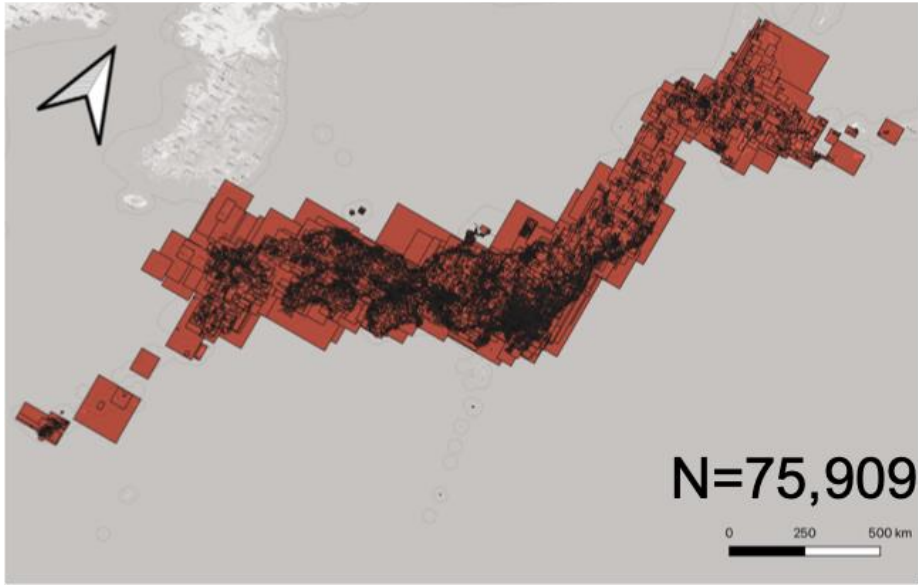
Findings main detection rules

- Possible Import
- Mass Modification
- Mass Deletion
- **New mapper**
- User has multiple blocks

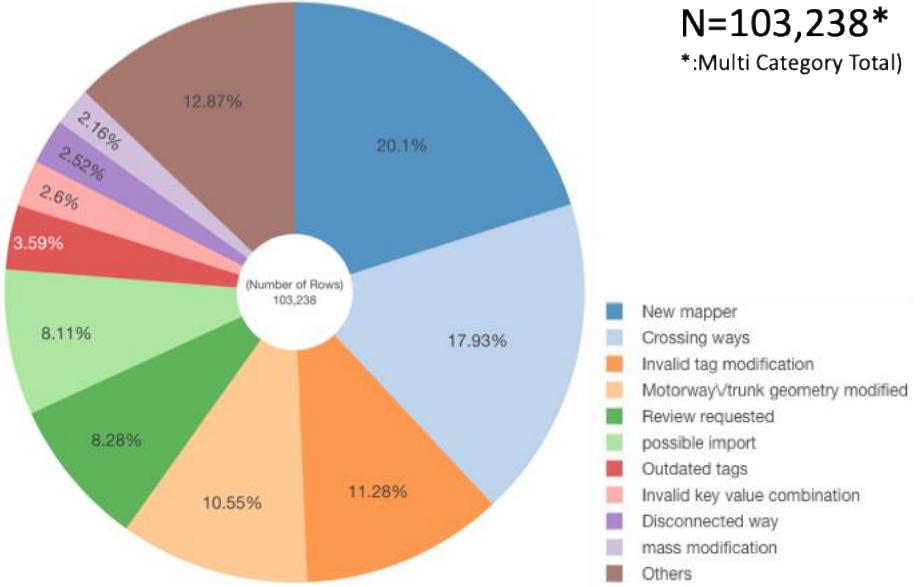


https://github.com/OSMCha

Regional Distribution & Editor Concentration



"suspicious" changesets coverage



Percentage of reasons based on OSMCha's detection rules

Key Finding

A large contribution from **New Mapper**, it is undeniable that it may contain a certain number of errors due to non-training. However, not all edits by New Mapper are suspect.

→Currently, extend the analysis to over the past five years, we are analyzing 740,000 log data within Japan.

Building 3D Attribute Coverage and Spatial Disparity of Edit OSM

20th International 3D GeoInfo Conference 2025:
https://doi.org/10.5194/isprs-archives-XLVIII-4-W15-2025-149-2025

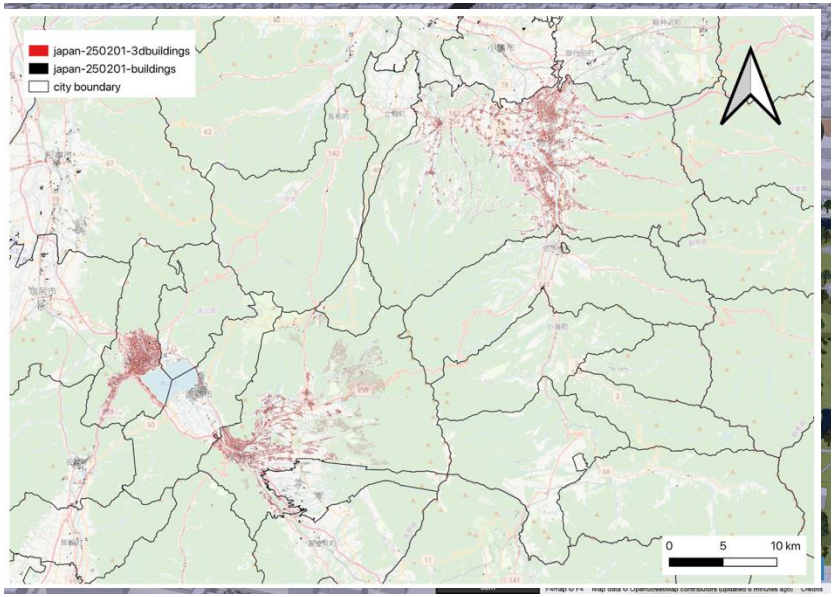
Study Scope

All Japan (47 prefectures, 1,905 cities) OSM data
24.2M buildings, 24,394 contributors (editors)

Target 3D Attributes

- **height; 1,125,395 buildings (4.7%)**
- building:levels; 1,104,648 buildings (4.6%)
- min_height;
- ele
- building:levels:underground

} Other attributes: 0.002-4.6%



4.7%
Height coverage

HHI 2,075
Avg. of HHI
editor concentration

$$HHI = \sum_{i=1}^{n} s_i^2$$

- Herfindahl-Hirschman Index (HHI)
  - where *Si* represents the **distribute share (%) of** editors *i*
  - Maximum value: 10,000
  - >2,500: high concentration

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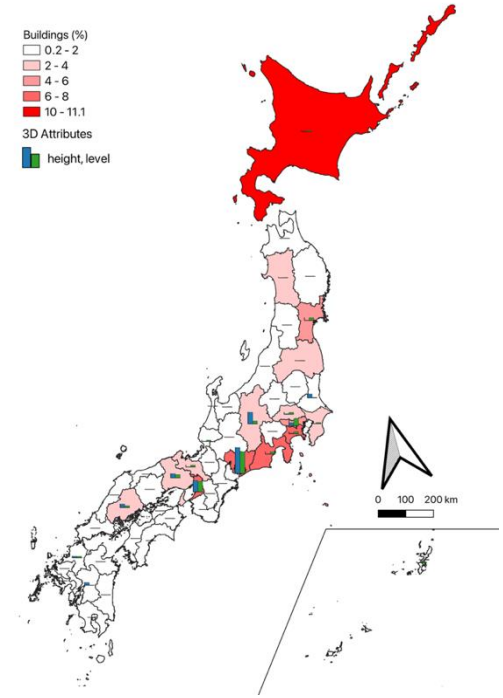
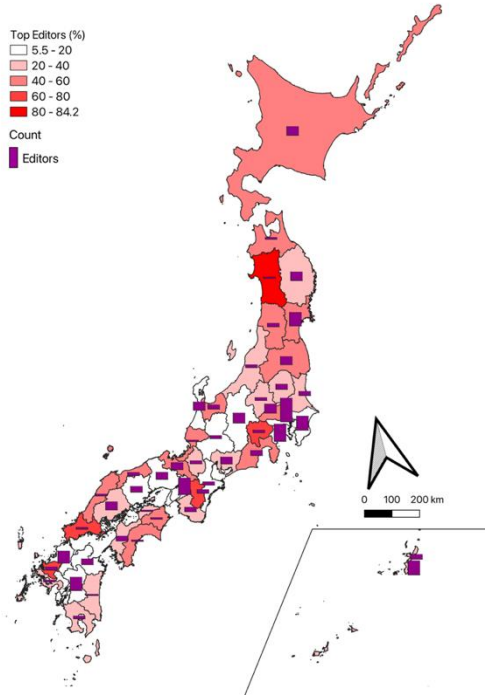
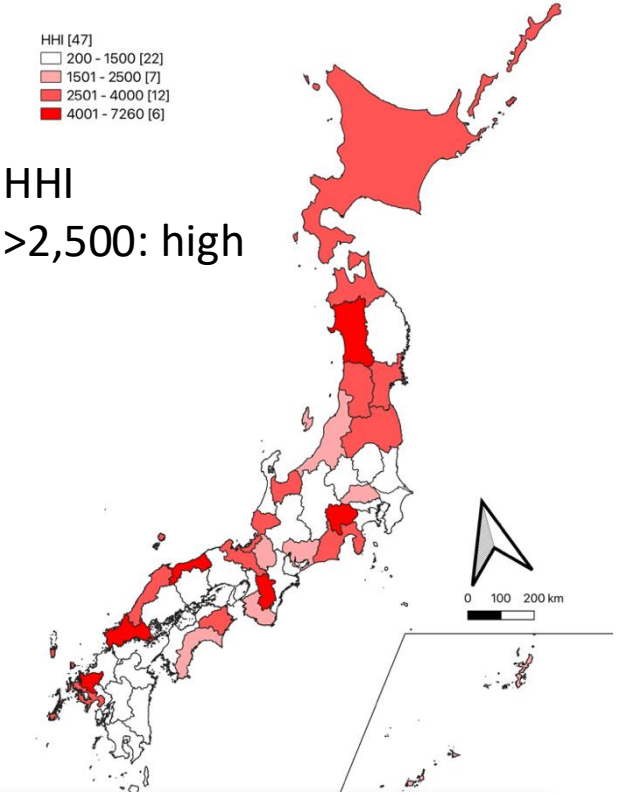
Regional Distribution & Editor Concentration



3D Attribute Coverage by Prefecture



Contributors Count by Pref.



Key Finding

Building count correlates with contributors (r=0.608), but height coverage does not (r=0.256).

Role of 3D City Model Data as Open Digital Commons

FOSS4G 2023 Academic Track: https://doi.org/10.5194/isprs-archives-XLVIII-4-W7-2023-201-2023

Project PLATEAU

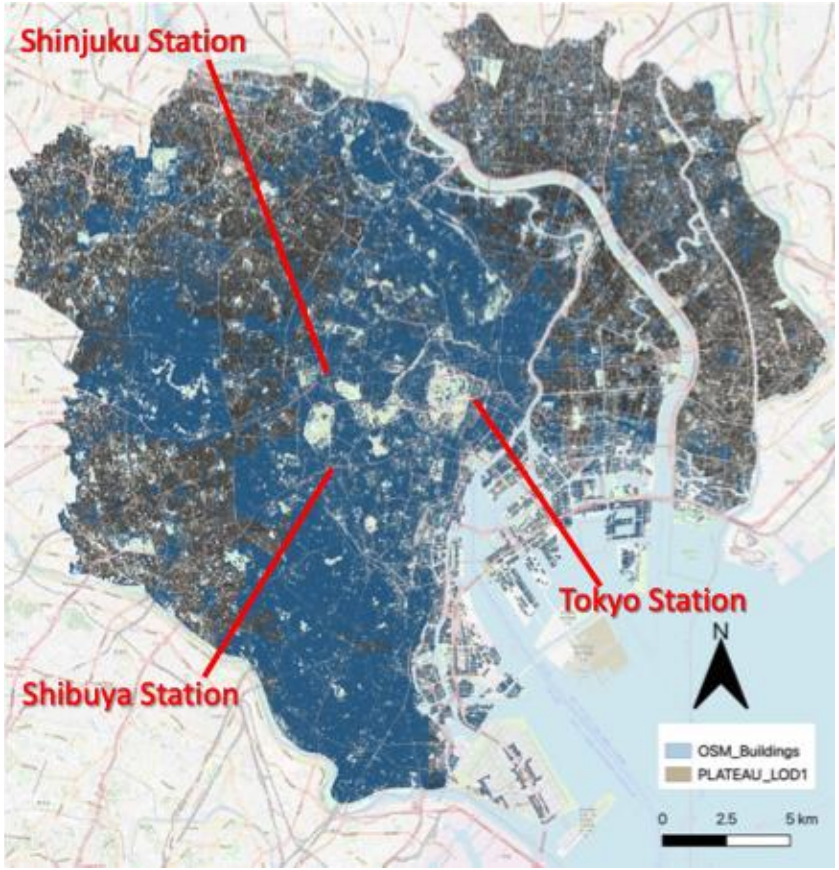
2020-2022's datasets
3D CityGML models, 150+ cities
18.3M+ buildings (LOD1/LOD2)

PLATEAU vs OSM

OSM covers ~31% of PLATEAU in target cities
Tokyo: OSM ~40% of PLATEAU objects
502 blocks where OSM exceeds PLATEAU

FOSS4G Tools usage and new developments

PLATEAU VIEW (Re:Earth)
16 open-source repositories on GitHub (2022)
→ **Now: 140+ repositories**



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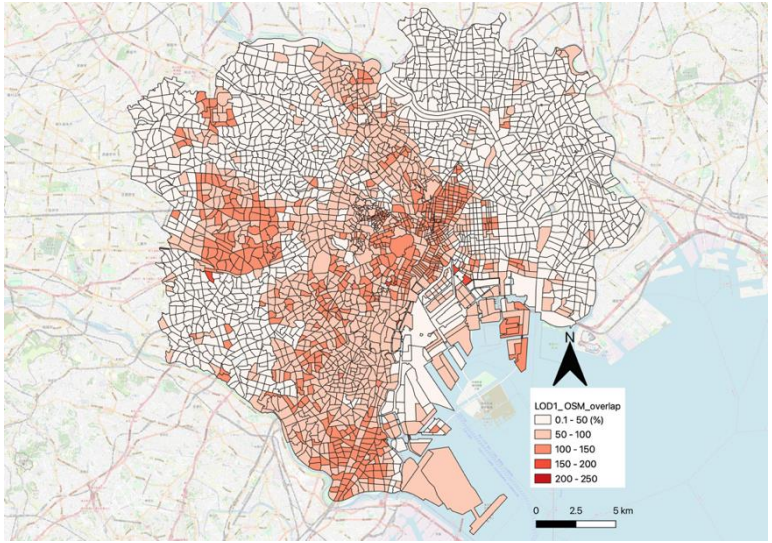
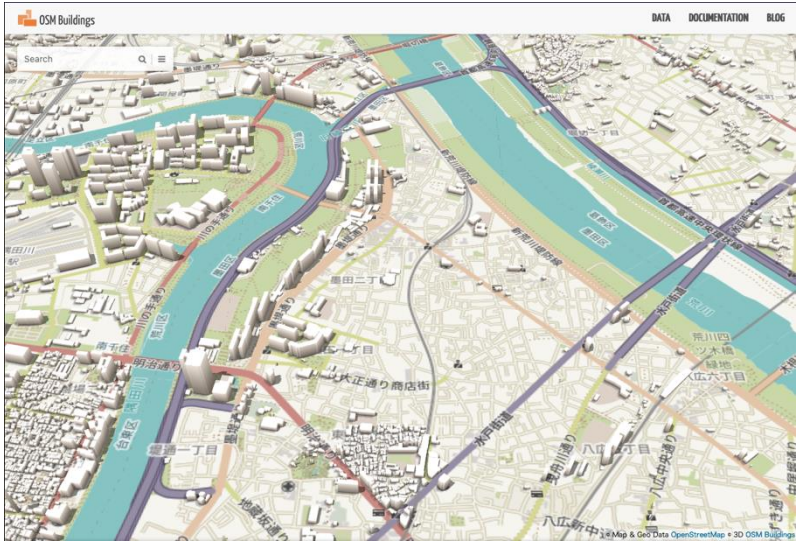
PLATEAU-OSM Coverage Comparison



PLATEAU 3D Building Model (LOD2)



OSM Buildings include “3D attributes”

Key Insights

3,190 city blocks in Tokyo analyzed. 1,548 blocks: OSM < 50% of PLATEAU. 502 blocks: OSM exceeds PLATEAU. Continuous updating and wider government coverage remain key challenges .

→ **Integrate PLATEAU data into OSM is ongoing based on community consensus.**

PART II

▲short video on YouTube

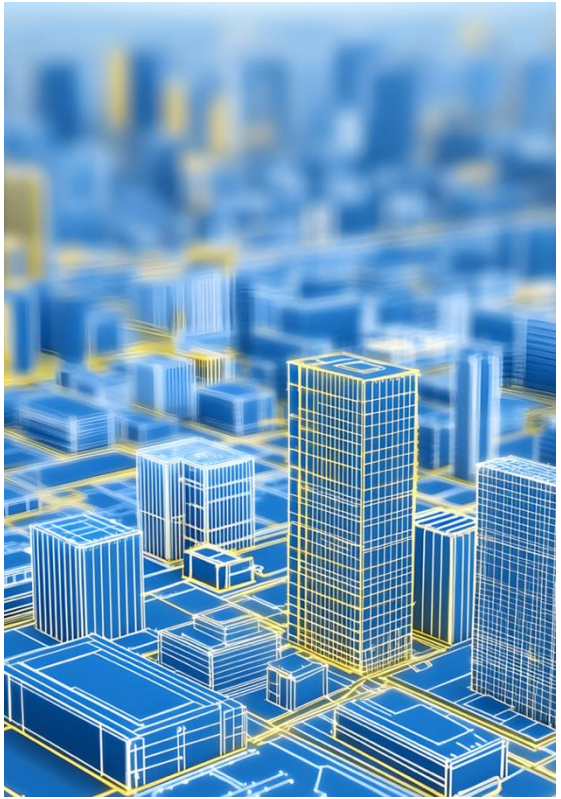
Project PLATEAU (short introduction)

Japan's Digital Twin Initiative: Open Data, Use case Developments

This part will be explained in detail in ”GEO1004” on June 3rd.

What is project PLATEAU?

PLATEAU is a **project led by MLIT (Ministry of Land, Infrastructure, Transport and Tourism, Japan)** that focuses on developing, utilizing, and sharing 3D city models for urban planning since 2020.



Openness: multi-licensed under CC BY 4.0 and ODbL

- PLATEAU provides various resources, including 3D city models and tools and materials for creating and utilizing them.
- By aligning with the OSM license (ODbL), the data import process is currently underway with the community's approval.

Collaboration

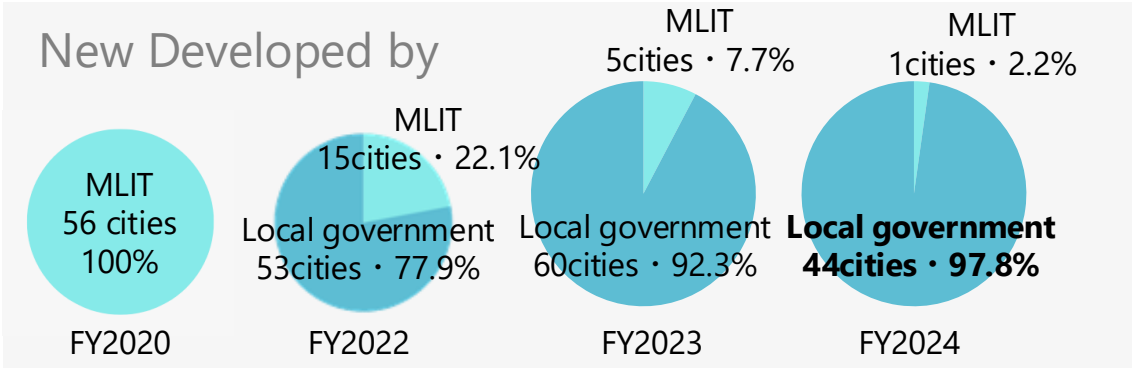
- Various entities, including government agencies, local governments, private companies, universities and research institutions, and local communities, are collaborating to create new value from 3D city models.

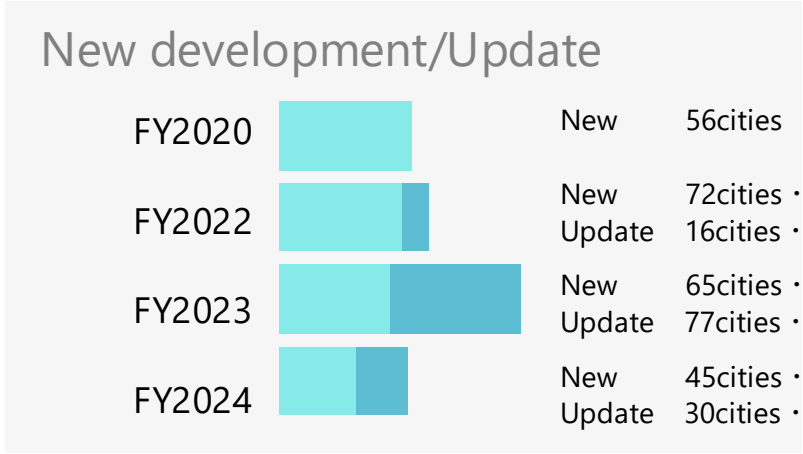
Sustainability

- PLATEAU's goal is to create an ecosystem for the development, utilization, and sharing of 3D city models to enhance urban resilience.

Project PLATEAU Achievements 2020-2024
(official release)

230+ City **30,000km²**	Total area
23million **LOD1**	Number of buildings
51.4%	Population coverage rate





Overview of data developments in Project PLATEAU

Establishment of high-quality and scalable data

accuracy-controlled within a horizontal deviation of 1.75 m and a height deviation of 0.66 m.

Urban Planning Base Map

2D map data of buildings, roads, blocks, etc.

Geometry (shape)

×

Aerial survey result

3D data of building heights, shapes, **texture** etc.

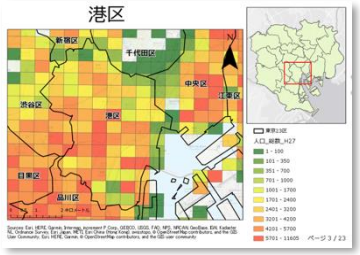
Buildings, Roads, Bridges, Tunnels, Trees, etc.

3D City Models

Semantics(attribute)

Urban Planning Basic Survey data

Current status of buildings and land, etc.



Development of Standard Data Product Specification +ADE for 3D city models in Japan

Standardization of 3D city model data products in Japan

- The Standard Data Product Specification for 3D City Model was developed in March 2021 as Japan's first standard data model for 3D city model, which was updated by version 3.0 in March 2023.
- The development of this standard document has resulted in the unification of the specifications, standards, and quality of 3D city models in Japan.
- As a result, software development will be more efficient, knowledge will be shared, and data will be linked more easily.

1,380 pages !

Compatible with international standards

- The PLATEAU standard data specification is based on **CityGML 2.0**, an open format developed by an international standards organization OGC.
- The PLATEAU standard is a localized standard unique to Japan that adds attribute information and detailed LOD definitions.

HTML version also available

- HTML version was released in 2022 to improve usability

https://www.mlit.go.jp/plateaudocument/

Modules of the PLATEAU standard (CityGML v.2 based)

建築物モデル-Building

LOD0 LOD1 LOD2 LOD3 LOD4

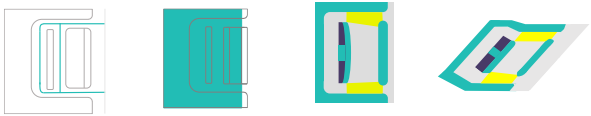
交通（道路）モデル-Transportation(Road)

LOD0 LOD1 LOD2 LOD3

交通（徒歩道）モデル-Transportation(Track)

LOD0 LOD1 LOD2 LOD3

交通（広場）モデル-Transportation(Square)



LOD0 LOD1 LOD2 LOD3

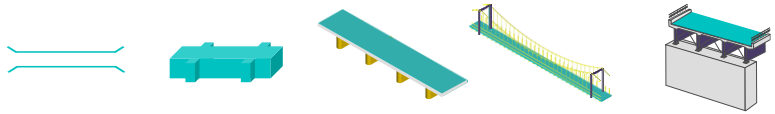
交通（鉄道）モデル-Transportation(Railway)

LOD0 LOD1 LOD2 LOD3

交通（航路）モデル-Transportation(Waterway)

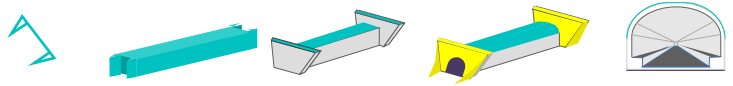
LOD0 LOD1 LOD2

橋梁モデル-Bridge



LOD0 LOD1 LOD2 LOD3 LOD4

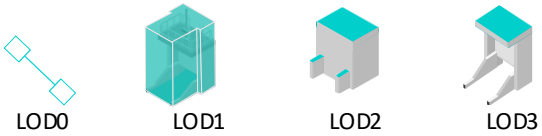
トンネルモデル-Tunnel



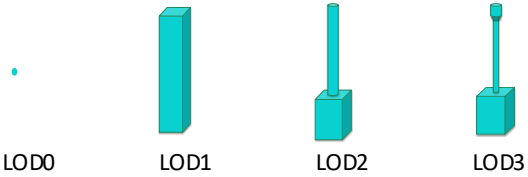
LOD0 LOD1 LOD2 LOD3 LOD4

Modules of the PLATEAU standard (CityGML v.2 based)

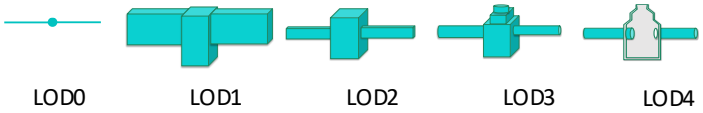
その他の構造物モデル-OtherConstruction



都市設備モデル-CityFurniture

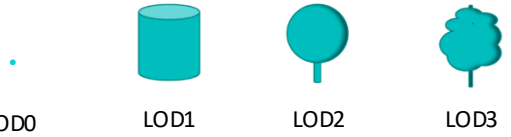


地下埋設物モデル-UtilityNetwork

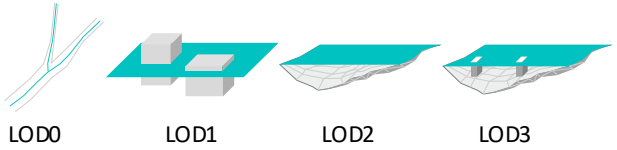


地下街モデル-UndergroundBuilding

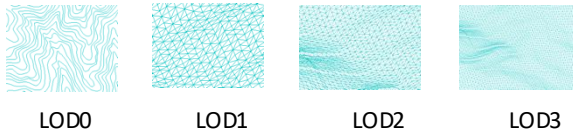
植生モデル-Vegetation



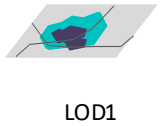
水部モデル-WaterBody



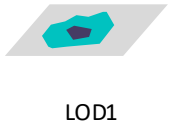
地形モデル- Relief



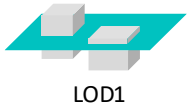
LandUse



UrbanPlanning Area



Disaster Risk area(flood)



Disaster Risk area(landslide)

OtherArea

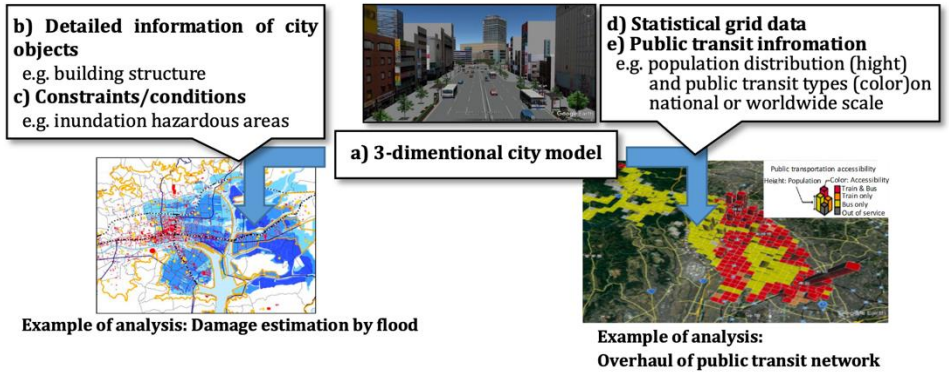
Urban Planning ADE (i-UR)

381 pages !

- Main components
  - **Urban Object module**
    - Extends physical objects (e.g., buildings, roads, vegetation)
    - Adds detailed attributes (e.g., structure type, usage, regulations) [mlit.go.jp]
  - **Urban Function module**
    - Represents **non-physical / regulatory concepts**
    - e.g., zoning, planning areas, hazard zones
- Data scope
  - Covers a wide range of urban elements: Buildings, transportation, water bodies, land use, city furniture
- Key contribution
  - Enables representation of planning regulations and policy information in 3D
  - Supports analysis, simulation, and consensus-building in urban planning

The i-Urban renovation and planning Data is the combination of following data:

a) 3-dimentional city objects and city model
b) Detailed information of city objects for analysis
c) Constraints/conditions (e.g. regulation) related to urban revitalization
d) Statistical grid data for global analysis and visualization
e) Public transit information to consider urban function accumulation in regional planning



Example of analysis: Damage estimation by flood

Example of analysis:
Overhaul of public transit network

https://www.chisou.go.jp/tiiki/toshisaisei/itoshisaisei/iur/index.html

The i-Urban renovation and planning Data Encoding Specification

Part 1: Urban Object Data Encoding Specification
This document targets on b) Detailed information of city objects for analysis and define them as properties of CityGML object.

Part 2: Urban Function Data Encoding Specification
This document targets on c) Constraints/conditions related to urban renovation and define constraints and conditions as subclasses of the root class in CityGML.

Part 3: Statistical Grid Data Encoding Specification
This document targets on d) Statistical grid data for demand and supply analysis and define a statistical grid as subclasses of the root class in CityGML.

Part 4: Extended LOD Data Encoding Specification for Global City Model
This document targets on e) Global city model for global analysis and visualization. To promote “compact cities”, global analysis and visualization are necessary for role sharing among cities, and global city model which is easy to handle is also required.

Feature		LOD0	LOD1	LOD2	LOD3	LOD4
Building		v1	v1	v1	v1	v1
Land Use			v1			
Transportation	Road	v3	v1	v2	v2	
	Track	v3	v3	v3	v3	
	Square	v3	v3	v3	v3	
	Railway	v3	v3	v3	v3	
	Waterway[2]	v3	v3	v3		
Urban Planning[1]			v1, v2			
Disaster Risk[1]			v1, v2			
City Furniture			v2	v2	v2	
Vegetation			v2	v2	v2	
Water Body		v3	v3	v3	v3	
Relief Feature			v1	v2	v2	
Bridge		v3	v3	v3	v3	v3
Tunnel		v3	v3	v3	v3	v3
Other Construction[2]		v3	v3	v3	v3	
Underground Building[1]			v3	v3	v3	v3
Utility Network[1]		v3	v3	v3	v3	
Zone[1]			v3			
Generic City Object		v1	v2	v2	v2	v3

1 Features defined in Urban Planning ADE
2 Features defined in Urban Planning ADE while ensuring consistency with CityGML 3.0

PART III

Sabbatical Research Activities

TU Delft, The Netherlands | April 2026 - March 2027

Background:

Open 3D-SDI and Sustainability

1. Global Expansion and Applications

- Open 3D geospatial data supports smart cities, urban planning, disaster management, and civic engagement worldwide.

2. National Initiatives and Challenges: for de-centralization SDI

- Japan's PLATEAU and the Netherlands' 3DBAG show government investment in open 3D data with sustainability challenges.

3. Socio-Technical System

- Open 3D data functions as a socio-technical system involving governments, academia, private sectors, and citizens.

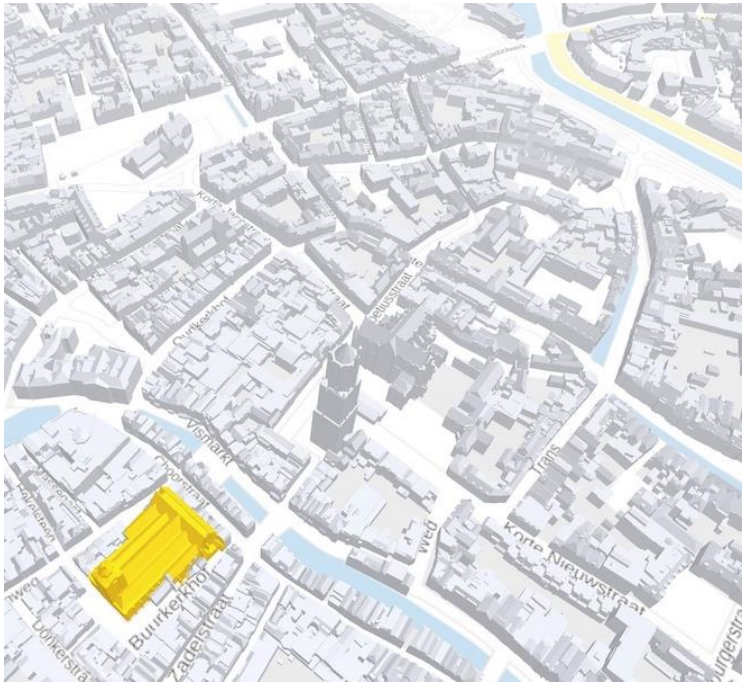
4. Context-Sensitive Sustainability

- Sustainability requires understanding how data infrastructures are maintained, taught, and used beyond technical aspects.

Research Question

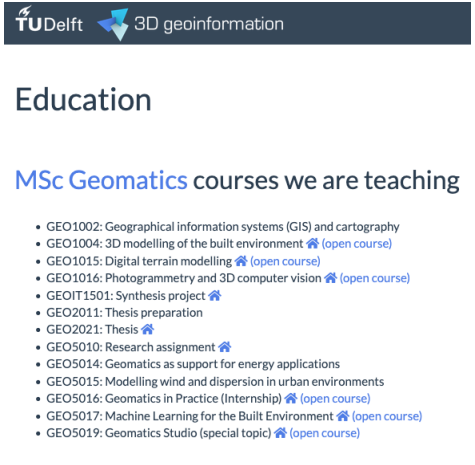
- **“How can open 3D geospatial data ecosystems achieve long-term sustainability as an SDI?”**
  - ✓ RQ1— **Technical Sustainability**: Web-native 3D geospatial data for a sustainable data commons
  - ✓ RQ2— **Socio-institutional Sustainability**: Use-cases, governance & education in open 3D-SDI ecosystems (JP ↔ NL, with & EU references)

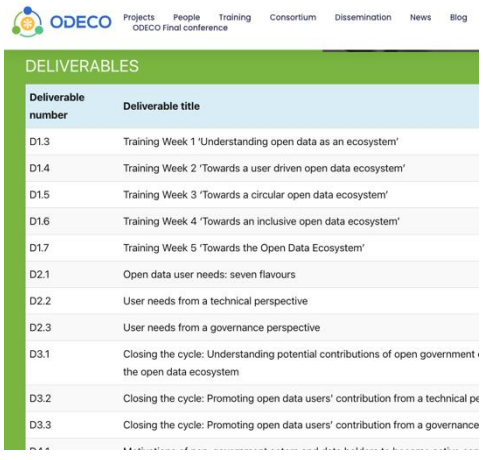
RQ1— Technical Sustainability: Web-native 3D geospatial data for a sustainable data commons



- **Data Model Modernization**: Evaluate CityJSON as an alternative encoding for PLATEAU (currently CityGML + ADE), focusing on file size, parse/render performance, and web tooling compatibility
- **Web-oriented Workflows**: Examine lightweight representations and their interoperability with CityJSON for data discovery and dissemination
- **Scalability Assessment**: Test scalability and limitations for Japan's nation-wide 3D city models, and derive requirements for a sustainable Data Commons infrastructure
- **Multi-class Feature Conversion**: Verify data conversion across PLATEAU's full range of feature types beyond buildings and roads (land use, vegetation, terrain, bridges, urban planning information, etc.); identify type-specific challenges of moving to web-native formats

RQ2— Socio-institutional Sustainability: Use-cases, governance & education in open 3D-SDI ecosystems





- **Ecosystem Mapping via Use Cases**: 3DGIS use-case along multi axes: **Domain** (planning, disaster, mobility…), **Technology** (visualization, simulation, AI…), **Sustainability** (organization, business model), etc…

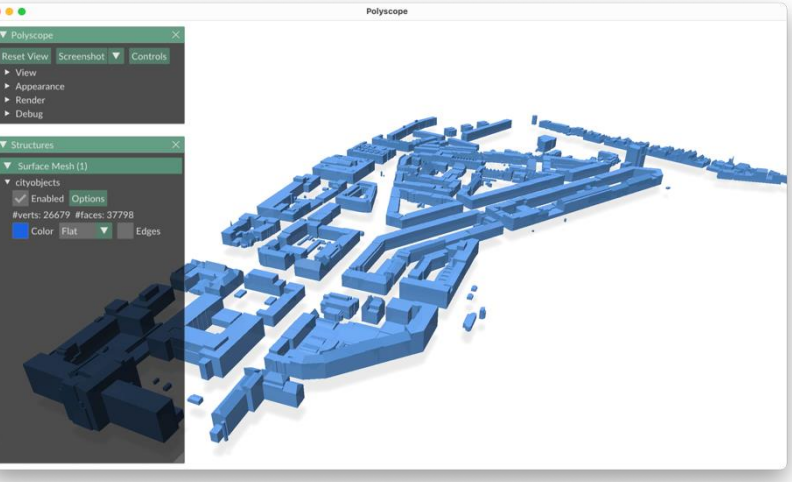
- **Governance & Stakeholder Roles**: Examine how government agencies, academia, and industry stakeholders share responsibility for data maintenance; compare cases across Japan, the Netherlands and the EU

- **Citizen engagement and Education as Knowledge Transfer:** Education as Knowledge Transfer: Identify how TU Delft's curricula (open data + open-source + real-world datasets) feed back into ecosystem sustainability; design localization paths for Japanese universities

My Research Agenda

@3D geoinformation
TUDelft

CityJSON



Topic1: CityJSON-based Implementation and Modernization of PLATEAU Data

- CityJSON implementation of PLATEAU datasets (CityGML + ADE) to evaluate alternative data models for efficient handling of large-scale 3D city data
- Optimization of data usability and performance, focusing on data discovery, lightweight representation, faster processing, and web-oriented workflows
- Assessment of CityJSON scalability and limitations for nation-wide 3D city models covering diverse feature classes, identifying requirements for modern, sustainable open 3D GIS infrastructures

My Research Agenda

@3D geoinformation TUDelft

Topic2: “Ecosystem” for Data Preparation, Utilization and Governance by Open 3D-SDI

- Data
  - +120 PLATEAU use cases technical reports (in Japanese)
  - Materials from INSPIRE reports and Dutch geomatics education materials, including TUDelft.
- Method
  - Classify and text-mining each case along several axes:
    - **Domain** (urban planning, disaster, mobility…)
    - **Technology** (visualization, simulation, AI…)
    - **Sustainability** (organization, business model…)
    - **Transfer** (educational material, open source…)
- Analysis
  - Identify dominant domain–technology patterns
  - Evaluate ecosystem openness (OSS vs proprietary)
  - Reveal how data characteristics shape application trends (visualization, simulation, spatial decision making etc…)

→ Compare with other EU cases

Topic1: Potential next MSc thesis list!

Japan's PLATEAU: from CityGML to CityJSON

Japan's PLATEAU project is the world's most ambitious 3D city modelling effort, covering 300+ cities with over 170,000 CityGML files where buildings and other city objects are modelled. The project page gives a good overview, and the datasets in CityGML are openly available for download. One of the most notable aspects of PLATEAU is the variety and richness of its content: besides buildings, it includes transportation models, water bodies, land use, vegetation, natural-disaster-related information, and in some cases even LoD3 and LoD4 data with rich textures.

The datasets use CityGML (still v2) with a behemoth of an Application Domain Extension (ADE): the i-Urban Revitalization (i-UR) ADE (to support all aspects of urban planning). The full details of the i-UR ADE are here and there is a scientific summary there.

In practice, PLATEAU datasets have not been ported to CityGML 3.0 or to another format mostly because of the complexity of this ADE. Converting the geometries and basic attributes is straightforward with citygml-tools, but that ignores all the rich extra attributes and new city objects defined in the i-UR ADE. Through PLATEAU, this research will help reveal how some of the richest CityGML datasets can be converted into CityJSON together with appropriate ADE replacements in the form of CityJSON extension.

https://3d.bk.tudelft.nl/education/msctopics/#japans-plateau-from-citygml-to-cityjson

Dank u wel / Thank You

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https://tossetolab.github.io/