The SELENA–*RISe* Open Risk Package

D.H. Lang, S. Molina, V. Gutiérrez, C.D. Lindholm, and F. Lingvall

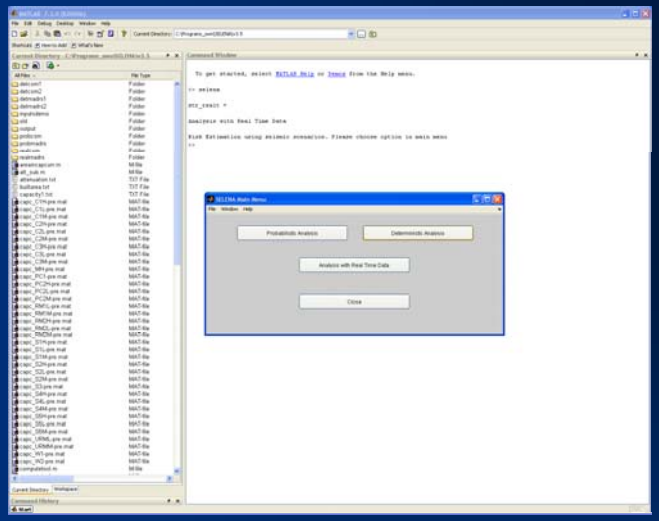
NORSAR/International Center of Geohazards (ICG)
Kjeller, Norway

International Conference on Open Risk Analysis
Cambridge, UK 12-13 June 2009

Terminology SELENA – *RISe*

SELENA:

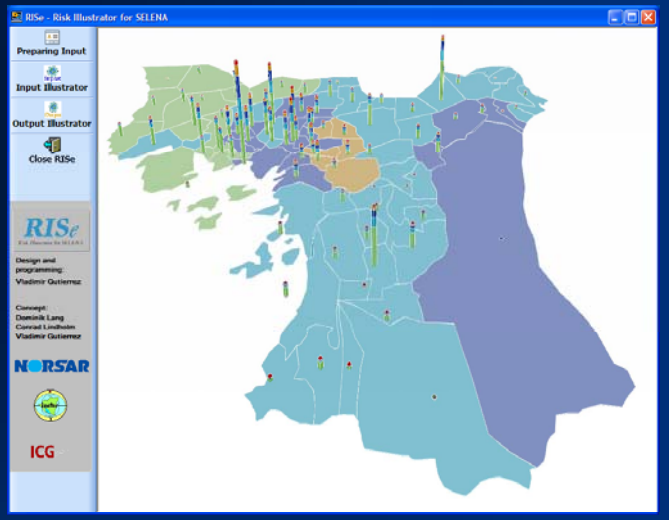
"Seismic Loss Estimation using a Logic Tree Approach"



Damage and loss computation software

RISe:

*"**R**isk **I**llustrator for **SE**LENA"*



Google Earth interface

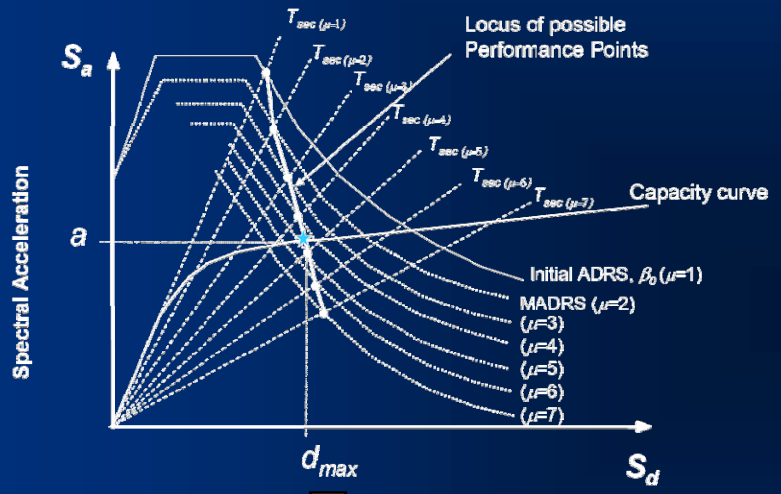
(KML file converter)

SELENA – Basic features (1)

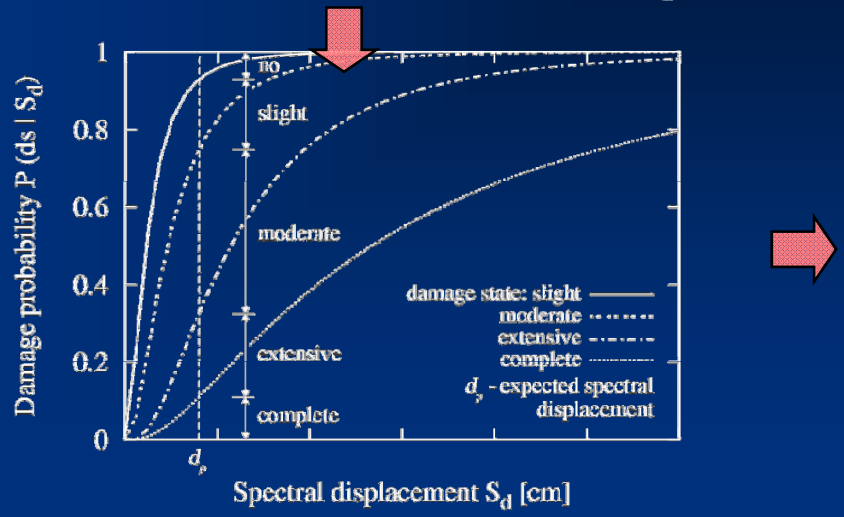
⇨ analytical (*engineering*) approach using capacity spectrum method (CSM)

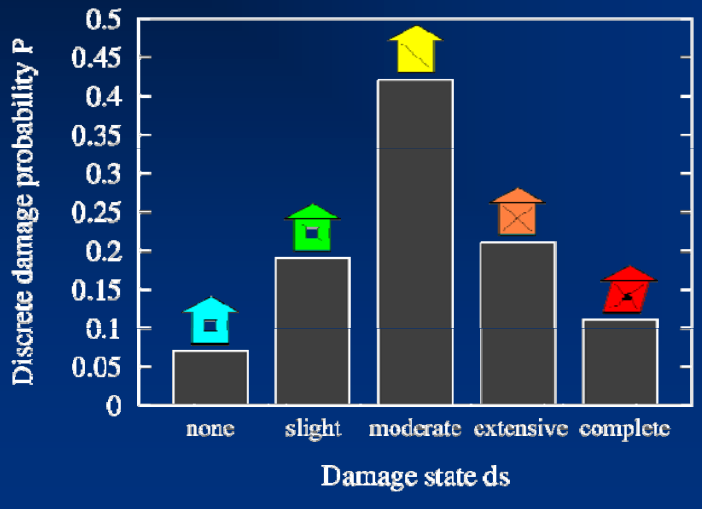
· iterative procedure A of ATC-40 (1996)

· procedure C of MADRS (FEMA-440, 2005)



⇨ classification of physical damage following *'HAZUS damage states'* (FEMA, 2003)





SELENA – Basic features (2)

⇨ ground motion values (PGA, S_a) can be provided on three different ways:

(1) deterministic scenario
(2) grided data (e.g. given by probabilistic shake maps)
(3) randomly distributed data (e.g. coming from recording stations)

⇨ seismic demand in the S_a–S_d domain is represented by a code design spectrum

→ currently incorporated: IBC-2006
Eurocode 8 – Type 1 & 2 (CEN, 2002)
Indian code IS 1893 (Part 1): 2002 (BIS, 2002)

→ respective soil classification schemes considered:

Soil type	Shear wave velocity $v_{s,30}$	IBC-2006 (NEHRP)	Eurocode 8	IS 1893 (Part 1): 2002
hard rock	> 1500 m/s	A	A	I
rock	760 – 1500 m/s	B		
stiff soil	360 – 760 m/s	C	B	
soft soil	180 – 360 m/s	D	C	II
very soft soil	< 180 m/s	E	D	III

SELENA – Basic features (2)

⇨ ground motion values (PGA, S_a) can be provided on three different ways:

(1) deterministic scenario
(2) grided data (e.g. given by probabilistic shake maps)
(3) randomly distributed data (e.g. coming from recording stations)

program sequence of a deterministic analysis:

SELENA – Basic features (3)

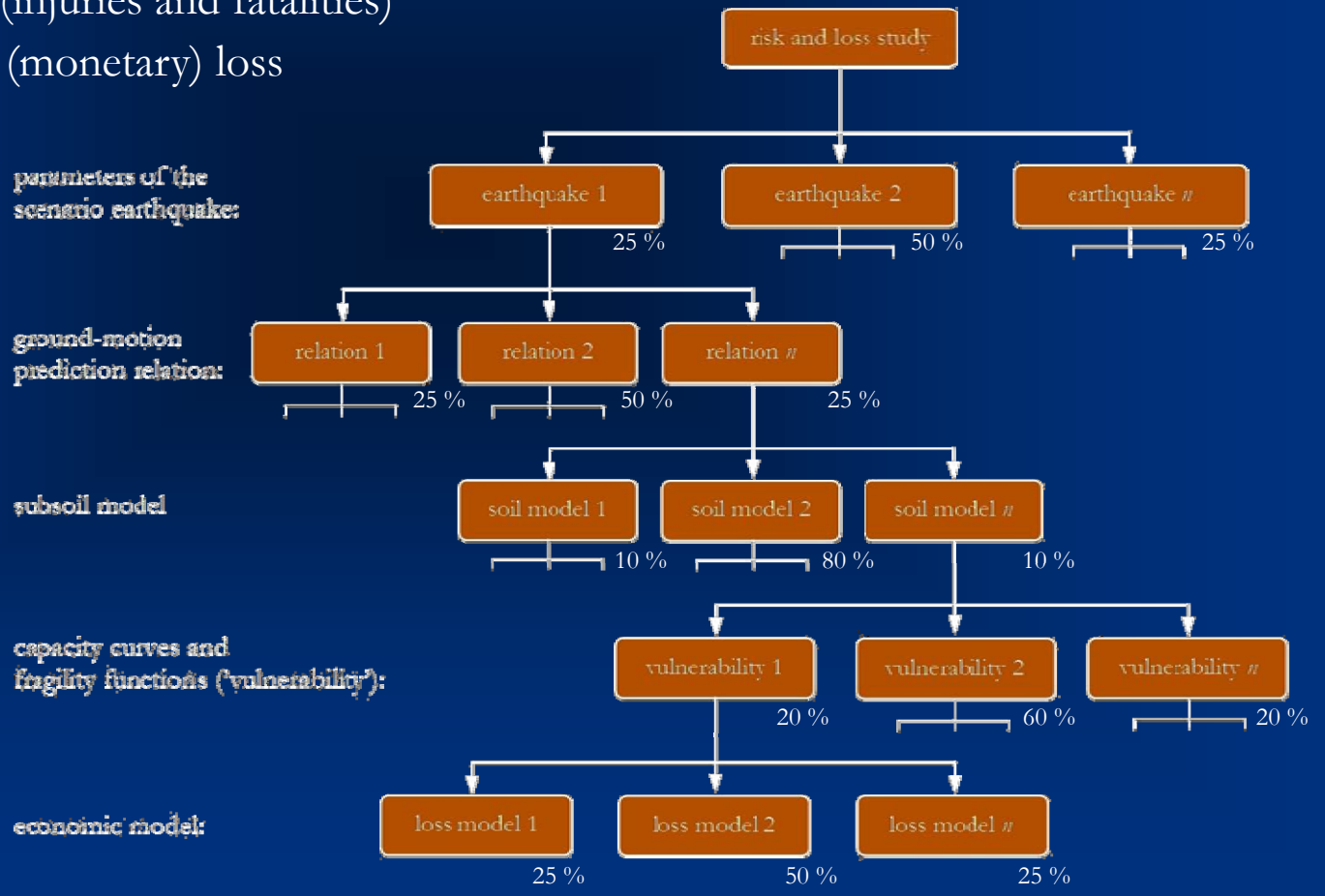
⇨ weighted logic tree computation scheme → weighted results will provide expected mean values and confidence levels (percentiles)

→ ground motion with and w/o soil amplification factors

→ damage probabilities and damage extent (no. of buildings or building floor area)

→ casualties (injuries and fatalities)

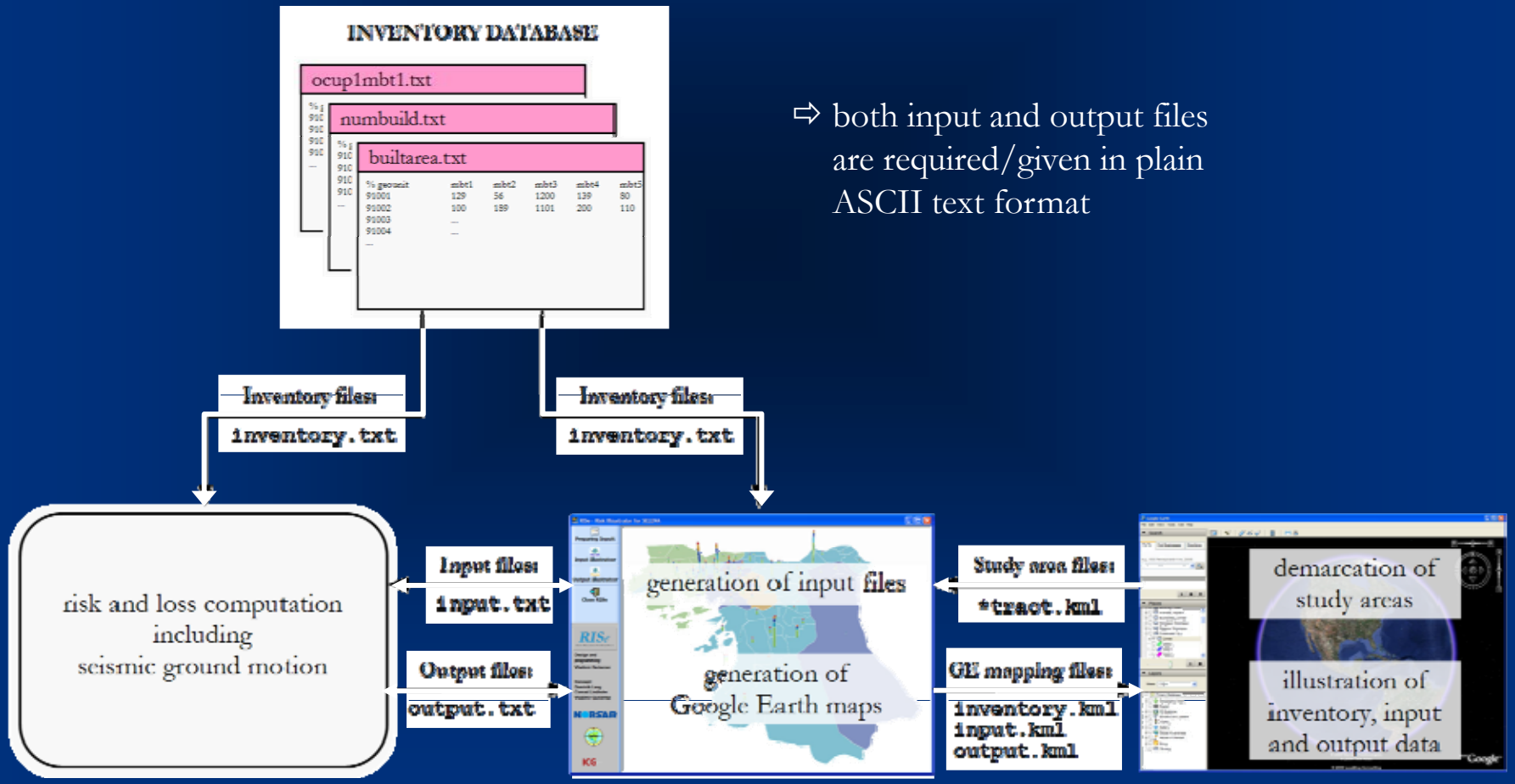
→ economic (monetary) loss



Connection SELENA – *RISe*

⇨ currently *RISe* is solely customized to the SELENA file structure

⇨ *RISe* serves as an intermediary between SELENA and Google Earth



⇨ both input and output files are required/given in plain ASCII text format

RISe – Illustrating input and inventory

⇨ all geo-referenced input files can be converted into GE maps

⇨ different illustration types are incorporated (color-shaded, bar chart plots, etc.)

Input file (.txt)	Mapping file (.kml)	Description
earthquake.txt	earthquake.kml	1 placemark for each defined earthquake epicenter (only deterministic analysis)
INVENTORY INFORMATION:		
numbuild.txt	numbuild.kml	1 color-shaded map for each model building type
builtarea.txt	builtarea.kml	1 color-shaded map for each model building type
population.txt	population.kml	1 absolute bar chart map
ocupmbt*l*.txt	ocupmbt*l*.kml	1 color-shaded map for each occupancy type and model building type *l*
occupancy.txt	occupancy.txt	1 normalized bar chart map illustrating the distribution of building floor area to the main occupancy types RES, COM, IND, REL, GOV and EDU irrespective of model building type
SOIL INFORMATION:		
soilcenter*k*.txt	soilcenter*k*.kml	1 color-shaded map for each soil model *k*
GROUND MOTION INFORMATION:		
shakecenter*i*.txt	shakecenter*i*.kml	3 color-shaded maps for each shakemap *i* separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*)

RISe – Illustrating input and inventory

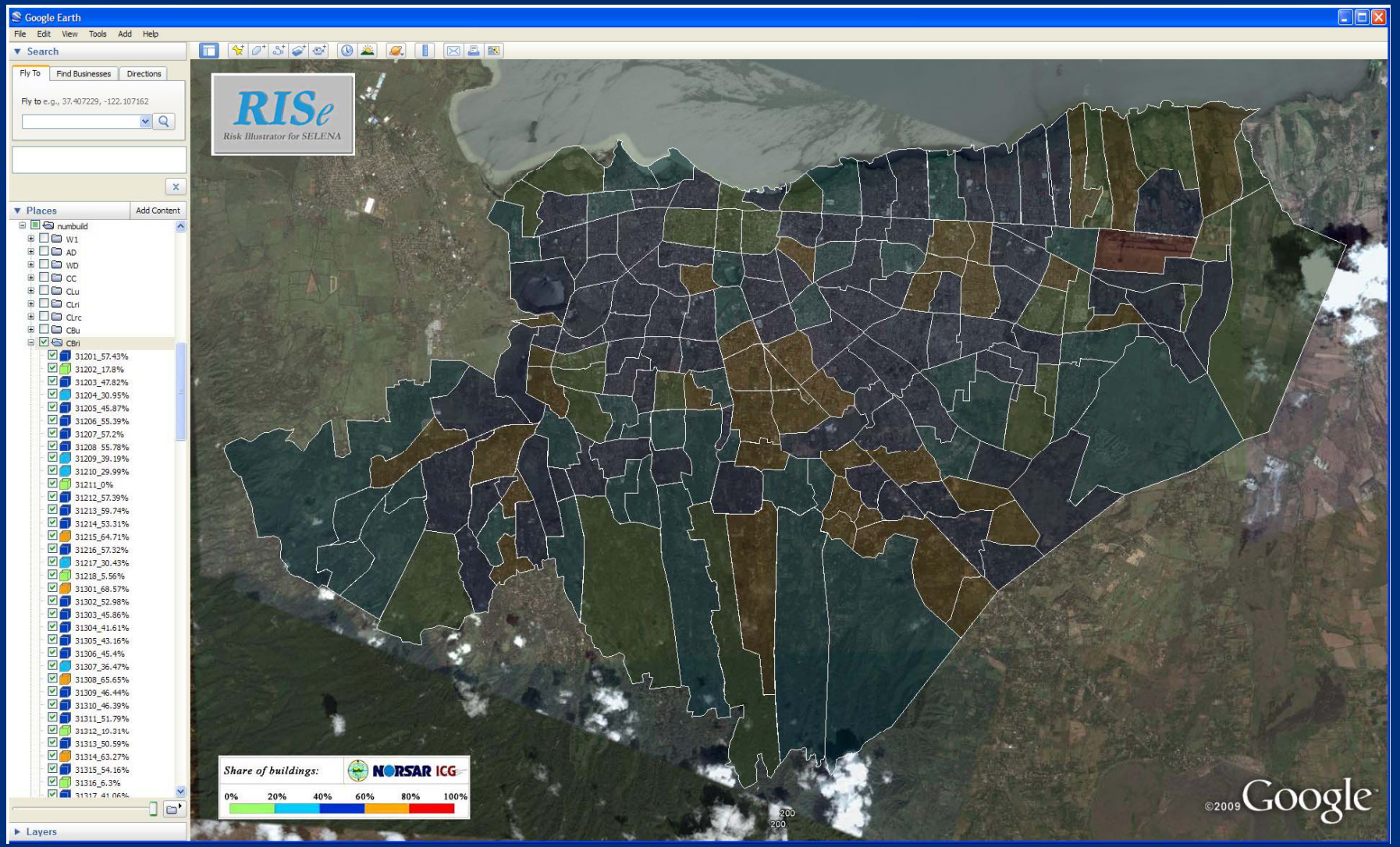
⇨ all geo-referenced input files can be converted into GE maps

⇨ different illustration types are incorporated (color-shaded, bar chart plots, etc.)

Input file (.txt)	Mapping file (.kml)	Description
earthquake.txt	earthquake.kml	1 placemark for each defined earthquake epicenter (only deterministic analysis)
INVENTORY INFORMATION:		
numbuild.txt	**numbuild.kml**	1 color-shaded map for each model building type
builtarea.txt	builtarea.kml	1 color-shaded map for each model building type
population.txt	population.kml	1 absolute bar chart map
ocupmbt*l*.txt	ocupmbt*l*.kml	1 color-shaded map for each occupancy type and model building type *l*
occupancy.txt	occupancy.txt	1 normalized bar chart map illustrating the distribution of building floor area to the main occupancy types RES, COM, IND, REL, GOV and EDU irrespective of model building type
SOIL INFORMATION:		
soilcenter*k*.txt	soilcenter*k*.kml	1 color-shaded map for each soil model *k*
GROUND MOTION INFORMATION:		
shakecenter*i*.txt	shakecenter*i*.kml	3 color-shaded maps for each shakemap *i* separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*)

RISe – Illustrating input and inventory

⇨ number of buildings disaggregated by MBT (→ numbuild.kml)



RISe – Illustrating input and inventory

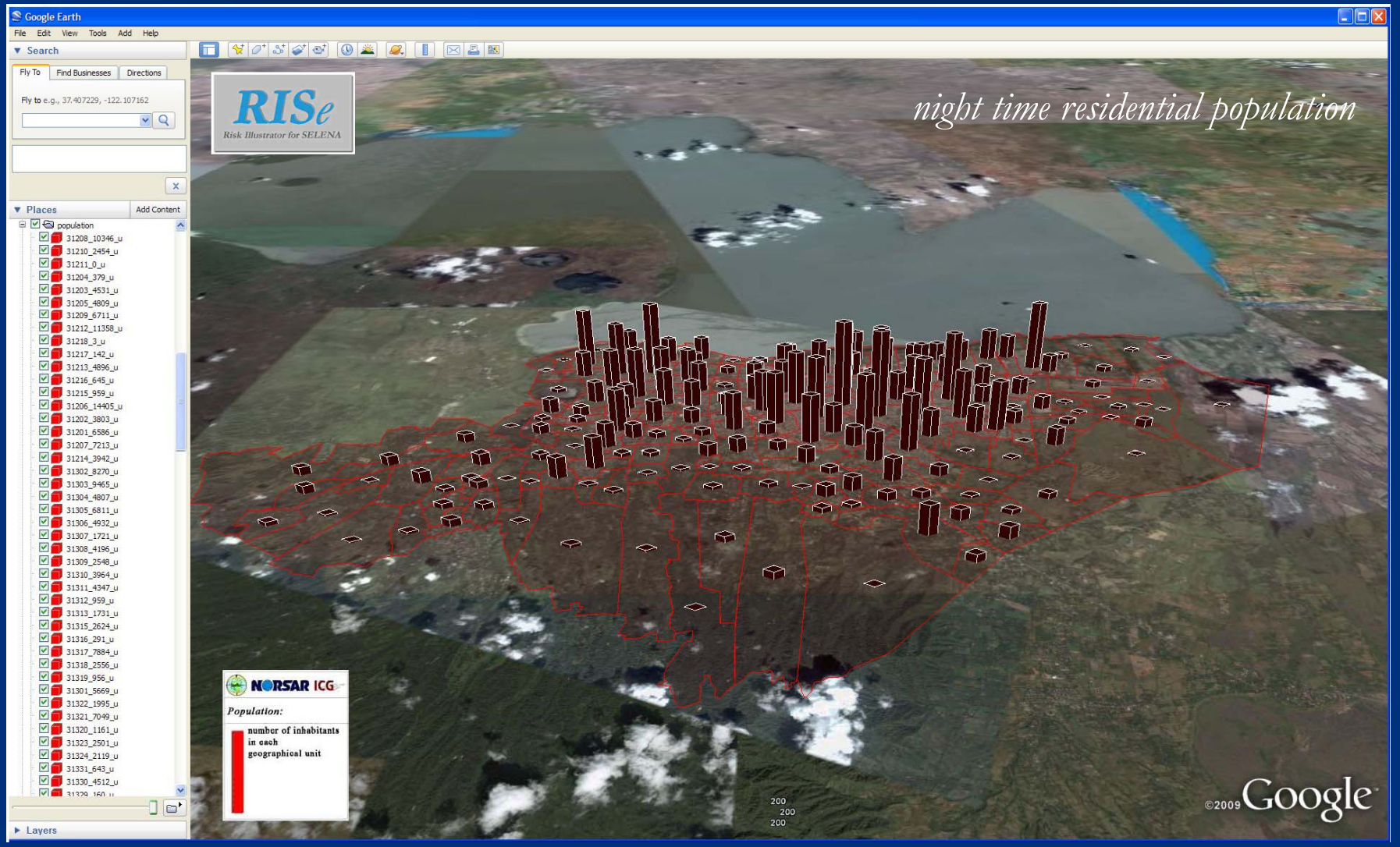
⇨ all geo-referenced input files can be converted into GE maps

⇨ different illustration types are incorporated (color-shaded, bar chart plots, etc.)

Input file (.txt)	Mapping file (.kml)	Description
earthquake.txt	earthquake.kml	1 placemark for each defined earthquake epicenter (only deterministic analysis)
INVENTORY INFORMATION:		
numbuild.txt	numbuild.kml	1 color-shaded map for each model building type
builtarea.txt	builtarea.kml	1 color-shaded map for each model building type
population.txt	**population.kml**	1 absolute bar chart map
ocupmbt*l*.txt	ocupmbt*l*.kml	1 color-shaded map for each occupancy type and model building type *l*
occupancy.txt	occupancy.txt	1 normalized bar chart map illustrating the distribution of building floor area to the main occupancy types RES, COM, IND, REL, GOV and EDU irrespective of model building type
SOIL INFORMATION:		
soilcenter*k*.txt	soilcenter*k*.kml	1 color-shaded map for each soil model *k*
GROUND MOTION INFORMATION:		
shakecenter*i*.txt	shakecenter*i*.kml	3 color-shaded maps for each shakemap *i* separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*)

RISe – Illustrating input and inventory

⇨ number of population in each geounit (→ population.kml)



RISe – Illustrating input and inventory

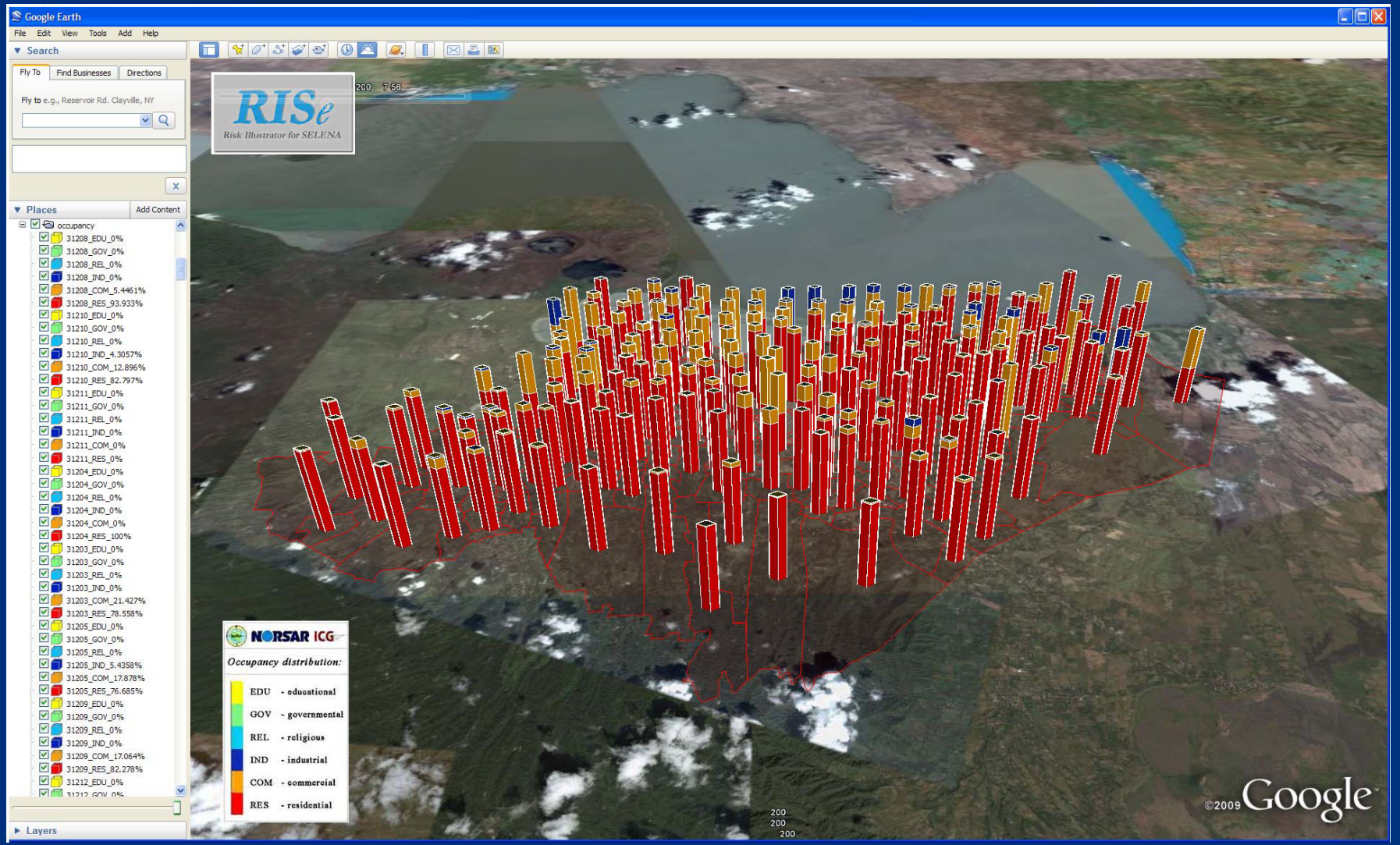
⇨ all geo-referenced input files can be converted into GE maps

⇨ different illustration types are incorporated (color-shaded, bar chart plots, etc.)

Input file (.txt)	Mapping file (.kml)	Description
earthquake.txt	earthquake.kml	1 placemark for each defined earthquake epicenter (only deterministic analysis)
INVENTORY INFORMATION:		
numbuild.txt	numbuild.kml	1 color-shaded map for each model building type
builtarea.txt	builtarea.kml	1 color-shaded map for each model building type
population.txt	population.kml	1 absolute bar chart map
ocupmbt*l*.txt	ocupmbt*l*.kml	1 color-shaded map for each occupancy type and model building type *l*
occupancy.txt	**occupancy.txt**	1 normalized bar chart map illustrating the distribution of building floor area to the main occupancy types RES, COM, IND, REL, GOV and EDU irrespective of model building type
SOIL INFORMATION:		
soilcenter*k*.txt	soilcenter*k*.kml	1 color-shaded map for each soil model *k*
GROUND MOTION INFORMATION:		
shakecenter*i*.txt	shakecenter*i*.kml	3 color-shaded maps for each shakemap *i* separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*)

RISe – Illustrating input and inventory

⇨ percental distribution of occupancy types in the geounits (→ occupancy.kml)



RISe – Illustrating output

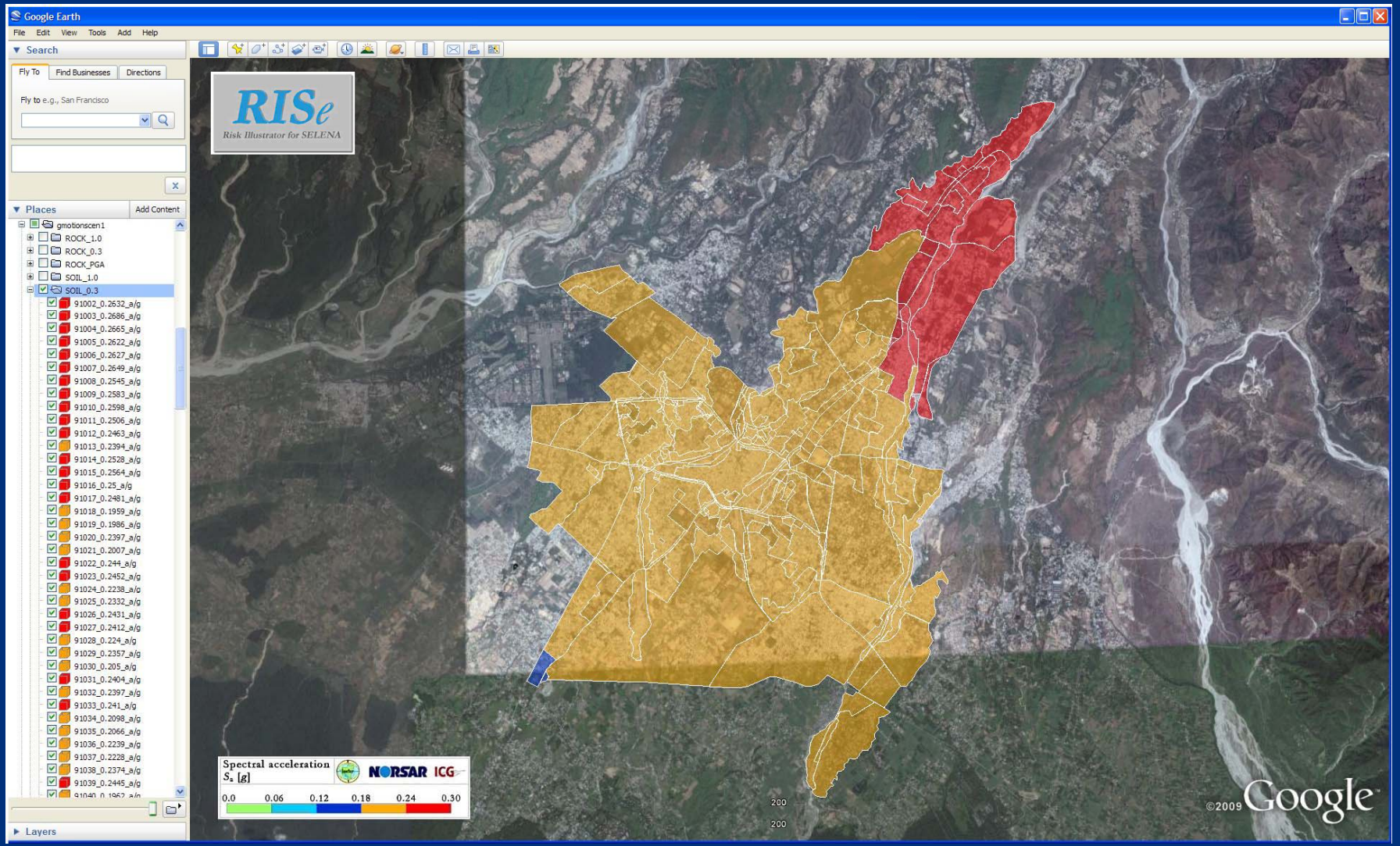
Output file	Mapping file	Description
GROUND MOTION INFORMATION:		
gmotionsceni.txt	gmotionsceni.kml	6 color-shaded maps (separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*) on rock and soil conditions) for each logic tree branch *i*
DAMAGE INFORMATION:		
douti.txt	douti.kml	normalized bar chart maps separate for each model building type for each logic tree branch *i*
medianct.txt	medianct.kml	absolute bar chart maps separate for each model building type
16prctile.txt	16prctile.kml	absolute bar chart maps separate for each model building type
84prctile.txt	84prctile.kml	absolute bar chart maps separate for each model building type
LOSS INFORMATION:		
lossmedian.txt	loss.kml	absolute bar chart map (median ± 1σ)
loss16prctile.txt		
loss84prctile.txt		
hlbyinjurmean.txt	hlbyinjurs.kml	absolute bar chart maps (median ± 1σ) for each injury severity level (1–4) and each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		
hlbyinjurmean.txt	totalinjurs.kml	absolute bar chart maps (median ± 1σ) for cumulated casualty numbers separated for each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		

RISe – Illustrating output

Output file	Mapping file	Description
GROUND MOTION INFORMATION:		
gmotionsceni.txt	**gmotionscen*i*.kml**	6 color-shaded maps (separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*) on rock and soil conditions) for each logic tree branch *i*
DAMAGE INFORMATION:		
dout*i*.txt	dout*i*.kml	normalized bar chart maps separate for each model building type for each logic tree branch *i*
medianct.txt	medianct.kml	absolute bar chart maps separate for each model building type
16prctile.txt	16prctile.kml	absolute bar chart maps separate for each model building type
84prctile.txt	84prctile.kml	absolute bar chart maps separate for each model building type
LOSS INFORMATION:		
lossmedian.txt	loss.kml	absolute bar chart map (median ± 1σ)
loss16prctile.txt		
loss84prctile.txt		
hlbyinjurmean.txt	hlbyinjurs.kml	absolute bar chart maps (median ± 1σ) for each injury severity level (1–4) and each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		
hlbyinjurmean.txt	totalinjurs.kml	absolute bar chart maps (median ± 1σ) for cumulated casualty numbers separated for each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		

RISe – Illustrating output

⇨ spectral ground motion maps (deterministic scenario) (→ gmotionscen*i*.kml)

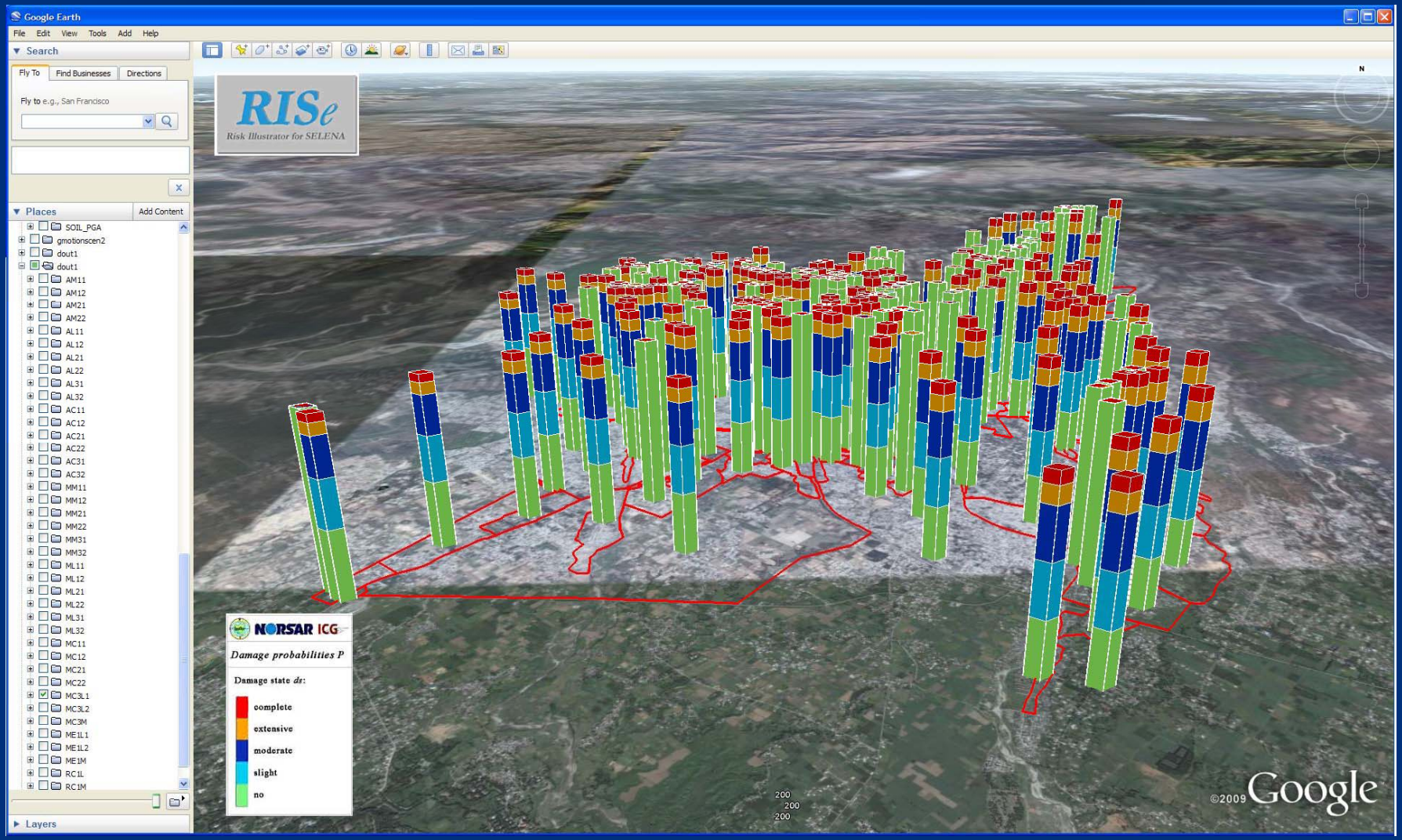


RISe – Illustrating output

Output file	Mapping file	Description
GROUND MOTION INFORMATION:		
gmotionsceni.txt	gmotionscen*i*.kml	6 color-shaded maps (separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*) on rock and soil conditions) for each logic tree branch *i*
DAMAGE INFORMATION:		
dout*i*.txt	**dout*i*.kml**	normalized bar chart maps separate for each model building type for each logic tree branch *i*
medianct.txt	medianct.kml	absolute bar chart maps separate for each model building type
16prctile.txt	16prctile.kml	absolute bar chart maps separate for each model building type
84prctile.txt	84prctile.kml	absolute bar chart maps separate for each model building type
LOSS INFORMATION:		
lossmedian.txt	loss.kml	absolute bar chart map (median ± 1σ)
loss16prctile.txt		
loss84prctile.txt		
hlbyinjurmean.txt	hlbyinjurs.kml	absolute bar chart maps (median ± 1σ) for each injury severity level (1–4) and each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		
hlbyinjurmean.txt	totalinjurs.kml	absolute bar chart maps (median ± 1σ) for cumulated casualty numbers separated for each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		

RISe – Illustrating output

⇨ damage probabilities separate for each building typology (→ dout*i*.kml)

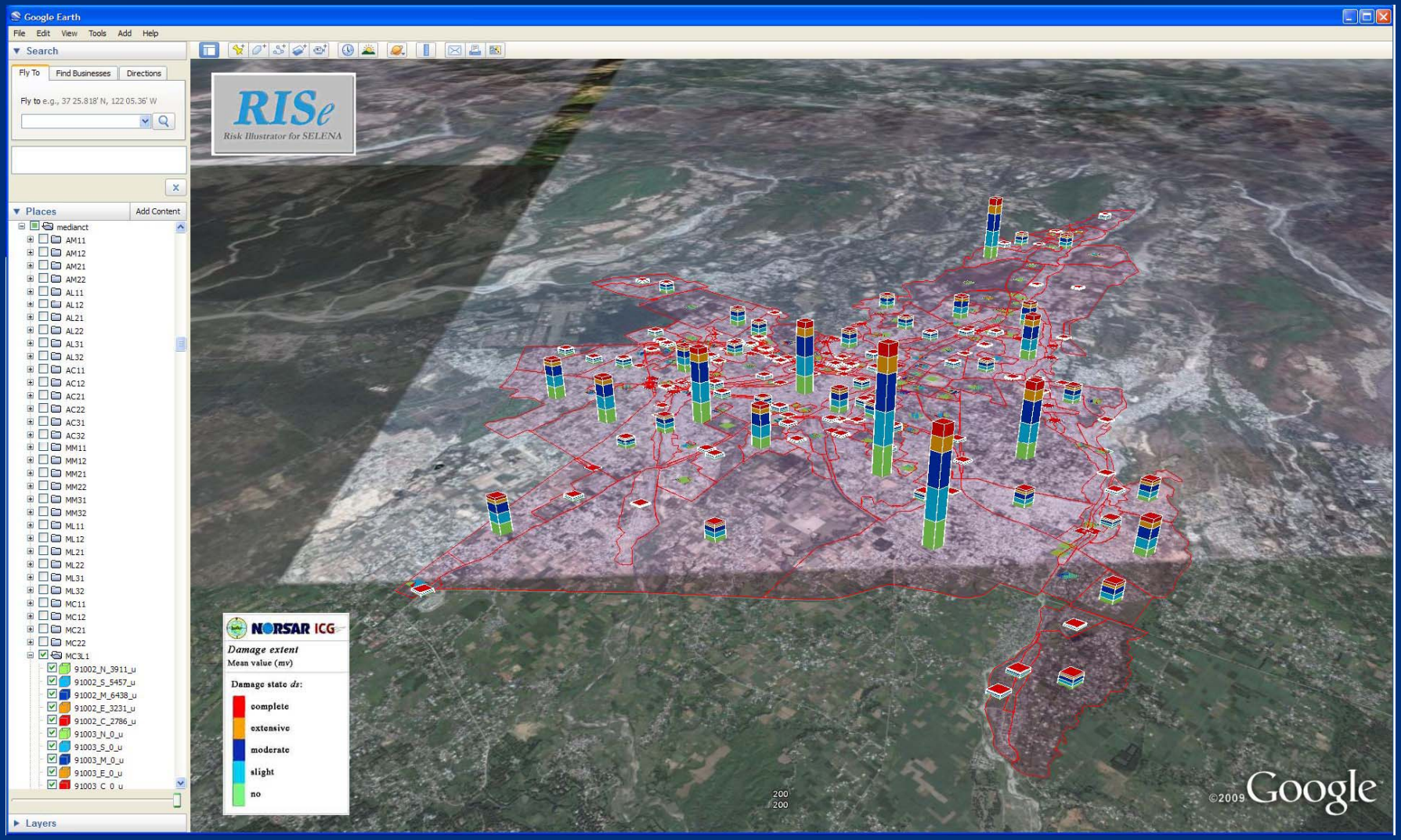


RISe – Illustrating output

Output file	Mapping file	Description
GROUND MOTION INFORMATION:		
gmotionsceni.txt	gmotionscen*i*.kml	6 color-shaded maps (separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*) on rock and soil conditions) for each logic tree branch *i*
DAMAGE INFORMATION:		
dout*i*.txt	dout*i*.kml	normalized bar chart maps separate for each model building type for each logic tree branch *i*
medianct.txt	**medianct.kml**	absolute bar chart maps separate for each model building type
16prctile.txt	16prctile.kml	absolute bar chart maps separate for each model building type
84prctile.txt	84prctile.kml	absolute bar chart maps separate for each model building type
LOSS INFORMATION:		
lossmedian.txt	loss.kml	absolute bar chart map (median ± 1σ)
loss16prctile.txt		
loss84prctile.txt		
hlbyinjurmean.txt	hlbyinjurs.kml	absolute bar chart maps (median ± 1σ) for each injury severity level (1–4) and each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		
hlbyinjurmean.txt	totalinjurs.kml	absolute bar chart maps (median ± 1σ) for cumulated casualty numbers separated for each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		

RISe – Illustrating output

⇨ absolute damage extent separate for each building typology (→ medianct.kml)

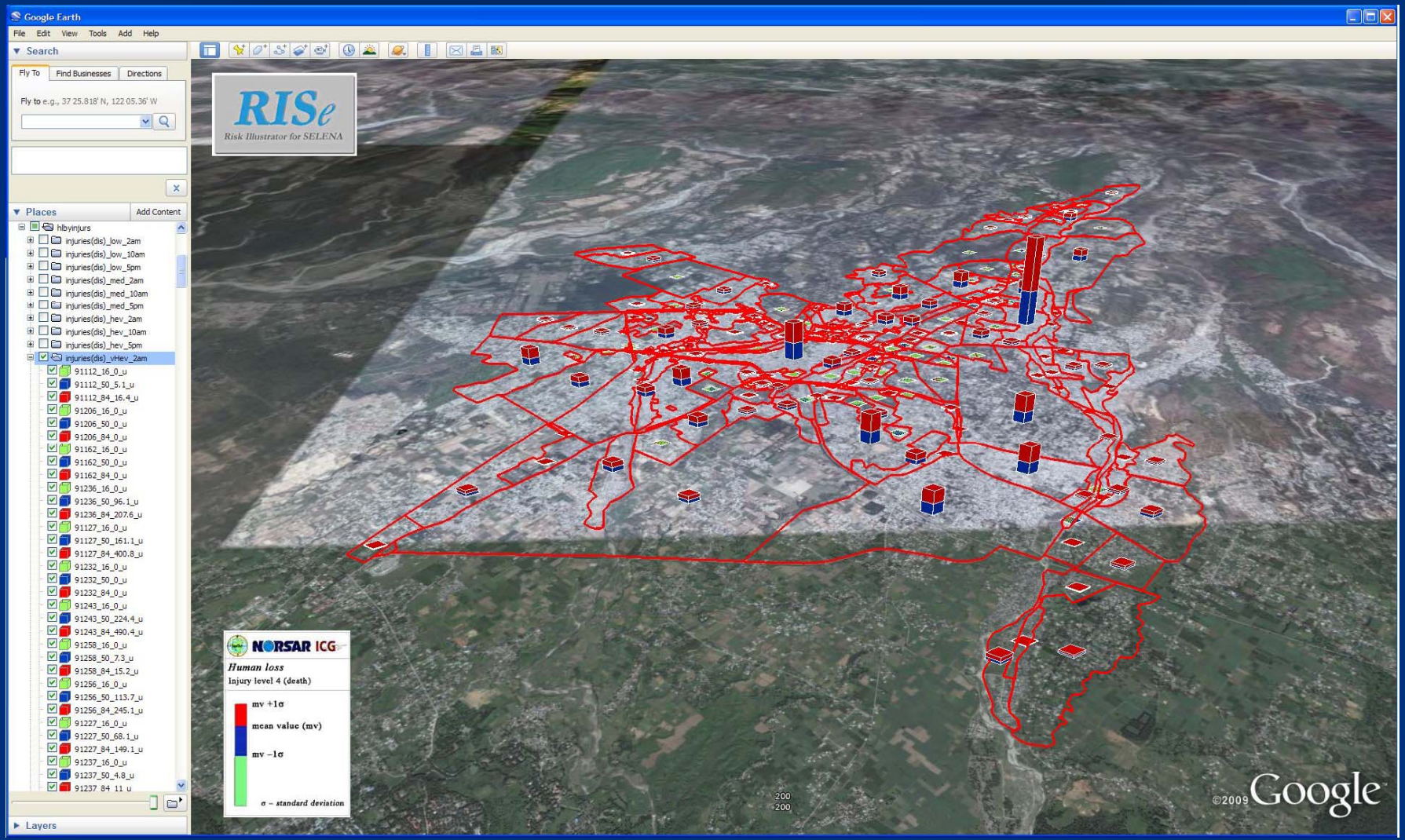


RISe – Illustrating output

Output file	Mapping file	Description
GROUND MOTION INFORMATION:		
gmotionsceni.txt	gmotionscen*i*.kml	6 color-shaded maps (separate for PGA, S_a (0.3 *s*) & S_a (1.0 *s*) on rock and soil conditions) for each logic tree branch *i*
DAMAGE INFORMATION:		
dout*i*.txt	dout*i*.kml	normalized bar chart maps separate for each model building type for each logic tree branch *i*
medianct.txt	medianct.kml	absolute bar chart maps separate for each model building type
16prctile.txt	16prctile.kml	absolute bar chart maps separate for each model building type
84prctile.txt	84prctile.kml	absolute bar chart maps separate for each model building type
LOSS INFORMATION:		
lossmedian.txt	loss.kml	absolute bar chart map (median ± 1σ)
loss16prctile.txt		
loss84prctile.txt		
hlbyinjurmean.txt	**hlbyinjurs.kml**	absolute bar chart maps (median ± 1σ) for each injury severity level (1–4) and each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		
hlbyinjurmean.txt	totalinjurs.kml	absolute bar chart maps (median ± 1σ) for cumulated casualty numbers separated for each daytime scenario (2 am, 10 am, 5 pm)
hlbyinjur16.txt		
hlbyinjur84.txt		

RISe – Illustrating output

⇨ casualties (mv±σ) for 4 severity levels and 3 daytime scenarios (→ hlbyinjurs.kml)



"Openess" of SELENA

⇨ Free: distributed free of charge through the NORSAR/ICG website

⇨ Open source: open source code, different formats now available

(1) MATLAB code

(2) "C" code which can be compiled into

a) stand-alone binary independent of MATLAB & toolboxes

b) binary (mex/oct) functions which can be used from within the MATLAB/Octave environment

Advantages:

- approximately 50 times faster than MATLAB code
- code can be run in the free (open source) MATLAB clone GNU Octave

⇨ Open documentation: open user manual in MS Word .doc and LATEX,

all figure files in gnuplot .gpl format

"Openess" of *RISe*

⇨ Freeware: distributed free of charge through the NORSAR/ICG website

⇨ Open source: open source code, coded in C#

Advantages:

- coding can be done in the *Integrated Development Environment* (IDE) provided free of charge by Microsoft (MS Visual Studio C# Express Edition 2008)
- running the RISe software only requires an installation of
  a) the free Microsoft .NET framework (at least version 2.0)
  b) Google Earth's free version

⇨

⇨ Open documentation: open user manual currently only in MS Word .doc