Digital Silk Road: Digital Humanities Approach to Spatial Documentation of Cultural Heritage

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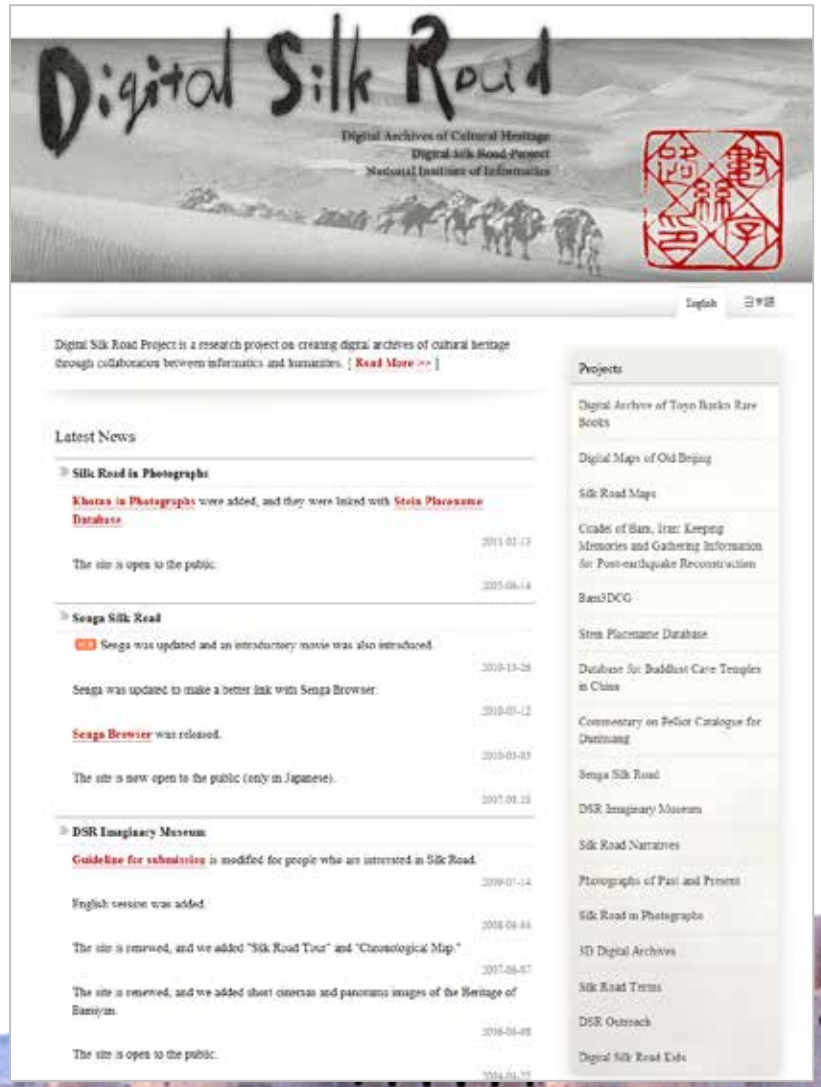
National Institute of Informatics / SOKENDAI

http://dsr.nii.ac.jp/bam/
http://dsr.nii.ac.jp/geography/

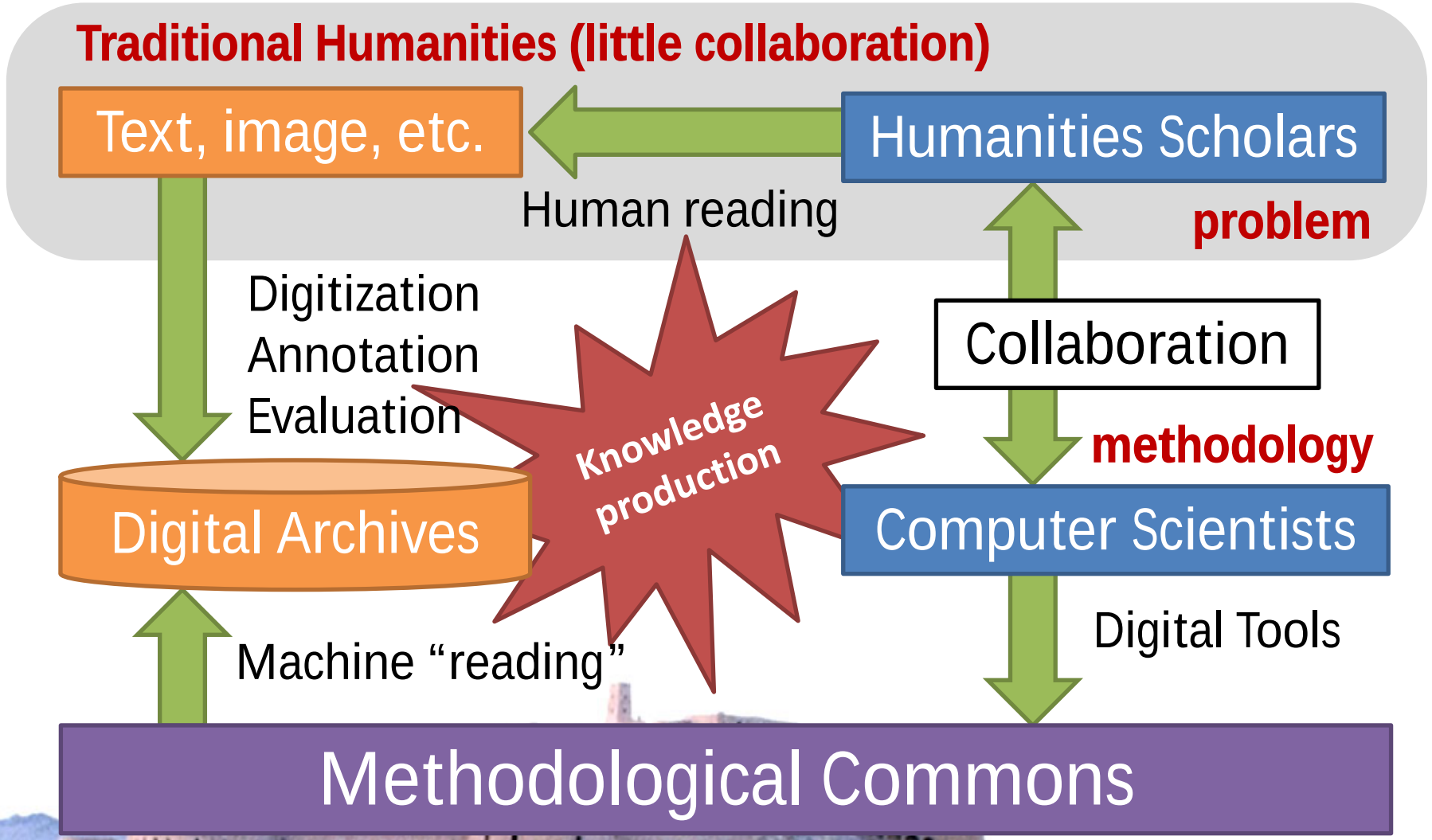
Digital Silk Road Project



- Started in 2001.
- Digital Humanities: Collaborative work among informatics + humanities scholars.
- Databases and digital resources are publicly accessible on the Web.

http://dsr.nii.ac.jp/

Digital Humanities



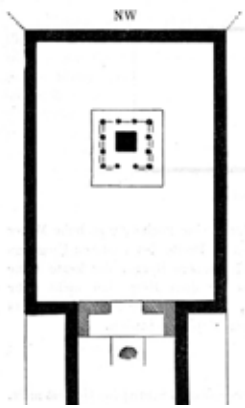
Toyo Bunko Rare Books

- Digitization of 203 books, 59358 pages.
- Collection of relevant academic references.
- Manual input of captions and TOCs.
- OCR for full-text search (with errors).

http://dsr.nii.ac.jp/toyobunko/

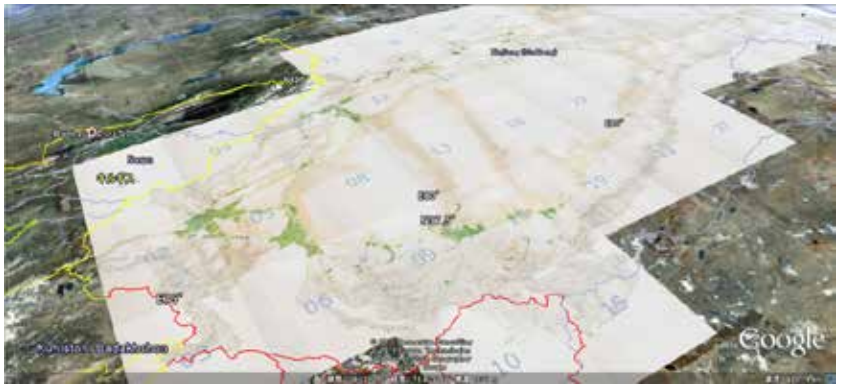
Dealing with Many Types of Data

Text



die obere sich wie eine in eine niedrigere 3,10 m tiefe Plattform eingepaßte Bank darstellt (auf der Skizze schraffiert) und die Mitte offen läßt. Vor dieser großen Unterstufe liegt der Rest eines mächtigen Sockels, in welchem ein tiefes Loch sich zeigt: hier hat also wohl eine große Statue oder eine Fahne gestanden. 12 m nach innen zu vom S.-Rand der Plattform des Hauptbaues, 5,50 m von den Seitenmauern und 7 m vor der Rückmauer, erhebt sich eine niedrige, 8 m ins Geviert betragende Stufe, auf deren Mitte ein jetzt zerstörter, 2 m großer, viereckiger Sockel steht; um diesen Sockel geht ein Gang herum, vorne und an den Seiten je 1,50 m breit, hinten aber nur 90 cm breit. Dieser Umgang ist nach außen von einer Mauer umgeben, welche durch zwölf kleine Säulen in kleine Abteile geteilt ist, von denen der mittlere der Frontseite den Eingang bildet. Auf der Rückseite ist dies aus zwei Eck- und zwei Mittelsäulchen bestehende System sehr zerstört. Vor den sechs Interkolumnien der Seiten und den zwei Interkolumnien neben dem Eingang sind je noch Sockel für Statuen erhalten: auch mancherlei dekoratives Bei-

Map



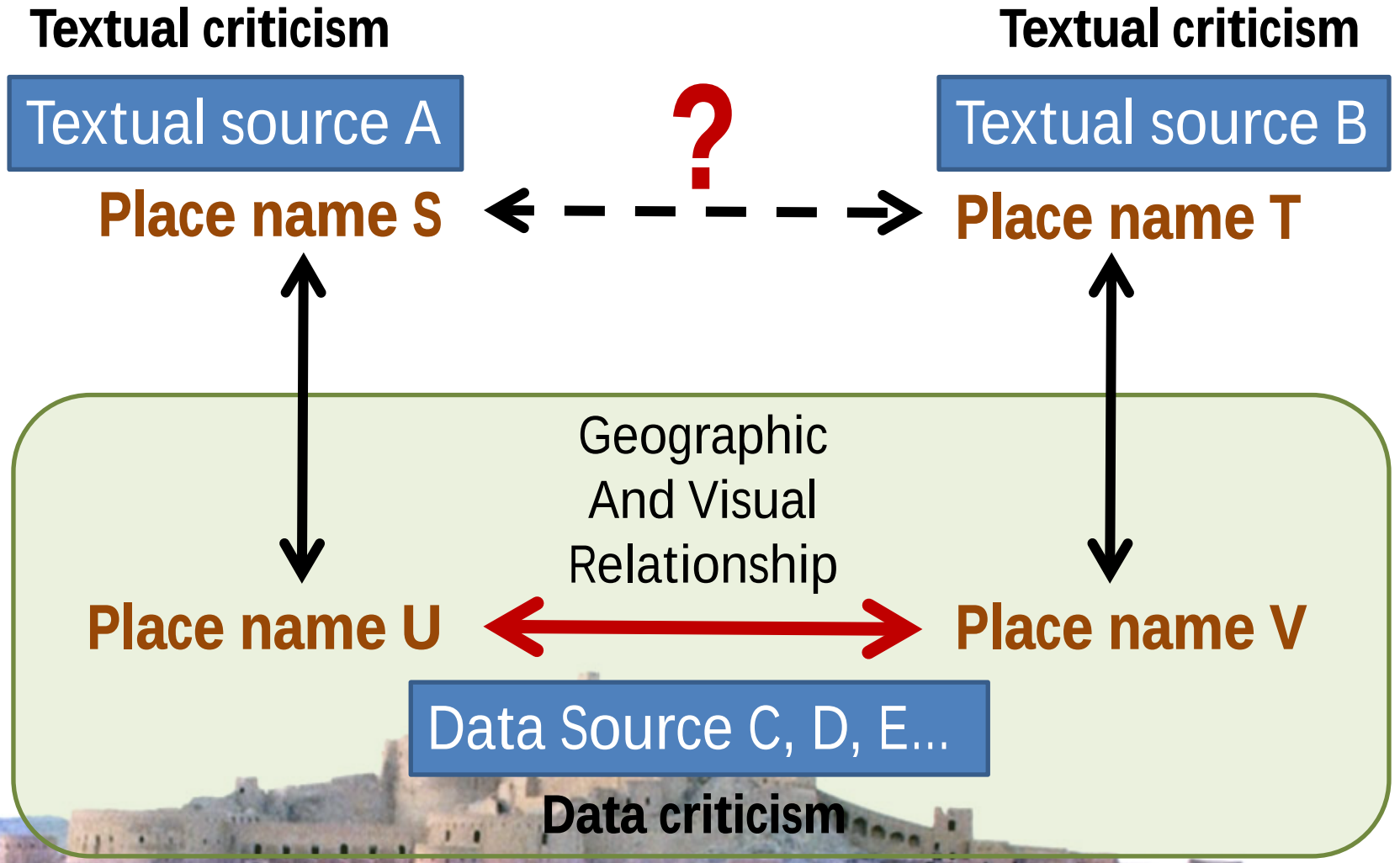
Photograph

1904(Le Coq, 1913, Tafel 70, I)

Gazetteer

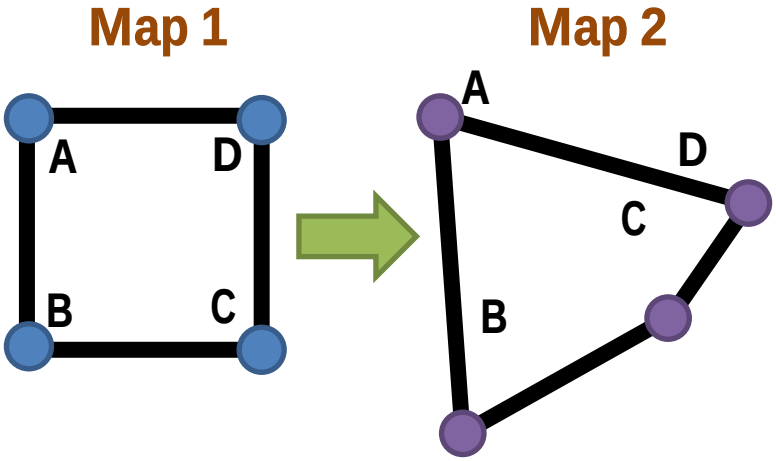
Abāb-langar, habit., 14. B. 3.
Ābād (of Ak-su), market-town, 12. A. 3.
Abād (of Kara-yulghun), vill., 12. B. 1.
Abād (of Karghalik), vill., 5. C. 4.
Ābād (of Kāshgar), vill., 5. A. 2.
Ābād (of Turfān), vill., 28. C. 3.
Ābād (of Yārkand), vill., 5. C. 2.
Ābād-jilga, valley, 12. B. 2.
Abdal, vill,. 30. B. 2.
Abdalkash-mazār, shrine, 14. C. 3.
Abdul-ghafūr-langar, loc., 10. C. 1.
Abdul-rahmān-jilga, valley, 9. A. 4.
Abshak-bēl, Pass, 2. B. 1.
Ach-tāgh, hill and vill., 7. C. 2.
Acha-dong (of Chizghān), hill, 19. C. 3.
Acha-dong (of Yārkand R.), loc., 7. D. 4.
Acha-kuduk, loc., 7. D. 4.
Acha-shīpang, loc., 22. D. 4.
Achak-aghzi, loc., 5. A. 4.
Achal (of Ak-su), vill., 12. A. 3.
Achal (on Charchak R.), loc., 21. C. 2.
Achchik-bulak (of Turfān), spring, 28. B. 4.
Achchik-bulak (of Yai-döbe), spring, 4. C. 4.
Achchik-daryā, river, 21. A. 2.
Achchik-dawān, pass, 9. B. 3.
Achchik-jilga (of Duwa), valley, 9. B. 3.
Achchik-jilga (of Kara-tāsh), valley, 2. D. 3.
Achchik-jilga (of Khotan), valley, 9. C. 3.
Achchik-jilga (of Sampula), valley, 14. A. 3.
Achchik-jilga (of Tawak-kēl), loc., 14. A. 1.
Achchik-kōl, lake, 15. D. 1.
Achchik-kuduk (of Kapa), well, 23. A. 1.
Achchik-kuduk (of Kuruk-tāgh), well, 28. C. 4.
Achchik-kuduk (of Marāl-bāshi), well, 5. D. 2.
Achchik-otan, loc., 7. C. 2.
Achchik-su, loc., 31. A. 4.
Achchik-tügemen, loc., 5. D. 2.
Achi-tāgh, hill, 32. B. 1.
Achik-aghzi, loc., 9. D. 3.
Achma (of Hanguya), vill., 14. A. 2.

Linking Entities Across Sources



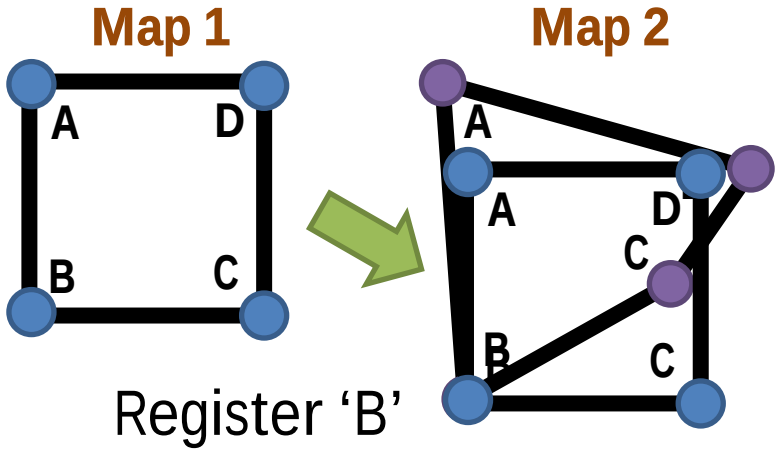
Registration of Maps

Geometric Correction



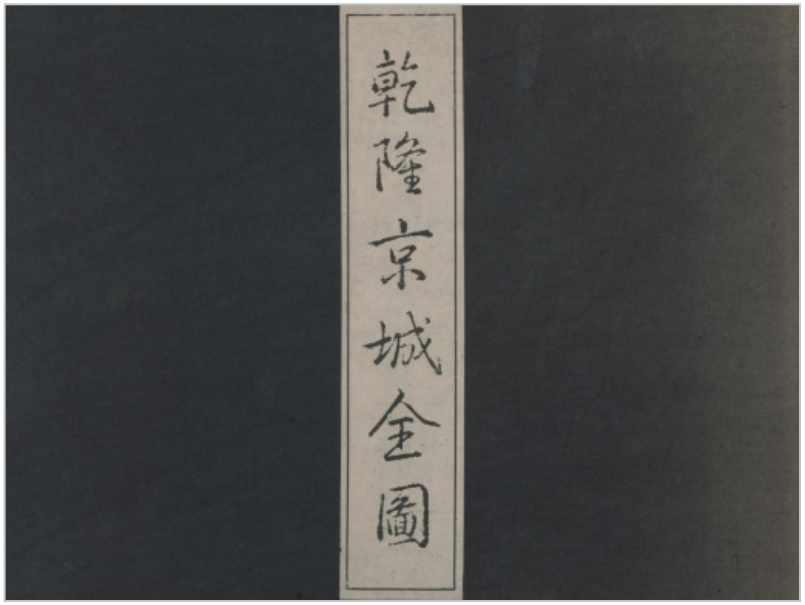
- All points are registered.
- Shapes are distorted.

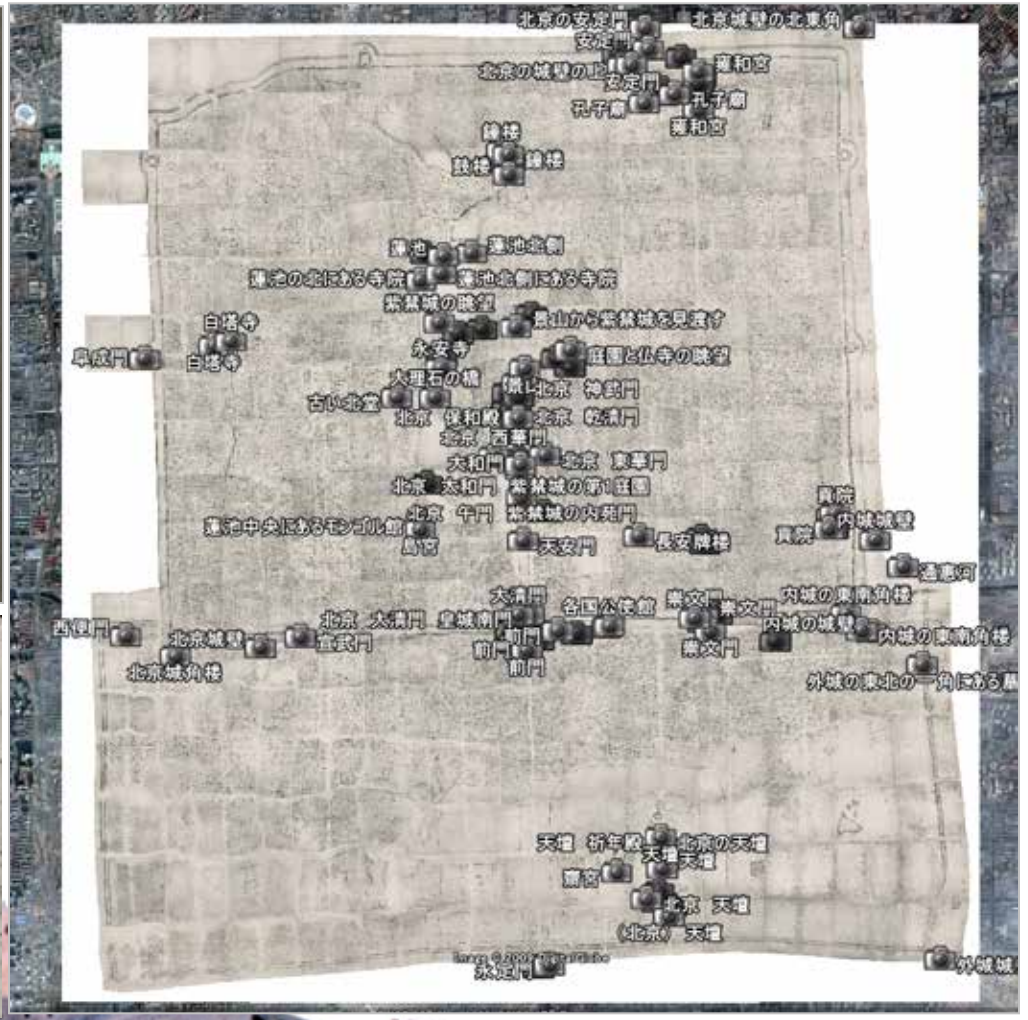
Interactive Georeferencing



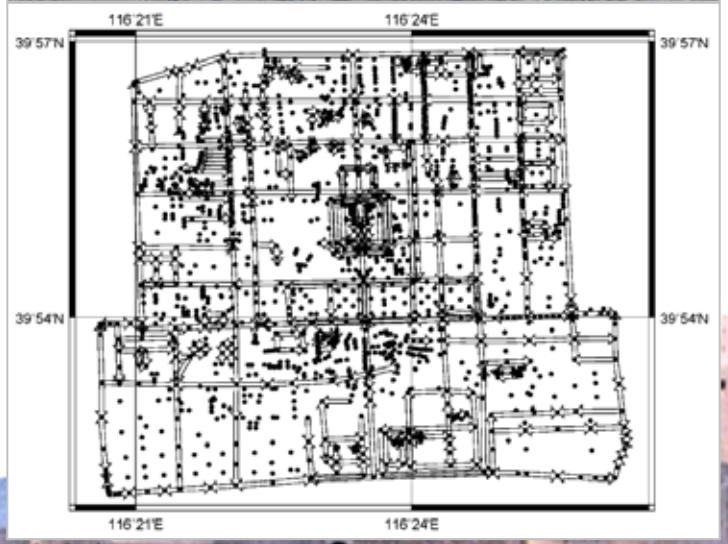
- Single point is registered (but no other points).
- Shapes are not distorted.

Qianlong Map (Beijing)





Massive Geometric Correction



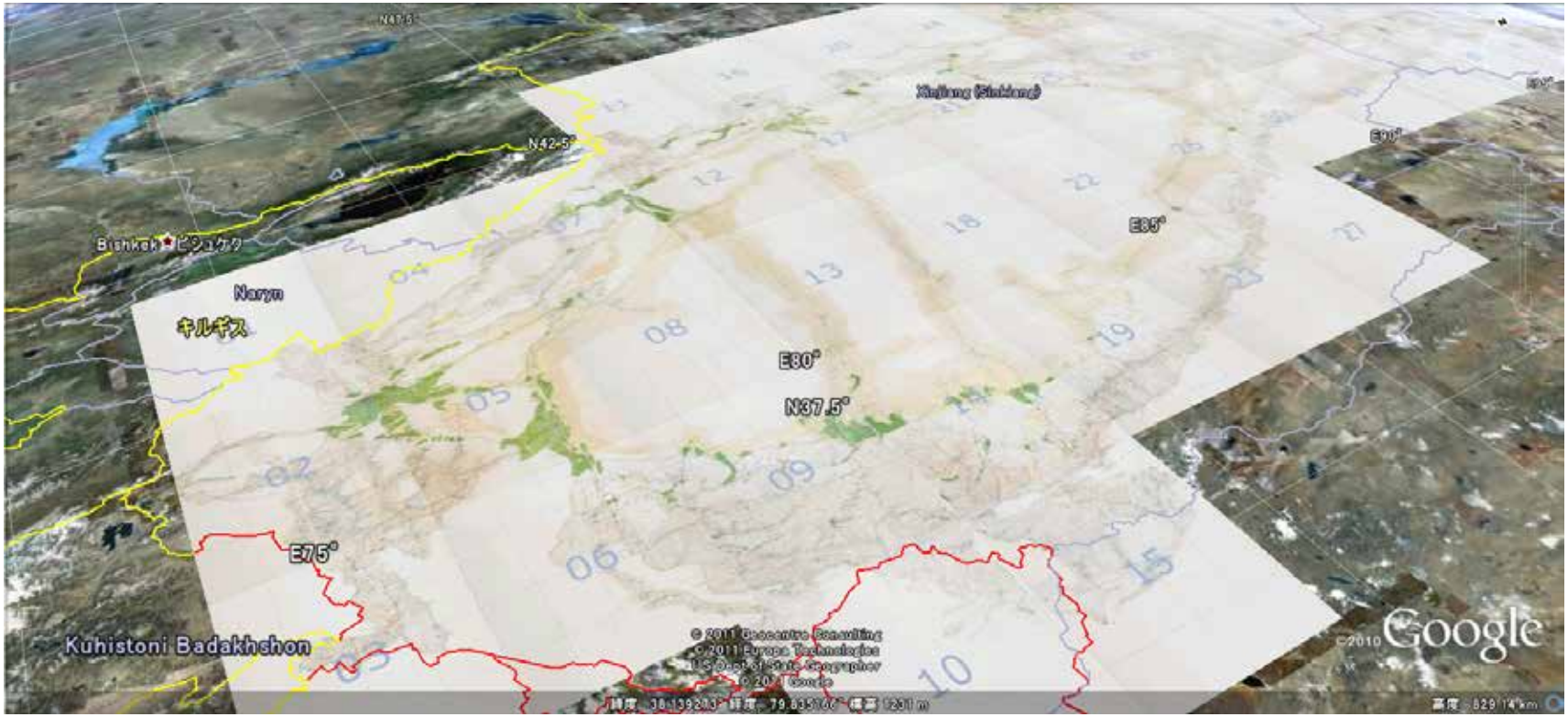
Huge size = W 13 m x H 14 m

Many sheets = 203 sheets in total

Massive pixels = 29 billion pixels

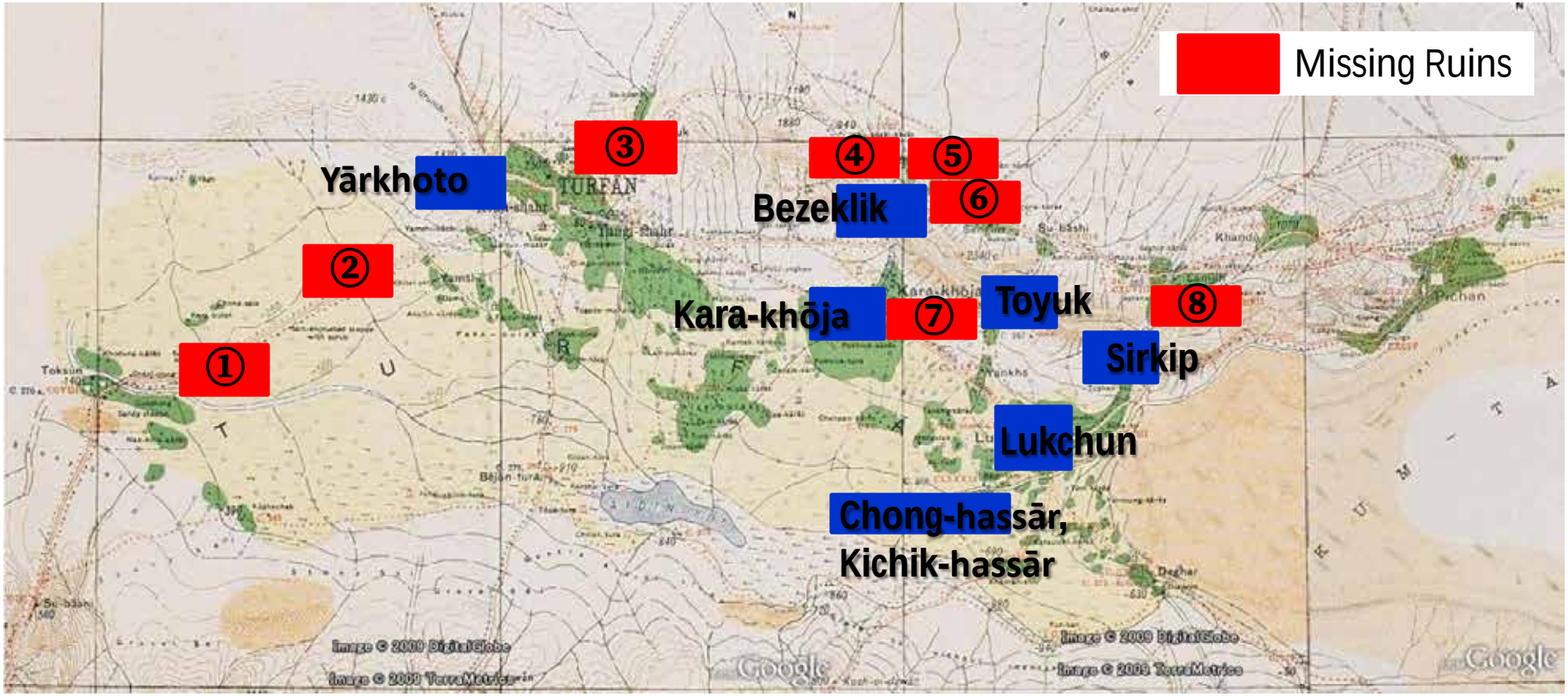
- **Control points + lines**: We proposed a new geometric correction.

Aurel Stein Maps (Silk Road)



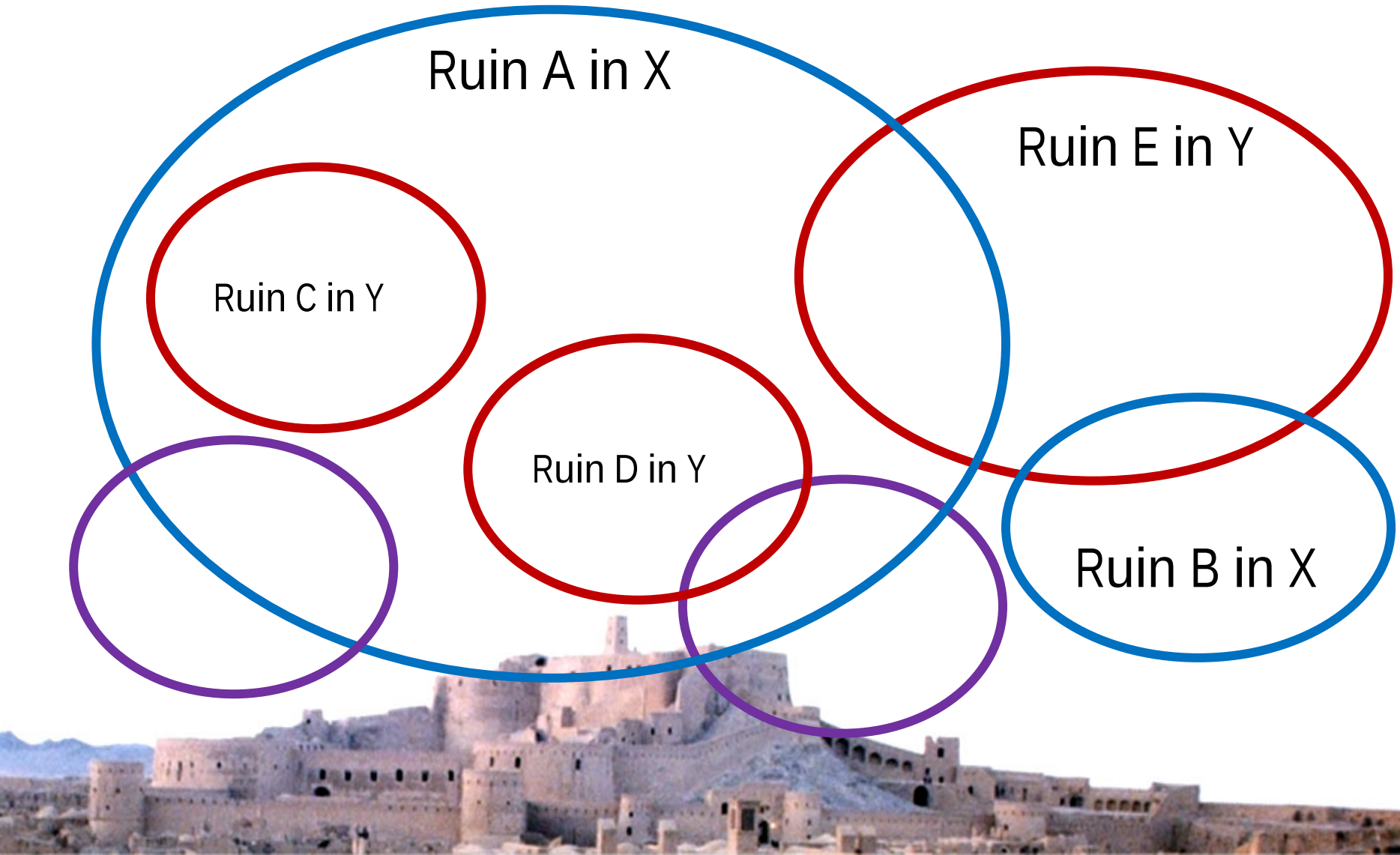
- Stein's map "Innermost Asia" was registered and displayed on Google Earth satellite images.

Problem of “Missing” Ruins

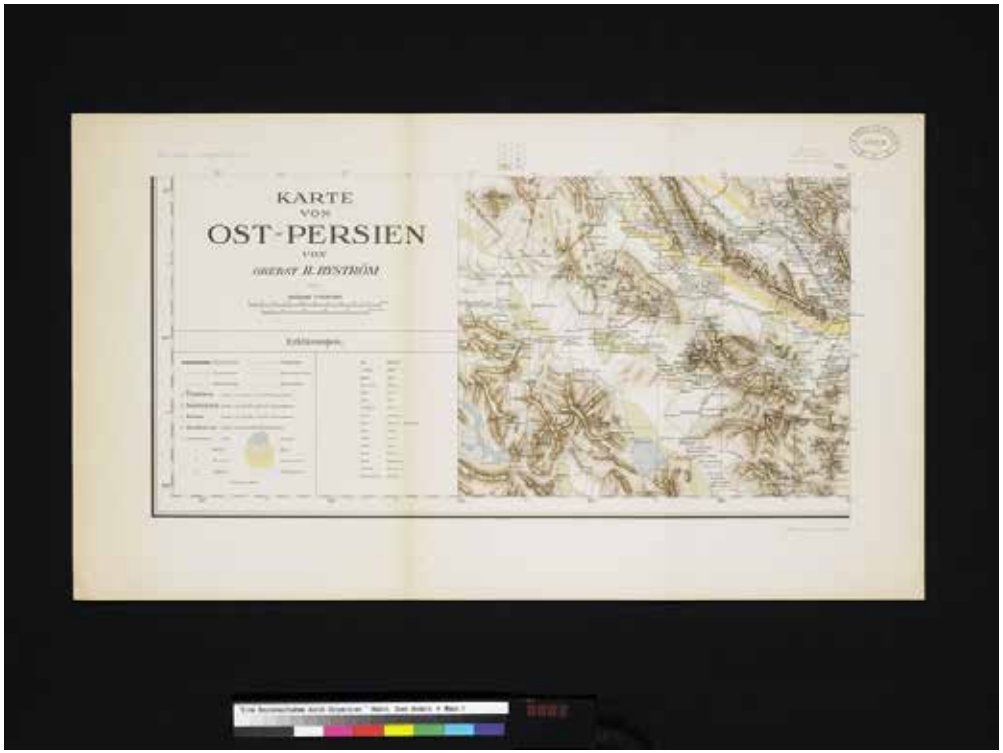


① Oi-tam, ruined fort
② Bögan-tura
③ Buluyuk (Shipang, Sassik-bulak, Kazma)
④ Murtuk-ruins
⑤ Yoghan-tura
⑥ Chikkan-köl
⑦ Bedaulat’s town, Bēsh-kāwuk, Kosh-gumbaz
⑧ Yutōgh

Different Conceptualization

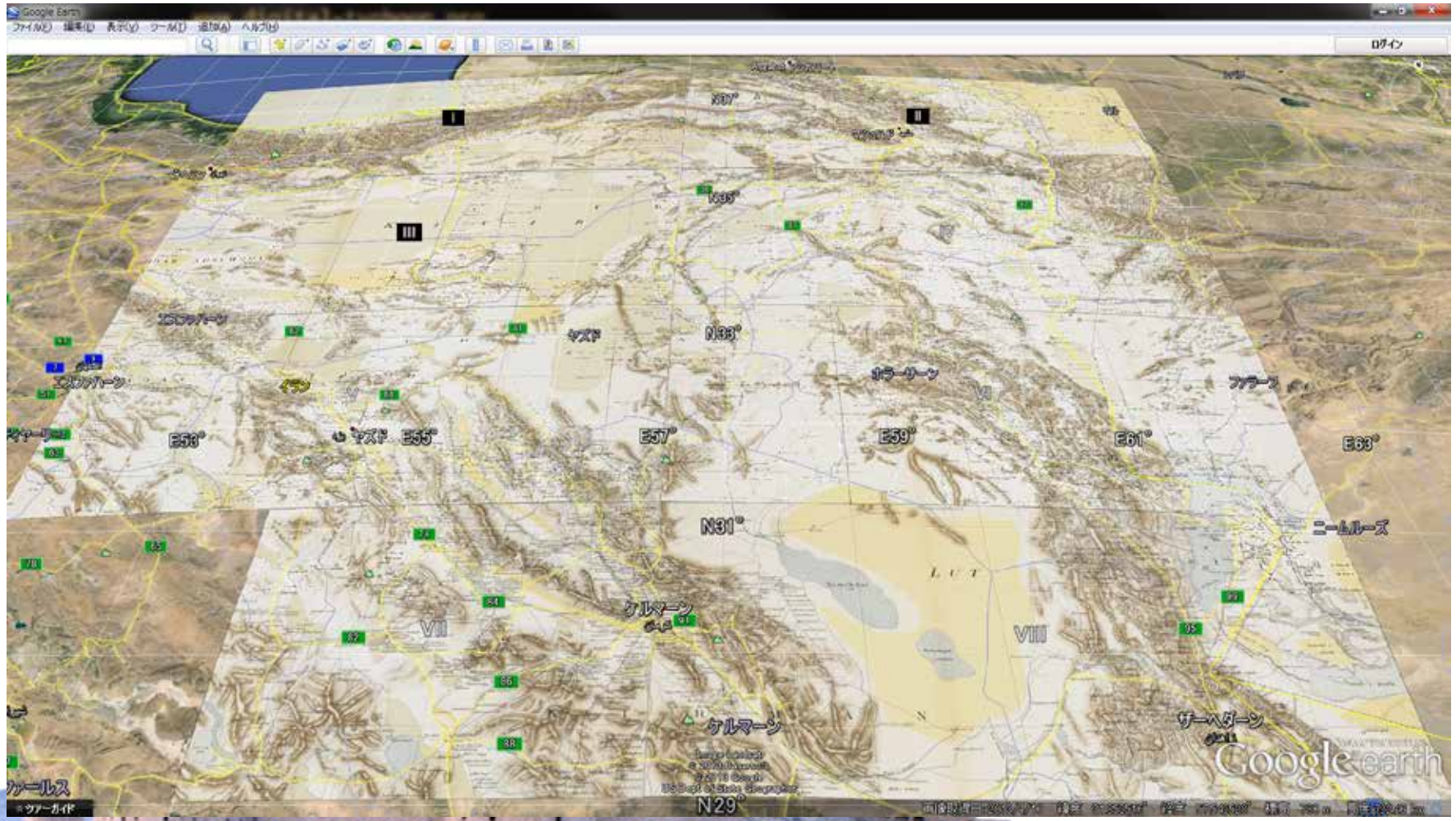


Sven Hedin Maps

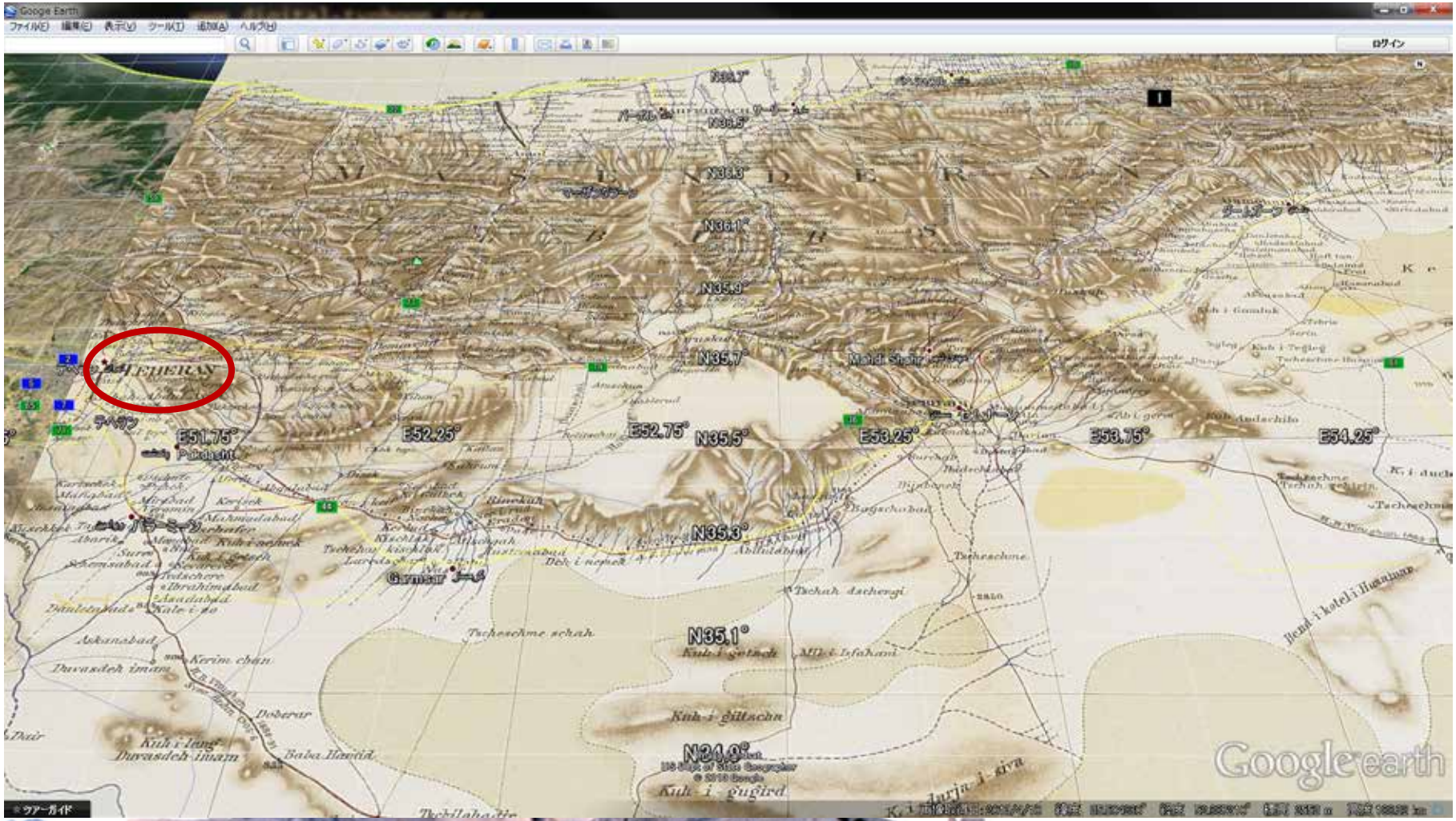


- Sven Hedin (1865-1952) explored Persia and Central Asia.
- His map (1920s) was digitized and geo-referenced.
- Overlay on satellite images.

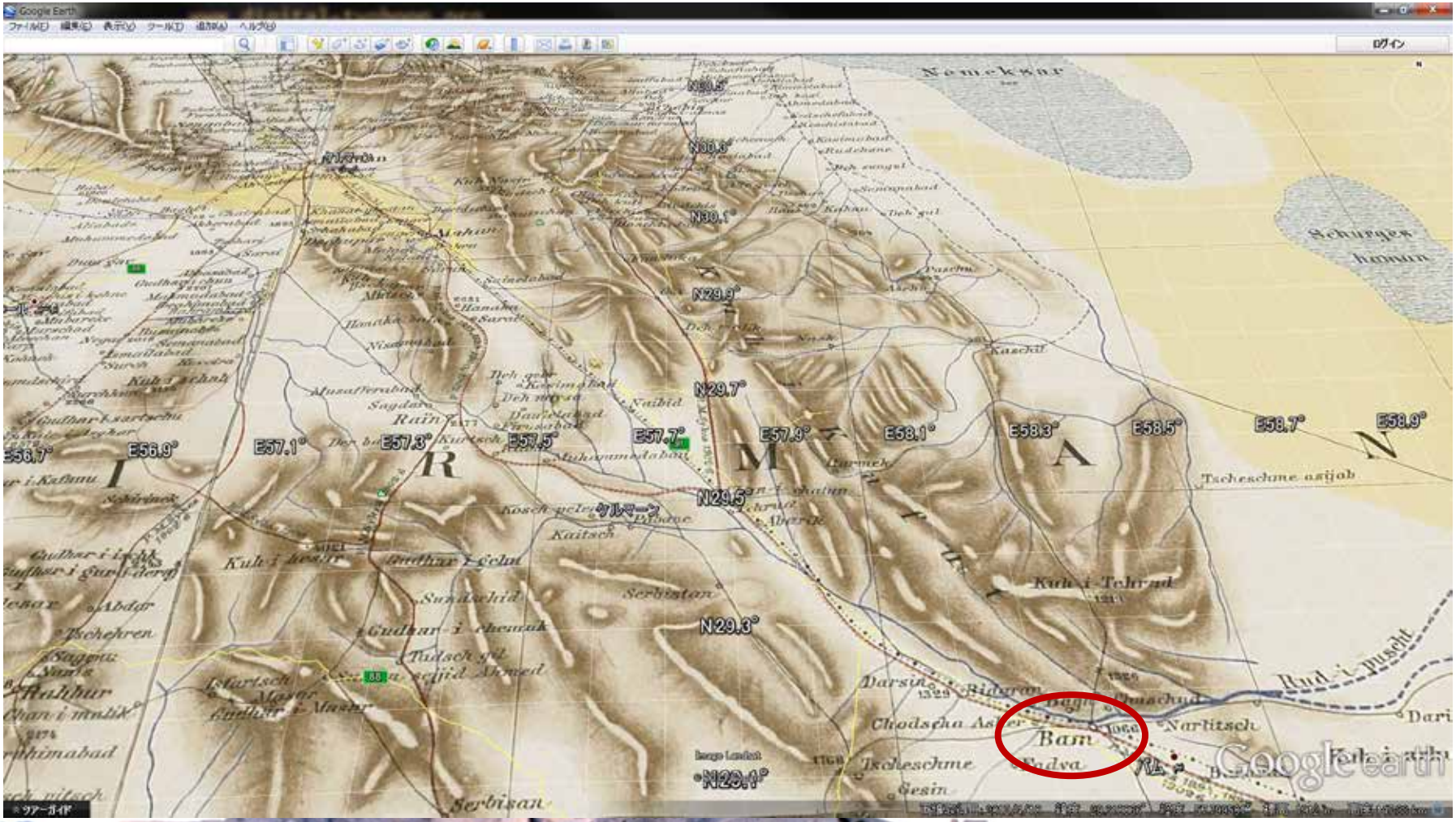
Sven Hedin Maps (Iran)



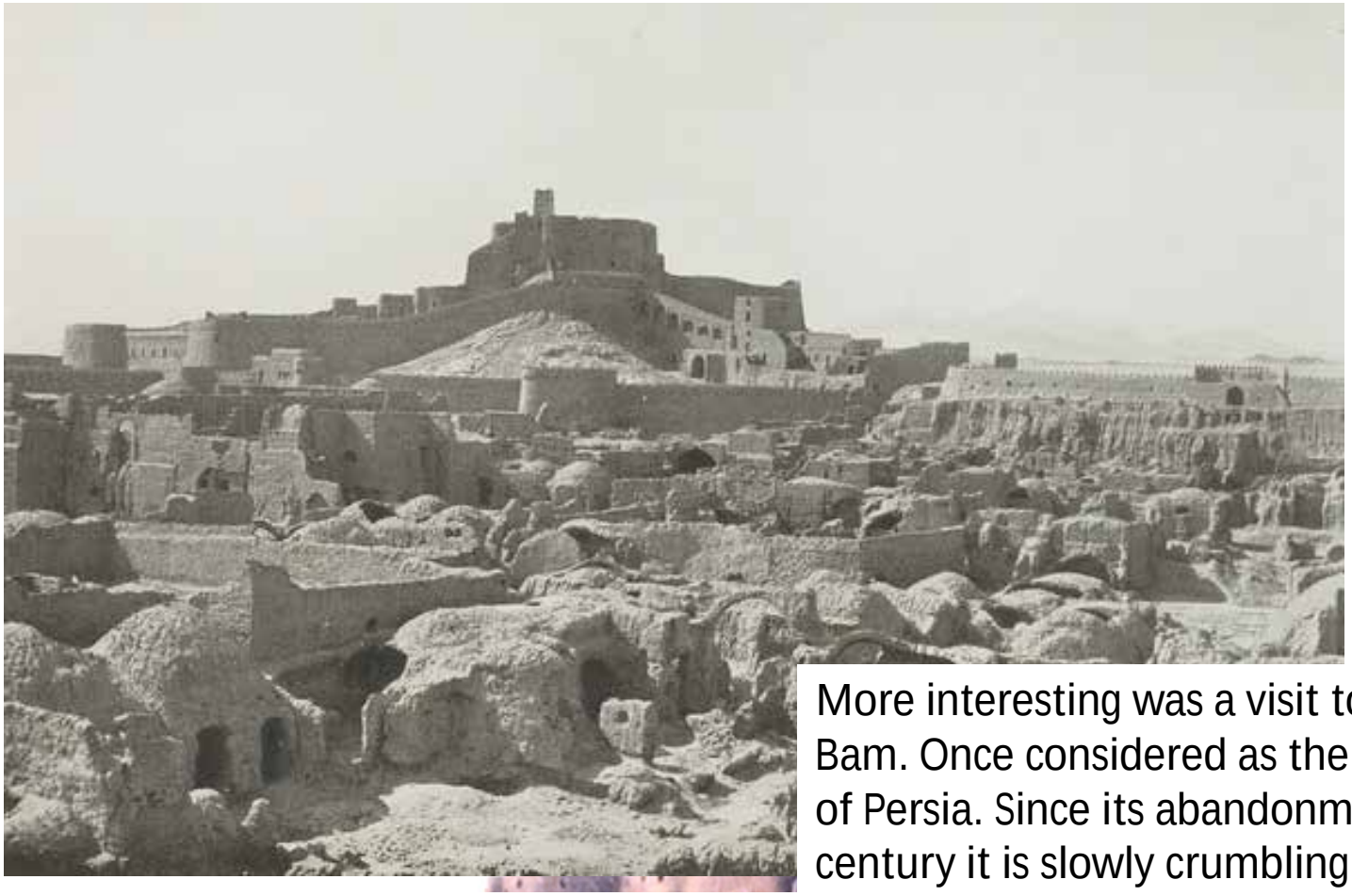
Sven Hedin Maps (Tehran)



Sven Hedin Maps (Bam)



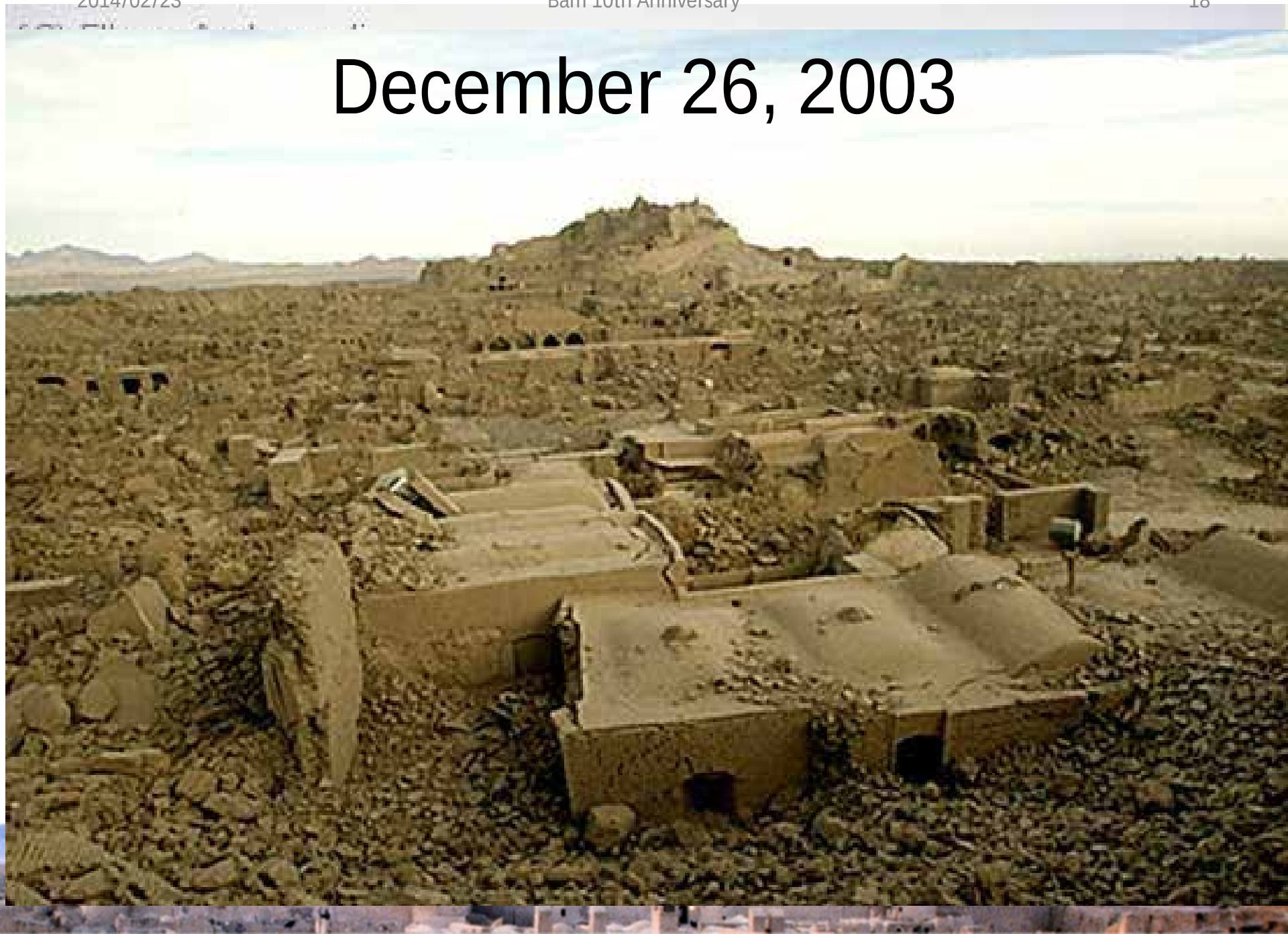
Aurel Stein's Visit to Bam in 1930s



More interesting was a visit to large Arq of Bam. Once considered as the strongest fortress of Persia. Since its abandonment in the last century it is slowly crumbling to ruins.

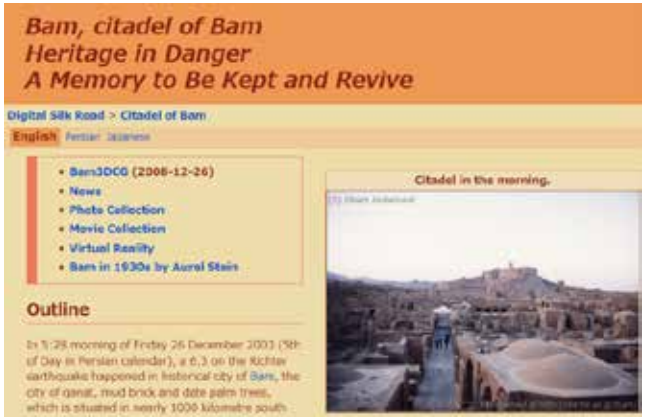
Archaeological Reconnaissances in North-Western India and South-Eastern Īrān : vol.1

December 26, 2003



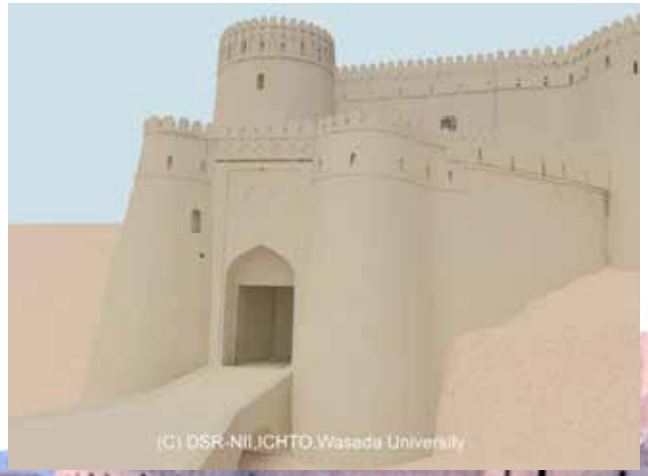
Project History

December 31, 2003



January 2004

April – June, 2006



December 26, 2008

Collaborators

Dr. Elham Andaroodi	Leading the 3D CG reconstruction of Bam in terms collection and management of data, supervision of CG rendering teams, and the design of metadata-based ontology.
Prof. Alireza Einifar	Directing 3D CG drawing and modeling of buildings of the Citadel of Bam
Mr. Saeed Einifar (Razahang)	Conducting 3D CG drawing and Modeling of buildings of the Citadel of Bam
Dr. Mohammad Reza Matini	Correcting, evaluating and completing 3D models, development of CAD-based 3D drawing.

Project Framework

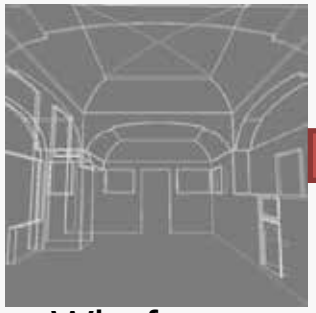
Architectural Process

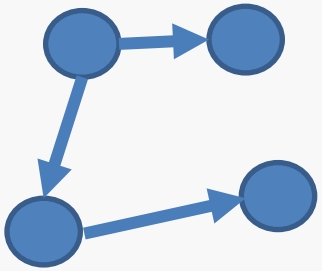
Conceptual Process

Multimedia

Website

Rendering





Wireframe

Ontology

Modeling

Heterogeneous data archives

Cyber world

Museum exhibition

Physical reconstruction

In the future

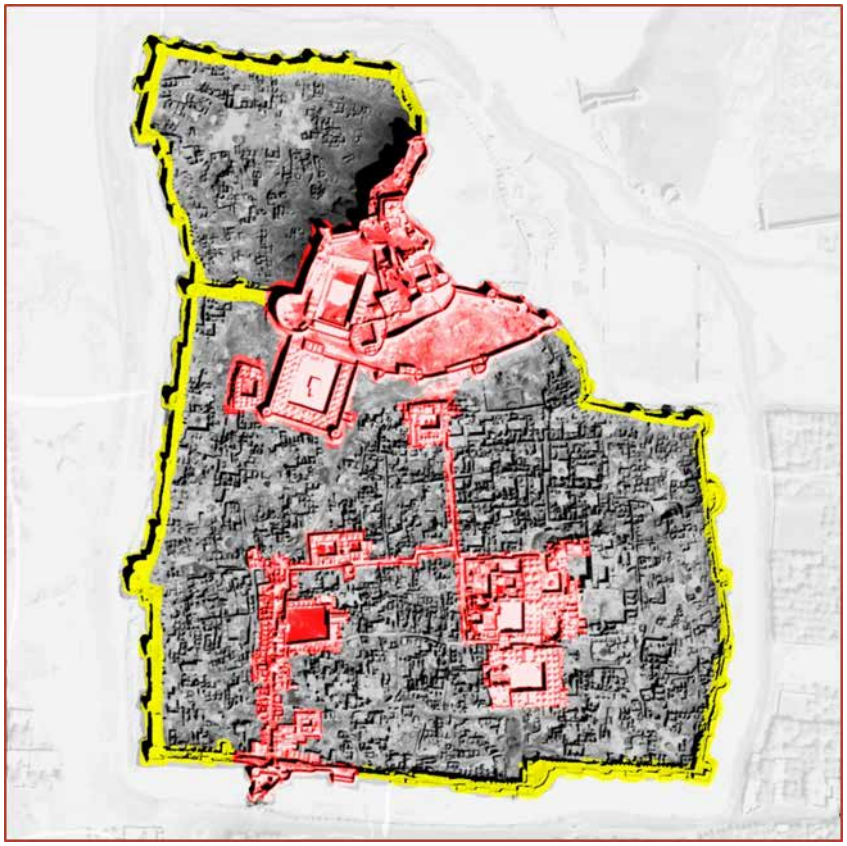
After the disaster

Voluntary data collection

Institutional data collection

Physical world

Architectural Process



Original image: Digital Globe

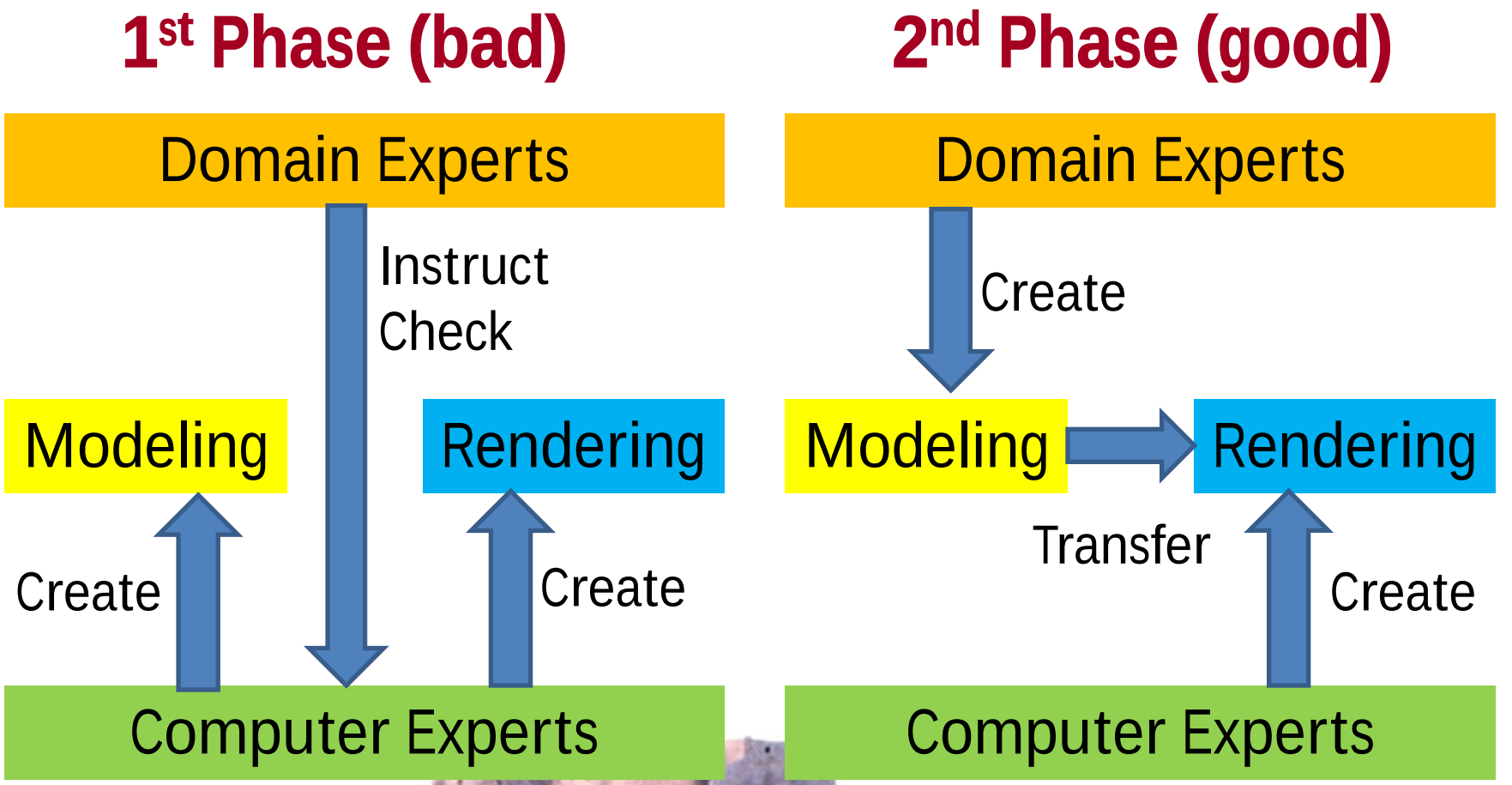
- **High**
- **Moderate**
- **Low**

Accurate — Inaccurate

Manual — Automatic

Good balance between accuracy and cost

Collaboration of Experts

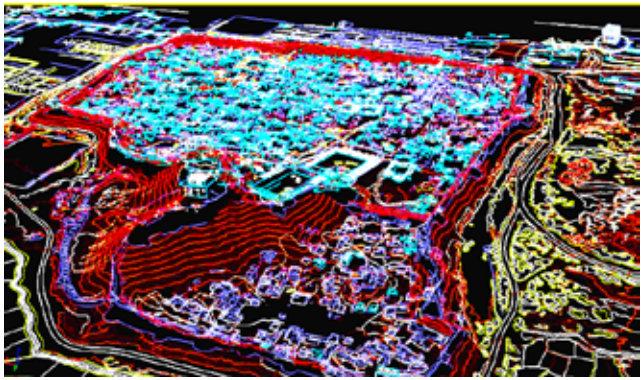


Modular Design

- Domain experts (e.g. architects) focus on the accuracy of models.
- Computer experts (e.g. CG engineers) focus on the appearance of rendered outputs.
- Separation of modeling and rendering made the architectural process more efficient.
- **Modular design and the division of roles.**

Semi-Automatic Modeling

Photogrammetric Map
From CNRS and ICHHTO



Overlay

Photographs
From experts and tourists

Structure

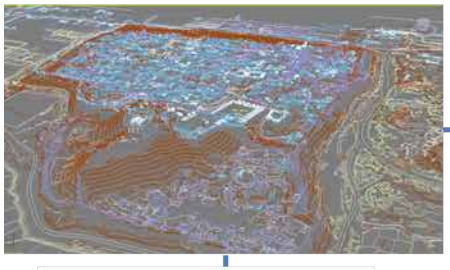
Texture

Simple 3D Model

Work by Mr. Natchapon Futragoon

Workflow

Tourist Photos (before earthquake)



Cartography map

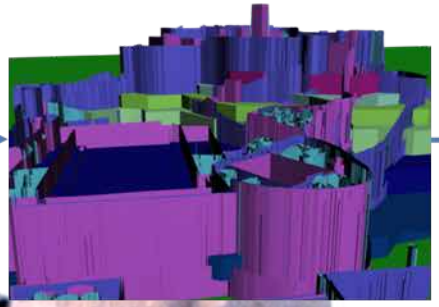
Photo adjustment

Photo Registration

Post Processing

Map Optimization

Mesh Interpret



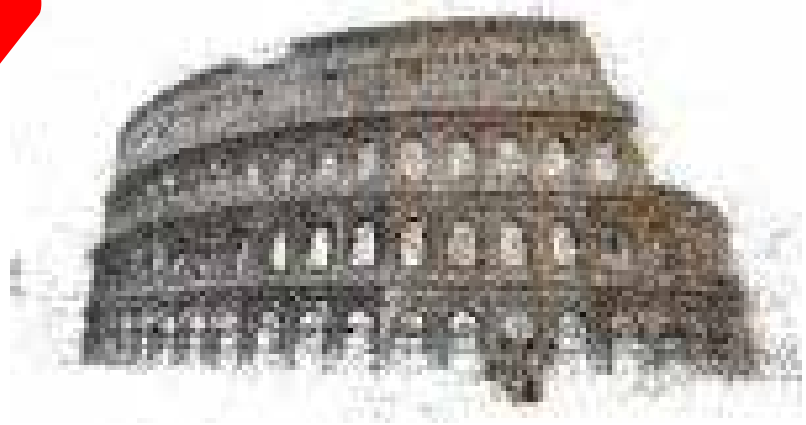
City's 3DMesh

Final Result

Automatic Modeling

Laser scanning

Image: Wikipedia



Structure from Motion

Image: Building Rome in a Day

New data cannot be measured for post-disaster reconstruction

Multiple Images and Videos

Using point correspondences and projective geometry fails due to the lack of photographs, variety of cameras, and temporal change due to renovation.

7-minute video taken from a helicopter by NHK in 1981 has potential for the automatic reconstruction of a 3D model, but not yet completed.

Work by Mr. Tiago da Silva

Project Framework

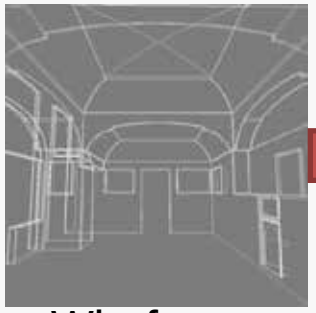
Architectural Process

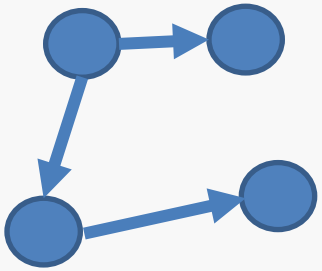
Conceptual Process

Multimedia

Website

Rendering





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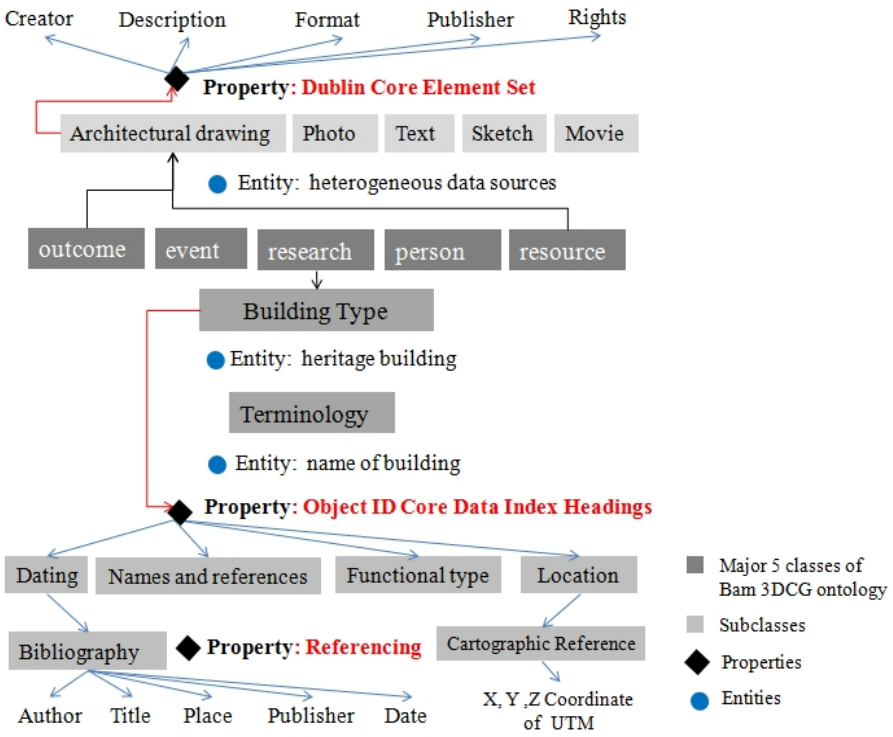
Conceptual Process

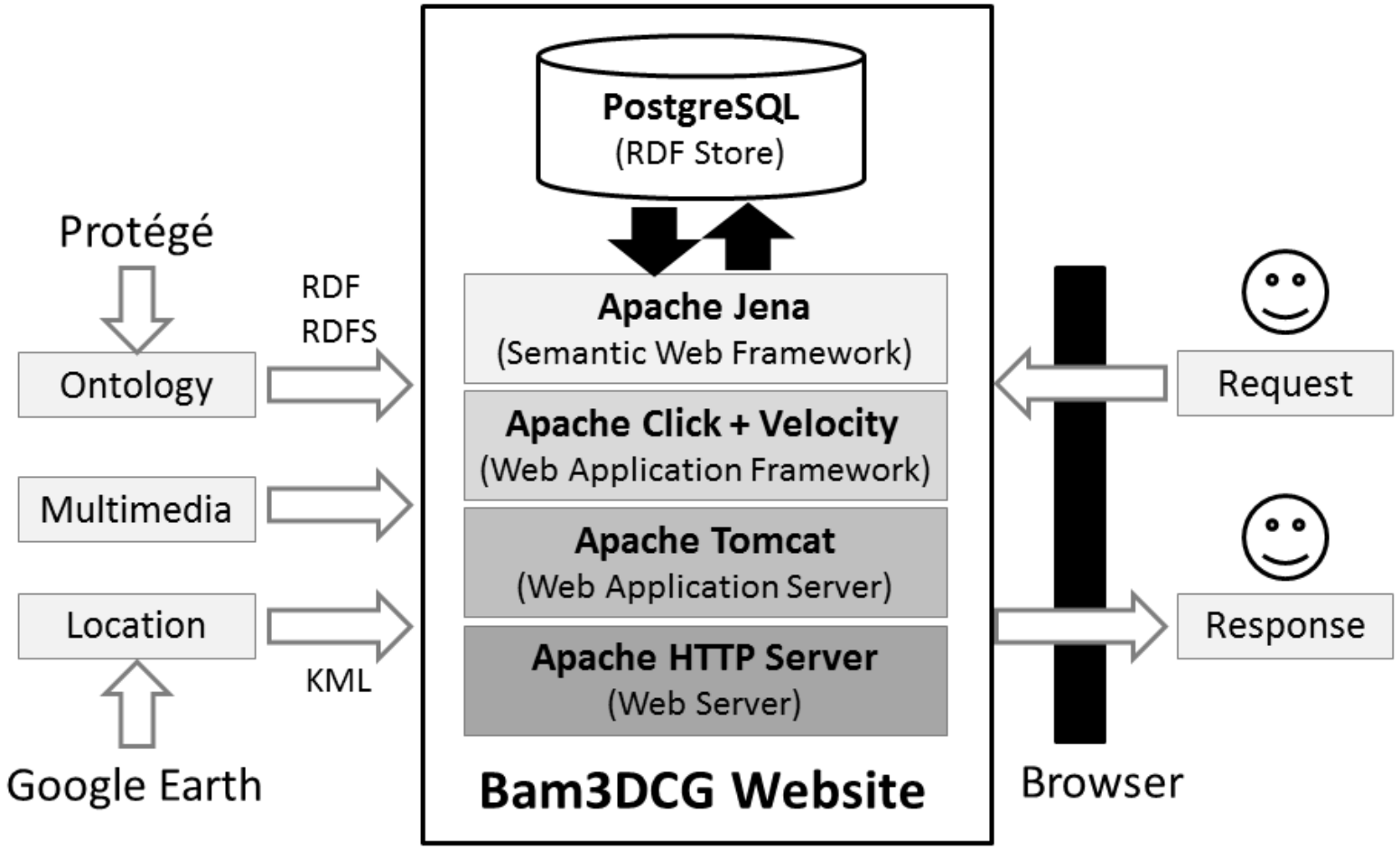


- We also need the modeling of knowledge for the heterogeneous data archives.
- Ontology uses classes, attributes, and relationships to define conceptualization.
- How to render the ontology?

Bam3DCG Website

http://dsr.nii.ac.jp/Bam3DCG/

Ontology Rendering System



Documentation and Disasters

Pre-disaster documentation

- Everything can be measured precisely, uniformly, repeatedly.
- Created data is mainly for academic communities.

Post-disaster documentation

- Available data is not sufficient, but we need to accept the situation.
- Created data is also monumental for local communities to revive memories.

East Japan Earthquake on 2011

Tsunami of 10m+ Heights

Radiation Monitoring

Japan-Iran International Collaboration

- We can share the experiences of earthquakes, and this is why I proposed Bam Project.
- Japan is contributing to Iran in terms of earthquake preparedness and recovery.
- Recovery is not only about physical reconstruction, but also about psychological reconstruction of memory in the community.
- **Bam Project will help you keeping memories.**

Acknowledgment

3D CG reconstruction of the Citadel of Bam is a collaborative research project between the Digital Silk Road project of NII and Iranian Cultural Heritage, Handicraft and Tourism Organization (ICHHTO), The University of Tehran, and Razahang Architectural Office. The 3D photogrammetric material is provided to NII by Professor Chahryar ADLE from CNRS and ICHHTO. We thank Mr. Tomohiro Ikezaki for implementing the Bam3DCG website generation system. We also thank students who worked for Bam Project at Kitamoto Lab during the NII internship program, namely Tiago da Silva, Natchapon Futragoon, and Xinling Chen.

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