MIRISK HELP

(v. 0.1: 21 May 07)

This HELP includes an Overview, Work Flow explanation, and more detailed Technical Information, and consists of the following sections (click to go directly to a section):

1 How to Use This Help

First time users should read Overview and Work Flow (the next two sections). More detailed technical information follows, which users may refer to as they continue to use MIRISK, so as to better understand the basis for the data and analyses MIRISK provides (including the limitations thereof).

A Glossary is provided, to define jargon and specialist terms.

MIRISK is currently in ***beta*** stage of development, meaning it is being released to selected users for their comments.

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2 MIRISK Overview

A Natural Disaster can destroy years of Development in a few seconds.

This is because building design codes are only a minimum level of design.

That is, the purpose of normal building design codes is not to eliminate all damage given a major earthquake, flood or tropical cyclone. Rather, the code's purpose is to prevent major loss of life – significant damage is acceptable per modern building codes, if not many people die.

It can be very wise, and cost-effective, for a Development Manager to require a moderately enhance level of construction for natural hazards for a Project.

This is especially true when one considers the total costs of damage, in terms of Project loss of use ("business interruption").

MIRISK (Mitigation Information and Risk Identification System) is a tool to help Development Managers consider natural hazards risk, and ways to reduce that risk, by:

- **identifying** natural hazards affecting a region
- **defining** the kinds of infrastructure ("assets") that make up typical Development projects
- **describing** the vulnerability of these assets to natural hazards, and how vulnerability can be reduced
- **analyzing** the natural hazards and vulnerability data, to assess whether Projects should follow normal design practices, or whether the cost of some enhanced design for natural hazards is justified by the benefits (of avoided losses).

Natural hazards currently considered are earthquakes, flood, tropical cyclone, and volcanism.

MIRISK's basic purpose is to allow a Development Manager to quickly learn if natural hazards are very significant in a region where the Manager is considering development. If so, MIRISH provides information on what can be done, and permits estimation of the added cost for a moderately enhanced level of construction for natural hazards. An 'optimum' level of enhanced construction is estimated, based on the degree of hazard, the type of facility, and the Project's benefit cost ratio (BCR, used to account for indirect costs of damage).

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3 Work Flow

A MIRISK user accesses four basic tabs or screens:

3.1 Study Data:

This screen is for administrative purposes – the user enters data for a new study, or resumes a previously saved study. Information recorded here are project identifier data, users names, and related information needed for administrative purposes.

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3.2 Location/Hazard Data:

The first step in risk analysis is to learn if a project is located in a high hazard region (ie, *what nature may put there*).

When the LOCATION/HAZARD tab is clicked, a map of the world is seen (and possibly some project numbers showing the Users previously identified projects). Users locate their project by:

- Clicking on Zoom In, and draw a box around a region, and so on, to zoom into the region of interest.
- Entering lat/long, or
- Entering a place name (which is searched for via a built-in gazetteer).

When the region is located, the degree of Earthquake, Wind, Flood or Volcano risk for a region can be seen via color codes (click Key tab on the bottom to see the degrees of risk, which are explained further below, under HAZARD DATA).

The LAYERS tab on the left controls what is visible on the map – all Hazards, Projects and other information can be turned on or off. The map can also be queried to learn the degree of risk at any location.

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3.3 Asset Data:

The second step in risk analysis is to define what the project consists of, in terms of types of facilities and construction (ie, *what you are thinking of putting there*).

On the page you define your project by clicking on some menus, and MUST input ASSET VALUE DATA (e.g. anticipated project cost, for construction and including overhead) and project BENEFIT COST RATIO (BCR). The project cost and BCR are used for a benefit-cost assessment. BCR is the estimate of the total project benefit (including some monetized estimate of future social benefits), divided by the total project cost.

To Define the Project when the ASSET tab is clicked, you can either:

- Retrieve an existing project, using the menus on the left, or
- Define a new Asset, using the menus on the right. These menus first ask you to define one of three ASSET CATEGORY:
    - Buildings
    - Transportation
    - Utilities / Industry
- For each of the three Asset Categories, the User then defines a CATEGORY CLASS, such as
    - Buildings
        - Wood
        - Light Metal
        - Low-rise Reinforced Masonry or Reinforced Concrete, etc
    - Transportation
        - Bridges, conventional
        - Bridges, Major
        - Tunnels, etc
    - Utilities / Industry
        - Chimneys
        - Cranes
        - Conveyor systems etc

When the Category Class (e.g. Low Rise Reinforced Masonry or Reinforced Concrete) is selected, the DESCRIPTION, DAMAGE AND DESIGN INFORMATION ON ASSETS pane changes, to provide photographs and a description of the class, its Vulnerability to various hazards and how to reduce (mitigate) the vulnerability. By reading these descriptions, a Development Manager can quickly gain some familiarity with what these various Classes are, how they are damaged by natural hazards and, in general, what are some of the techniques used to reduce their vulnerability to natural hazards. This information is provides a good background for users not expert in natural hazards mitigation.

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3.4 Analysis/Results:

This MIRISK tab summarizes the input information, and uses it to estimate:

- potential losses due to a natural hazard for the identified site and
- the cost of enhanced design for that hazard, to identify if enhanced design may be warranted, given the regional hazards for the project location and the value of the project.

The page can be printed out (hard copy or pdf) as a report for your project, using the icons on the upper right.

The Results are provided for the various hazards, and consist of the expected cost of construction for minimum code, and for some moderately enhanced level of construction (for natural hazards). The enhanced level is shown as a factor (eg, 1.02) which represents designing the Project for "2%" more than the minimum code requirement for the Project for that site. Enhancing the level of construction increases the cost of construction, and an estimate of that increased cost is shown in the table on this tab.

When a natural hazard occurs, such as an earthquake or tropical cyclone, damage is likely to occur, especially if the Project was designed only per the minimum building code requirements. **This is because the purpose of normal building design codes is not to eliminate all damage given a major earthquake, flood or tropical cyclone.** Rather, the code's purpose is to prevent major loss of life – significant damage is acceptable per modern building codes, if not many people die.

Therefore, the cost of damage and associated losses are estimated for minimal code level design. The technical details of this estimation are discussed further below, but basically the MIRISK estimates the cost of damage from a database of such costs for various hazards and types of facilities. It includes is this loss estimate not only the direct cost of repairs to the facility, but also the associated costs of loss of use of the facility (eg, renting another facility while the first is repaired). These associated costs are estimated using the BCR input by the User.

In return for the increased expenditure for natural hazards, the enhanced level of construction should have less damage when a natural hazard occurs. Therefore, the cost of damage and associated losses are estimated for not only for minimal code level design, but also for each level of design, from 1.0 (minimum code requirement) to 1.4 (40% greater than minimum code). These are tabulated in the Results Table.

Lastly, the Total Cost of the Project, which is the sum of the cost of construction (increasing with enhanced level of design) plus the cost of damage and associated losses (decreasing with enhanced level of design), are tabulated.

The minimum Total Cost is the 'optimum' enhanced level of construction design for the Project.

The results are presented in tabular for, and graphically, for each hazard.

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4 Example Analysis

This section walks the User through an example analysis.

This is the opening screen.

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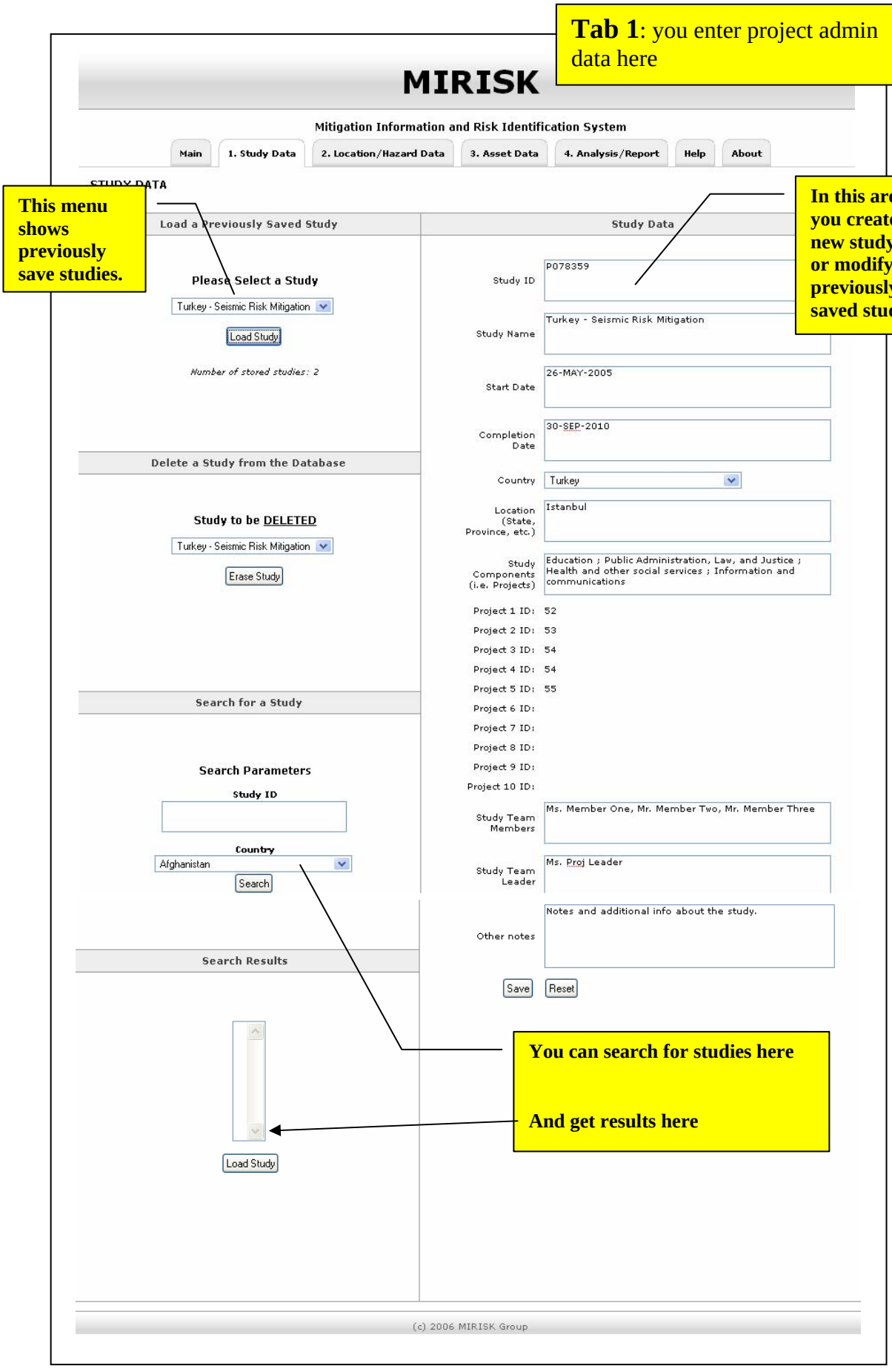
Tab 1: you enter project admin data here
MIRISK
Mitigation Information and Risk Identification System
Main
1. Study Data
2. Location/Hazard Data
3. Asset Data
4. Analysis/Report
Help
About
This menu shows previously save studies.
In this area you create a new study, or modify a previously saved study
Load a Previously Saved Study
Please Select a Study
Turkey - Seismic Risk Mitigation
Load Study
Number of stored studies: 2
Delete a Study from the Database
Study to be DELETED
Turkey - Seismic Risk Mitigation
Erase Study
Search for a Study
Search Parameters
Study ID
Country
Afghanistan
Search
Search Results
Load Study
Study Data
Study ID
P078359
Study Name
Turkey - Seismic Risk Mitigation
Start Date
26-MAY-2005
Completion Date
30-SEP-2010
Country
Turkey
Location (State, Province, etc.)
Istanbul
Study Components (i.e. Projects)
Education ; Public Administration, Law, and Justice ; Health and other social services ; Information and communications
Project 1 ID: 52
Project 2 ID: 53
Project 3 ID: 54
Project 4 ID: 54
Project 5 ID: 55
Project 6 ID:
Project 7 ID:
Project 8 ID:
Project 9 ID:
Project 10 ID:
Study Team Members
Ms. Member One, Mr. Member Two, Mr. Member Three
Study Team Leader
Ms. Proj Leader
Other notes
Notes and additional info about the study.
Save
Reset
You can search for studies here
And get results here
(c) 2006 MIRISK Group

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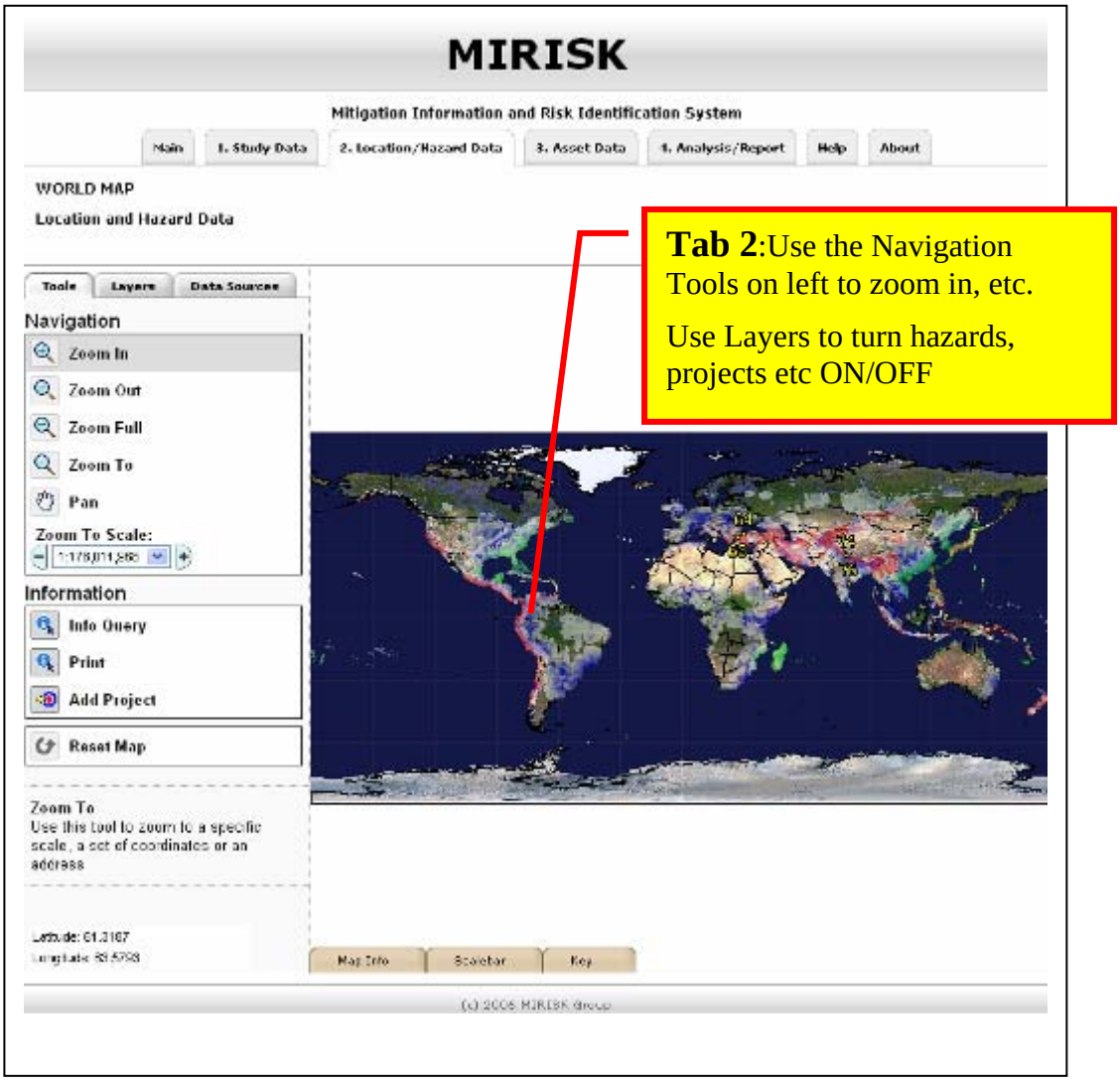
MIRISK
Mitigation Information and Risk Identification System
Main
1. Study Data
2. Location/Hazard Data
3. Asset Data
4. Analysis/Report
Help
About
WORLD MAP
Location and Hazard Data
Tools
Layers
Data Sources
Navigation
Zoom In
Zoom Out
Zoom Full
Zoom To
Pan
Zoom To Scale:
Information
Info Query
Print
Add Project
Reset Map
Zoom To
Use this tool to zoom to a specific scale, a set of coordinates or an address
Map Info
Scalebar
Key
Tab 2:Use the Navigation Tools on left to zoom in, etc.
Use Layers to turn hazards, projects etc ON/OFF

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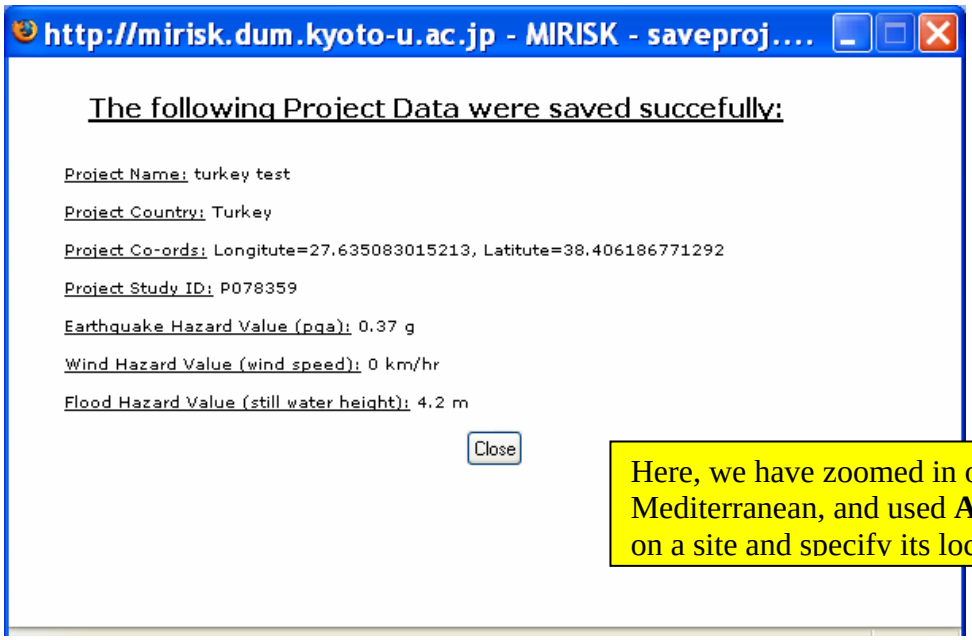
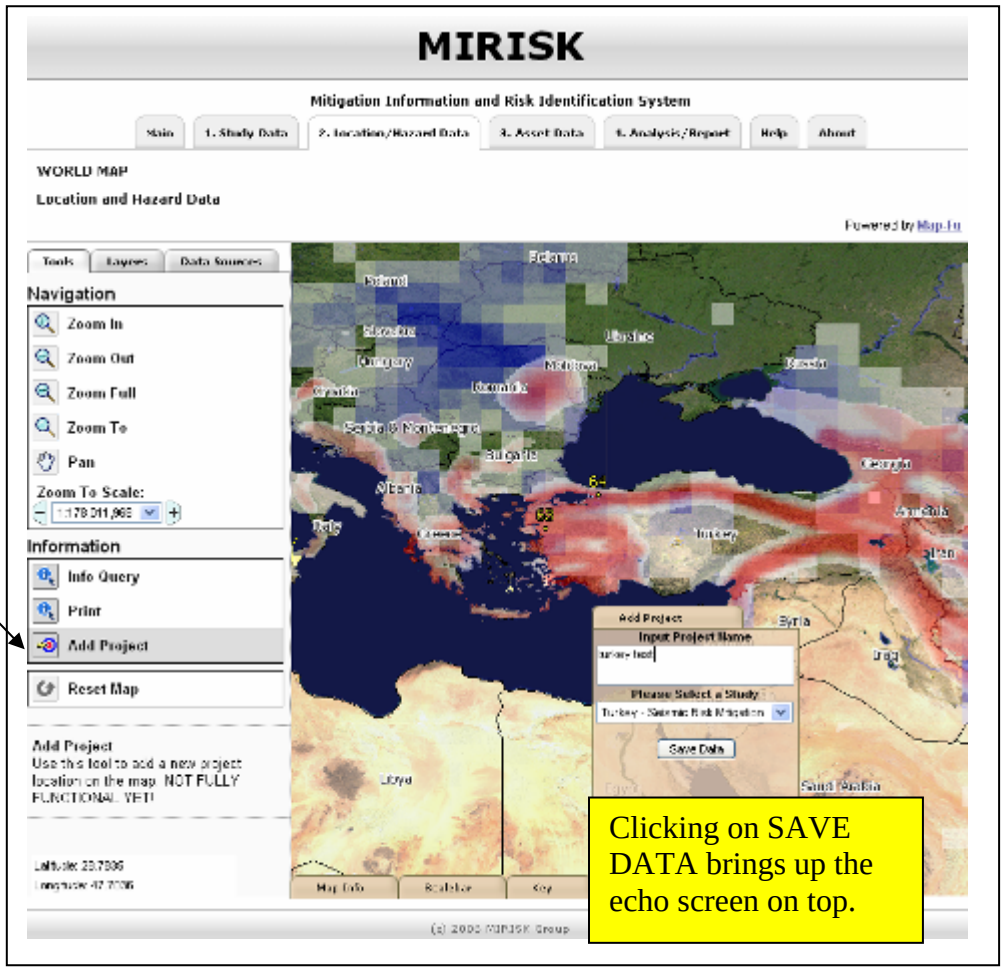
Tab 2 (cont.)



Here, we have zoomed in on the eastern Mediterranean, and used **ADD PROJECT** to click on a site and specify its location

ADD PROJECT



Clicking on SAVE DATA brings up the echo screen on top.

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MIRISK

Mitigation Information and Risk Identification System

Main | 1. Study Data | 2. Location/Hazard Data | 3. Asset Data | 4. Analysis/R

ASSET INFORMATION

Load a Previously Saved Project | Project/A

Please Select a Project

turkey test

Load Project Data

Number of stored projects: 6

Project Study ID: P078359
Project ID: 77
Project Name: turkey test
Project Country: Turkey
Asset Category: Buildings
Category Class: Mid-Rise Reinforced Masonry or Reinforced Concrete
Project Value: 1000000
Currency: USD
Benefit to Cost Ratio: 6
Real Interest Rate: 0.03
Earthquake Hazard Level:
Flood Hazard Level:
Wind Hazard Level:
Volcanic Hazard Level:

Save | Reset

l design information on assets

Tab 3: here you enter Project Asset data – (1) pick a Asset Category; (2) pick a Category Class. (3) Input Project VALUE, CURRENCY, BCR (benefit cost ratio) and REAL INTEREST RATE, (4) click SAVE and an echo screen appears

Lower on this page is information on each Asset class' natural hazards' vulnerability, and options for risk reduction

http://mirisk.dum.kyoto-u.ac....

Project Data Saved Succefully:

Project ID: 77
Asset Category: Buildings
Category Class: 84
Project Value: 1000000
Currency: USD
Project Benefit to Cost Ratio: 6
Real Interest Rate: 0.03

Close

Buildings, Mid Rise Reinforced Masonry or Reinforced Concrete

Mid Rise RC/RM Building Under Construction, Turkey
Photo Source: C. Scawthorn

Contents

- Earthquake Description
- Earthquake Performance
- Earthquake Design
- Wind Description
- Wind Performance
- Wind Design
- Flood Description
- Flood Performance
- Flood Design

Earthquake

Earthquake Description

Mid-rise (RM) reinforced masonry (RM) or reinforced concrete (RC) are typically residential, office or industrial, occupancies buildings.

Typical Seismic Damage and Performance

Mid-rise RC/RM Bldg Collapse, 1995 Kobe Japan Earthquake
Photo Source: C. Scawthorn

While MR RM/RC buildings can and have performed well in strong earthquakes, the design and detailing are critical to pr construction subtypes fall under this category: (a) nonductile RM/RC frames with reinforced or unreinforced infill walls, (b) no Some typical problems are:

1. Large tie spacings in columns can lead to a lack of concrete confinement and/or shear failure.
2. Placement of inadequate rebar splices at the same location can lead to column failure.
3. Insufficient shear strength in columns can lead to shear failure prior to the development of moment hinge capacity.
4. Insufficient shear tie anchorage can prevent the column from developing its full shear capacity
5. Lack of continuous beam reinforcement can result in hinge formation during load reversal.
6. Inadequate reinforcing of beam-column joints or location of beam bar splices at columns can lead to failures.

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Tab 4: User (1) selects study and project; (2) clicks on Analysis/Results, and then below Results appear, consisting of Project Input data etc, and estimated Expected Annualized Loss (EAL) for design level factor = 1 (minimum code), related data, and tabulated and graphed results of a benefit-cost analysis for various natural hazards affecting the project at the specified site. Optimum enhanced code levels are easily seen, as well as added construction cost and Total Cost Savings for the project. Icons permit printing or creating a pdf.

MIRISK

Mitigation Information and Risk Identification System

Main | 1. Study Data | 2. Location/Hazard Data | 3. Asset Data | 4. Analysis/Report

Analysis and Report

Select Study and Project

STUDY	PROJECT	RESULTS
Turkey - Seismic Risk Mitigation	turkey test	Analysis & Report

Analysis Resuslts and Report

MIRISK ANALYSIS AND REPORT

Study Information

Study Name: Turkey - Seismic Risk Mitigation

Study ID: P078359

Study Location: Turkey, Istanbul

Study Components: Education ; Public Administration, Law, and Justice ; Health and other soc

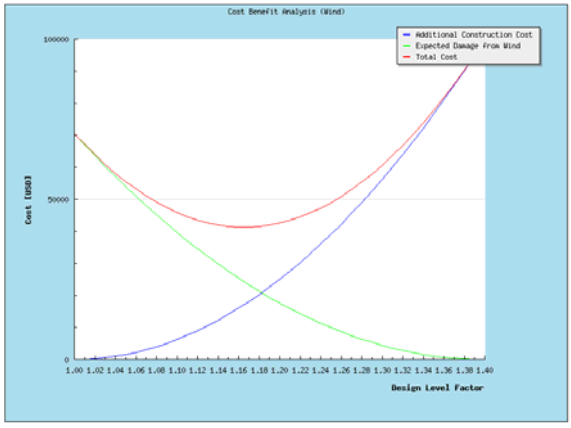
Study Start Date: 26-MAY-2005

Study Completion Date: 30-SEP-2010

Study Team Memb

Study Team Leade

Other Notes: Note



Flood Analysis

Asset Related Information

Asset Value: USD 1000000.00

Asset Benefit to Cost Ratio: 6.00

Real Interest Rate: 0.03

Asset Category: Buildings

Category Class: Mid Rise Reinforced Masonry or Reinforced Concr

Cost Benefits Analysis

Earthquake Analysis

Project Site Earthquake Hazard Value (pga): 0.370 g

Results

(1) AEL = 0.0039
(2) PV(Direct Losses) = (1) / (Real Interest Rate) = 0.1313
(3) PV(Indirect Losses) = (2) x BCR = 0.7877
(4) PV(Total Losses) = (2) + (3) = 0.919

Design Level Multiplier	Construction Cost (USD)	Increase in Cost (From the base design cost) (USD)	Total Loss (USD)	Total Cost (USD)
1	1,000,000	0	918,955	1,918,955
1.01	1,000,063	63	873,581	1,873,644
1.02	1,000,250	250	829,357	1,829,607
1.03	1,000,563	563	786,281	1,786,843
1.04	1,001,000	1,000	744,353	1,745,353
1.05	1,001,562	1,562	703,575	1,705,137
1.06	1,002,250	2,250	663,945	1,666,195
1.07	1,003,063	3,062	625,464	1,628,526
1.08	1,004,000	4,000	588,131	1,592,131
1.09	1,005,063	5,062	551,947	1,557,010

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5 Technical Information

5.1 Location/Hazard Data

The HAZARD data is derived from the Global Hotspots data set, which itself is a compilation of other datasets on a 2 by 2 degree lat/long grid. Some assumptions were made to employ the Hotspots data set…(to be completed later)

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5.2 Asset Data

The ASSET data set is derived from …(to be completed later)

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5.3 Analysis/Results

The Analysis is …(to be completed later)

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6 Glossary

Aa	Hawaiian word used to describe a lava flow whose surface is broken into rough angular fragments.
Active volcano	A volcano that is erupting. Also, a volcano that is not presently erupting but that has erupted within historical time and is considered likely to do so in the future.
Andesite	Volcanic rock (or lava) characteristically medium dark in color and containing 54 to 62 percent silica and moderate amounts of iron and magnesium.
Ash	Fine particles of pulverized rock blown from an explosion vent. Measuring less than 1/10 inch in diameter, ash may be either solid or molten when first erupted. By far the most common variety is vitric ash, glassy particles formed by gas bubbles bursting through liquid magma.
Ash flow	A turbulent mixture of gas and rock fragments, most of which are ash-sized particles, ejected violently from a crater or fissure. The mass of pyroclastics is normally of very high temperature and moves rapidly down the slopes, or even along a level surface.
Ashfall (Airfall)	Volcanic ash that has fallen through the air from an eruption cloud. A deposit so formed is usually well sorted and layered.
attenuation	the rate at which earthquake ground motion decreases with distance
Avalanche	A large mass of material or mixtures of material falling or sliding rapidly under the force of gravity. Avalanches often are classified by their content, such as snow, ice, soil, or rock avalanches. A mixture of these materials is a debris avalanche.
Average wind speed	Speed of the wind averaged over the previous 10 minutes (mean surface wind) as read from the anemogram or the 3 minutes mean determined with the non-recording anemometer or estimated wind at sea by the mariners using the Beaufort scale.
Basalt	Volcanic rock (or lava) that characteristically is dark in color, contains 45 to 54 percent silica, and generally is rich in iron and magnesium.
Benefit-cost Ratio (BCR)	BCR is the estimate of the total project benefit (including some monetized estimate of future social benefits), divided by the total project cost.
Block	Angular chunk of solid rock ejected during an eruption.
Bomb	Fragment of molten or semi-molten rock, 2 1/2 inches to many feet in diameter, which is blown out during an eruption.

	Because of their plastic condition, bombs are often modified in shape during their flight or upon impact.
Caldera	The Spanish word for cauldron, a basin-shaped volcanic depression; by definition, at least a mile in diameter. Such large depressions are typically formed by the subsidence of volcanoes. Crater Lake occupies the best-known caldera in the Cascades.
Central pressure of a tropical cyclone	Surface pressure at the centre of the tropical cyclone as measured or estimated.
Centre of the tropical cyclone	The centre of the cloud eye, or if not discernible, of the wind/pressure centre.
Cinder cone	A volcanic cone built entirely of loose fragmented material (pyroclastics.)
Composite volcano	A steep volcanic cone built by both lava flows and pyroclastic eruptions.
Continental crust	Solid, outer layers of the earth, including the rocks of the continents.
Continental drift	The theory that horizontal movement of the earth's surface causes slow, relative movements of the continents toward or away from one another.
Crater	A steep-sided, usually circular depression formed by either explosion or collapse at a volcanic vent.
Cyclone	Tropical cyclone
Cyclonic storm	A cyclonic disturbance in which the maximum average surface wind speed is in the range of 34 to 47 knots (62 to 88 km/h).
Dacite	Volcanic rock (or lava) that characteristically is light in color and contains 62 to 69 percent silica and moderate amounts of sodium and potassium.
damage	physical disruption, such as cracking in walls, overturning of cabinets etc (often used synonymously with loss)
Debris avalanche	A rapid and unusually sudden sliding or flowage of unsorted masses of rock and other material. As applied to the major avalanche involved in the eruption of Mount St. Helens, a rapid mass movement that included fragmented cold and hot volcanic rock, water, snow, glacier ice, trees, and some hot pyroclastic material. Most of the May 18 deposits in the upper valley of the North Fork Toutle River and in the vicinity of Spirit Lake are from the debris avalanche.
Depression	A cyclonic disturbance in which the maximum sustained surface wind speed is between 17 and 33 knots (31 and 61 km/h). If the maximum sustained wind speed lies in the range 28 knots (52 km/h) to 33 knots (61 km/h) the system may be

	called a "deep depression".* A cyclonic disturbance in which the maximum sustained surface wind speed is between 22 and 33 knots (41 and 61 km/h. If the maximum sustained wind speed lies in the range 28 knots (52 km/h) to 33 knots (61 km/h) the system may be called a "deep depression".+
Detachment plane	The surface along which a landslide disconnects from its original position.
Dome	A steep-sided mass of viscous (doughy) lava extruded from a volcanic vent, often circular in plane view and spiny, rounded, or flat on top. Its surface is often rough and blocky as a result of fragmentation of the cooler, outer crust during growth of the dome.
Dormant volcano	Literally, "sleeping." The term is used to describe a volcano which is presently inactive but which may erupt again. Most of the major Cascade volcanoes are believed to be dormant rather than extinct.
ductile detailing	special requirements such as, for reinforced concrete and masonry, close spacing of lateral reinforcement to attain confinement of a concrete core, appropriate relative dimensioning of beams and columns, 135 degree hooks on lateral reinforcement, hooks on main beam reinforcement within the column, etc)
ductile frames	frames required to furnish satisfactory load-carrying performance under large deflections (i.e., ductility). in reinforced concrete and masonry this is achieved by ductile detailing
ductility factor	the ratio of the total displacement (elastic plus inelastic) to the elastic [i.e., yield] displacement
Ejecta	Material that is thrown out by a volcano, including pyroclastic material (tephra) and, from some volcanoes, lava bombs.
epicenter	the projection on the surface of the earth directly above the hypocenter
Eruption	The process by which solid, liquid, and gaseous materials are ejected into the earth's atmosphere and onto the earth's surface by volcanic activity. Eruptions range from the quiet overflow of liquid rock to the tremendously violent expulsion of pyroclastics.
Eruption cloud	The column of gases, ash, and larger rock fragments rising from a crater or other vent. If it is of sufficient volume and velocity, this gaseous column may reach many miles into the stratosphere, where high winds will carry it long distances.
Eruptive vent	The opening through which volcanic material is emitted.

Extinct volcano	A volcano that is not presently erupting and is not likely to do so for a very long time in the future.
Eye of the tropical cyclone	The relatively clear and calm area inside the circular wall of convective clouds, the geometric centre of which is the centre of the tropical cyclone.
far-field	(beyond near-field), also termed teleseismic
fault	a zone of the earth's crust within which the two sides have moved - faults may be hundreds of miles long, from one to over one hundred miles deep, and not readily apparent on the ground surface.
Fault	A crack or fracture in the earth's surface. Movement along the fault can cause earthquakes or, in the process of mountain-building, can release underlying magma and permit it to rise to the surface.
Fissures	Elongated fractures or cracks on the slopes of a volcano. Fissure eruptions typically produce liquid flows, but pyroclastics may also be ejected.
Flank eruption	An eruption from the side of a valcano (in contrast to a summit eruption.)
focal mechanism	refers to the direction of slip in an earthquake, and the orientation of the fault on which it occurs
Fracture	A general term for any break in a rock including cracks, joints, and faults.
fragility	the probability of having a specific level of damage given a specified level of hazard
Fumarole	A vent or opening through which issue steam, hydrogen sulfide, or other gases. The craters of many dormant volcanoes contain active fumaroles.
Gale force wind	Average surface wind speed of 34 to 47 knots (62 to 88 km/h).
Geothermal energy	Energy derived from the internal heat of the earth.
Geothermal power	Power generated by using the heat energy of the earth.
Graben	An elongate crustal block that is relatively depressed (downdropped) between two fault systems.
Gust	Instantaneous peak value of surface wind speed, recorded or expected.
Harmonic tremor	A continuous release of seismic energy typically associated with the underground movement of magma. It contrasts distinctly with the sudden release and rapid decrease of seismic energy associated with the more common type of earthquake caused by slippage along a fault.
hazard	the potential for or occurrence of natural phenomena, such as

	ground shaking, liquefaction, tsunami, etc, which might lead to loss.
Heat transfer	Movement of heat from one place to another.
Horizontal blast	An explosive eruption in which the resultant cloud of hot ash and other material moves laterally rather than upward.
Hot-spot volcanoes	volcanoes related to a persistent heat source in the mantle.
Hurricane force wind	Average surface wind speed 64 knots or more.
Hydrothermal reservoir	An underground zone of porous rock containing hot water.
hypocenter	the location of initial radiation of seismic waves (i.e., the first location of dynamic rupture)
intensity	a metric of the effect, or the strength, of an earthquake hazard at a specific location, commonly measured on qualitative scales such as MMI, MSK and JMA.
Lahar	A torrential flow of water-saturated volcanic debris down the slope of a volcano in response to gravity. A type of mudflow. Also known as a "glowing avalanche."
Lapilli	Literally, "little stones;" round to angular rock fragments measuring 1/10 inch to 2 1/2 inches in diameter, which may be ejected in either a solid or molten state.
lateral force resisting system	a structural system for resisting horizontal forces, due for example to earthquake or wind [as opposed to the vertical force resisting system, which provides support against gravity]
Lava	Magma which has reached the surface through a volcanic eruption. The term is most commonly applied to streams of liquid rock that flow from a crater or fissure. It also refers to cooled and solidified rock.
Lava Flow	An outpouring of lava onto the land surface from a vent or fissure. Also, a solidified tongue like or sheet like body formed by outpouring lava.
Lava tube	A tunnel formed when the surface of a lava flow cools and solidfies, while the still-molten interior flows through and drains away.
liquefaction	a process resulting in a soil’s loss of shear strength, due to a transient excess of pore water pressure.
loss	the human or financial consequences of damage, such as human injury or cost of repairs.
Low or Low pressure area	An area enclosed by a closed isobar with minimum pressure inside when mean surface wind is less than 17 knots (31 km/h).

Magma	Molten rock beneath the surface of the earth.
Magma chamber	The subterranean cavity containing the gas-rich liquid magma which feeds a volcano.
magnitude	a unique measure of an individual earthquake's release of strain energy, measured on a variety of scales, of which the moment magnitude M_W (derived from seismic moment) is preferred
Magnitude	A numerical expression of the amount of energy released by an earthquake, determined by measuring earthquake waves on standardized recording instruments (seismographs.) The number scale for magnitudes is logarithmic rather than arithmetic; therefore, deflections on a seismograph for a magnitude 5 earthquake, for example, are 10 times greater than those for a magnitude 4 earthquake, 100 times greater than for a magnitude 3 earthquake, and so on.
magnitude-frequency relation	the probability of occurrence of a selected magnitude - the commonest is $log_{10}\, n(m) = a - bm$ [Gutenberg And Richter, 1954]
Mantle	The zone of the earth below the crust and above the core.
Maximum sustained wind	Maximum value of the average wind speed at the surface.
mitigation:	literally the moderating of a force or intensity of something that causes suffering, and is used in earthquake engineering as synonymous with reducing earthquake risk.
Mudflow	A flowage of water-saturated earth material possessing a high degree of fluidity during movement. A less-saturated flowing mass is often called a debris flow. A mudflow originating on the flank of a volcano is properly called a lahar.
non-ductile frames	frames lacking ducility or energy absorption capacity due to lack of ductile detailing - ultimate load is sustained over a smaller deflection (relative to ductile frames), and for fewer cycles.
normal fault	a fault that exhibits dip-slip motion, where the two sides are in tension and move away from each other
Nuee ardente	A French term applied to a highly heated mass of gas-charge ash which is expelled with explosive force, and hurricane speed, down the mountainside.
Obsidian	A black or dark-colored volcanic glass, usually composed of rhyolite.
Oceanic crust	The earth's crust where it underlies oceans.
peak ground acceleration (PGA)	the maximum amplitude of recorded acceleration (also termed the ZPA, or zero period acceleration)

Phreatic eruption (explosion)	An explosive volcanic eruption caused when water and heated volcanic rocks interact to produce a violent expulsion of steam and pulverized rocks. Magma is not involved.
Pillow lava	Interconnected, sack-like bodies of lava formed underwater.
Plate techtonics	The theory that the earth's crust is broken into about 10 fragments (plates,) which move in relation to one another, shifting continents, forming new ocean crust, and stimulating volcanic eruptions.
Plug	Solidified lava that fills the conduit of a volcano. It is usually more resistant to erosion than the material making up the surrounding cone, and may remain standing as a solitary pinnacle when the rest of the original structure has eroded away.
Plug dome	The steep-sided, rounded mound formed when viscous lava wells up into a crater and is too stiff to flow away. It piles up as a dome-shaped mass, often completely filling the vent from which it emerged.
Pluton	A large igneous intrusion formed at great depth in the crust.
pounding	the collision of adjacent buildings during an earthquake due to insufficient lateral clearance.
Pumice	Light-colored, frothy volcanic rock, usually of dacite or rhyolite composition, formed by the expansion of gas in erupting lava. Commonly seen as lumps or fragments of pea-size and larger, but can also occur abundantly as ash-sized particles.
Pyroclastic	Pertaining to fragmented (clastic) rock material formed by a volcanic explosion or ejection from a volcanic vent.
Pyroclastic flow	Lateral flowage of a turbulent mixture of hot gases and unsorted pyroclastic material (volcanic fragments, crystals, ash, pumice, and glass shards) that can move at high speed (50 to 100 miles an hour.) The term also can refer to the deposit so formed.
reverse fault	a fault that exhibits dip-slip motion, where the two sides are in compression and move away towards each other
Rhyolite	Volcanic rock (or lava) that characterics tically is light in color, contains 69 percent silica or more, and is rich in potassium and sodium.
Rhyolite	A fine-grained volcanic rock, which although different in texture, has the same composition as granite.
Ridge, Oceanic	A major submarine mountain range.
Rift system	The oceanic ridges formed where techtonic plates are separating and a new crust is being created; also, their on-land counterparts like the East African Rift.

Ring of fire	A zone of major global seismicity due to the interaction (collision and subduction) of the Pacific plate with several other plates.
Ring of Fire	The regions of mountain-building earthquakes and volcanoes which surround the Pacific Ocean.
risk	: the potential for loss. Risk can be expressed in absolute terms such as 'the risk of collapse', or in probabilistic terms, such as 'the risk per year is $1,000).
sand boils or mud volcanoes	ejecta of solids (i.e., sand, silt) carried to the surface by water, due to liquefaction
Seafloor spreading	The mechanism by which new seafloor crust is created at oceanic ridges and slowly spreads away as plates are separating.
seismic gap	A portion of a fault or seismogenic zone which can be deduced to be likely to rupture in the near term, based on patterns of seismicity and geological evidence.
seismic hazards	the phenomena and/or expectation of an earthquake-related agent of damage, such as fault rupture, vibratory ground motion (i.e., shaking), inundation (e.g., tsunami, seiche, dam failure), various kinds of permanent ground failure (e.g. liquefaction), fire or hazardous materials release.
seismic risk	the product of the hazard and the vulnerability (i.e., the expected damage or loss, or the full probability distribution.
Seismograph	An instrument that records seismic waves; that is, vibrations of the earth.
Severe cyclonic storm	A cyclonic disturbance in which the maximum average surface wind speed is in the range of 48 to 63 knots (89 to 118 km/h).
Severe cyclonic storm with a core of hurricane winds+	A cyclonic disturbance in which the maximum average surface wind speed is 64 knots (119 km/h) or more.
Shearing	The motion of surfaces sliding past one another.
Shield volcano	A gently sloping volcano in the shape of a flattened dome, built almost exclusively of lava flows.
Silica	A chemical combination of silicon and oxygen.
soft story	a story of a building signifiantly less stiff than adjacent stories (that is, the lateral stiffness is 70% or less than that in the story above, or less than 80% of the average stiffness of the three stories above [BSSC, 1994]).
Somma	A circular or cresent-shaped ridge that is steep on its inner side and represents the rim on an ancient volcanic crater or caldera.

Spines	Horn-like projections formed upon a lava dome.
Squally wind	When sudden increases of wind speed occur in squalls with the increased speed reaching a minimum of 22 knots (40 km/h) and persist for at least one minute.
Storm force wind	Average surface wind speed of 48 to 63 knots.
Storm surge	The difference between the actual water level under the influence of a meteorological disturbance (storm tide) and the level which would have been attained in the absence of the meteorological disturbance (i.e. astronomical tide). (Storm surge results mainly from the shoreward movement of water under the action of wind stress. A minor contribution is also made by the hydrostatic rise of water resulting from the lowered barometric pressure).
Storm tide	The actual water level as influenced by a weather disturbance. The storm tide consists of the normal astronomical tide and the storm surge.
Stratovolcano	A volcano composed of both lava flows and pyroclastic material.
Strike-slip fault	A nearly vertical fault with side-slipping displacement.
subduction	refers to the plunging of a tectonic plate (e.g., the Pacific) beneath another (e.g., the North American) down into the mantle, due to convergent motion
Subduction zone	The zone of convergence of two techtonic plates, one of which usually overrides the other.
Super cyclone	A cyclonic disturbance in which maximum wind speed is 120 knots and above (222 km/h and above). {+ Meaning of term as used nationally in Bangladesh}
tectonic	Relating to, causing, or resulting from structural deformation of the earth's crust. [*from Greek tektonikos, from tektn, builder*]
Tephra	Materials of all types and sizes that are erupted from a crater or volcanic vent and deposited from the air.
thrust fault	low-angle reverse faulting (blind thrust faults are faults at depth occurring under anticlinal folds - they have only subtle surface expression)
Trans-alpide belt	A zone of major global seismicity, extending from the Mediterranean through the Middle East, Himalayas and Indonesian archipelago, resulting from the collision of several major tectonic plates..
transform or strike slip fault	a fault where relative fault motion occurs in the horizontal plane, parallel to the strike of the fault
Tropical cyclone	Generic term for a non-frontal synoptic scale cyclone originating over tropical or sub-tropical waters with

	organized convection and definite cyclonic surface wind circulation. The term is also used for a storm in the South-West Indian Ocean in which the maximum of sustained wind speed* is estimated to be in the range of 64 to 90 knots and in the South Pacific and South-East Indian Ocean with the maximum of the sustained wind speed over 33 knots. (Note: *Maximum sustained wind speed: Average period of one, three, or ten minutes depending upon the regional practices.)
Tsunami	A great sea wave produced by a submarine earthquake, volcanic eruption, or large landslide.
Tuff	Rock formed of pyroclastic material.
uniform hazard spectra	response spectra with the attribute that the probability of exceedance is independent of frequency.
Vent	The opening at the earth's surface through which volcanic materials issue forth.
Very severe cyclonic storm	A cyclonic disturbance in which maximum wind average is 64 knots to 119 knots (119 to 221 km/h).
Viscosity	A measure of resistance to flow in a liquid (water has low viscosity while honey has a higher viscosity.)
Volcanic complex	A persistent volcanic vent area that has built a complex combination of volcanic landforms.
vulnerability	the expected damage given a specified value of a hazard parameter

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