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Current Landscape of Spatial Decision Support Systems (SDSS) and Software Applications for Earthquake Disaster Management in Turkey

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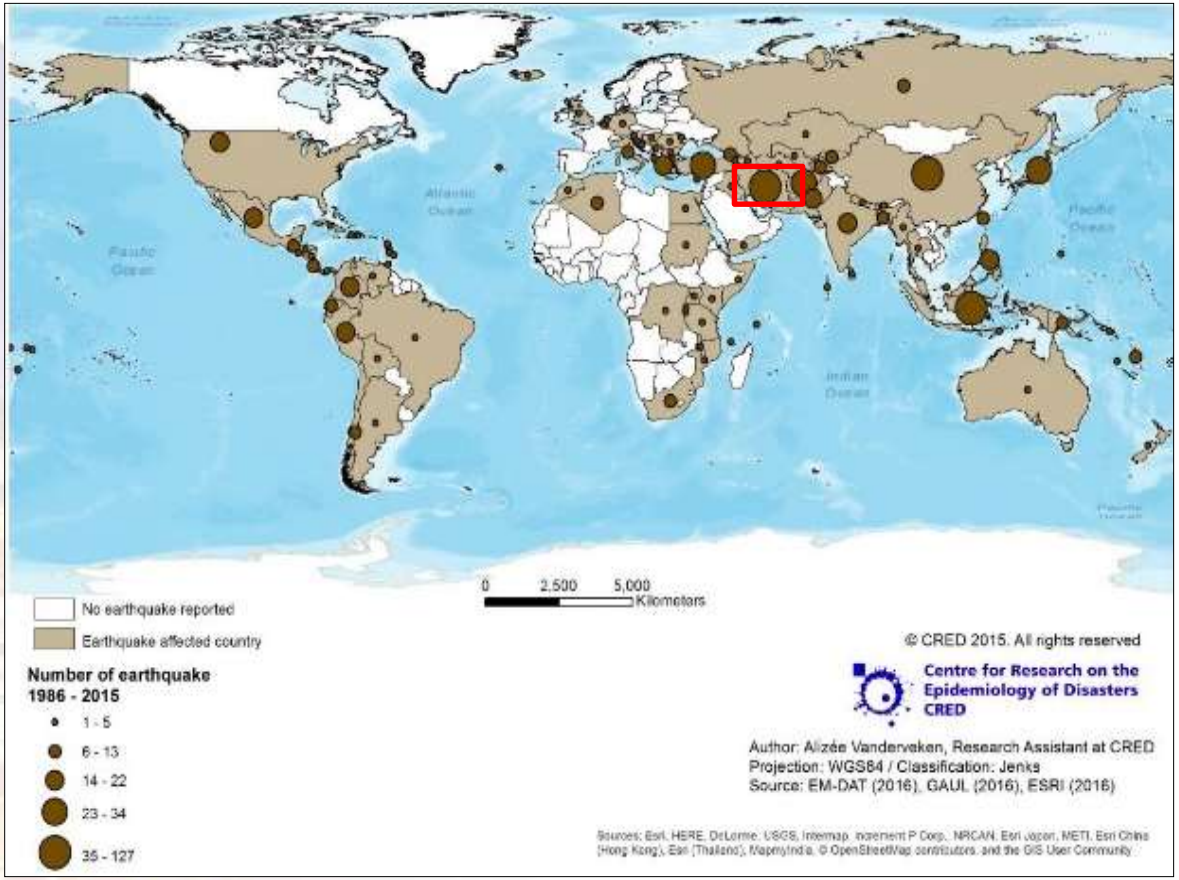
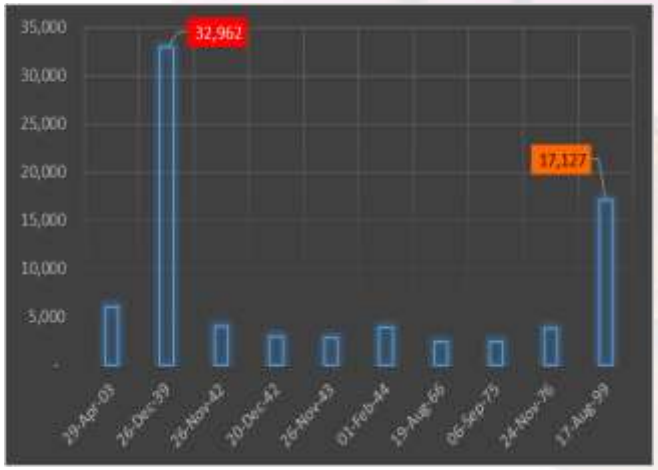
Presentation Outline

- Introduction
- Overview and Principle of SDSS
- SDSS for Earthquake DEM
- Categories of SDSSs
- SDSS usage and experience in Turkey

Introduction: Earthquake Disasters in Turkey





- Most recent, Mw > 7:
- *1999 Kocaeli/Duzce*
- *2011/2 Van, 604 lives*

Introduction: What is the Role of GIS?

- GIS, powerful analysis tool:

- *each phase is geographically and spatially inter-related*

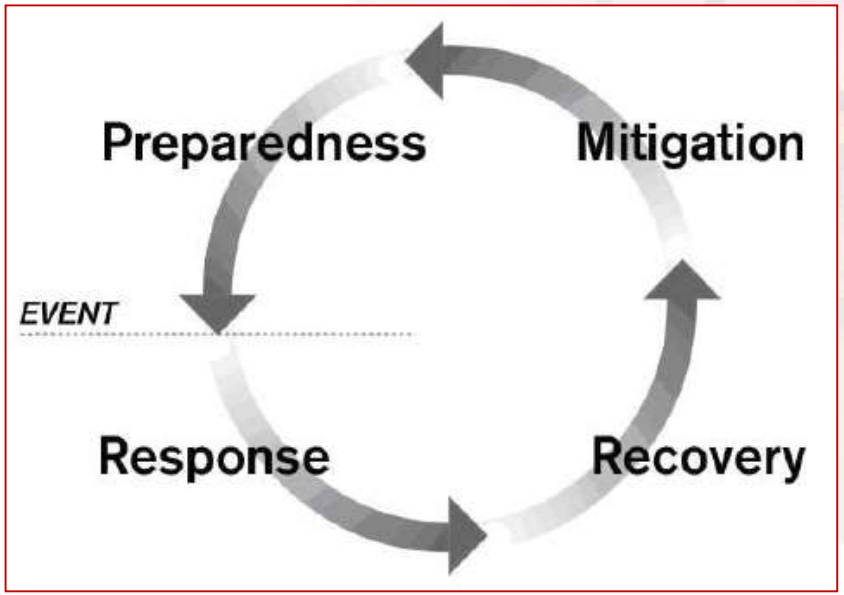
- *supports decision-making process*

- *Phases of DEM cycle:*
  - *preparedness*
  - *mitigation*

  } *pre-disaster*

  - *response – during (co-) disaster*
  - *recovery - post-disaster*

  } = *Rapidness, is key!!*



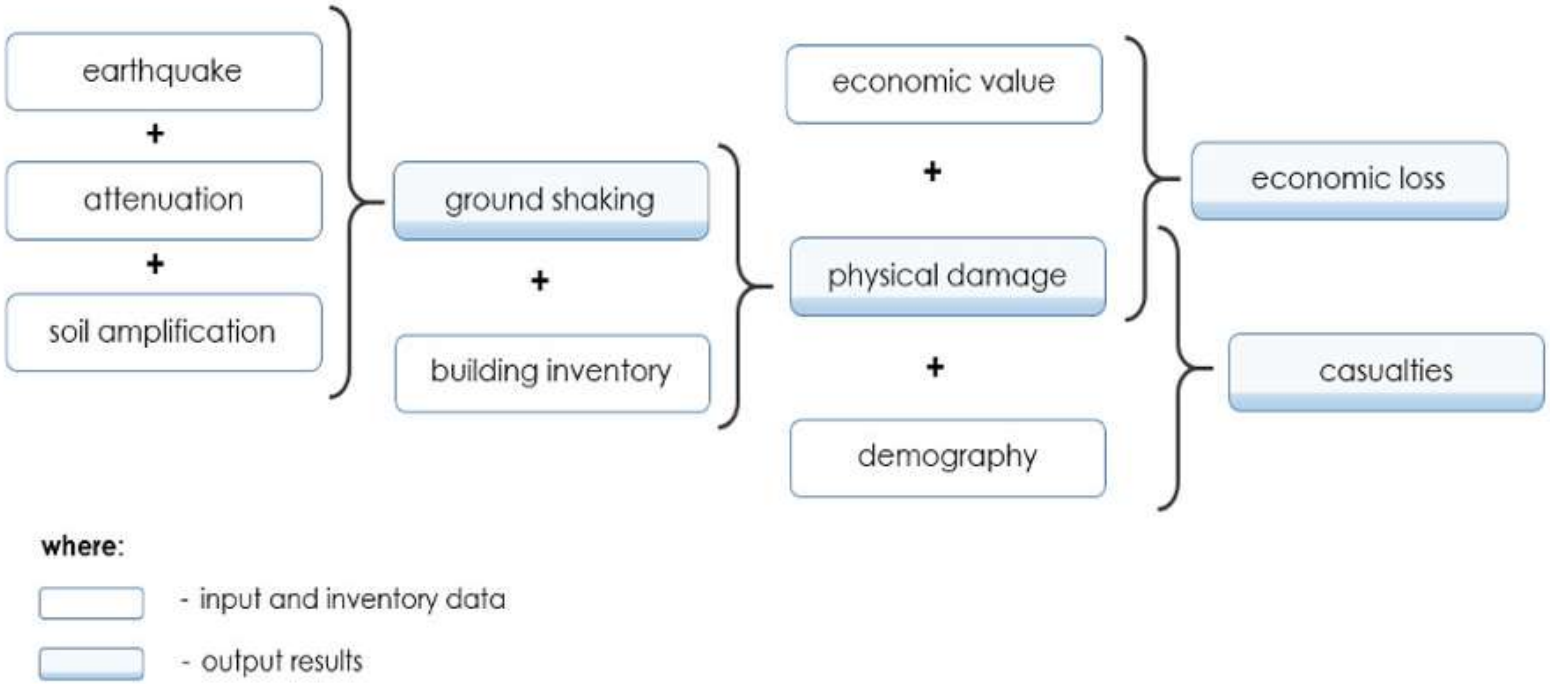
What is an SDSS? Principle and aim of SDSS

- **SDSS** - *decision support systems that aid and improve the quality of decision-making by quantitative approaches using GIS*
- *SDSS, is composed of:*
  - *spatial database system*
  - *decision model – predicting decision outcomes*
  - *graphical user interface (GUI) – output display*
- *SDSS aim: providing enhanced support for disaster decision-making and risk management*

Categories of SDSS for Earthquakes: Global SDSS

SDSS	*Region*	*Platform*	*Data categories*	*Essential district features*	*Outputs*
SELENA, DBELA, Emergeo/ NHEMATIS, CATS, OpenRisk	Europe, Worldwide	ESRI ArcGIS Google UML	Socio-economic, demographic, topography, soil, geology, building inventory, lifelines	Earthquake, Secondary hazards – landslide, tsunami, fire	GIS graphic display of predicted losses – building, damage, injury maps, hazard maps, dynamic maps, socio-economic loss estimation reports
	Scenario or simulation-based, User-friendly interface				
HAZTURK	Turkey, Worldwide	ESRI	Socio-economic, geology, topography, building inventory	Earthquake	Hazard maps for earthquake spectral acceleration, PGA, PGV
	Scenario or simulation-based, User-friendly interface				
OpenQuake, GDACS, PAGER, QLARM	Europe, Worldwide	Web-based GIS	Socio-economic, demographic, soil, hazard information, vulnerability, building	Earthquake	Maps, alerts, shake maps, population exposure and risk maps, google earth maps/ map data files, risk analysis reports
	Early warning systems (EWS), User-friendly interface				

Categories of SDSS for Earthquakes: e.g. SELENA



- *Principle flowchart of analysis using **SELENA** software*

Categories of SDSS for Earthquakes: Regional SDSS

SDSS	*Region*	*Platform*	*Data categories*	*Essential district features*	*Outputs*
ELER, SIGE/ESPAS, LNECLOSS, QuakeIST	Europe	ESRI ArcGIS Google	Socio-economic, demographic, building/facility, lifelines	*Earthquake*	*Loss maps, rapid earthquake damage and casualty estimates, statistical GIS/GPS/GPRS maps, reports, lifelines/facility*
KOERILoss	*Turkey, Europe*	MapInfo GIS	*Socio-economic, demographic, building*	*Earthquake*	*GIS display of building damage, socio-economic losses*
HAZUS-MH, Maevis, EPEDAT	*USA*	ESRI ArcGIS	*Socio-economic, population, demographic, building inventory, bridges and gas network*	*Earthquake, flood, tropical storm, fire*	*Loss maps, damage, socio-economic loss reports/analysis, gas networks*
READY, SUPREME	*Japan*	GIS	*City gas network, building, strong motion accelograph networks*	*Earthquake*	*Earthquake risk analysis, seismic intensity maps of damage assessment and locations*
			Scenario or simulation-based, User-friendly interface		
IERREWS, IGDAS	*Turkey*	GIS	Strong motion and natural gas pipeline network, socio-economic, demographic, building, near-real time hazard data, soil and seismotonic database	*Earthquake*	*Loss and shake maps, damage distribution maps in natural gas infrastructure and building stock*
			Early warning systems (EWS), User-friendly interface		

Categories of SDSS for Earthquakes: e.g. ELER

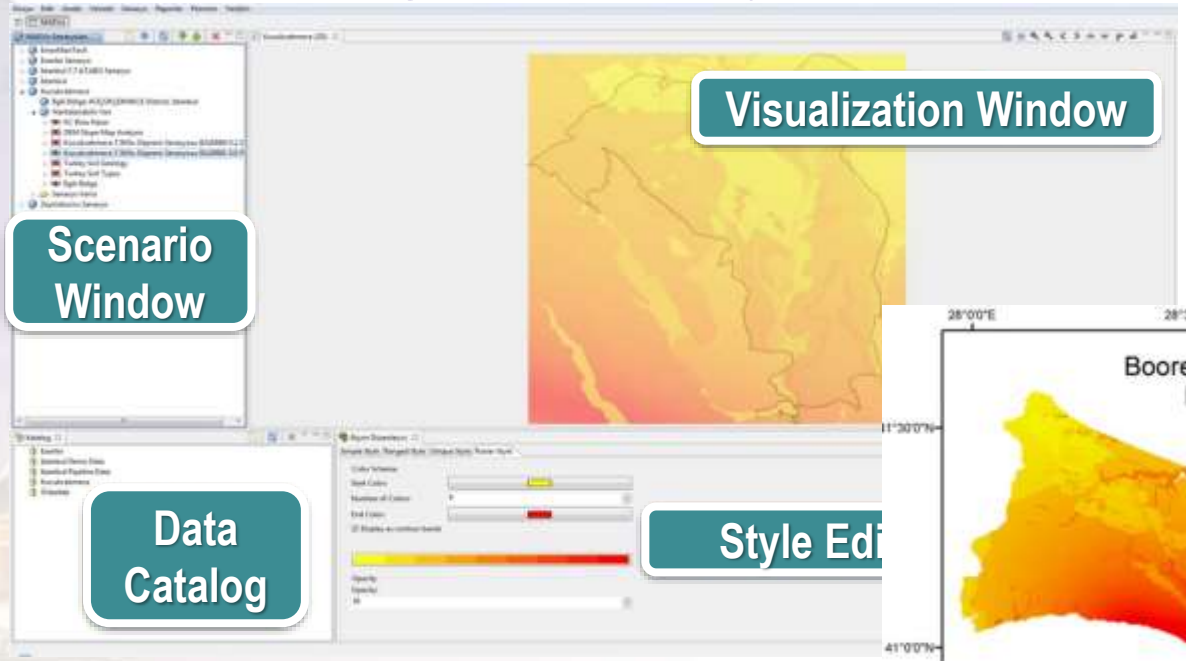
	LEVEL 0	LEVEL 1	LEVEL 2
HAZARD (Shake-map) & INVENTORY	**Intensity Map** (Point Source/Extended Source based on Seismotectonic Database + Observed GM values + Vs30); City Locations + Landscan Population Distribution	**Intensity Map** (Point Source/Extended Source based on Seismotectonic Database + Observed GM values + Vs30); Building Inventory (types and storey numbers) + Population Distribution	**Intensity Map** (Point Source/Extended Source based on Seismotectonic Database + Observed GM values + Vs30); Building Inventory (types and storey numbers) + Population Distribution
BUILDING DAMAGE	N/A	EMS8 Intensity based Building Vulnerability with Uncertainties	Spectral Displacement based Building Vulnerability with Uncertainties
CASUALTY	Regionally Adjusted Fatality vs Magnitude and/or EMS8 Relationships	Building Damage related Casualty Distribution	Building Damage related Casualty Distribution
ECONOMIC LOSS	N/A	Replacement cost and loss ratio related to damage states	Replacement cost and loss ratio related to damage states
PIPELINE DAMAGE		Pipeline damage using PGV based on GMPEs	

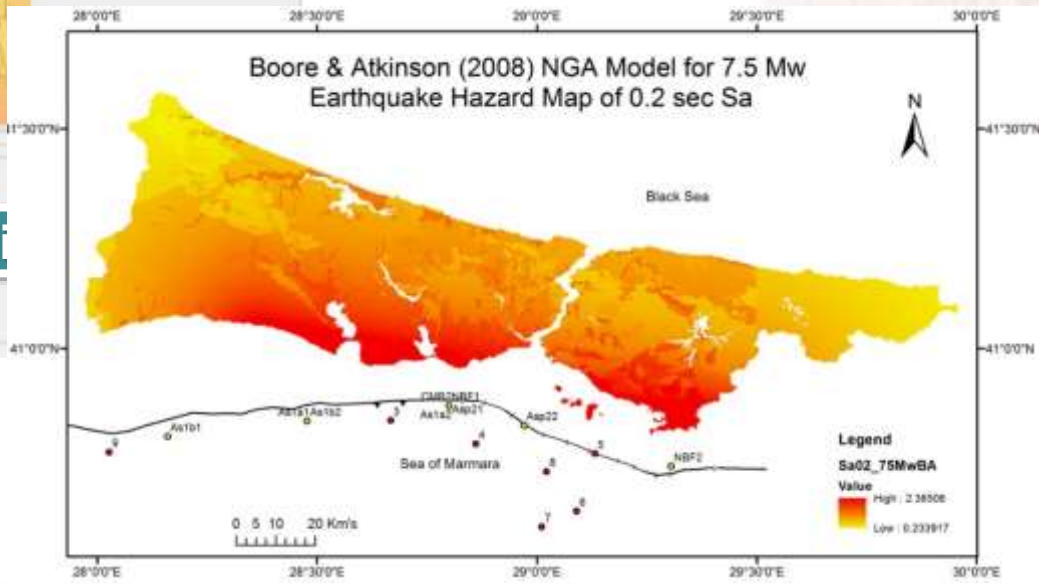
- *Three (3) levels of analysis in **ELER** software*

SDSS usage in Turkey

- **ELER –** *throughout Euro-Mediterranean region, 2011 Van earthquake*
- **KOERILoss, SELENA, SIGE –** *Istanbul, Izmir, Bishkek and Tashkent regions*
- ***CATS*** *– Izmit and Duzce*
- ***DBELA*** *– Marmara region*
- *Integrated earthquake simulation (IES) – Zeytinburnu district*
- ***HAZTURK*** *– Zeytinburnu district*

SDSS usage in Turkey: **HAZTURK software**





Why recommend HAZTURK for usage in Turkey?

- *structural based analysis method focusing on a single building structure for hazard value assignment in ELE calculations*
- *datum transformation module*
- *capability to use customizable, user-defined fragility curves for building codes in Turkey and the world*
- *module for post-earthquake ignition vulnerability assessment*
- *interdependence analysis of individual elements of lifeline networks e.g. natural gas pipelines*
- *considers non-structural elements (NSE) of building structures*

Conclusions and future developments

- **SDSS** aid in effective DEM **– Earthquakes**
- ***GIS*** *tools are at the core of SDSS for* ***emergency managers***
- *SDSS are supported by mapping and visualization methods for easier interpretation of results*
- Selected SDSS applications for earthquake risk/loss estimation
- **Future developments –** decreasing degree of *uncertainty*, increasing *accuracy* of earthquake risk/loss estimations, *accurate models* for *risk vulnerability* from *socio-economic losses*