



Seismic Risk Maps for Non-Ductile Concrete Buildings

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Motivation of Risk Maps

Outline

Motivation

Risk

Risk Maps

Case Studies

Closing

- To prevent catastrophic failures, concrete buildings built prior to the building code revision in 1976 are in need of seismic retrofit
- Given the quantity of these buildings, a systematic method to identify the highest risk buildings is desired

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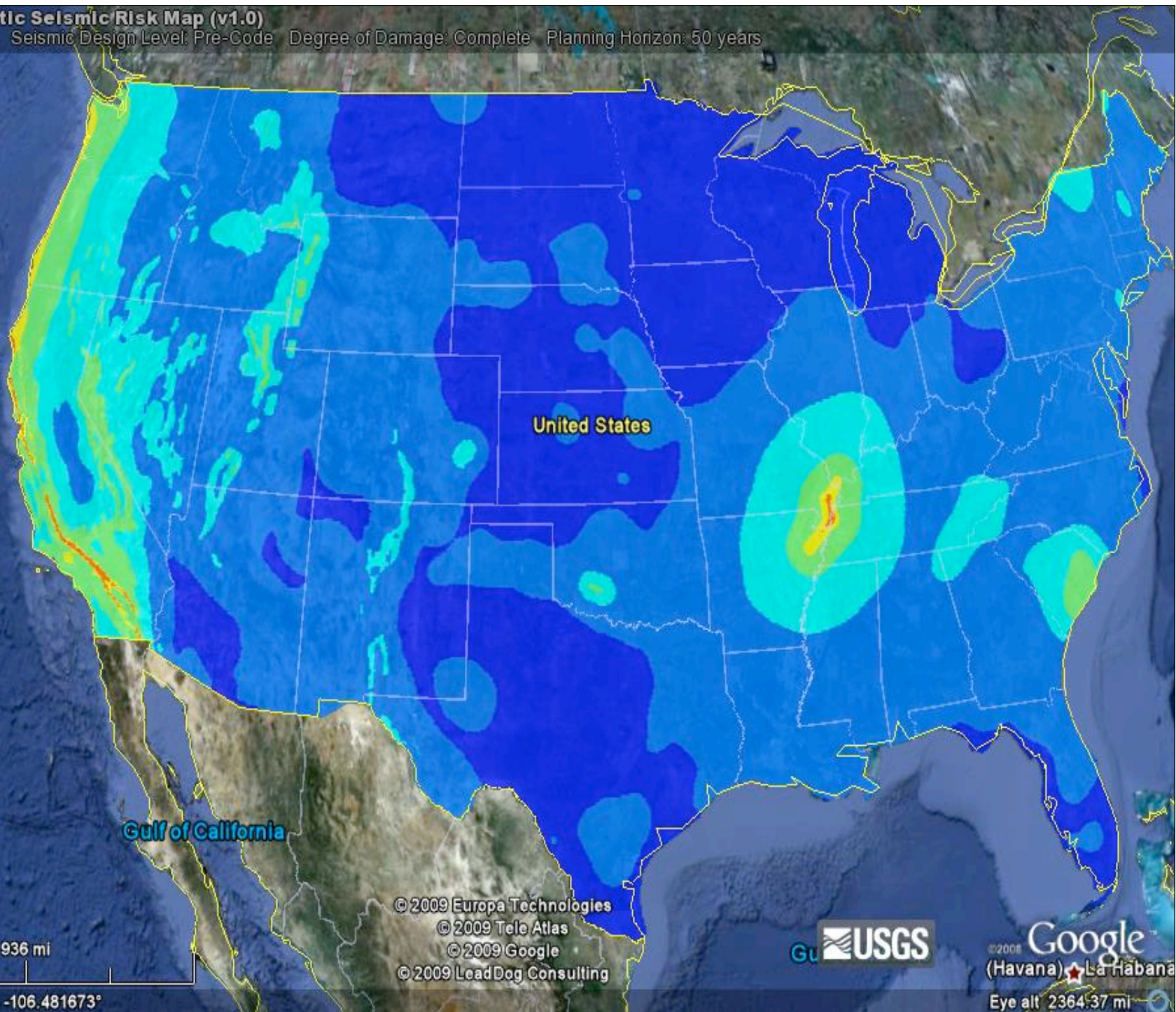
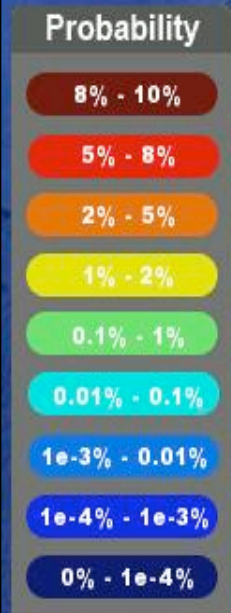
Case Studies

Closing

- Contour/Raster Maps
- Several types to be discussed
 - General Risk Map
 - Inventory-Specific Risk Map
 - Loss Ratio Map
 - Difference Map

USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C2H Seismic Design Level: Pre-Code Degree of Damage: Complete Planning Horizon: 50 years



Gulf of California

United States

936 mi

lat 43.150930° lon -106.481673°

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© 2008 Google
(Havana) La Habana

Eye alt 2364.37 mi

- Updated Tool
 - Raster maps
 - Assume site class distribution based on VS30 values determined from topography (Wald and Allen 2007)
 - Inventory-specific risk maps
 - User-specified site class (Inventory maps only)
 - User-inputted fragility/vulnerability information
 - Difference maps – site distribution & code level
 - Loss Ratio maps

USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C2H Seismic Design Level: Pre-Code Degree of Damage: Complete Planning Horizon: 50 years

Probability

20% - 25%

10% - 20%

5% - 10%

1% - 5%

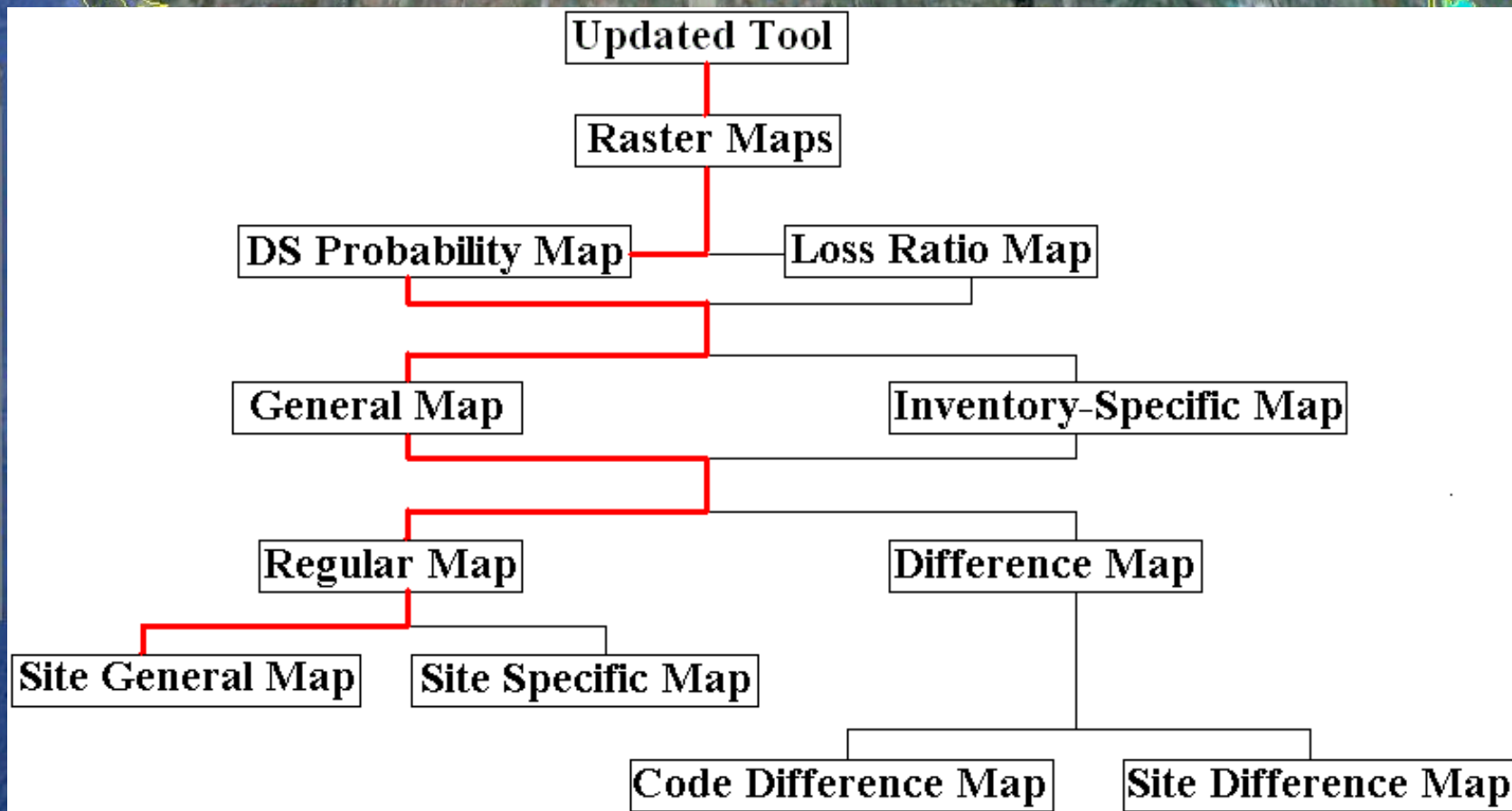
0.1% - 1%

0.01% - 0.1%

1e-3% - 0.01%

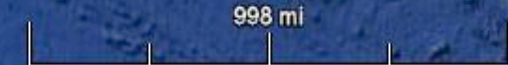
1e-4% - 1e-3%

0% - 1e-4%



Gulf of California

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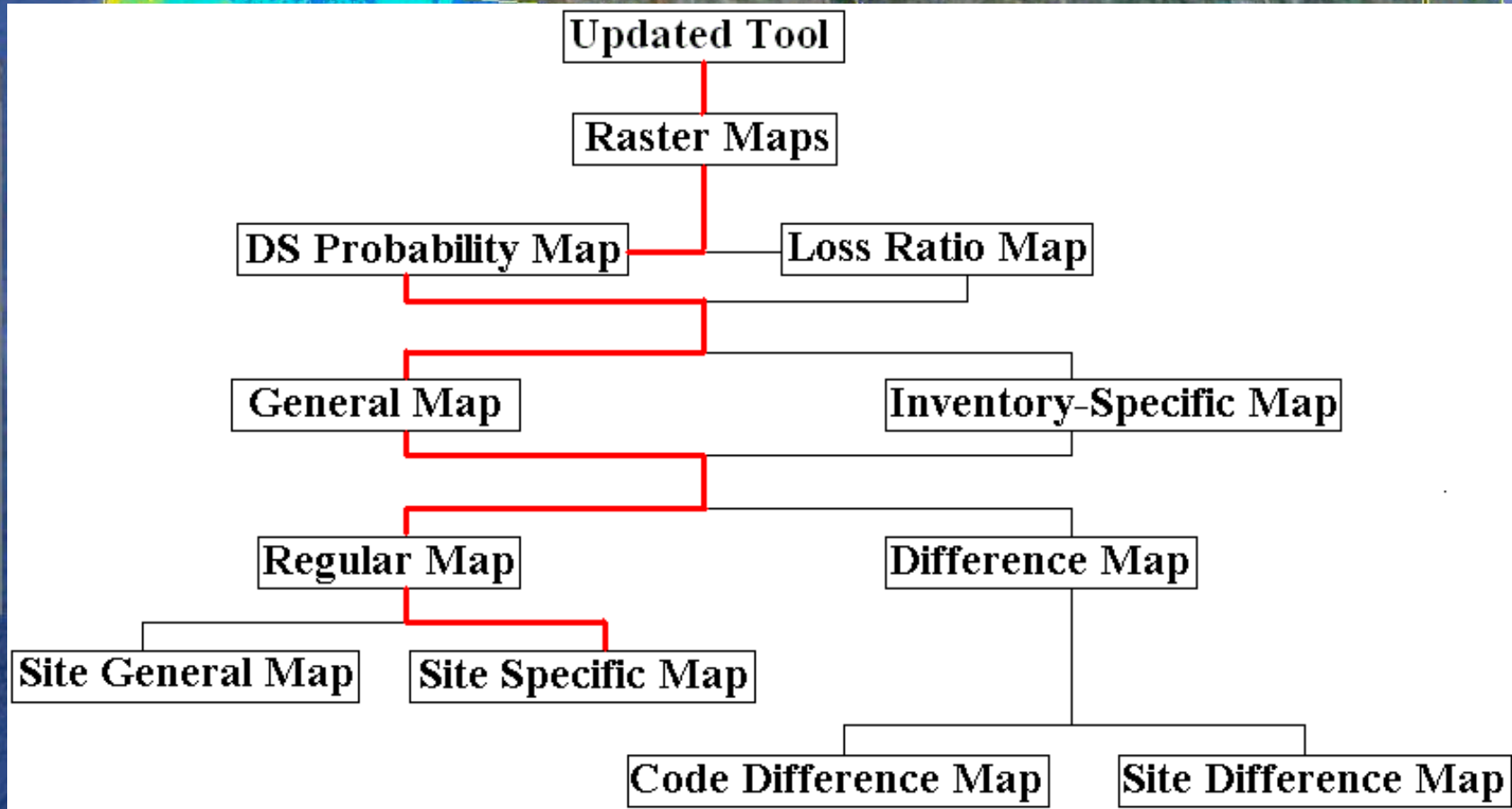
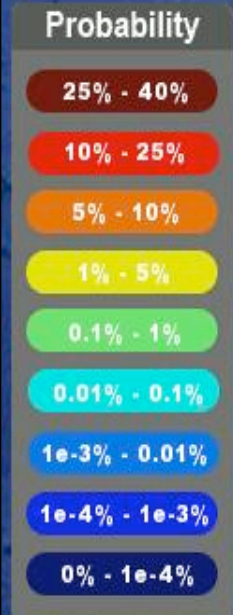


lat 38.995115° lon -102.695103°

Eye alt 2426.20 mi

USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C2H Seismic Design Level: Pre-Code Degree of Damage: Complete Planning Horizon: 50 years



USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C2H Seismic Design Level: DIFF[Pre/High]-Code Degree of Damage: Complete Planning Horizon: 50 years

Probability

20% - 25%

10% - 20%

5% - 10%

1% - 5%

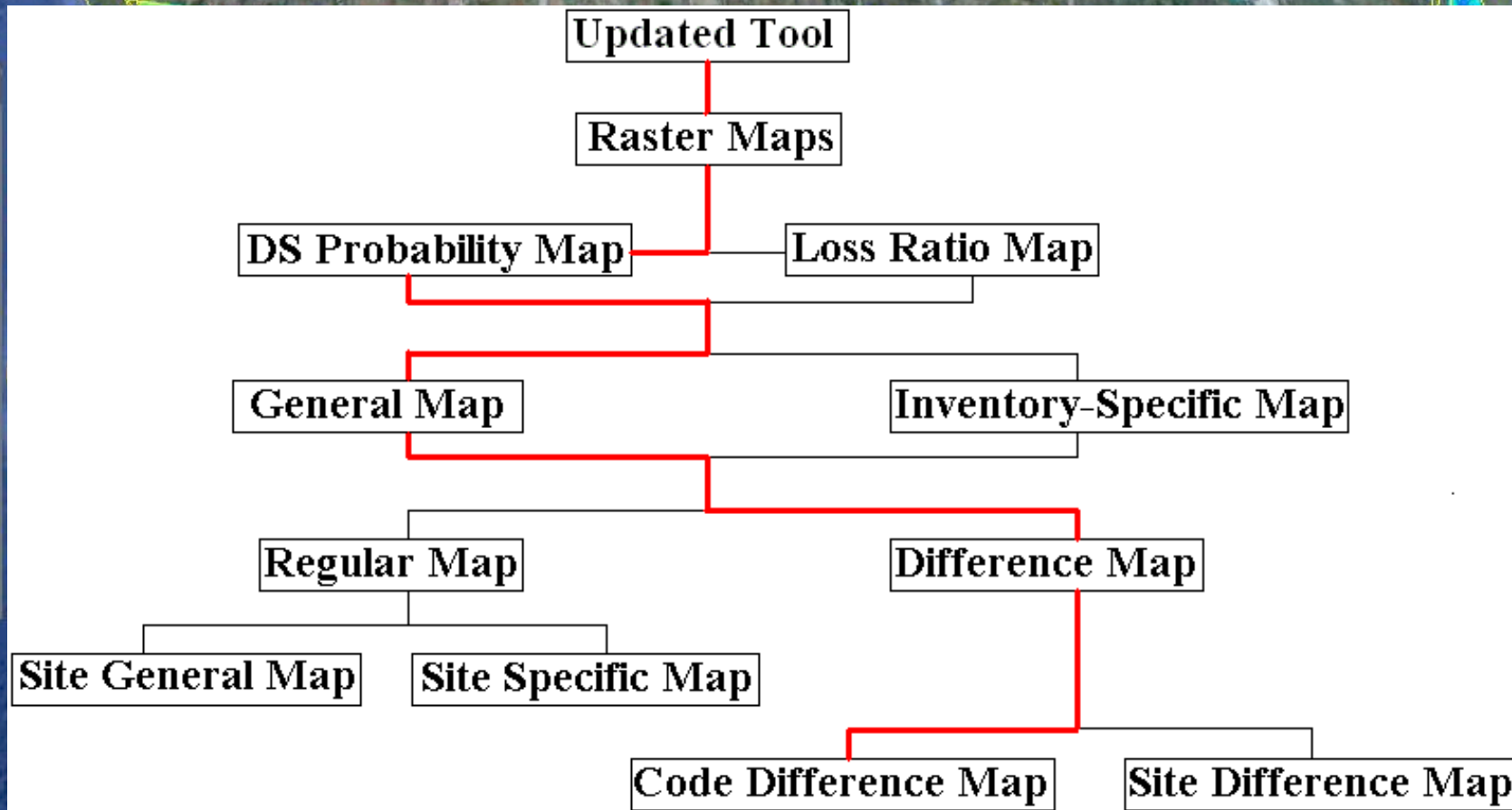
0.1% - 1%

0.01% - 0.1%

1e-3% - 0.01%

1e-4% - 1e-3%

0% - 1e-4%



Gulf of California

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987 mi

lat 38.831649° lon -102.665713°

Eye alt 2410.11 mi

USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C2H Seismic Design Level: Pre-Code Degree of Damage: Complete Planning Horizon: 50 years

Probability

20% - 25%

10% - 20%

5% - 10%

1% - 5%

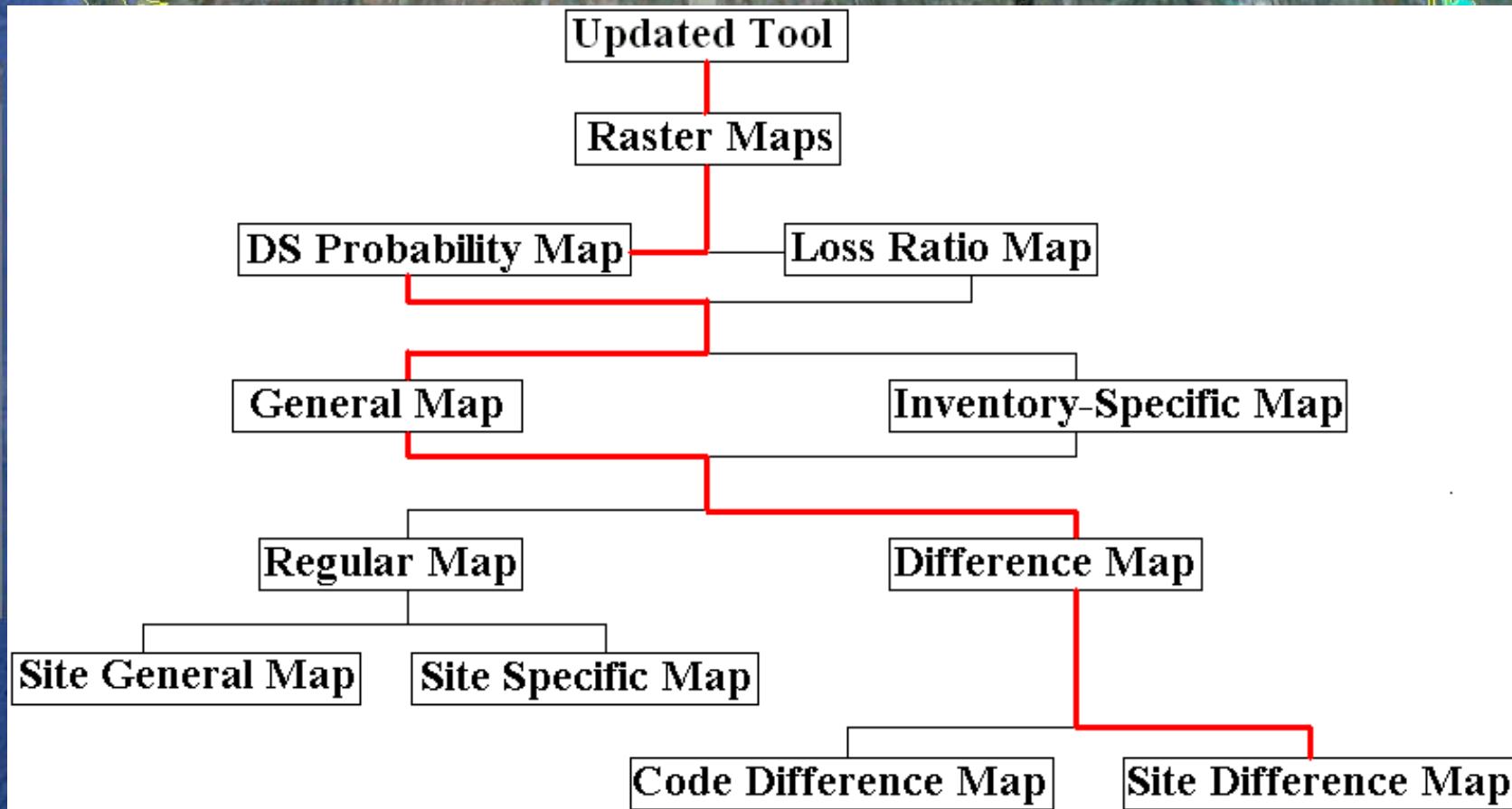
0.1% - 1%

0.01% - 0.1%

1e-3% - 0.01%

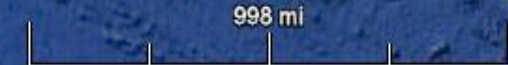
1e-4% - 1e-3%

0% - 1e-4%



Gulf of California

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lat 46.556610° lon -80.148895°

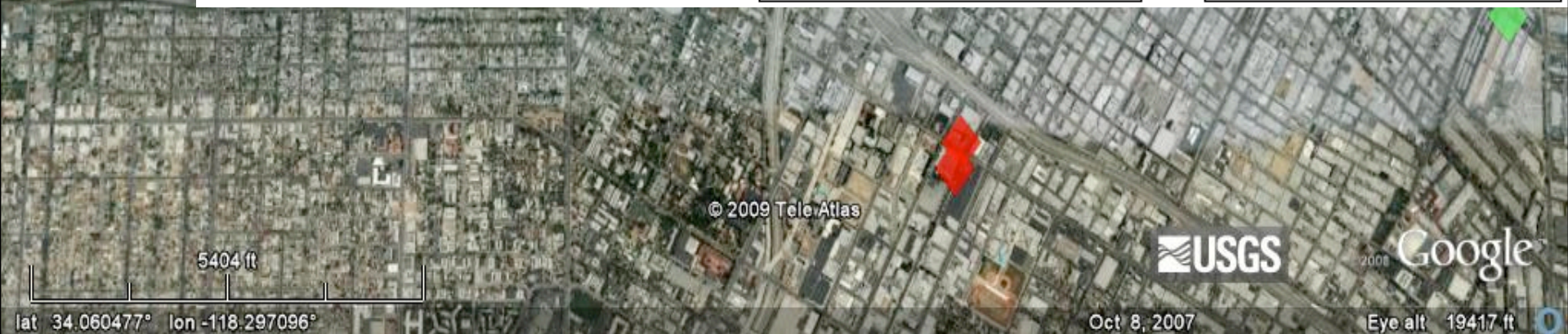
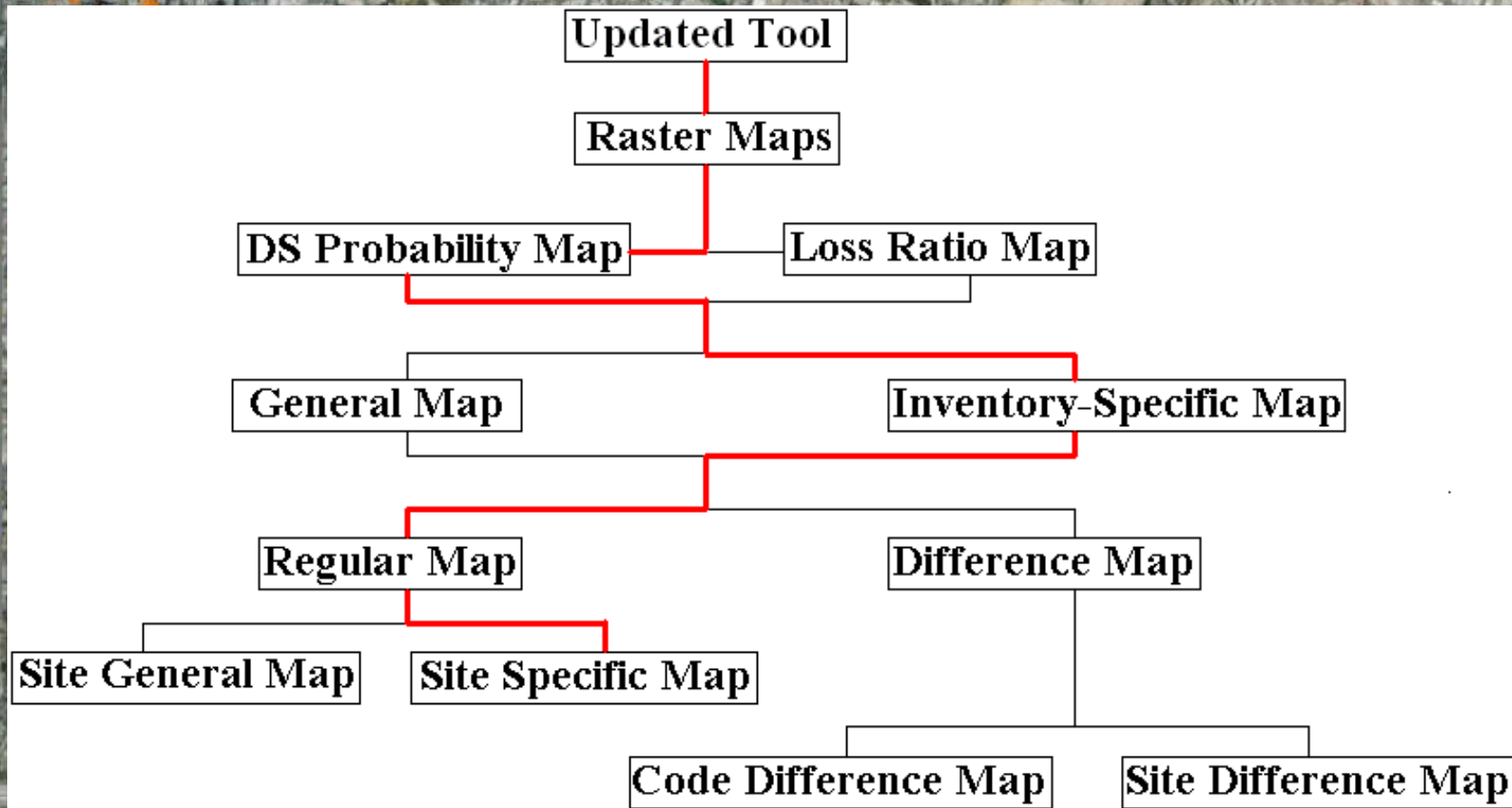
Eye alt 2426.20 mi

USGS Probabilistic Seismic Risk Map (v1.0)

Inventory Location: Los Angeles Risk Map Type: Regular Degree of Damage: Complete Planning Horizon: 50 years

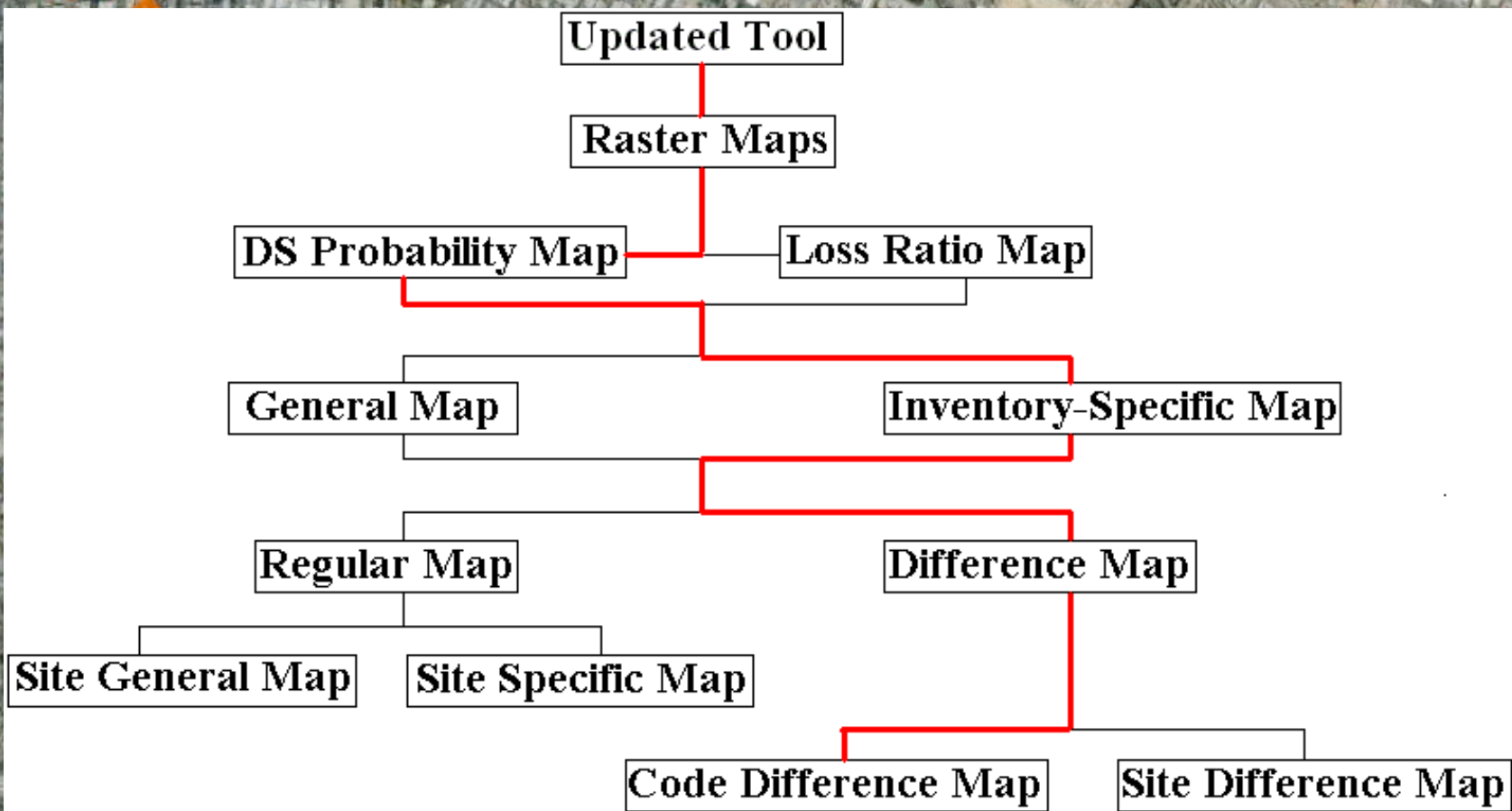
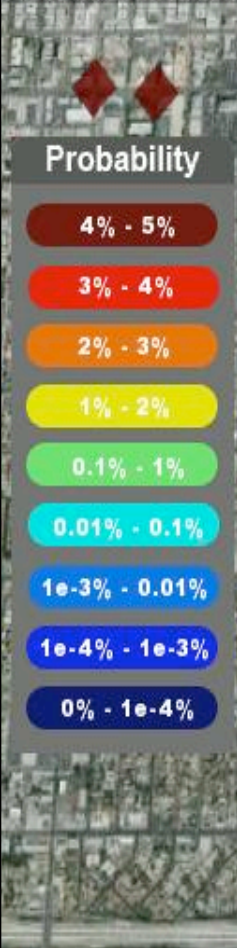
Probability

- 4% - 5%
- 3% - 4%
- 2% - 3%
- 1% - 2%
- 0.1% - 1%
- 0.01% - 0.1%
- 1e-3% - 0.01%
- 1e-4% - 1e-3%
- 0% - 1e-4%



USGS Probabilistic Seismic Risk Map (v1.0)

Inventory Location: Los Angeles Risk Map Type: Difference Degree of Damage: Complete Planning Horizon: 50 years



Outline

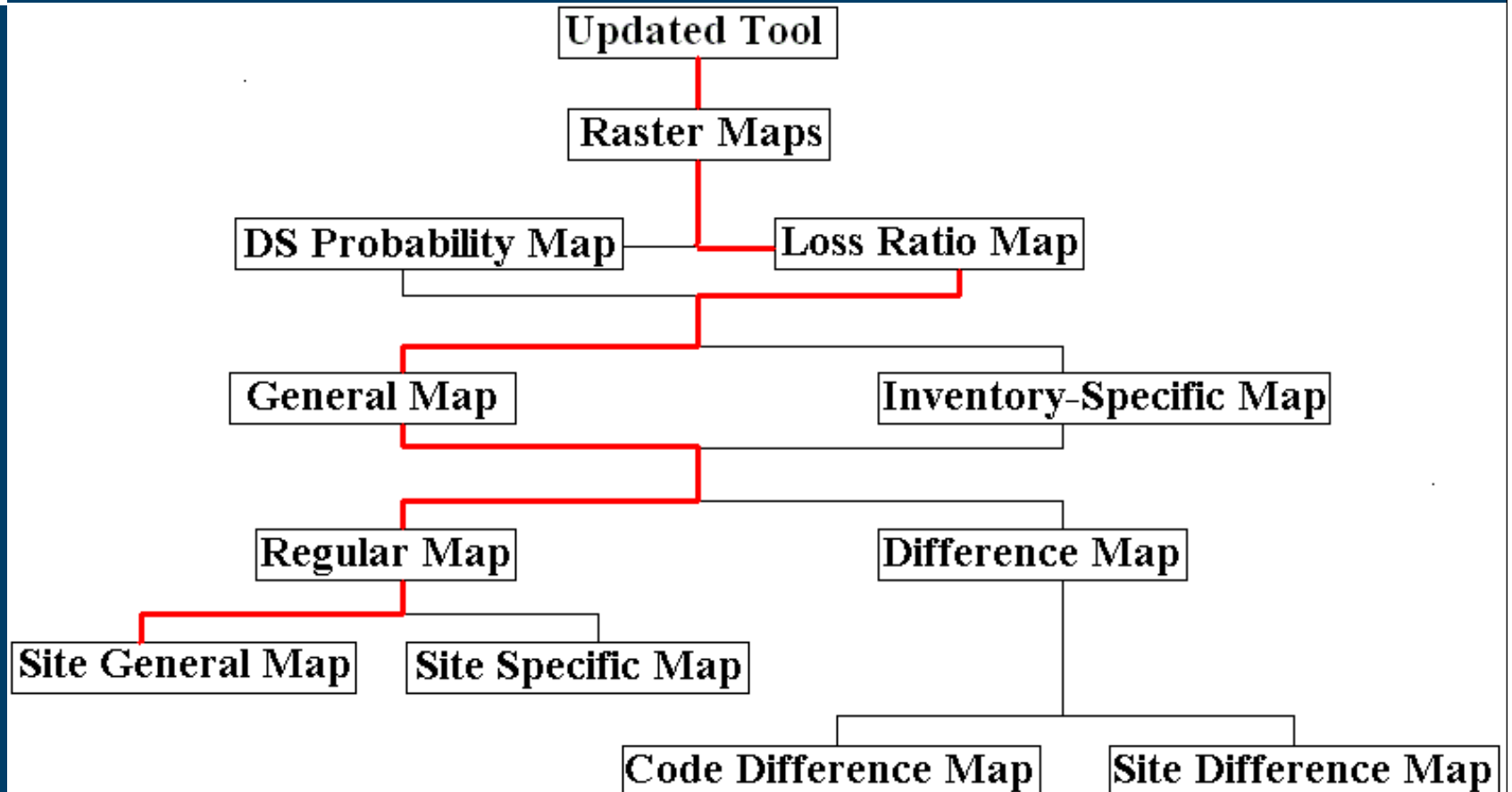
Motivation

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Case Studies

Closing



USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C2H Seismic Design Level: Pre-Code Occupancy Type: COM4 Planning Horizon: 1 year

Loss Ratio

5e-3 - 0.01

1e-3 - 5e-3

5e-4 - 1e-3

1e-4 - 5e-4

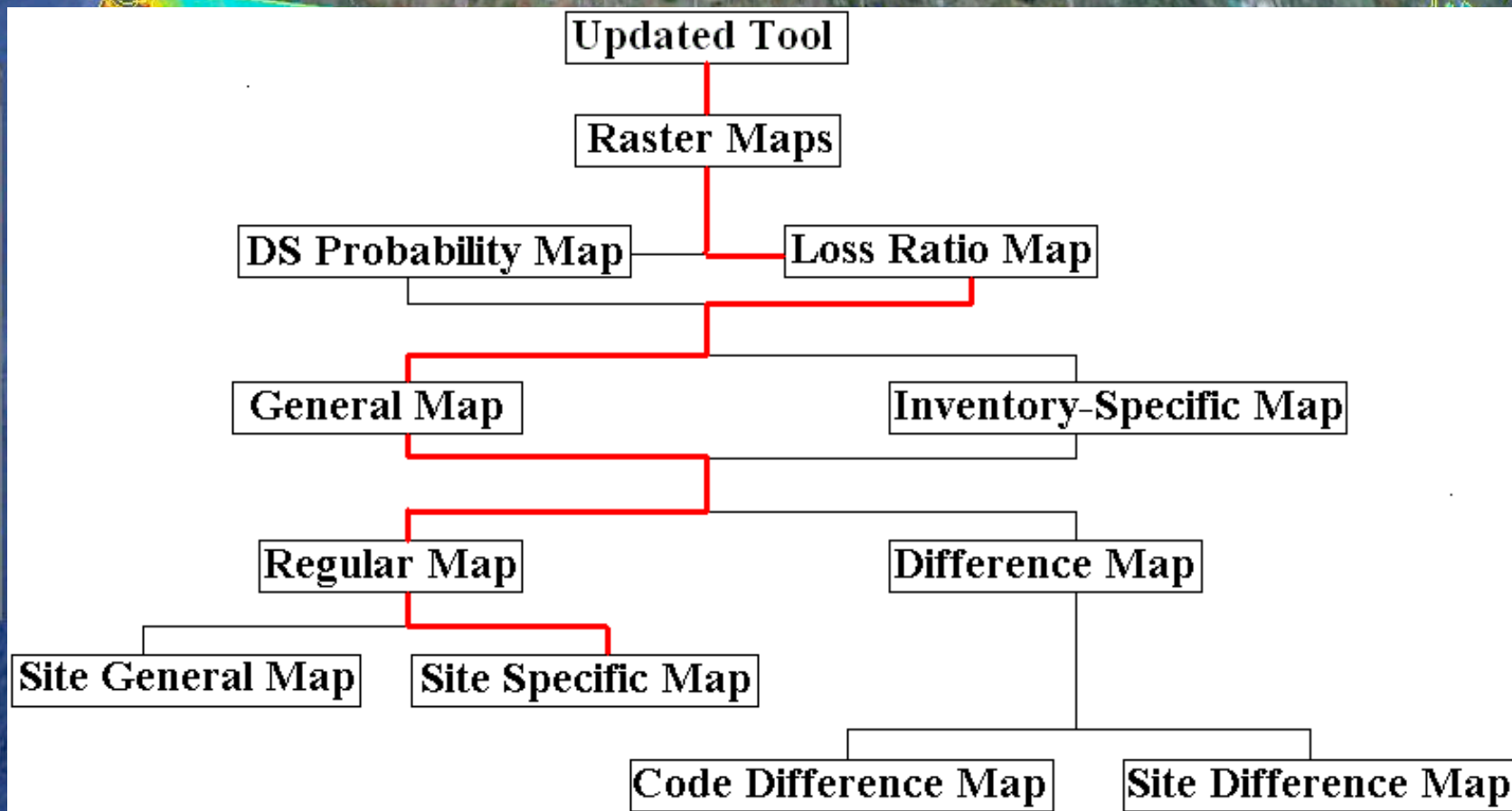
5e-5 - 1e-4

1e-5 - 5e-5

5e-6 - 1e-5

1e-6 - 5e-6

0 - 1e-6



Gulf of California

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Gulf of Mexico

La Habana



Havana

Eye alt 2435.39 mi

1005 mi

lat 38.251602° lon -94.150341°

USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C2H Seismic Design Level: DIFF[Pre/High]-Code Occupancy Type: COM4 Planning Horizon: 1 year

Loss Ratio

5e-3 - 0.01

1e-3 - 5e-3

5e-4 - 1e-3

1e-4 - 5e-4

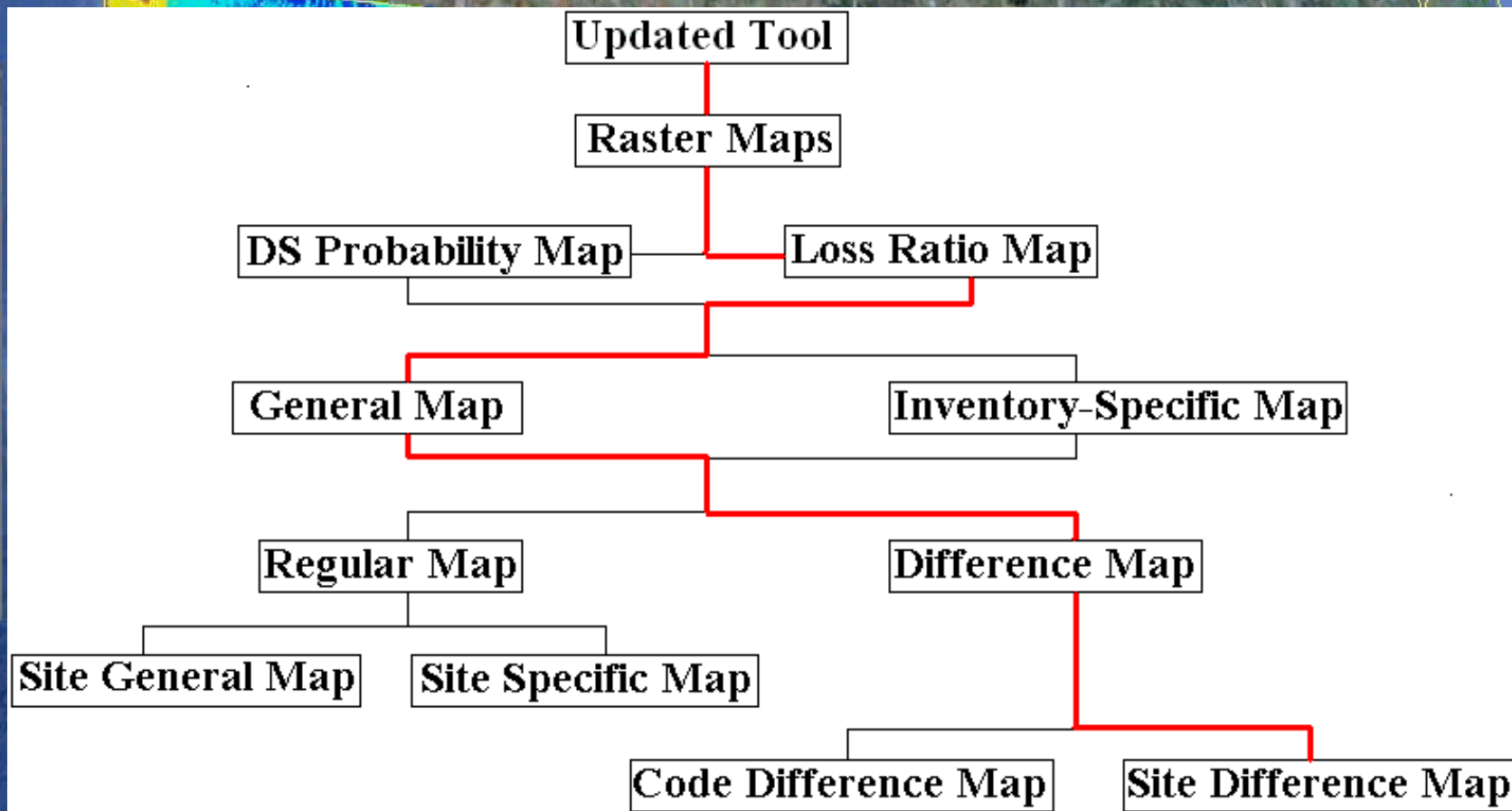
5e-5 - 1e-4

1e-5 - 5e-5

5e-6 - 1e-5

1e-6 - 5e-6

0 - 1e-6



USGS Probabilistic Seismic Risk Map (v1.0)

Inventory Location: Los Angeles Risk Map Type: Regular Degree of Damage: N/A Planning Horizon: 1 year

Loss Ratio

5e-3 - 0.01

1e-3 - 5e-3

5e-4 - 1e-3

1e-4 - 5e-4

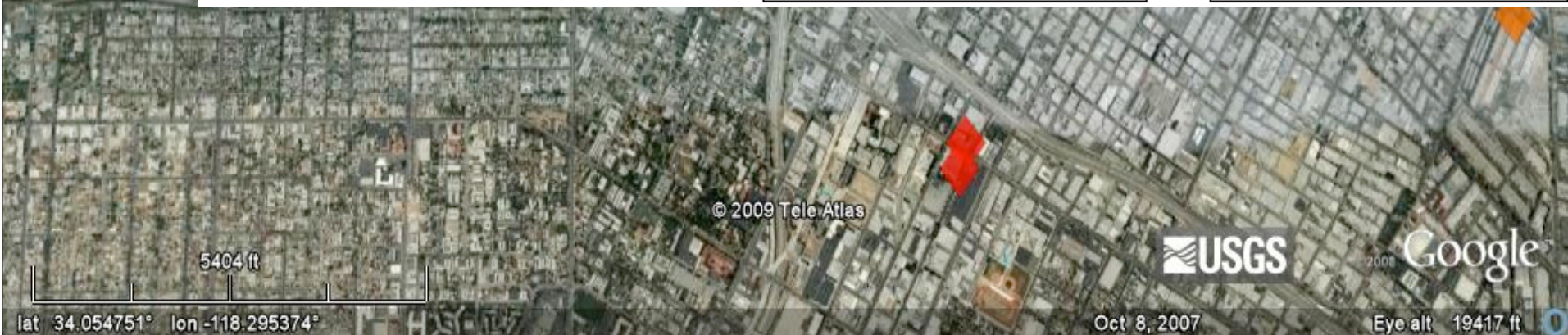
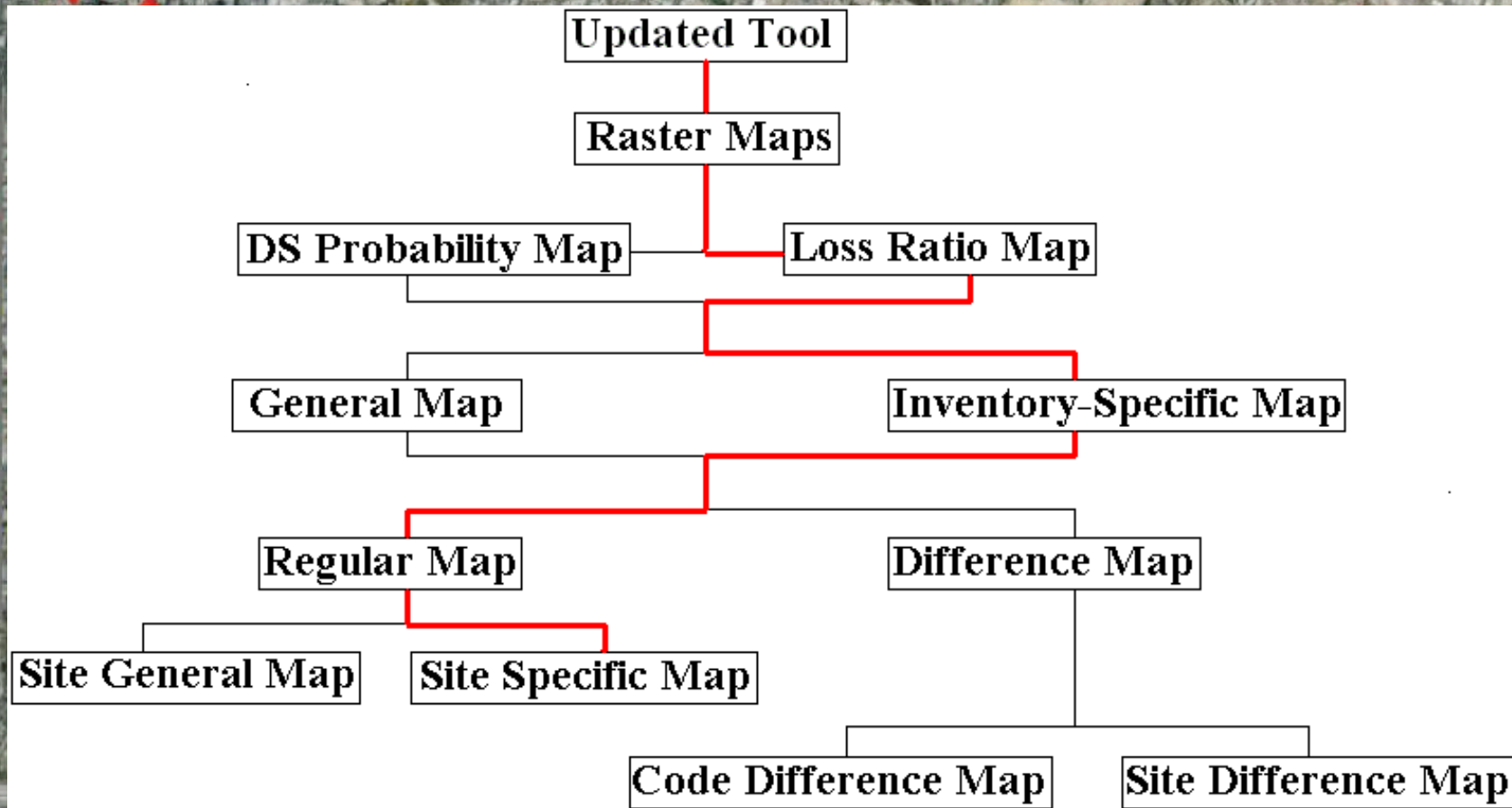
5e-5 - 1e-4

1e-5 - 5e-5

5e-6 - 1e-5

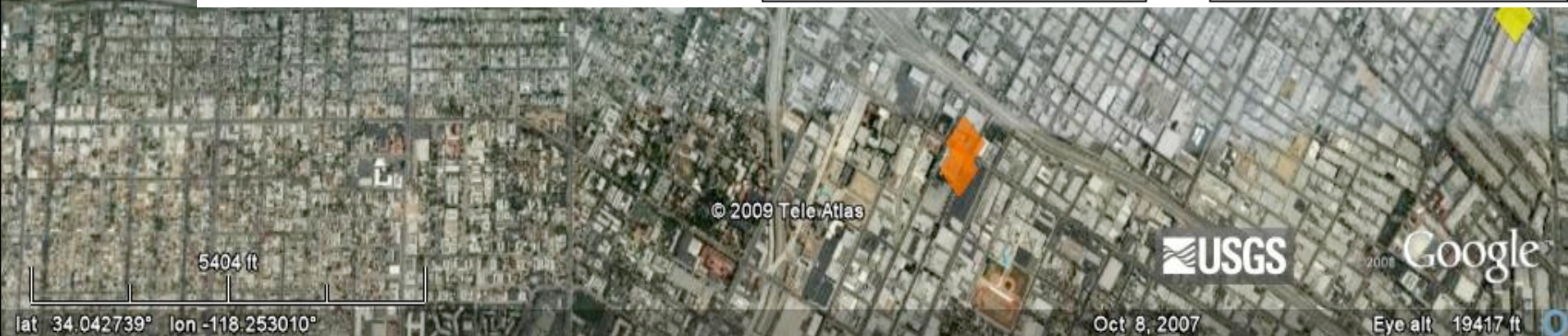
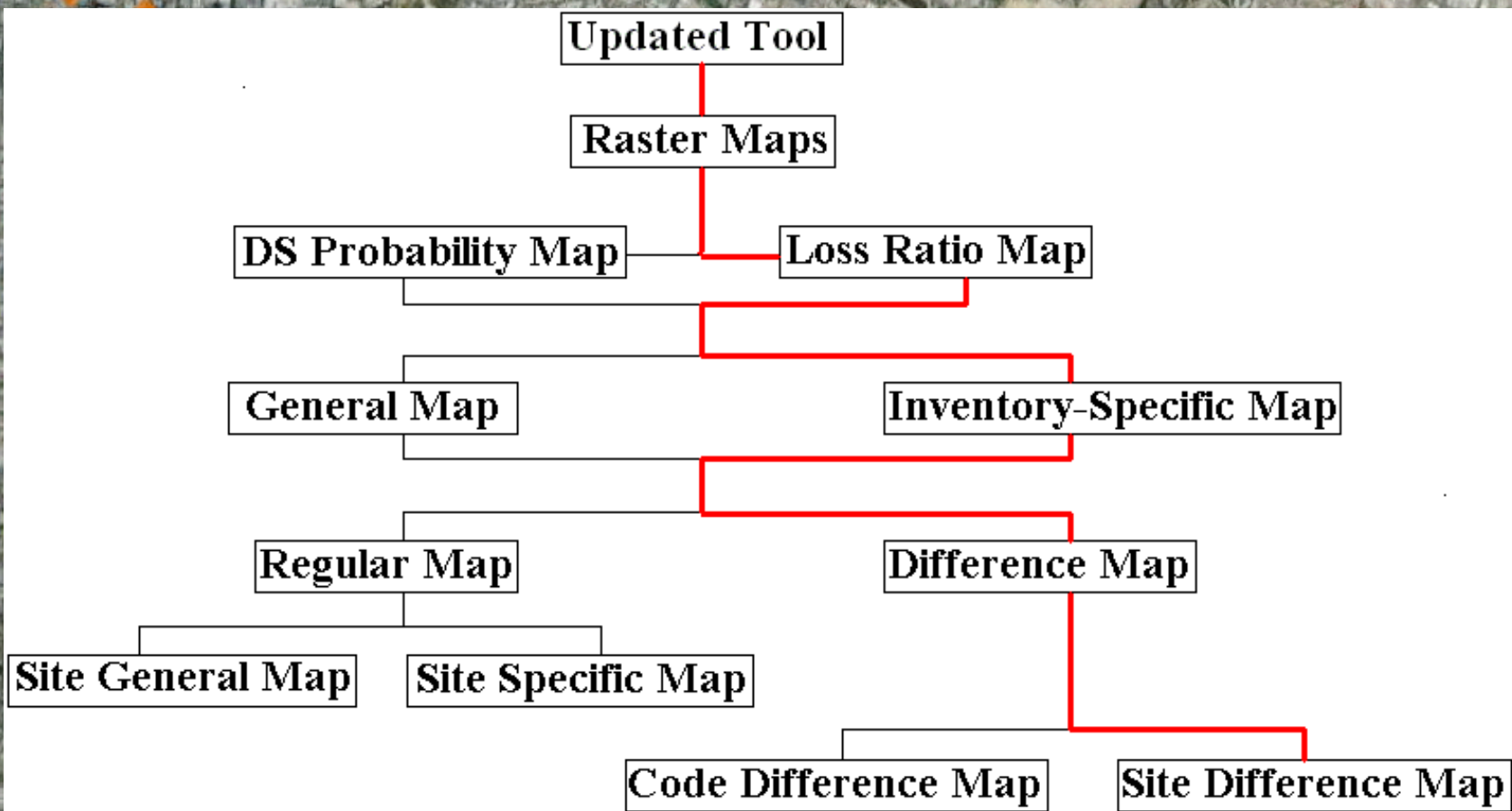
1e-6 - 5e-6

0 - 1e-6



USGS Probabilistic Seismic Risk Map (v1.0)

Inventory Location: Los Angeles Risk Map Type: Difference Degree of Damage: N/A Planning Horizon: 1 year

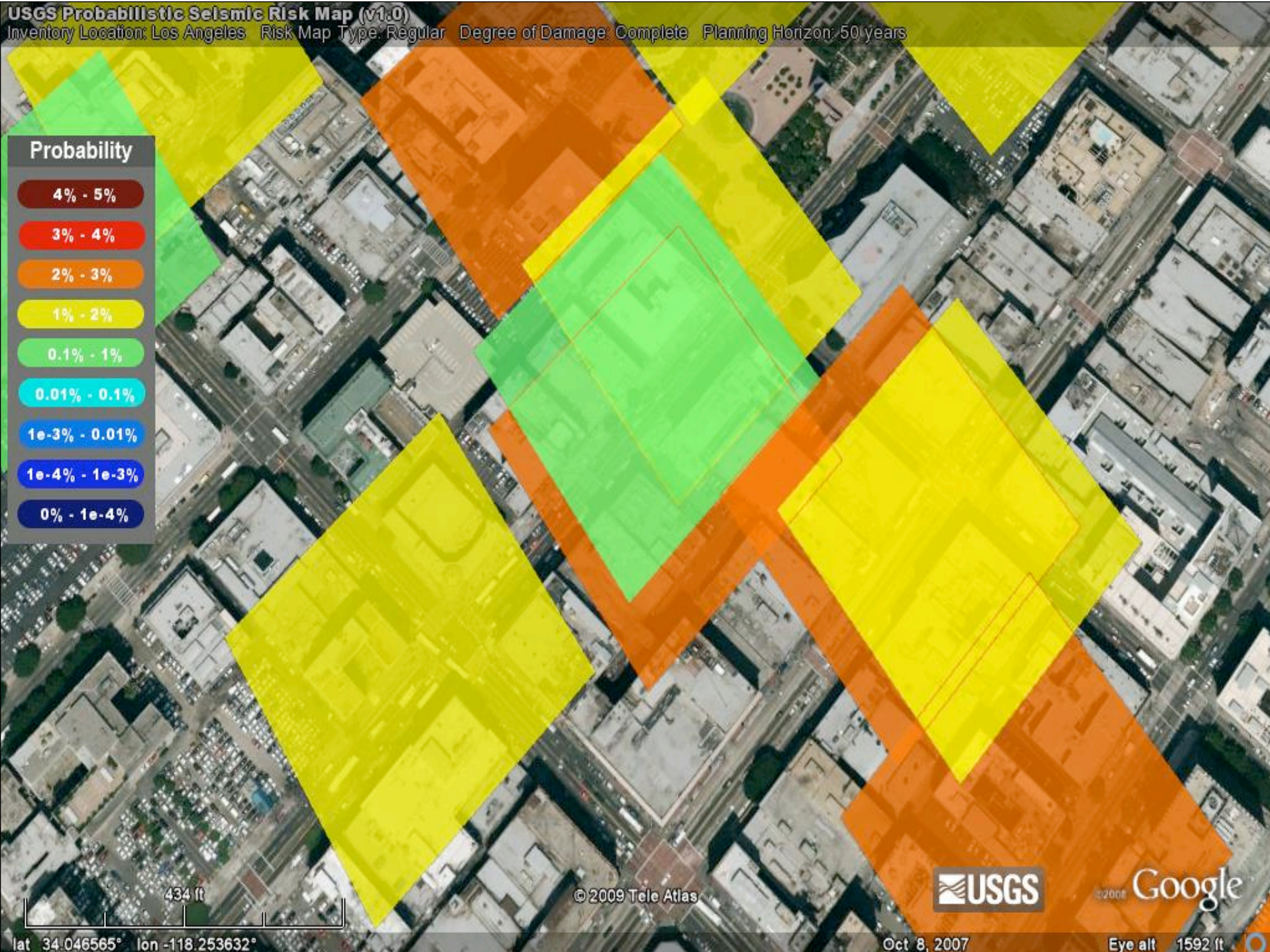


USGS Probabilistic Seismic Risk Map (v1.0)

Inventory Location: Los Angeles Risk Map Type: Regular Degree of Damage: Complete Planning Horizon: 50 years

Probability

- 4% - 5%
- 3% - 4%
- 2% - 3%
- 1% - 2%
- 0.1% - 1%
- 0.01% - 0.1%
- 1e-3% - 0.01%
- 1e-4% - 1e-3%
- 0% - 1e-4%



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lat 34.046565° lon -118.253632°

Oct 8, 2007

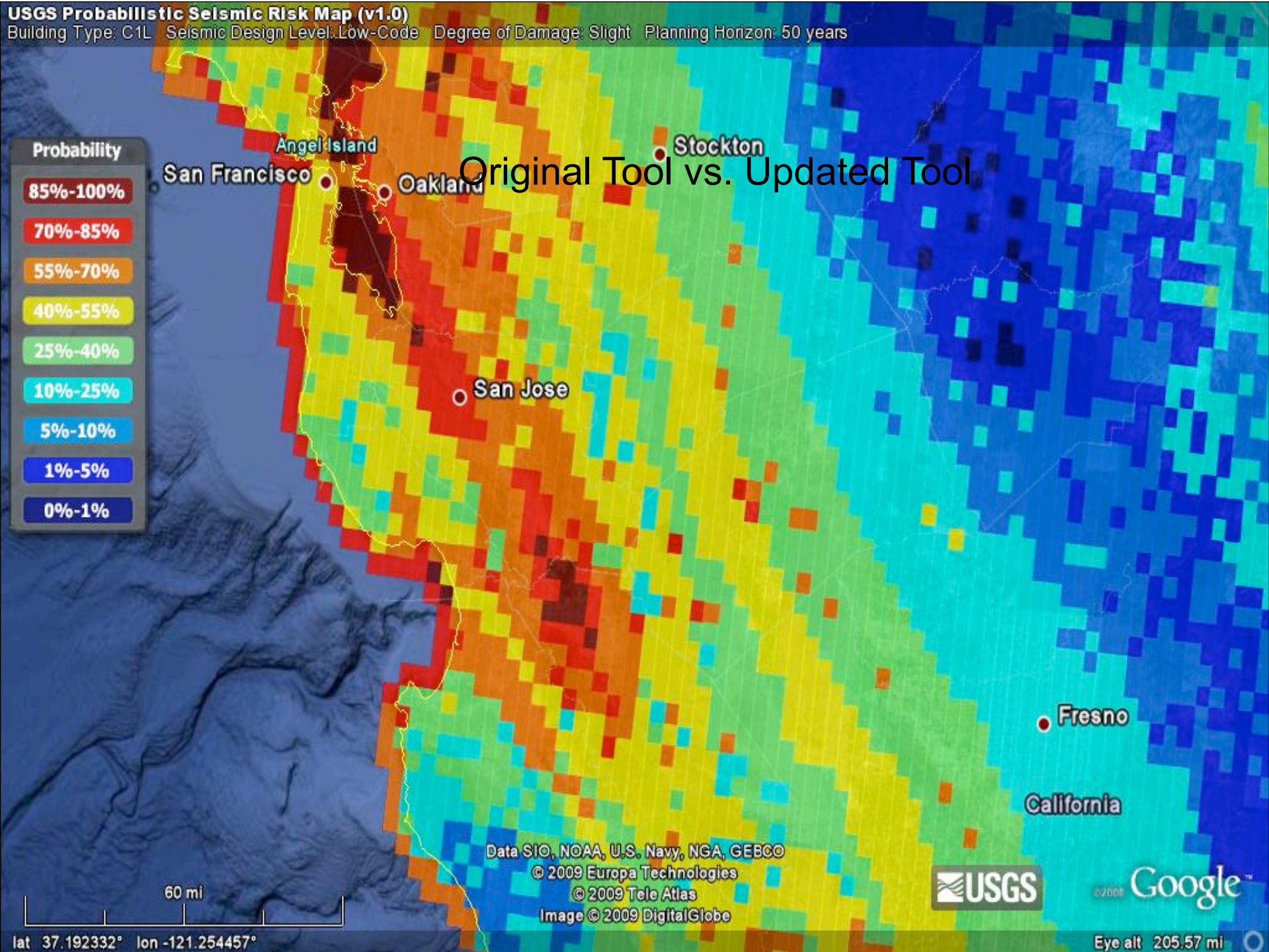
Eye alt 1592 ft

USGS Probabilistic Seismic Risk Map (v1.0)

Building Type: C1L Seismic Design Level: Low-Code Degree of Damage: Slight Planning Horizon: 50 years

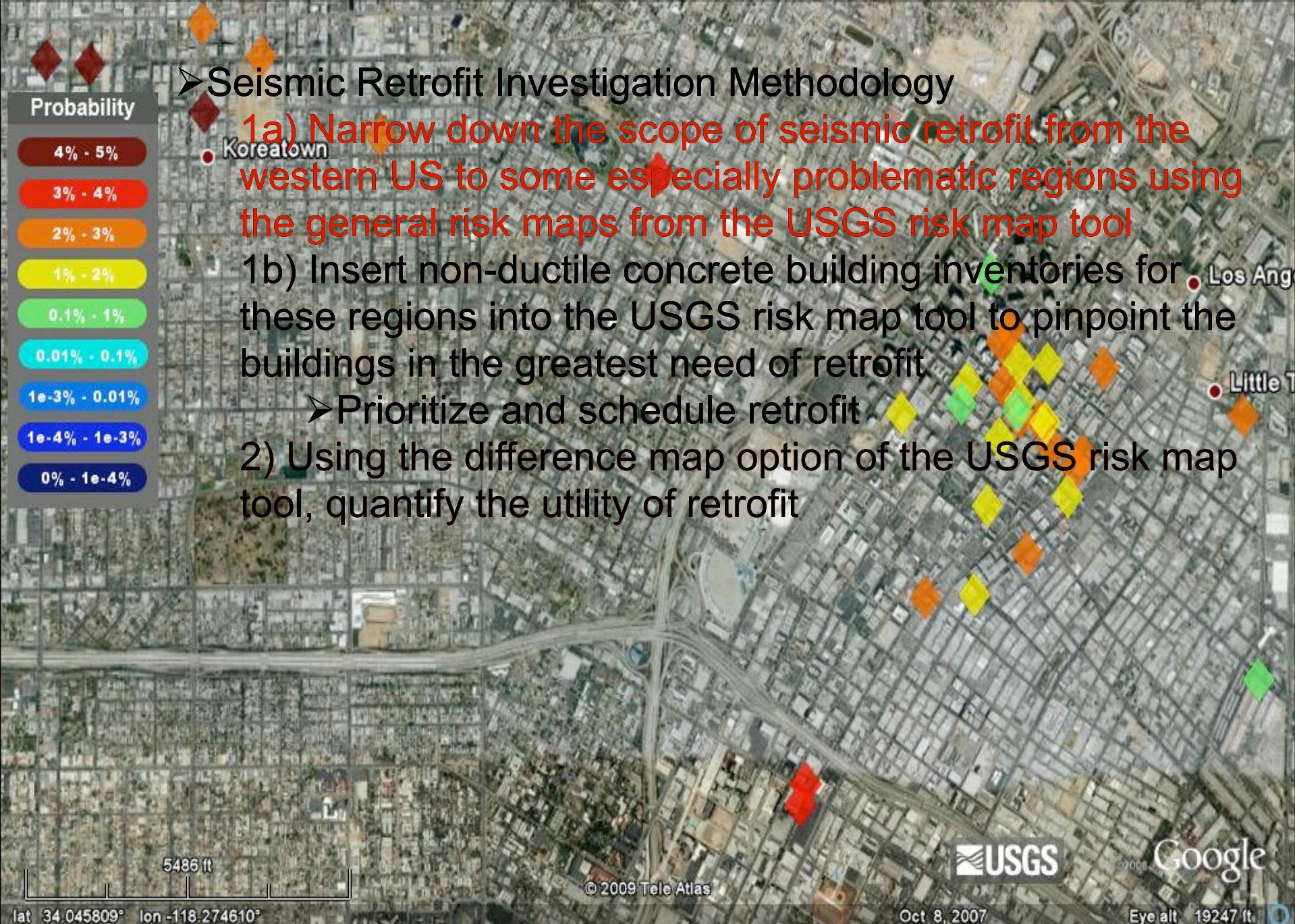


Original Tool vs. Updated Tool



lat 37.192332° lon -121.254457°

Eye alt 205.57 mi



➤ Seismic Retrofit Investigation Methodology

1a) Narrow down the scope of seismic retrofit from the western US to some especially problematic regions using the general risk maps from the USGS risk map tool

1b) Insert non-ductile concrete building inventories for these regions into the USGS risk map tool to pinpoint the buildings in the greatest need of retrofit

➤ Prioritize and schedule retrofit

2) Using the difference map option of the USGS risk map tool, quantify the utility of retrofit

- Updated web tool currently exists only as a series of MATLAB functions
 - Next step: Translate MATLAB code into Java to put on the web
- Limitations of USGS Risk Map Web Tool:
 - User-specified inventory, fragility, or vulnerability information must be in XML format
 - Not capable of a complete cost-benefit analysis
 - Expected Loss vs. Cost of Retrofit
 - Requires:
 - Building Values
 - Cost of Retrofit
 - Discount Rate

- Possible Direction of Risk Map Web Tool:
 - Confidentiality protection
 - User-specified Hazard Data
 - Accept user-friendly specification formats
 - Excel files
- Currently searching for improved fragility functions
 - This project would benefit from specific non-ductile concrete fragilities

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- Civil Engineering Concepts:
 - Hazard
 - Fragility/Vulnerability
 - Risk
 - Application of Total Probability Theorem
- Computer Science Concepts:
 - MATLAB – Efficiency and Self-Learning
- Exposure to the Research World
- Technical Writing, Poster & Presentation Creation

Questions?

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- Thank you for your attention
- Any questions or comments?

