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Correspondence between the GSD of Digital Aerial Photographs and the Scale of Maps – Japanese Case Study and Multi-Country Comparison

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Introduction

- Digitalization of geospatial information
- Map production process has changed
  - Aerial photographs: film cameras >> digital cameras
  - Maps: paper maps >> both paper and digital maps
- Standards for public surveys in Japan have been revised
  - Former: process by both film and digital cameras >> Current: digital cameras; no film camera
  - Former: map scale >> Current: map information level = $(\text{map scale})^{-1}$: inverse of map scale
- Specification and quality criteria of digital photos and maps
  - Unchanged, inherit the same process and quality criteria in analog era

Current quality criteria for digital aerial photos in Japanese standards (focusing on photos)

- relation between map information level and GSD
  - B/H: ratio of baseline B and flight height H of aerial camera positions

Map Information Level	(former) Photo scale of film	(current) Ground Sample Distance
500	1:3,000 – 1:4,000	90x2xB/H – 120x2xB/H mm
1000	1:6,000 – 1:8,000	180x2xB/H – 240x2xB/H mm
2500	1:10,000 – 1:12,500	300x2xB/H – 375x2xB/H mm
5000	1:20,000 – 1:25,000	600x2xB/H – 750x2xB/H mm

  - Hard-to-understand formulas

GSD depends on B/H, which depends on the specification of cameras

- B/H= 0.25 for DMC III (Leica); B/H= 0.39 for UCFp (Vexcel) when overlap=60%

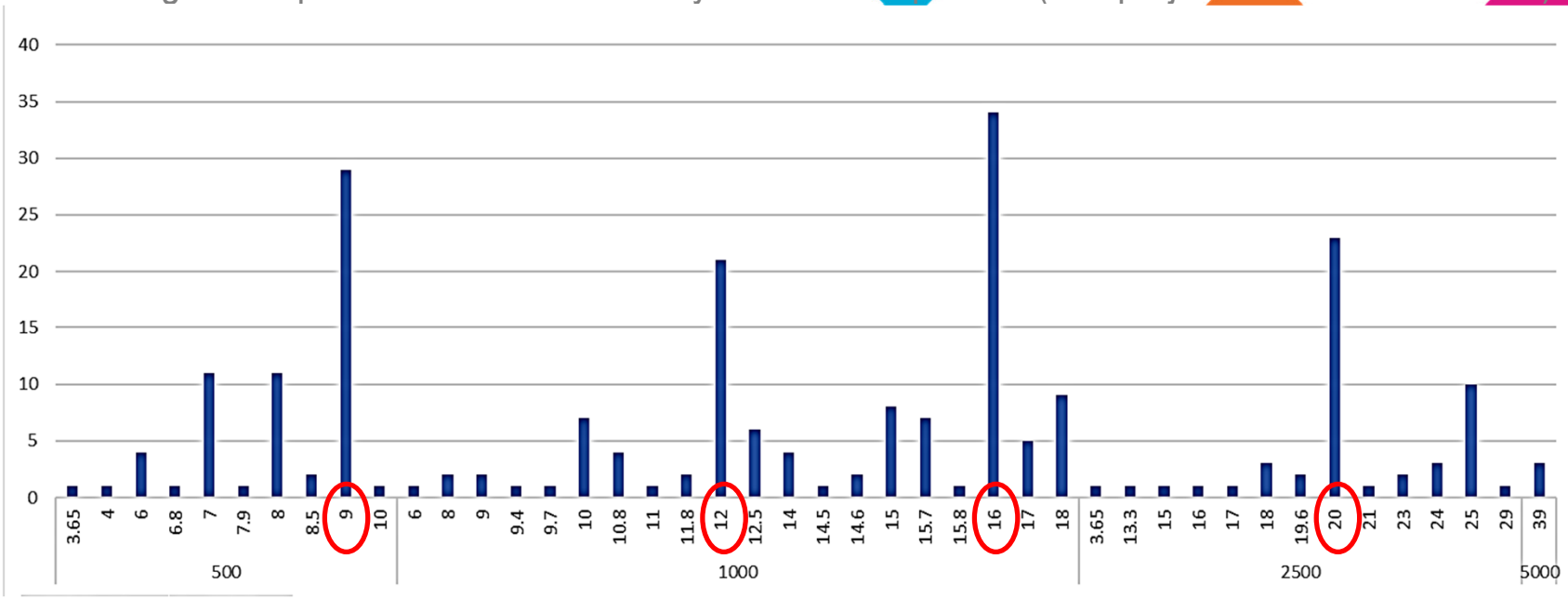
  cf. B/H= 0.6 (constant) for film cameras

Map Information Level	Ground Sample Distance lower limit (B/H=0.25)	Ground Sample Distance upper limit (B/H=0.39)
500	4.5 cm	9.4 cm
1000	9 cm	18.7 cm
2500	15 cm	29.3 cm
5000	30 cm	58.5 cm

➢ Unable to specify the positional accuracy >> update needed.

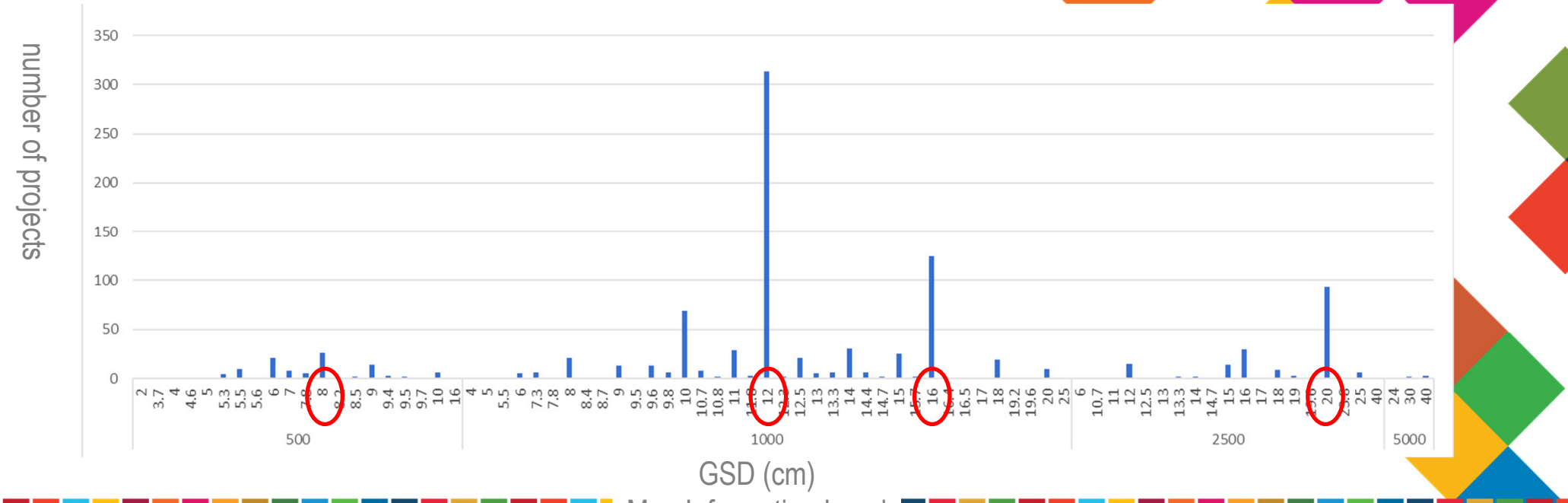
Practical tendencies of digital aerial photos in public surveys in Japan

- Analysis of two datasets of digital aerial photographs in public surveys:
- A) Data brought to Japan Association of Surveyors for its inspection (234 projects from 2016 to 2022)



Practical tendencies of digital aerial photos in public surveys (cont.)

- B) Data submitted to GSI (=national geospatial agency) for its review (1055 projects from 2019 to 2021)



Comparison of the relation between GSD and map scale among four countries

- No common relationship found among three countries
  - German standards seem not to indicate the corresponding map scale (or we could not find any documents)

	Japan in this study	AdV (2023)	RICS (2010)	ASPRS (2023)	
map scale	GSD (cm)	GSD (cm)	GSD (cm)	GSD_L (cm)	GSD_U (cm)
1:500	8 or 9	Not related	4	6.3	12.5
1:1000	12 or 16		6.3	12.5	25
1:2500	20		15	31.3	62.5
1:5000	40		30	62.5	125.0

some GSD values are obtained by interpolation and extrapolation

Comparison of the relation between GSD and planimetric accuracy

- Planimetric accuracy: 1 ~ 2 times of GSD?

	Japan in this study	AdV (2023)	Upper: RICS (2010) Lower: RICS (2023)	ASPRS (2023)	
σxy	(1/2)xGSD †	1xGSD (cm)	2.5xGSD – 3.3xGSD 1.4xGSD – 1.5xGSD	$2xGSD_L$	$1xGSD_U$

† the value is an assumption and may be overevaluated.
<= data and its analysis are needed.

Conclusion

- Multi-country comparison made in order to update Japanese standards
  - ➢ No common relationship between GSD, map scale, and accuracy found among four countries
    - Is there any international standards on digital aerial photos?
- Investigation of the theoretical and practical background of the relationship needed
- Future outlook: GSD => position accuracy/photos and maps => corresponding map scale
  - ➢ 1st step: Collect data relevant to evaluating photo accuracy at respective GSD levels
  - ➢ 2nd step: Clarify quantitative relationship between photo and map accuracy
  - ➢ 3rd step: Identify traditional map scales corresponding to map accuracy

The most relevant SDGs related to the presentation and theme of this session

1st relevant SDG

2nd relevant SDG

3rd relevant SDG

SUSTAINABLE DEVELOPMENT GOALS

International Federation of Surveyors supports the Sustainable Development Goals