Cadastre2014 Japan To Osaka- Alkis Type Cadastre

Hiroyuki Hasegawa And Marie Sato, Japan

Key words: Japanese feudal era cadastral system, Archival photo photogrammetry, 4D- Image Map Archive, PEGASUS satellite surveying, ALKIS type 3D-city representation Cadastre

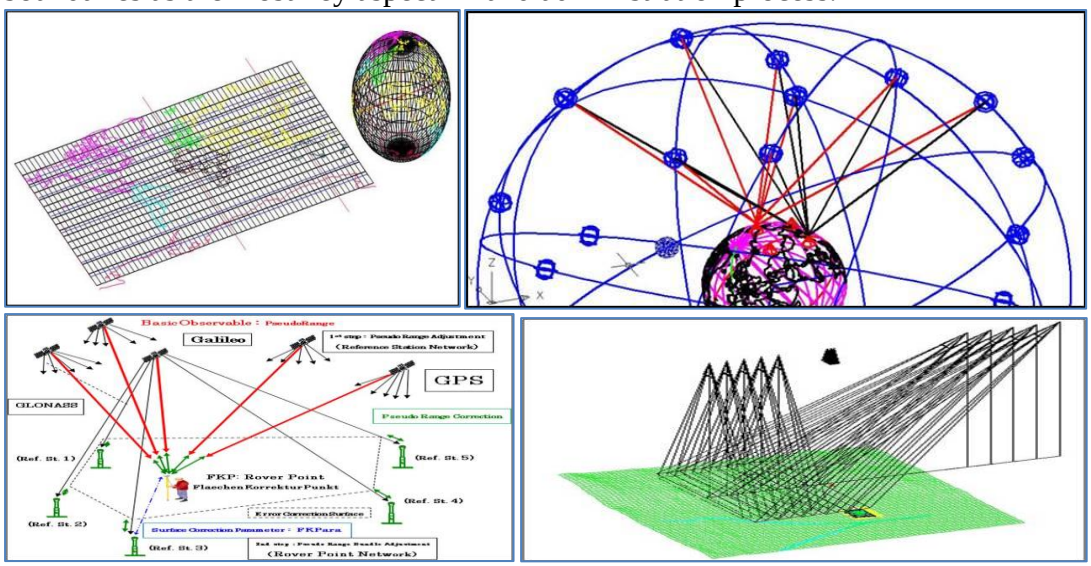
SUMMARY

Japanese cadastral survey was restarted in feudal era; 1590s from Osaka to nationwide. Cadastral system was extended toward 4 major national mapping projects from 1600s to 1840s, which were compiled with Inoh's modern coastline-route line mapping in 1820s and summarized in 1/200,000 maps in 1880s based on Bessel 1841 ellipsoid. Taxation cadaster was promoted from 1873 in Japan and in Taiwan and Korea by triangular surveying till 1910.

As German cadastral system: ALKIS(Official cadastral information system) is the basis of national land information system(GISe; GeoInformationsSysteme), cadastral surveying methods regulated in Japan National Land Survey Act are modernized for ground control points for parcels and photogrammetric 3D models for boundary survey with 4 approaches of satellite surveying and drone to satellite photogrammetry in Osaka city area, which was severely bombed during WW II, like sister-city: Hamburg, comparing with the oldest urban cadastral maps in 1890s in Japan.

4 approaches consist of Parameter Estimation geodetic network surveying, archival aerial photogrammetry, helicopter image σ : 1cm 3D modeling and satellite photogrammetry.

As final products, cadastral map in 3D and cadastral book are combined in 3D city modeling and representation system with non-stereo-glasses 3D display for consensus of land owners' boundaries as the most key aspect in land administration process.



Map and CAD-Globe : Satellite Geodesy-Parameter Estimation approach
FKP Parameter Estimation adjustment : Satellite Photogrammetry

Cadastre2014 Japan To Osaka- Alkis Type Cadastre

Hiroyuki Hasegawa And Marie Sato, Japan

1. JAPANESE CADASTRAL SURVEY AND MODERN MAPPING

1.1 Heian Capital and Jyori- rectangular cadastral system

National land administration system started in 676 A.D. as Capital and in 757A.D. local rectangular cadastral systems. National administrative boundaries were divided from 701 in Koku(66 and extras), Gun and Ri or Gou. Jyori – rectangular cadastral system had a unit of 109m squared area called Tsubo, and subdivided into 10 Dans for taxation purposes. The remained land blocks are still now to some extent reflected rural and urban townships as public land survey system in Japan,on archival aerial photos(1940s) as Fig. 1.

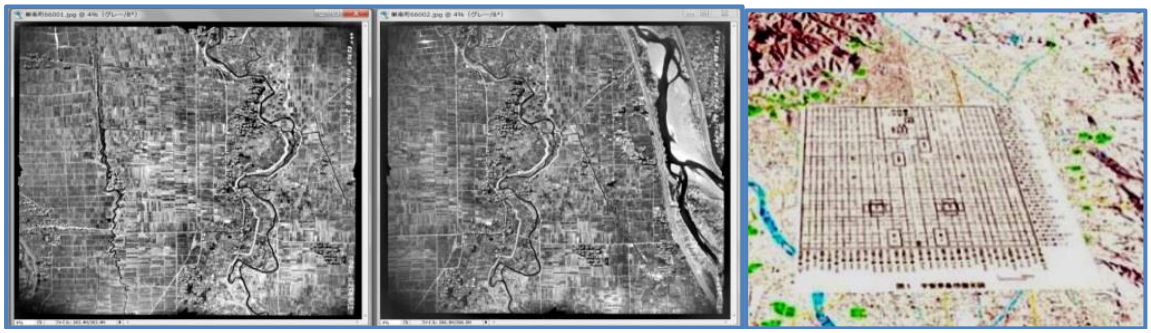


Fig.1 Johri rectangular cadastral system and Heian-capital: 8th century

1.2 Taiko (Feudal Prime-minister) cadastral system(16century) and Feudal-Shogun era country mappings (17-18-19 centuries)

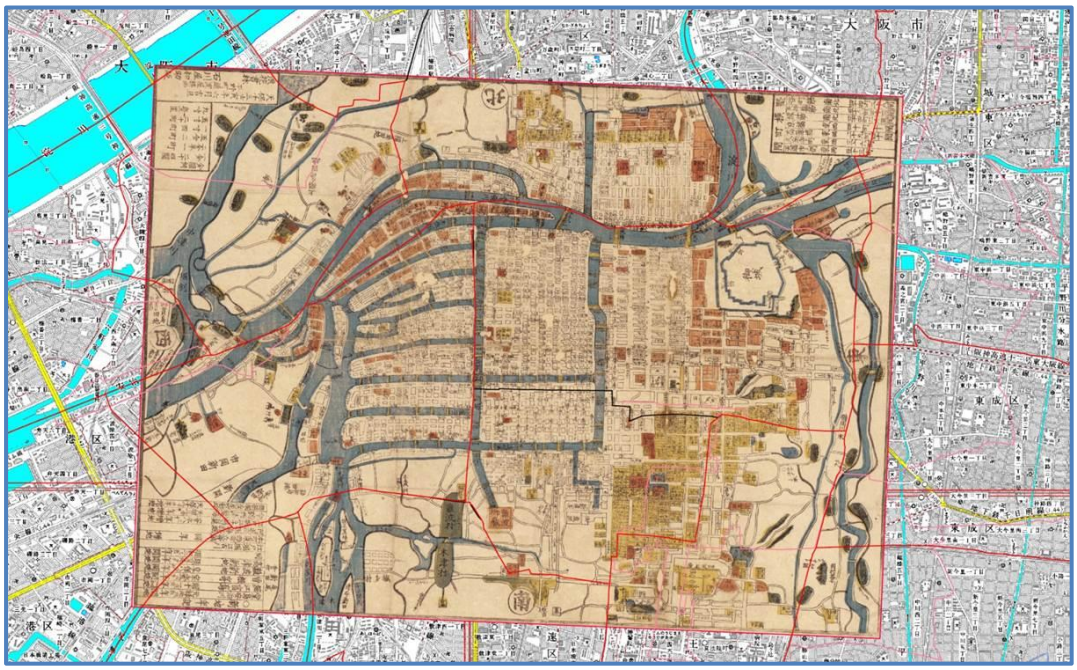
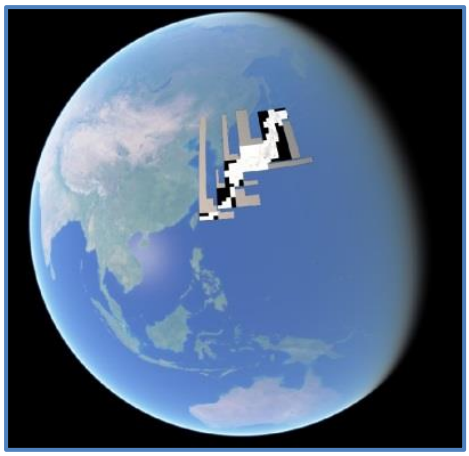


Fig.2 Osaka - Feudal Shogun era mapping (1840)

In the medieval era after long civil wars among Samurai lords, Japan was reunified by Toyotomi Hideyoshi (Taiko; Feudal Prime-minister) in 1591, and cadastral survey for taxation was conducted nationwide. The major city- Osaka was constructed as military and commercial capital of Japan, which had the largest donjon at that time in 16 century. Cadastral survey was combined with Feudal territory mappings in Tokugawa-Feudal era (1603- 1868) at 4 times. Those Feudal territory maps (named as Kuni-Ezu) were combined and edited in 1880s with Inoh maps, which mainly covered sea shore lines and major traffic routes, both for military and cadastral maps. Now they are projected on the CAD-Globe with AutoCAD InfraWorks, which realizes CAD maps and Global representation of cadastral survey results. Historical Reality from map, aerial photo and satellite images are displayed as 3D image models showing the geographical features and terrain landscape dynamically. 3D models are archived as mensuration object in 4D- Image Map Archive. This process is called 4D Image Map Archive Designed Aerial Survey in 21 century.

1.3 Taxation cadastral mapping in 1870-1910, Japan-Okinawa-Taiwan-Korea

In main lands of Japan of new Meiji administration in 1870s, cadastral systems were based on old taxation parcel maps. Based on the national triangulated networks from 1883, modern cadastral survey started from Okinawa islands(1899), Taiwan(1898) and Korea(1910).



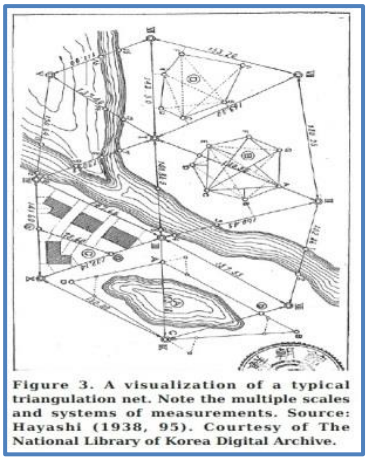


Figure 3. A visualization of a typical triangulation net. Note the multiple scales and systems of measurements. Source: Hayashi (1938, 95). Courtesy of The National Library of Korea Digital Archive.

Fig.3 Japan 200K maps in 1880s on CAD-Globe and Korean cadastral triangulation net

2. CADASTRAL SYSTEM AS 3D GEOINFORMATIONSSYSTEME: GERMAN STYLE GIS

2.1 Geodetic networking as the basis of cadastral system

Geodetic networking (σ =1cm) is required both for earthquake prediction and cadastral survey. Especially land price; more than US$ 10,000/㎡ and restoration/reconstruction projects after East Japan earthquake in 2011 push our government to reestablish precise cadastral system like in Germany. German report in 2016 on geodetic network adjustment of 400 prime Electronic Control Points reached to the accuracy level of 2mm, after integrated ECP- Leveling- Gravimetric geodetic network adjustment. GeoInfoDok of AdV has organized ALKIS cadastral survey system based on world standard GIS and CAD systems. Parallel with documentary translations, we planned and tried nationwide and regional geodetic network adjustments, using German standard GEONAP- parameter estimation geodetic approach.

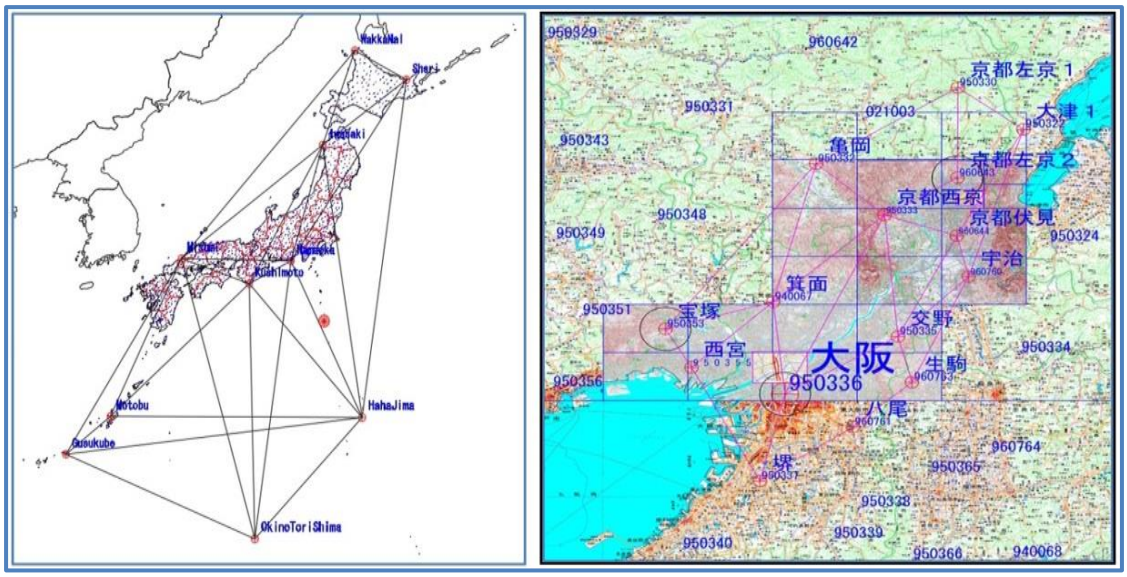


Fig. 4 Japan and Osaka area geodetic networking

2.2 GPS-GNSS Geodetic networking since 1995 Kobe earthquake to UN-GGRF initiative

Having learned from 1995 Kobe earthquake and 2011 East-Japan earthquake, we have been developing world leading GNSS surveying, introduced from Germany since 1999. Since then, we had critical situations in cadastral survey both in urban and forestry areas, in accuracy, reliability and efficiency, to pursue real time point positioning. As satellite photogrammetry has reached to the accuracy level of 10cm on the ground and film-aerial camera is now abandoned, we proceeded to set up public photogrammetric specification for cadastral survey in 2016, using Digital Globe: World View2 stereo images of Kyoto University area. For ground control accuracy, our FKP real time satellite surveying reached to 1cm accuracy level.
To establish IGS ECP networking in UN-GGRF initiative for pan-pacific earthquake belts, we established Osaka-PEGASUS(Parameter Estimation Gnss Assisted SUrveying System)-center in Osaka (GeoNet office roof) where Osaka active faults pass to JR-Shin Osaka St..

Fig. 5 PEGASUS-center reference station

3. OSAKA URBAN PLANNING AND CADASTRAL SYSTEM

Osaka was memorized with 2 major national level constructions for Naniwa first capital planning (645 A.D.) and Osaka castle urban planning(1592 A.D.).

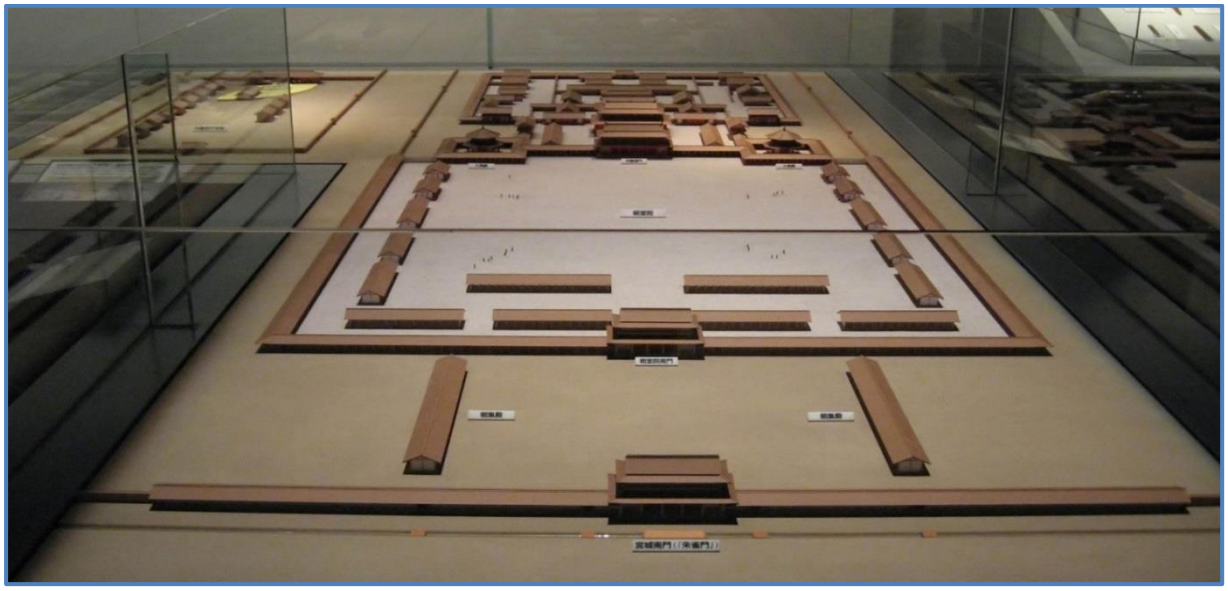


Fig. 6 Naniwa first capital planning (courtesy of Osaka city HP)

After modernization of Japan from 1860s, national first cadastral mapping was established in 3 capital size cities, Tokyo, Kyoto and Osaka (1908 A.D.) as urban cadastral maps and books

Major street and subway plan in Osaka was organized with Japanese Aerial photos (1928) and continued (1942) for anti- bombing reconstruction projects in Osaka.

After bombing, as part of nationwide aerial photos by USAF (1948), we constructed 4D-Image Map Archive of Osaka city starting from JR-Osaka station and Osaka city hall is.
This area is well known active faults area of expected cycle of 200 years (Uemachi fault).

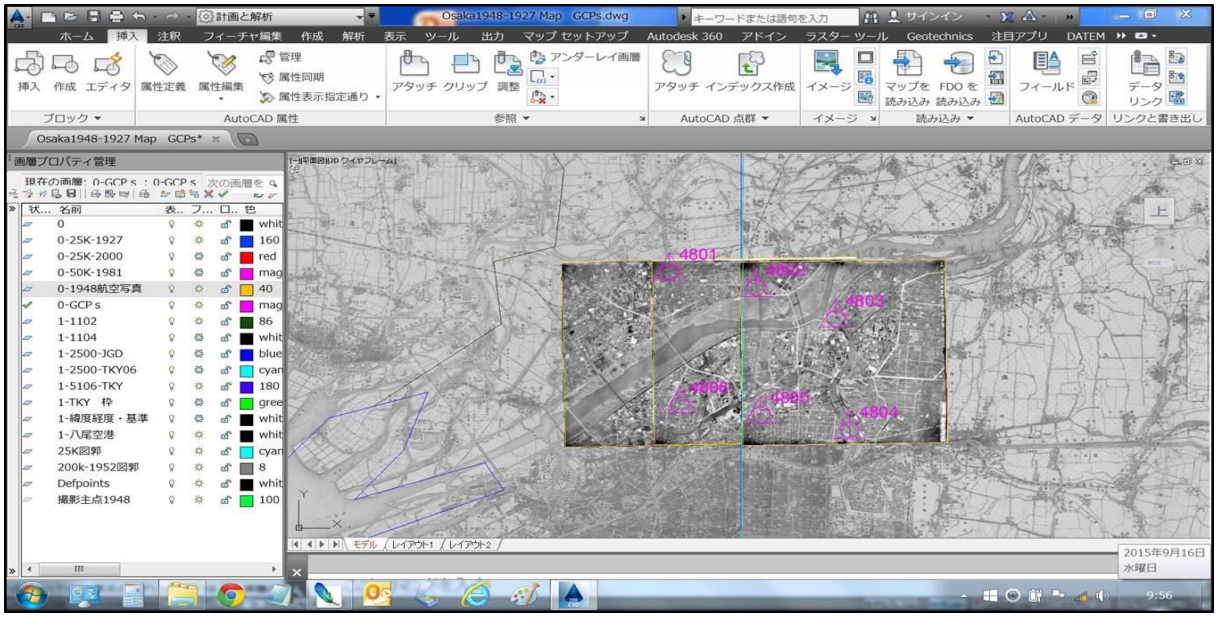


Fig. 7 4D Image Map Archive : 1927 Osaka maps and 1948 aerial photos

4. OSAKA ALKIS TYPE CADASTER

German GISe(GeoInformationsSysteme) is summarized in GeoInfoDok and cadastral system is regulated in ALKIS system. Aiming at 3D GIS, based on WGS84/GRS80, Global Geodetic Reference Frame could be applied through Parameter Estimation Geodesy and 4D-Image Map Archive Designed SUrveying System(IMADAS for short).CAD-Globe concept was created on AutoCAD in 1992 by me.

4.1 Osaka GGRF: Global Geodetic Reference Frame

IGS(International GNSS Service) Global Geodetic Reference Stations(ca. 500) are mapped on Latitute Longitude coordinate system and WGS84 ellipsoid in AutoCAD. Japan Electronic Control Points are also adjusted by parameter estimation method: GEONAP.

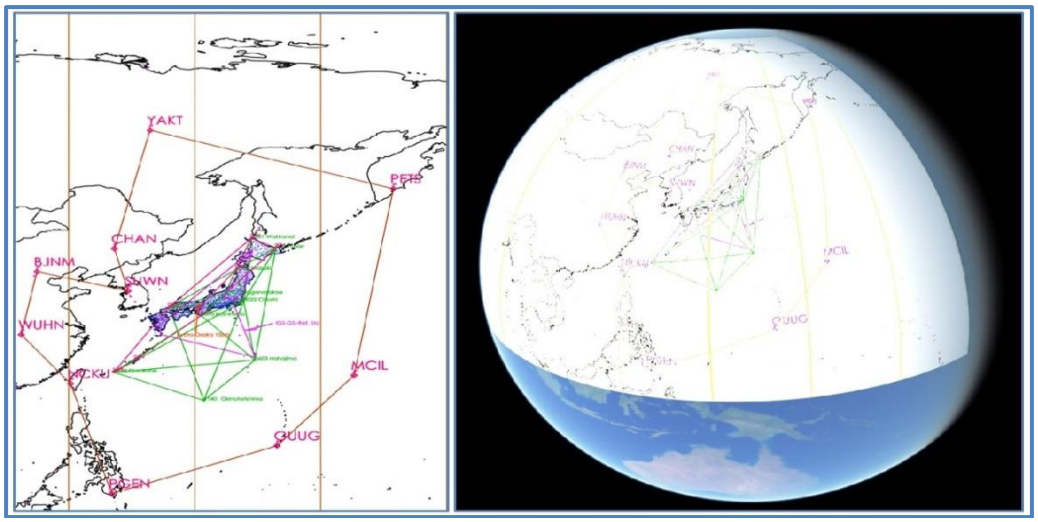


Fig.8 UN-GGRF- Osaka geodetic networking

4.2 Osaka Historical Reality: First photogrammetric mappings

Aerial photos are adjusted by bundle triangulation software to reconstruct Historical Reality in 1971 after Osaka EXPO1970 on Summit Evolution with 3D display with and without polarized glasses with AutoCAD, to establish 4D-IMADAS Osaka station area.

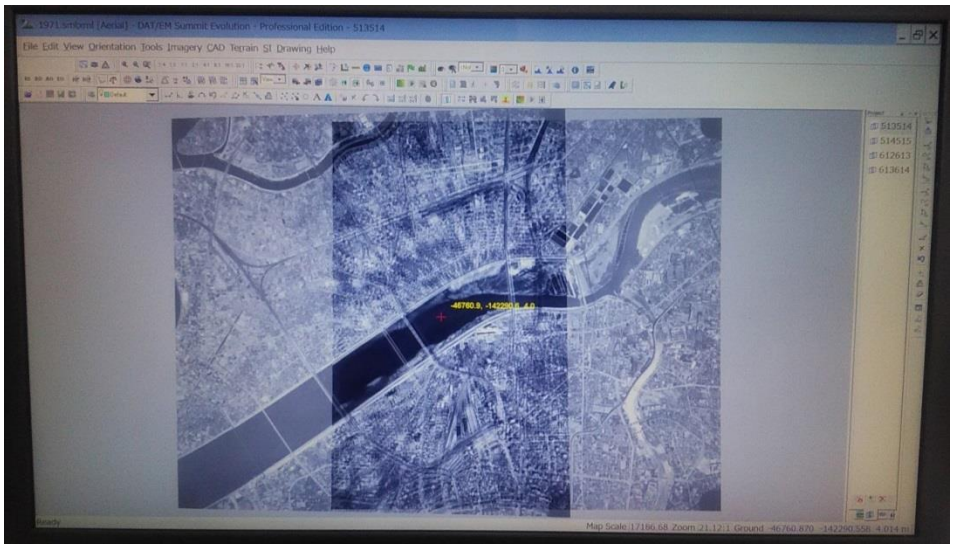


Fig. 9 Osaka 1971 stereo model after EXPO1970

4.3 Osaka σ =1cm 3D City modeling: Helicopter digital camera bundle triangulation

For precise cadastral survey: σ =1cm 3D City modeling, Helicopter digital camera bundle triangulation is being planned along road-street center lines. Measuring objects are mapped as 3D image models continuously photographed and adjusted in photogrammetric precision. Japanese digital cameras (36mm x 24mm size; calibrated) are well installed with flight control system according to UAV-Photogrammetric procedures on economic size helicopters.

Fig.10 Author; Hasegawa at Kyoto Heliport and 3D diorama-Kyoto University

4.4 Osaka Satellite Photogrammetry: Satellite stereo 3D model mapping

Satellite Photogrammetry has been organized, tested and regulated as standard specification for cadastral survey, both for urban and forestry area, using 3D-CAD related digital stereo plotter. From ground resolution of a pixel, the accuracy at check points is now achieved to be 1/3 of pixel size =30cm , i.e., 10cm on the ground for the entire model area.

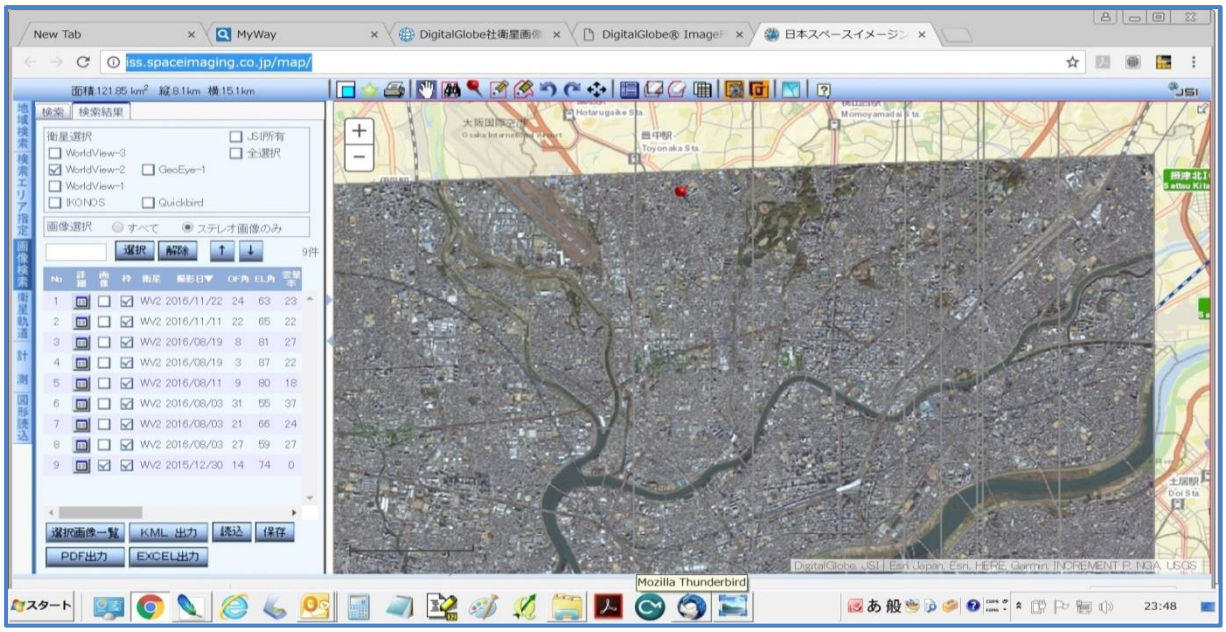


Fig. 11 Index map of World View2 - 20151230-stereo image area

4.5 Osaka 3D City modeling : GeoInfoDok- AAA- ALKIS version

The future of 3D cadastral survey is expected as kern basis of GeoInformationsSysteme, to be displayed, measured and archived in 4D- Image Map Archive (IMA means “now” in Japanese) as Historical Reality, like Artificial, Virtual and Augmented Reality. 3D image models are shown with polarized glasses or without glasses (naked eyes) in 3D-CAD.

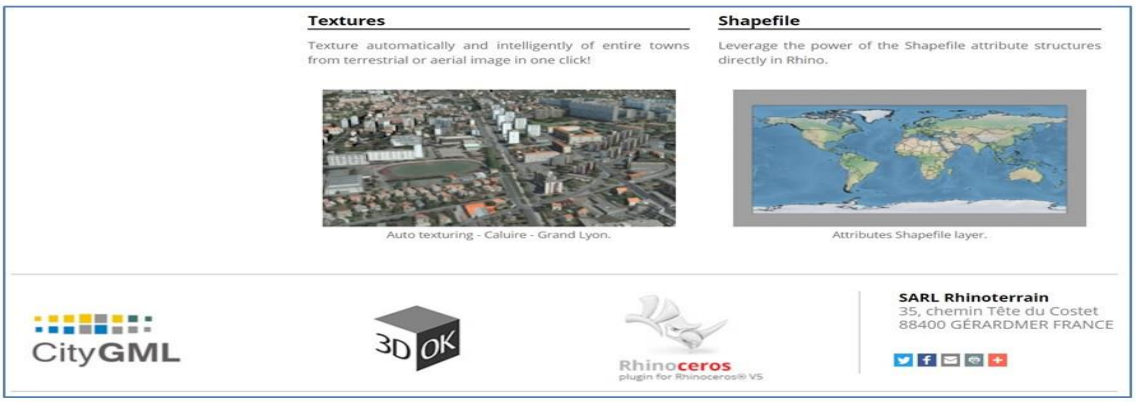


Fig.12 3D city modeling with CityGML

Fig.13 3D-displays without and with Glasses for consensus meeting

CONCLUSION

The above mentioned procedures are now preliminary expressed in 4 types of public cadastral survey specifications for Ministry of Land, Infrastructure, Transport and Tourism, as follows;

1) Parameter estimation geodetic networking for ground control points as standard parcel surveying, using official electronic control points of Japan GSI and the same quality.
2) Aerial photogrammetry, using archival and old aerial photos by bundle triangulation
3) Helicopter photogrammetry, establishing 3D image models with σ =1cm accuracy
4) Satellite photogrammetry, stereo model of 1/3 accuracy level of ground resolution

ACKNOWLEDGEMENT

We wish to thank cadastral survey office of Ministry of Land, Infrastructure, Transport and Tourism for the guidance and organization of cadastral survey in Japan.

REFERENCES

Hasegawa, Hiroyuki (2013)
, 3D Image Map Archive Designed Area Studies (3D-IMADAS)
Pacific Neighborhood Consortium :
Annual Conference and Joint Meetings 2013, Kyoto – Kyoto University

Kraus, Karl (2000)
, "Photogrammetrie" Band III; Duemmler

Kummer, Koetter, Eichhorn (Hrsg.) (2015)
, "Das deutsche Vermessungs- und Geoinformationswesen 2015"
; Wichmann

Luhmann, Thomas et.al. (2014)
, "Close Range Photogrammetry and 3D Imaging "; 2nd Edition
;De Gruyter

Seeber, Guenter (2003)
, "Satellite Geodesy "; Walter de Gruyter

Snyder, John P. (1987)
, "Map Projections-A Working Manual "
U.S. Geological Survey Professional Paper 1395

BIOGRAPHICAL NOTES

Hiroyuki Hasegawa obtained a BA in Human Geography in 1971 from Kyoto University, Japan. In 1976 he was graduated from ITC, The Netherlands as Photogrammetric Technologist.
From 1971 until 1999 he worked at PASCO Corporation in Tokyo, Japan.
From 1999 until now he is working in GeoNet, Inc. in Osaka, Japan.
In 2014 as the researcher of Graduate School of Asian and African Area Studies Kyoto University, Japan, he presented a paper in FIG2014 " Cadastre2014 Japan-Initiative".

Currently, for newly revised cadastral survey specification, he has been conducting accuracy-efficiency evaluation projects with governmental cadastral survey office.

CONTACTS

Hiroyuki Hasegawa
President
GeoNet, Inc.
1-5-25 Higashi-Nakajima
Higashi-Yodogawa-ward, Osaka
Japan : Postal code; 533-0033
Tel. +81-90-2148-0501
Email: hasegawa@geonetz.com
Web site: http://www.geonetz.com

Marie Sato
JSPS Research Fellow
Ritsumeikan-University
56-1 Tojiin Kitamachi,
Kita-ward, Kyoto
Japan : Postal code; 603-8577
Tel. +81-75-465-8224
Mobile. +81-80-3408-8929
Email: satohmarie@gmail.com