Sustainable Design Studio

Final Report

Findings & Suggestions

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A brief introduction

Israel is experiencing a major earthquake every 80 years on average. The last big earthquake occurred in 1927, and had devastating effects in a number of settlements, among them Shekhem-Nablus, Tiberias, Ramleh, and Jerusalem. The one before, in 1837, devastated Tsfat. The Israeli Standard for earthquake resistant construction (IS 413) was launched in 1975 and became mandatory in 1980. This means that most – if not all – buildings built or designed till 1980 may sustain damages of varying degrees during the next earthquake. Depending on the magnitude, even buildings designed according to IS 413 may sustain serious damage. In 2005, National Master Plan 38 introduced guidelines and incentives for the reinforcement of existing structures, yet today only few buildings have been reinforced. Assuming emergency services will be overwhelmed and fully occupied in the big urban centers of the country, the periphery may have to take care of itself, at least during the first hours and days – which are the most critical as far as lives are concerned. It may also have to deal with evacuees from afflicted areas.

The workshop dealt with issues such as emergency shelter and services, water and food, infrastructures, planning, public health, supplies, areas for evacuee camps, accessibility, services, legal framework. Students and faculty from various backgrounds (water, health, engineering, energy, architecture and planning, social services, refugee care etc.) worked as a multi-disciplinary task team, with task allocation being complimentary rather than competing.

Following is the studio's end product which aimed at raising questions as to the degree of local, national and regional preparedness, and tried to sketch a few basic guidelines.

I wish to take this opportunity to thank all those that participated and contributed to the studio.

Isaac (Sakis) A. Meir
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Earthquakes in Israel

Y. Kalman
Earthquakes

- Most are caused by the shifting of tectonic plates.
- Much less frequently they are caused by volcanic eruptions or nuclear explosions.

Plate Tectonics

- The theory that describes how, divided into plates, the sections of the earth's crust move in relation to one another.
- There are three general types of boundaries between plates:

http://en.wikipedia.org/wiki/Plate_tectonics
Plate Tectonics cont.

- Transform Boundaries:
  - Plates slide horizontally causing slip faults.
  - Earthquakes formed thus can be as intense as 8 on the Richter scale.

Plate Tectonics cont.

- **Convergent boundaries:**
  - Plates move towards each other, causing reverse faults. The denser plate undergoes subduction and slides below the less dense plate.
  - Oceanic plates are denser than continental plates.
  - Where two continental plates meet, neither will subduct, and mountains are formed at the fault.
  - Earthquakes occurring along convergent boundaries are generally the most intense.
  - Earthquakes occurring along convergent boundaries are generally the most intense.

http://pubs.usgs.gov/gip/dynamic/understanding.html
Divergent boundaries:
- Plates move apart, causing normal and reverse faults with one side of the fault dipping below or rising above the other.
- Can open gaps in the earth's crust and form volcanoes.
- Where two continental plates meet, neither will subduct, and mountains are formed at the fault.
- Usually results in earthquakes of no more than 5 on the Richter scale.
How Earthquakes Work

- Faults are not smooth. The earth's plates cause friction as they move.
- Hypocenter: place of initiation of seismic activity. It is here that energy builds up as the plates shift and energy is released suddenly and violently. Can open gaps in the earth's crust and form volcanoes.
- Epicenter: at ground level directly over the hypocenter. The first location that tremors are felt at the land's surface.
- Asperities: places where plates are stuck to one another.
- Plates rapidly shift until they reach tension points on other asperities. If the energy released is great enough, these asperities are broken through, causing subsequent tremors.
- These may be part of the same earthquake if they are broken through at nearly the same time, or they may be felt as aftershocks, or if there was not enough movement to break through all of them, they may occur later as separate earthquakes.
How Earthquakes Work: Waves

There are four different kinds of waves:

- Compressional, or P-waves, spread spherically from the hypocenter, causing contractions and expansions as they pass. Contractions in a material cause atoms to move closer together and the volume of the material to decrease, while during expansion volume increases. P-waves can pass through solids, liquids and gasses.

http://wiki.cs.messiah.edu/~bbarrett/slin_com.gif
How Earthquakes Work: Waves

- Shear, or S-waves produce shape changes (much like an S-curve) which radiate out from the hypocenter. These waves can only pass through solids, as liquids can't support the shape change. P-waves travel at speeds around 6km/sec while S-waves travel at around 3.5km/sec. Measuring stations record the difference time taken for the different kinds of waves to reach (the S-P interval) and can use that difference, granted there are at least three stations able to record the waves, to triangulate the epicenter of the earthquake.
How Earthquakes Work:

Waves

- Rayleigh waves move along the earth's surface, displacing land in much the same way as S-waves, though they do not have much affect far below the surface.
- Love waves are also characterized by overland movement, moving over the surface in a snake-like fashion, but they cannot move through water.
- Rayleigh waves are considered the most destructive to buildings, while Love waves can knock them off their foundations, and are also quite destructive.

http://geophysics.eas.gatech.edu/classes/Geophysics/misc/pics
What Characterizes Wave Action?

- **Distance from epicenter:**
  - The farther the quake travels from the epicenter, the more energy it loses.

- **Duration of strong waves:**
  - Damage increases drastically as strongest waves continue.
    - Strong waves last 5-6 seconds longer on soft bedrock than on medium bedrock, and 10-12 seconds longer than on hard bedrock.
    - Average earthquake duration increases by 1-1.5 seconds for every 10km distance from the epicenter. (Yanklovski et. al, 2011)
What Characterizes Wave Action?

- **Peak Ground Acceleration (PGA):**
  - The maximum speed and movement of a wave. Defined mainly by earthquake intensity, distance from the epicenter (acceleration decreases with distance) and ground section.

- **Frequency:**
  - The number of waves per unit time.

- **Self-frequency:**
  - The frequency at which a building or building material resonates to create greater vibrations in the material than those occurring around it. This occurs when oscillations are in time with the opposing forces created by the body's weight distribution, creating a pendulum motion but with outside energy continually being exerted on the body.
  - Self-frequency is different for every material.
Amplification

- Shaking is amplified in soft sediments, particularly those laying atop hard bedrock. The greater the difference between the hardness of the layers and the thicker the surface sediments, the greater will be the amplification. In addition, if the frequency of a wave matches the frequency of the layer, the ground amplification is liable to be very great. In this case, buildings with a self-frequency which matches the frequency of the amplification are likely to be particularly damaged.

Amplification in Israel

- There are sites around Israel which are at risk of amplification during an earthquake. These include areas in and around Tel Aviv, Haifa, Be'er Sheva and Eilat, as well as around the Dead Sea and the Sea of Galilee.

http://www.gsi.gov.il/Index.asp?CategoryID=104
Liquefaction

- Refers to granular earth which is saturated with water. Under steady conditions, the ground is able to hold the weight of buildings which it supports. In the case of slow shaking, water is able to flow from between solid particles, but when shaking is rapid, water prevents friction between solid particles and the ground acts as a liquid. Danger to buildings is in the changing state of the ground and the chance of all or parts of the foundation sinking. Ground shaking in this case is not the important factor in building damage. Low relative density of solid matter, low clay content, small effective size of the grains and low pressure on the ground increase the dangers of liquefaction.

http://www.ce.washington.edu/~liquefaction/selectpiclique/nigata64/tiltedbuilding.jpg
Liquefaction in Israel

- The coastal plain of Israel, which is heavily built up, is made up in large part of sand aggregates. This area is susceptible to liquefaction if a heavy earthquake reaches it. Part of the city of Tiberias is both susceptible to liquefaction and amplification due to its geological structure. The bay of Haifa has not seen liquefaction in recorded history, but the potential is there. In addition, there have been in the past occurrences of liquefaction in Eilat, the Jericho area and around the Dead Sea.
Landslides

- Slope stability fails, and earth or stone slides down. This instability can be the result of earthquakes. Landslides can occur as slowly as millimeters per year or faster than 200 km/h as with the fastest debris flows. Geological conditions such as stone with low shear strength, discontinuous or fractured stone, or layered stone (such as shale, which is geologically abundant, layered, and is clay-rich) and human-induced topographical changes such as deforestation and construction can increase the chances of a landslide.
Landslides in Israel

- The Galilee region has a mountainous topography, stone weak in shear strength and there are active faults throughout. Rivers which flow into the Sea of Galilee from the east and west, as well as areas in the southern Galil are also at risk of landslides.

http://www.gsi.gov.il/Index.asp?CategoryID=104
Tsunami

- Waves of several meters in height which are the results of earthquakes and landslides which occur in the sea. These waves move quickly across the open sea, slowing down and gaining height when they encounter a narrow bay and shallow waters. They can have devastating results on coastal areas. Tsunamis can occur in relatively small lakes. When this occurs they are called Seiche, and can also be very damaging.

http://0.tqn.com/d/urbanlegends/1/0/T/5/tsunami_sm.jpg
Tsunami in Israel

- Since the 2\textsuperscript{nd} century BCE there have been 10-12 tsunamis which have struck Israel's Mediterranean coast, making occurrence about one every 200 years. These occur in the Haifa region, the area around Tel Aviv, and Ashdod/Ashkelon. Tsunamis can also occur in the Sea of Galilee (Seiche), the Dead Sea and on the Eilat coast. These are caused by earthquakes and landslides on land and under the sea.
Full Preparation for Earthquakes

- Geological conditions, soils and ground bedrock must be thoroughly assessed in order to predict chances of landslides, amplification, liquefaction and tsunamis.
- The seismic history of the area must be known, along with details about nearby geological rifts.
- There must be up-to-date standards dealing with earthquake resistance in new buildings.
- There must be estimates of the resilience of existing buildings and upgrades, along with the resilience of infrastructure and industrial facilities. Problems must be treated accordingly.
- Of particular importance are facilities which may pose threats, such as storage sites for dangerous materials and special treatment facilities.
Earthquake Classification

- **Richter Magnitude Scale:**
  - Ranks earthquakes by the amplitude of the P- and S-waves at a distance of 100 km.
  - It is a logarithmic scale, meaning each whole-digit increase corresponds to a ten-fold increase in amplitude from the previous whole-digit rank.
  - Frequency can also be used to measure magnitude under the Richter scale. More energetic earthquakes have a higher proportion of low-frequency waves than less energetic ones. Each whole-digit increase in scale corresponds to about a 32-fold increase in energy released.
Earthquake Classification

- Moment Magnitude (Mw) Scale:
  - Ranks earthquakes by the shear strength of the material, the area of the fault which is ruptured, and by the average displacement of the fault. It is considered a more consistent measurement of earthquake magnitude.
Earthquake Classification

- Modified Mercalli Scale:
  - Ranks earthquakes based on the damage they cause to people and buildings.
  - The scale ranges from I-XII. While ratings of VI and lower typically measure damage to people and VII and higher measure damage to buildings, because of the different building codes from region to region, the modified Mercalli scale is location-dependent.

![Modified Mercalli Scale](http://raymondpronk.files.wordpress.com/2011/03/mercalli.gif)
The Arabian plate is one of three tectonic plates, along with the African and Indian plates, which is moving towards the Eurasian plate.

- These plates are moving at different rates, resulting in seismic activity.
- The Dead Sea Transform runs along the boundary between the African and the Arabian plates. It is a transform boundary, the only type of strike-slip fault which can be found at the boundaries between plates.
- The Dead Sea Transform is the source of most of the seismic activity in the region of Israel.
Seismic Activity in Israel

- Israel lies along the fault between the African and Arabian tectonic plates. This rift runs from Eilat in the south, through the Dead Sea and up to the Golan in the north. Movement along this rift is around 5 mm/year.

- There have been ten earthquakes of magnitudes between 6 and 7.2 in the last thousand years. The previous earthquake of this magnitude was in 1927, causing considerable damage to the cities of Jerusalem, Tsfat, Nablus, Ramla and Lod.

Israeli Standard 413

- Israeli standard 413 deals with building for earthquake resistance.
  - Passed in 1975, it did not apply to building plans which were already accepted. Anything built before the early 1980s in Israel does not meet the requirements.
  - States that residential buildings should be planned and built to be able to withstand an earthquake which has a 10% chance of occurring every 50 years (occurs on average about every 500 years).
  - More important buildings and facilities should be planned and built to stand an earthquake which has a 2% chance of occurring every 50 years (occurs on average about every 2500 years).
Guidelines for Engineers, Architects, Builders and Building Officials

W. Motzafi-Haller
Earthquake Relevant Design of Buildings

Fundamental Guidelines for Engineers, Architects, Contractors and Building Officials

Based on – Richtlinien des Bundesamtes fuer Wasser und Geologie
Bern, 2002
Close cooperation between architect and engineer from the start of planning stage
Wrong
Sequential Planning

Architect: Concept for load-bearing and non load-bearing building elements.
Engineer: Calculations for load-bearing and non load-bearing elements as well as earthquake specific reinforcements

Better and less costly approach
Cooperative Planning

Architect and engineer plan together – multifunctional load-bearing elements
Avoid soft ground floors
Avoid soft upper floors
Differences in stiffness and resistance are problematic
Avoid stepping of reinforcement elements
Avoid asymmetric positioning of reinforcement elements
Avoid short pillars

Pushing force leads to failure
Non-load bearing walls in skeleton style building must be separated from load-bearing element
Load bearing and non-load bearing elements should be tuned against each other
Stiffening of brick-wall through reinforced concrete wall elements

Reinforced load-bearing concrete wall

Load-bearing brick wall
Avoid filling of frame with bricks
Avoid mixing of pillars and load-bearing wall elements
Ductility

![Graph showing stress-strain relationship](source: sciencelesson.org.nz)

- **Stress** vs **Strain**
- **Strain Hardening**
- **Necking**
- **Ultimate Strength**
- **Fracture**
- **Yield Strength**

**Young's Modulus**

\[
\text{Young's Modulus} = \frac{\text{Rise}}{\text{Run}} = \frac{\text{Slope}}{\text{Run}}
\]
Steel cables tie joints together

Cables stretch, so joints can open without breaking when building moves in earthquake
Soft story buildings are characterized by having a story which has a lot of open space.

When a building has a story without shear walls, or with poorly placed shear walls, it is known as a soft story building, referencing the idea that the story without reinforcement will be soft and vulnerable in an earthquake.

There are many buildings in Israel that fit this description.

source: wisegeek.com
Avoid half walls within load-bearing frame

Reinforced load-bearing pillars
Design and calculate suitable steel-frame
Execute steel-frame as ductile element
Design appropriate voids between building elements
Design compact floor shapes
Increase strength through connected ceiling plate
Lateral rebar in load-bearing elements and pillars are anchored with a 135 degree return at a distance of not greater than 5 times the width of the rebar.
Never make unplanned openings in plastic areas. Openings must be carefully planned not to jeopardize overall performance.

Unplanned openings are forbidden!!
Context and Limitations

Y. Kalman
National Plan 38

- National Guideline Plan 38 (תת"א 38) was written up by the Ministry of the Interior and passed by the Israeli government in May 2005. This plan concerned all those buildings built before Standard 413 was implemented, creating incentives for owners and contractors to renovate unprepared structures.

- There have been several revisions to the plan aimed at improving its applicability and increasing the number of renovations carried out. (2007, 2009, 2011, and a separate plan for Jerusalem in 2011) There are also discussions about future changes. (2011, חברה להגנת החבועות)
<table>
<thead>
<tr>
<th>Year</th>
<th>Epicenter</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1033</td>
<td>Jordan Rift, Mediterranean Sea</td>
<td>6.3 on the Richter Scale</td>
</tr>
<tr>
<td>1068</td>
<td>Mediterranean Sea</td>
<td>6.3 on the Richter Scale</td>
</tr>
<tr>
<td>1201-2</td>
<td>Jordan Rift – between Dead Sea and Galilee</td>
<td>6.6 on the Richter Scale</td>
</tr>
<tr>
<td>1546</td>
<td>Jordan Rift – between Dead Sea and Galilee</td>
<td>6.6 on the Richter Scale</td>
</tr>
<tr>
<td>1759</td>
<td>Jordan Rift – between Emek HaHula and Galilee</td>
<td>6.3 on the Richter Scale</td>
</tr>
<tr>
<td>1837</td>
<td>Jordan Rift – between Emek HaHula and Galilee</td>
<td>6.6 on the Richter Scale</td>
</tr>
<tr>
<td>1927</td>
<td>Jordan Rift, north of Jericho</td>
<td>6.25 on the Richter Scale</td>
</tr>
<tr>
<td>1969</td>
<td>Northern Red Sea, the area of Sharm El' Sheik</td>
<td>6.5 on the Richter Scale</td>
</tr>
<tr>
<td>1979</td>
<td>Southern Dead Sea</td>
<td>5.3 on the Richter Scale</td>
</tr>
<tr>
<td>1982</td>
<td>The Galilee area</td>
<td>4.1 on the Richter Scale</td>
</tr>
<tr>
<td>1983</td>
<td>Eilat bay</td>
<td>5 consecutive earthquakes between 4.7-5.3 on the Richter Scale</td>
</tr>
<tr>
<td>1987</td>
<td>The Area of Arad</td>
<td>4.2 on the Richter Scale</td>
</tr>
<tr>
<td>1993</td>
<td>Tiberias, Golan</td>
<td>4.9, 4 on the Richter Scale</td>
</tr>
<tr>
<td>1995</td>
<td>Between Dahab and Nueba</td>
<td>6.2 on the Richter Scale</td>
</tr>
</tbody>
</table>
National Plan 38

Goals

- To improve the earthquake resistance of existing residential buildings.
- To create guidelines for building improvement.
- Second Revision: Adds guidelines and incentives for demolishing and rebuilding preexisting structures.

http://www.moin.gov.il/SubjectDocuments/tama38/%E2%80%8F%E2%80%8Fnosah_meshulav.pdf
National Plan 38
Implementation and Incentives

- Gives organizational and managerial suggestions including:
  - Promoting the reinforcing of buildings using such incentives as:
    - Allowing a deviation outside the boundaries set for a building's area and height according to the plan of operation.
    - Allowing building additions of either 25 meters to each additional apartment or the addition of new apartments of equivalent area.
    - Allowing these additions without the requirement of a town plan.
  - Additions of an elevator and visual renovations are used as incentives for residents to agree for their building to be reinforced to withstand earthquakes.
National Plan 38

Limitations

- The Ministry is to judge if these additions (combinations of addition types) are suited to the building according to the local conditions, location and surroundings.

- ס"כ 38 fails to provide a proper guideline or standard for executing renovations.

- Lack of experience of Israeli engineers has been a detriment to plan progress.
  - Renovations in Israel can typically cost 1,000,000 NIS.
Baruch Yarmolinsky

- Structural engineer with a long history of earthquake reinforcement. Claims that sufficient renovations can be made for as little as 10,000-30,000 NIS.

Experience Matters!
Ramat Gan

- Total proposals: 141
- Proposed before the commission: 45
- Proposals not accepted by the commission: 7
- Proposals accepted by the commission: 57
- Projects completed: 32

Tel Aviv: 195 Proposals accepted to date

http://www.ce.washington.edu/~liquefaction/selectpiclique/nigata64/tiltedbuilding.jpg
Reasons for Increased Implementation

- Addition of building rights was increased to 3 storeys.
- Now includes a destruction/reconstruction clause in case renovation is not an option. This method is more sturdy.
- Flexibility to transfer building rights to neighboring buildings when height is limited, in order to preserve historic buildings, etc.
- Required agreement rate by tenants was reduced to 2/3.
- Added incentive, to increase the size of existing apartments.
- Implemented tax incentives.
- Promotes gentrification, improving neighborhood property values.
- Professionals have been gaining experience over time.
- The establishment of organizations aiding in the process.
Be'er Sheva

- Strong need for renovation.
- “Periphery” problems.
Solutions?

- Transfer of building rights:
  - Reinforcing the periphery allows building additions in the center.
- Proper guidelines for renovations.
- Strong disaster mitigation planning is necessary even if buildings are prepared for disasters.
The Civil Realm

I. Kaplan
Earthquake disaster research takes for granted that “earthquakes do not kill people, buildings do”. Buildings are built and inhabited by people who make a range of choices that shape whether these buildings cause earthquake-related deaths.

(Solberg et al 2010)

- Resilience strategies
- Vulnerability
- Factors influencing preparedness
- Enhancing preparedness
- Case of Israel
Research from US, Iran, Turkey, Israel, Morocco, Romania and New Zealand tends toward the same overall conclusion.

In sum, a large proportion of respondents do nothing or very little to adjust to seismic hazards.
Factors Influencing Seismic Adjustment

Perception of Risk

Seismic risk reduction efforts have often operated on the assumption that communicating scientific estimates of seismic hazard and societal vulnerability to exposed communities will raise risk perceptions and concerns to levels that will drive seismic adjustments (Smith, 2006).
Factors Influencing Seismic Adjustment

Perception of Risk

- A number of psychological variables have been consistently linked to increased perception of risk. First and foremost, past experience of damaging earthquakes has been found to increase risk concerns.
- However, the strength of the relationship between past experience and increased concern seems to vary depending on how earthquake experience is measured, and on the outcome of the experience (Lindell and Perry, 2000).
Factors Influencing Seismic Adjustment

Perception of Risk

- Despite living in high earthquake risk communities, being aware of future risk and having memories of past earthquakes, people’s critical awareness of earthquakes is often low in the absence of trusted warnings or predictions of imminent risk (Armas, 2006).
Factors Influencing Seismic Adjustment
Psychological Biases in Seismic-Risk Perception

 “Optimistic bias” (OB) displayed in the face of being affected by a risk.
 OB is a pattern of judgments where people see themselves as being less likely to be harmed by future risks than peers of a similar age and gender who they are asked to compare themselves to (Spittal et al., 2005)
Factors Influencing Seismic Adjustment
Psychological biases in seismic risk perception

- The literature suggests that this is partly related to culturally contingent notions of the self – in collectivistic cultures the emphasis on a relational, interdependent self-concept militates against such optimism. This suggests that optimism would be a less common psychological coping mechanism in more collectivist societies (Solberg et al 2010).
Factors Influencing Seismic Adjustment
Social factors and seismic risk perception

- Older people are less likely to see earthquakes as a risk when compared with younger people.
- In locations as diverse as the US, Turkey, Romania, Japan and Morocco, females and minority groups perceive themselves to be more at risk of being affected by earthquakes than men and majority groups, respectively (Solberg et al 2010).
Factors Influencing Seismic Adjustment
Material Risk Factors and Seismic Risk Perception

- Studies demonstrate the importance of treating the material and built environment not merely as the origin of exposure or hazard, but as a source of meaning for the people who live in it.
- For instance, strong attachment to a place of living, high satisfaction with property and attachment to possessions might drive higher risk concerns as well as place-protective motivations (Stedman, 2002).
Factors Influencing Seismic Adjustment
Norms and Social Identities

Social structural variables such as age, gender, ethnicity and status influence the content and strength of seismic risk perceptions.
Factors Influencing Seismic Adjustment Norms and Social Identities

- Groups with less social, economic and psychological power, such as females, the old and the young, ethnic minorities, groups low in socioeconomic status and populations with special needs (e.g., physically or mentally challenged people, homeless, transients and tourists) are most vulnerable to environmental hazards (Solberg et al 2010).

- Lessons learned from 1999 earthquake of Turkey show that factors of social alienation and education level have extremely significant effect on behavioural patterns of preparation for and during disaster incident (Ecevit and Aytül 2002).
Factors Influencing Seismic Adjustment
Norms and Social Identities

- Norms derive from people’s perceptions of others’ behaviours, irrespective of whether these are approved of or not. They also derive from perceived outcomes of behaviours.
- An example would be individuals seeing that their neighbours had installed latches on their cupboard doors (Mileti and Darlington, 1997).
Factors Influencing Seismic Adjustment Norms and Social Identities

- People’s seismic adjustment attitudes and decisions are influenced by whether and how they see and hear social reference groups attending and responding to seismic risk information.

- By following what members of their reference group say and do people ensure that they behave in ways that are congruent with their own and society’s expectations of them (Mileti and Darlington, 1997).
Factors Influencing Seismic Adjustment

Trust

- In a number of countries community planning in general, and emergency management and disaster resilience building in particular, are arenas filled with increasingly professionalised, specialised and politicised actors.
Factors Influencing Seismic Adjustment

Trust

- Trust is a crucial factor underpinning adjustment adoption. Levels of trust strongly influence whether people take hazard warnings seriously and how they deal with them. A lack of trust in civic risk managers can lead to controversy and divisiveness, thus hampering efforts to enhance individual and social resilience (Slovic, 2000).
Results from both New Zealand and Japan indicate that collective efficacy has a positive influence on seismic adjustment intentions (Paton, 2008; Paton et al., 2010).
Strategies Towards Preparedness

- First ascertain the characteristic patterns of seismic damage and transform them into simple models that are applicable to significant proportions of buildings in a given urban area. This will help explain how people are put at risk. It is helpful if such buildings can be mapped for emergency planning purposes so as to show where the greatest vulnerabilities lie (Paton and Johnston 2001).
Strategies Towards Preparedness

Individual Preparedness

House adjustment
Identifying the safest part of the house
Exit strategy
Mutual support Networks
Collection and storage of emergency supplies and equipment (See appendix)
Strategies Towards Preparedness
Individual Preparedness

- With respect to earthquake engineering, of particular note is people’s strong association with preparedness being related to ‘survival’ and the ‘basics’. This is physically reflected in the fact that people are more likely to prepare by gathering together survival items than undertaking more complicated or expensive actions such as retrofitting their homes. It appears that there is still work to be done to assist people in understanding that the retrofit of buildings and securing of building contents is an important part of earthquake preparedness (Becker et al, 2011).
Whether individuals do, or do not prepare and mitigate for future earthquake occurrences is significantly affected by the degree to which they engage in public education activities about the earthquake hazard.

Thus strategy needs to include:

- Available information on earthquake scenarios and action
- Community Emergency Team
- List of possible risks
- Demographic mapping
- Data base of volunteers
Strategies Towards Preparedness
Planning and Communicating Survival Strategies

Passive information - predominantly raise awareness and knowledge, but also might lead to fatalism

Interactive information - more likely to apply any lessons learned during the activity at home

Experience - extremely influential in helping people understand the consequences of a disaster and in forming beliefs (Becker et al. 2011).
Strategies Towards Preparedness
Planning and Communicating Survival Strategies


• Regional programs: such as the Earthquake Country Alliance’s “Dare to Prepare” campaign launched in 2007. It focuses on the earthquake hazard in southern California organizing the largest-ever earthquake drill, the “Great Southern California Shakeout,” in 2008.

• Local programs: In Los Angeles and San Francisco are well tailored to the demographics of the local communities and effectively use local media outlets (e.g., local news, PSAs, bus and shelter ads, community fairs, etc.) to disseminate their messages. (Alfred E. Alquist Seismic Safety Commission 2009)
The following chart demonstrates the level of effect of various means of earthquake risk communication to the public

(Alfred E. Alquist Seismic Safety Commission 2009)
People tend to see damage incurred in earthquakes as uncontrollable.

A related state is learned helplessness.

A related notion is earthquake fatalism.

Fatalism was negatively correlated with preparedness.
Strategies Towards Preparedness
The Role of Media

• Most people in areas at risk from earthquakes have never experienced a major earthquake and rely on other sources for information. Mass media comprise a primary source of information on disasters and play an important role in shaping citizens’ knowledge of natural disasters.

• News reports on disasters have public appeal, attract large audiences and are well remembered.
Strategies Towards Preparedness
The Role of Media

• Distinctiveness of the damage to buildings
• People attributed distinctive damage more to the building’s design, a controllable factor, whereas generalized damage was attributed to the magnitude of the earthquake, an uncontrollable factor.
Strategies Towards Preparedness
The Role of Media

• Lack coverage comprehensiveness
• Most tragic incident-images of mass destruction
• Contain inaccuracies
• Overdramatize social and individual reactions
• Journalists select information that confirms a panic image, thereby portraying the impression that panic is inevitable
Strategies Towards Preparedness
The Role of Media

• The Day-After Reports
  • ‘General damage’ - number of buildings being damaged in the earthquake. However no specification on the construction of the buildings, no comparative information on the proportion of buildings that was damaged
Strategies Towards Preparedness
The Role of Media

• The Day-After Reports
  • Earthquake agency’-earthquake as the agent that produced the effects and are defined as sentences that present the earthquake as the subject, followed by a verb and an object an uncontrollable cause, caused this destruction
• Year-after earthquake newspaper reports
  • “Specific damage” - comparative and quantified account of building damage
  • Different types of buildings in the same area suffered different levels of damage from the earthquake.
  • Levels of damage varied (good/poor structural design) and implied that damage is caused by a particular building’s construction, a controllable cause.
  • “Lessons”
Strategies Towards Preparedness

The Role of Media

• Judgments

• As predicted, with earthquake agency and general damage scenarios from day-after reports, participants attributed the damage to earthquake magnitude more than building design, whereas with specific damage and lessons scenarios from year-after reports, they attributed the damage more to building design.

• The results support the prediction that damage would be judged more preventable for a specific preventive action (modifying a building to meet building codes) than for a general question about whether damage could be prevented (Cowan et al. 2003).
The Case of Israel
Reference Scenario to Israel

7.5 magnitude earthquake
16000- killed
6000-seriously injured
377,000 – displaced
10,000 buildings will collapse
20,000 building will be heavily damaged

(www.knesset.gov.il/mmm 2010)
The Case of Israel

Relevant Agencies

- Government of Israel decided in August 1999 to establish a ministerial committee on preparedness of the State of Israel to Earthquakes.
- The Ministerial Committee established the steering committee for earthquake preparedness which is headed since January 2008 Dr. Avi Shapira
- National Emergency Agency (NEA) established under government decisions since 2007 and is intended to be responsible for the functioning of various emergencies, including an earthquake. NEA operating under the responsibility of the Defence Ministry and its budget, working on earthquake preparedness, planning and conducting large-scale exercises and general practices of the relevant agents and organizations in case of earthquakes

- Local municipality - https://sites.google.com/site/herumbash
- Third sector - http://www.childrenatrisk.co.il/Page.asp?PiD=0.2.8&id=9
The Case of Israel

Accessibility

- IDF (Home Front) – no accessibility by phone
- National committee for earthquakes – no accessibility by phone
- Beer Sheba local call center- no accessibility by phone
- Community preparedness – Social work coordinator – Municipality level preparation program, dissemination to community not yet started. No survey on dispersal of special populations or approach considering different strata of residents
The Case of Israel

Accessibility

- It appears that the load of preparing the civic population for earthquakes is perceived as a role of local municipalities and assisting NGOs (see appendix)
Health, Water & Sanitation Effects of Earthquakes

W. Nasrallah
Public Health Impacts of Earthquakes

Deaths resulting from earthquakes can be instant, rapid or delayed

- Instant deaths occur due to severe crushing injuries to the head or chest, internal or external bleeding or drowning due to earthquakes tsunami.

- Rapid death occurs within minutes or hours due to dust inhalation, chest compression or Environmental exposure (e.g. hypothermia).

- Delayed death occurs within days due to hypothermia, hyperthermia or wound infections.
Additional or Secondary Disasters Following an Earthquake

**Fire:** Severe shaking may cause overturning of stoves, heating appliances or lights starting a fire. Earthquakes that trigger fires cause 10 times as many deaths as those that do not.

**Dams:** Can be a threat to all communities downstream.
Additional or Secondary Disasters Following an Earthquake

In industrialized countries earthquakes cause major technological disasters by damaging nuclear power stations, research centers and areas storing or producing chemical and toxic products.

Example: Japan Earthquake in 2011 caused a massive leak spilling, contaminated water containing radioactive material that was then flushed into the sea.
Factors that influence Earthquakes Mortality

Natural Factors

• Tsunami: A tsunami can be created directly by underwater ground motion during earthquakes or by landslides, including underwater landslides. Tsunamis can travel thousands of miles at 300-600 mph with very little loss of energy.

• Aftershocks: Most earthquakes are followed by many aftershocks, some of which may be as strong as the main shock itself. Many fatalities and serious injuries occur from a strong aftershock.

• Time of the day: Time of day is an important determinant of a population's risk of death or injury, primarily because it affects people's likelihood of being caught in a collapsing building.
Factors that influence Earthquakes Mortality

Occupant location in a building and entrapment: people who are over 60 years old are at increased risk of death or injury, children between 5 and 9, women and the chronically ill are also at high risk of death or injury than the rest of the population.

Occupant behavior: people’s behavior during an earthquake is important for their survival (panicking, rushing to the nearest exist)

Time until rescue: Although the probability of finding live victims diminishes very rapidly with time, entrapped people have survived for many days. People have been rescued alive 5, 10, and even 14 days after an earthquake.
Anticipated Public Health Problems

• Water Sanitation related diseases
• Diseases associated with overcrowding
• Mass feeding without adequate food handling, storage and sanitary facilities
• Disposal of dead bodies
• Rodents and stray dogs (animals problems)
• Psycho-social and Mental health problems.
• Sexually transmitted diseases.
Health Effects of Earthquakes

- Water and Sanitation related diseases – due to interruption or damage caused by an earthquake to the water and sanitation systems.
Water and Sanitation

- The number of people needing water and sanitation services after an earthquake is much higher than the number of people killed or injured.

- Lack of water and sanitation services increase the number of persons affected.

- Lack of water can cause panic and lead people to drink from unsafe sources resulting in rising disease rates.

- Contamination of water due to damaged sewage infrastructure increase the disease rates. (E. Coli Diarrhea)
Water and Sanitation

Earthquake effects on Wastewater systems

- Direct effects – Damages which are caused directly from ground shaking or movement. The most critical part of a WWS are the pipelines.

- Indirect effects – Through tsunami waves flooding the systems or damaging the Electricity.
Prevention and Control Measures

- **Primary Prevention** – implementing public health measures that would reduce the population exposure to risk factors such as ensuring safe drinking water supplies, adequate food supply to prevent malnutrition and providing vaccination for diseases that are more likely to spread in disasters.

- **Secondary Prevention** – Curing patients with diseases through early detection and treatment.

- **Medical preparedness** – Development of specific training programs for medical and rescue personnel as well as the appropriate deployment of medical and rescue equipment in advance of an earthquake disaster.
Prevention and Control Measures

- Training programs for search and rescue teams: in order to act fast after an earthquake hit, this will help minimize number of entrapment casualties.

- Effective emergency medical services: the greatest demand of medical treatment occurs in the first 24 hours after an earthquake. Treatment sites, whether at hospitals or in temporary field clinics should designate someone to organize surveillance of injuries, collect data, and see that the data are tabulated and reported to disaster-response health officials.

- Environmental Health: Effective environmental control measures should prevent secondary environmental health problems.

- Solid Waste disposal – Is it a problem? How do people dispose of their waste? What type of waste is produced and what is the quantity?
Prevention and Control Measures

- Hygiene and sanitation measures – providing toilets (no more than 20 people should use each toilet, separate toilets for men and women), providing enough water for hygiene needs, at least 250g of soap per person per month.

- How much water is enough?

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<th>2.5 to 3 litres per day</th>
<th>Depends on: the climate and individual physiology</th>
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<td>Depends on social and cultural norms</td>
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<td>Basic cooking needs</td>
<td>3 to 6 litres per day</td>
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<td>Total basic water needs</td>
<td>7.5 to 15 litres per day</td>
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</table>
Prevention and Control Measures

- Quality of water – throughout the water supply chain from source, through transport to the storage, use chlorine to disinfect water, boil water before drinking.

- Survival Kit - includes water, canned food, can opener, extra medication, whistle, flash light, batteries, blankets, toilet paper, soap, shampoo, tooth brush, toothpaste, feminine hygiene supplies.
Disaster Relief and Response Organization

A.N. McBride
Responding to Disasters

▪ There has been extensive research done in order to set a standard of response and best practices for aiding communities in disasters.

▪ The following suggestions are based on the best practices set forth by:
  ▪ USAID protocol
  ▪ US Air Force Refugee Camp protocol
  ▪ UNHCR Disaster Response
  ▪ SPERES Guidelines for Disaster Response
  ▪ Israeli Disaster Response
Example: Be’er Sheva

- For this studio we are running the scenario of a major earthquake affecting Be’er Sheva and the surrounding communities.
- Areas of the city would be greatly damaged.
- Already marginalized groups would be greatly affected.
- Current plans would require the city of Be’er Sheva to host at least 8,000 displaced individuals.
- Our plan is preparing for 12,000 in the short term in need of care and housing.
95% of the administration of a disaster response will be governmental either through the military, emergency services or ministries.

Local NGOs can be vital in supplying supplementary services and assistance to long term reintegration.

International Organizations, NGOs and other nations should be utilized for expertise, additional supplies and support.
Organizational Phases of Disaster Response

**Initial Phase**
- Chaotic & Disorganized
- Damage to infrastructure
- Survivors first responders (highly dangerous)

**Primary Phase**
- Military (Home Front) major player
- Coordination with local authority
- International Assistance
- Survivors removed from relief response

**Transitional Phase**
- Response not complete but military intervention no longer needed
- Transition to civil administration of disaster
- Approaching return to pre-disaster standards
The First Hours

- It is an error in previous disaster plans to place so much responsibility for the first response on local emergency services.
- Local services are not equipped to meet the needs of a major earthquake and many of the emergency workers will not be able to report to work immediately as they will be attempting to secure their families.
- It should be assumed that it will take a minimum of three days for emergency services and local government to be at full capacity.
- However a response should begin as soon as possible both by local and national emergency services.
- Israel has proven very affective at sending medical teams to areas of the globe. Israel has been able to respond to earthquakes in Turkey, Greece and Haiti in less then 48 hours.
- It is not unrealistic to suggest that the beginning of an aid response by these same units should occur within the first 24 hours.
Structural organization of Home Font Command for deployment during national emergency.
Timeline of Relief Response to an Earthquake in Be’er Sheva: Initial Phase

1. Earthquake Zero Hour
   - Survivors try to help themselves and others

2. Local First Response Hour 0-5
   - Survivors help others
   - Local Rescue and Evacuation
   - Mobilization of national response

3. Initial Home Front Response Hour 5-72
   - Rescue/Evacuation
   - Triage/Emergency Medical
   - Establish supply train
   - Coordinate with Local Government
   - Rally points and assistance in leaving area
   - Establish Evacuee camp
Assembly Points

Assembly Points will be established around the city (parks, open spaces) these will be used to calm individuals, help unite families, provide first aide and transport injured people to the hospital. As many personnel as possible should be sent to distribute water, first aide, blankets and talk to people. If phone service is down assistance should be given for people to make calls to family or arrange to leave the area.
Timeline of Relief Response to an Earthquake in Be’er Sheva: Primary Phase

Primary Home Front Response
Hour 72+
- Complete S&R
- Establish law and order
- Eliminate threat to human life
- Help reestablish local government services
- Keep supply chain coming

Evacuee Services
Hour 72+
- Assist in family reunification
- Assist those who wish to leave the area
- Maintain evacuee camp
- Provide trauma counseling

Rubble Removal and Vital Infrastructure
Hour 72+
- Reestablished damaged vital infrastructure
- Remove hazards
- Begin reconstruction
Timeline of Relief Response to an Earthquake in Be’er Sheva: Transitional Phase

**Reconstruction**
Week 1+
- Help facilitate Public/Private initiative to reconstruct damaged areas keeping community needs in mind

**Transitional Camp**
Month 6
- Move remaining evacuees in camp to homes or provide more stable housing
- Provide social services needed to transition back to normal life

**Military/Civil/Private change over ASAP**
- When threat to human safety is alleviated military response should work in partnership to transition to a civil administration of the disaster
- Level of response from the private sector will be determined
A.N. McBride

Be’er Sheva Evacuee Camp
Camp

• Camp based on international standards established by the UNHCR and SPHERE
• Standard of living and cultural considerations taken into account as much as possible
• Initial response is to house 12,000 people. Which will be divided into 3 camps of 4,000 on the same site. Site has potential for 2 more camps of 4,000 if need arises.
• Beer Sheva’s maximum capacity for temporary shelters within the city after an earthquake is approximately 22,000 individuals. Relocation outside the city will be necessary after that.
Camp

• First Response Camp Team should be attached to the larger military response to the area

• Response team should include designated Camp Commander, Security Officer, Medical Officer, Civil Affairs Officer, Supply Officer, Survey Team (Hydrologist, Civil Engineer and other pertinent experts) and least 1 platoon (30) of soldiers though a company (90) is preferred per each camp.

• Camp Construction in Two Phases
  • Evacuee Camp Phase One: Tents Day 1-Month 6
  • Evacuee Camp Phase Two: Transition to caravans while construction of housing occurs
Immediate Response: On the Ground

- Survey Team will first locate the designated “camp sites” pre-selected for a camp and insure that the sites are appropriate to use after the Earthquake. If the sites are damaged the Survey Team is responsible for finding alternative sites that are safe and accessible. They should also survey any buildings they wish to commandeer for the camp.

- Civil Affairs should link with local government. Assess disruption in governmental infrastructure and estimate how many evacuees need to be addressed. They should also assist in any legal necessities for acquiring land or buildings.

- Medical, Security, and Commander should coordinate with rescue efforts (military and civil) to assess the number of evacuees, their health and possible Rally Points and transport routes.
Camp Construction & Supply Distribution

- Rubble must be cleared quickly.
- Camp Central is established first (Triage tent, Command tent, and Mess tent minimum) with light perimeter fence. A full outer perimeter fence does not need to be established at this time but should be a priority. A gate is preferred. Using surroundings to create boarder without having to create a full perimeter fence is preferred.
- A reception area must be established with shade, water and toilets available.
- Water points and toilets need to be established in tent clusters. Portable toilet/shower trailers should be used with disposal handled by the military or contracted to a local company.
- Military personnel should establish their camp and secure supplies
- Military and Medical personnel should keep their sleeping quarters at a distance from the evacuees area for the mental health of the personnel.
Camp Unit-Holds up to 1,000

- Mess Hall and kitchen
- Meeting space
- Unit Admin
- Shower/Toilet Trailer
- Cluster Holds up to 100
- Tent
Camp Construction & Supply Distribution

- The Assembly Points will begin coordinating people to the camp either on foot or if transportation is available with vehicles. Efforts should be made to bring the elderly, children and the disabled first.
- Military constructs first camp clusters preferably around Camp Central. If that is not possible then a configuration that limits the walk to the center of camp to less than 10 minutes.
- Special clusters for unaccompanied minors or special cases will be housed closest to Camp Central.
- The reception area receives first evacuees. People are counseled, hot food, water and toilets available, children should be entertained as adults register with the camp. Evacuees will receive camp orientation. Issue some form of identification for evacuees registered in the camp. Arm bands usually work best though it may not be culturally sensitive in Israel.
- In groups of 50 evacuees will be brought back to camp clusters by staff and be given matting, bedding, towels and jerry cans.
- If there are more evacuees arriving then the rate of tent construction, employ evacuees to help in tent construction or to build their own tent.
Camp Construction & Supply Distribution

- In the first 48 hours the main priority is to keep people out of harm’s way, have injuries taken care of, assist in the uniting of families, provide trauma counseling, feed the evacuees and let them have access to clean water.

- Cooking should be discouraged and eating at the mess hall encouraged in the first few days.

- Urge people to sign out of the camp if they plan to leave so that their tent can be reused.

- Security should be present but should make an effort to not appear as a threat to the evacuees.
Intermediate Period

First month

- As the initial shock of the event fades the remaining evacuees in the camp will be there because they have no other alternative.

- As early as the first 72 hours after the disaster the military operation can begin to transition to a joint military-civilian administration. Partnering with the ministries of Housing, Education, Transportation, Health, Environmental Protection, National Infrastructure, as well as NGOs to help provide needed services and maintain the camp.

- Camp Commander should lead a joint committee of providers in the public and private sector to insure consistency of service. NGOs wishing to work with the evacuees should register through the camp commander or partner with a governmental agency.
Intermediate Period
Month 1-6

- Entertainment and enrichment activities should be made available and children should rejoin school as soon as possible.
- Evacuees should be given priority in placement in Absorption Centers or other alternative housing options.
- Those who remain in camp after 6 months should be upgraded to caravans or more stable housing with running water and a toilet. Mess hall can be removed and triage center down graded to clinic.
- Those that leave the area must be insured that they are not revoking their rights to property they own.
Transition Period
Month 6- onward

- Military support for the camp is limited to security and camp command is transferred to civilian authority, preferably the Ministry of Housing.
- Military Camp Commander should issue Transition Report with recommendations to civilian personnel on transitioning the population post earthquake.
- Focus of civilian administration should be on transitioning population out of camp.
Evacuee Site, Temporary Shelters and Rehabilitation

Y. Cohen
Disaster Sheltering Strategy

Post-Earthquake Strategy Goals, Approaches and Ramification
## 25 Last Earthquakes in the Region

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<th>Y (Tm)</th>
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<td>Elat-Deep</td>
</tr>
<tr>
<td>2012-03-12</td>
<td>02:31:31</td>
<td>27.248</td>
<td>32.740</td>
<td>-24.620</td>
<td>131.800</td>
<td>32.0</td>
<td>4.1</td>
<td>4.2</td>
<td>0</td>
<td>0</td>
<td>Egypt</td>
</tr>
</tbody>
</table>

Why Be’er Sheva?

- The Negev Highland & Israel Costal Plain south of Haifa are within the safest area of the country.
Why Shelter?

• Devastating Earthquakes are followed by inability to provide basic needs
• Shelters provide, as well, the possibility to reorganize the impacted area and its inhabitants
Requirements

• Rapidly available
• Draw on local suppliers and/or local resources
• Meet local living standards in terms of comfort, services and location
• Design for the length of time temporary housing is needed or an efficient long-term plan for the units
• Easy to remove and non-polluting (Reusables)
When, What?

• The 4 Stages of Housing in the Recovery Process:

1. Immediate relief (within hours); setting safe zone
2. Immediate shelter (within a day or two); tents & plastic sheets
3. Temporary housing (preferably within weeks); prefabricated or self-made dwelling Units
4. Permanent housing reconstruction (probably within a few years). Evacuation and replacement of damaged structures.
## Shelters Time Line

<table>
<thead>
<tr>
<th>Time:</th>
<th>*</th>
<th>1 yr</th>
<th>2 yrs</th>
<th>3 yrs</th>
<th>4 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency aid and rehabilitation</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Construction of emergency shelters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction of temporary housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction of temporary infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Execution of 'soft' outputs for recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction of permanent housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dismantling of temporary housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End of the temporary housing project</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In black: the time that people lived without permanent housing
Strategy Layout- Two Approaches

1. The ‘Self-Help-Only’
   - Introduction of sustainable self-sufficient development
   - Concentrating on the long-term rehabilitation
   - Overseeing the urgency

2. The ‘Import-Ready-Made-Solutions-at-any-Cost’
   - Solving the immediate shelter/housing problem
   - Leaving the community development aspect for later
   - Waste of resources
Two Different Housing Steps

Turkish Case

- Apartment
- Tent
- Temporary housing
- Temporary housing

Colombian Case

- House
- Improvised shelter
- Temporary shelter
- Temporary housing

* Becoming permanent de-facto
# Realty Check

## Advantage & Disadvantage of “Soft” & “Hard” T.H.

<table>
<thead>
<tr>
<th></th>
<th>Soft</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Availability</strong></td>
<td>Immediate - Both in public &amp; private sector – Army, equipment stores, civilian, etc.</td>
<td>Scarce – Local manufacturers if exists or imported</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>Unplugged</td>
<td>Plugged</td>
</tr>
<tr>
<td><strong>Climate Resilient</strong></td>
<td>Not adapted &amp; fragile</td>
<td>Could be climatic resilient &amp; stabile</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Cheap</td>
<td>Expensive – Although assist local manufacturers</td>
</tr>
<tr>
<td><strong>Pre-Planning</strong></td>
<td>Not necessary</td>
<td>Needed</td>
</tr>
<tr>
<td><strong>Psychological Effects</strong></td>
<td>Immediate ease only</td>
<td>Longer positive effects</td>
</tr>
<tr>
<td><strong>Long-Term</strong></td>
<td>Abandoned &amp; non-recyclable</td>
<td>Tend to stay longer &amp; recyclable or tradable</td>
</tr>
</tbody>
</table>
What Usually & Universally Occurs

- Immediate response by the government (Including the Army) and by relevant NGOs
- “Soft” temporary housing is provided (tents)
- “Hard” temporary housing is provide to those waiting for their rehabilitation
- The creation of slums and refugee ghettos
- No long-term plans or strategy regarding these two outcomes
- The reconstruction process concentrated only on fast, cost-effective dwelling units
Outcomes

- Immediate shelters do not fit the communities
- Prefabricated or any type of “Hard” shelter create problems (waste, social and economical)
- Victims stay longer then expected in most “Hard” units
- Post-development disregard the needs of communities and the environment
Conclusion

- There are Many “Types” of Shelters
- The Governments has its Disaster-Plan (Which is Almost Universal)
- There is no Contingency Planning
- And no Specific Post-Disaster Planning and Rehabilitation
Malon Orchim (Lodging Place, Jeremaia, 9, 1)

The Approved Israeli National Post-Disaster Plan

- Conduct by the Ministry of Home Front Defense
- Main Goals
  - Operation plan for all disasters
  - Allocating responsibilities
  - Funding and Budget Sources
Responsibilities

- Macro responsibility & resources - Army & Police
- Local responsibility (site locations, distribution & sociological and physiological assistant) – Municipal
- Education & Entertainment – Ministry of Education
- Shelter & Rehabilitation – Ministry of Housing
- The Negev Highland settlements are designated to Host Evacuee
- Worst Scenario – 300,000 Evacuees
Evacuation Site

- Each municipality will host a minimum of 4% of its Population (for example: Beer-Sheva must host min. of 8000 p.)
- Small gathering “Safe Sites” – (up till 100 p.)
- Distribution of evacuee (by buses 50 p. each)
- Evacuation sites (Could be commandeered if needed)
  - Stage I – Tents
  - Stage II – Hotel Confiscation
  - Stage III – Caravan Site
  - Stage IV – Rehabilitation
- Each family will receive some form of financial compensation
- Education, social & health – Locate within or near sites
Site Location Strategy

Preplanning with the available tools
GIS software based modeling
Site Location

- As concluded before site location is crucial and unaddressed
- Pre-Location would provide:
  - a safety net for the responsible authority
  - Awareness among the population
Strategy Scheme

Assembly Site

Suitability:
- Safe Zone
- Accessibility
- Future Development

Evacuee Site

Rehabilitation Site
Assembly Site
Suggested Strategy

- Open space
- Near a public building designated to host evacuees
- Inside the maximum structural collapse buffer *
- Clear Accessible Routes

* Calculated individually to each structure according to its height and within 360 degrees of possible collapse buffer
Site Location

Suggested Digital Strategy

- Building a GIS Model for the ideal site location

- GIS – Geographic Information System
  - Available in municipalities
  - No needed extra data just reorganize it according to a set formula
  - Fast & flexible computing
  - Easely reproduce and adjust to on-site changes
Site Location
Suggested Strategy

• Euclidean Distance Base Model
  – Combining and computing different aspects effecting site location
  – The model would include all need and given data according to:
    • Suitability Index (according to the weight of each aspect)
    • Danger Buffers
    • Future Development
Site Location
Suggested Strategy – Example

- An example of a model given the available data we collected from local government GIS departments
- Each available aspect is marked with its “weight” in the formula
- The sum of all of the relative Euclidean Distances would result within the suitability index
Model Construction

- Calculating the Euclidean Distance of the Selected Services

Hospital

Main Public Transportation Stations

Example

Example
Model Construction

- The suitability computing process* results in a index-map presenting the areas most suited for hosting evacuation sites.

* After summing the relative weight of each aspects’ Euclidean Distance and the area’s slope and elevation.
Site Selection – preferable sites

Legend
suitability
Value
High : 371.17
Low : 0.93

North Site
Center Site
South Site

Adding the Maximum Structure Collapse Buffer

Within the “Hotspot”

Adjacent to the Built Tissue

Open-Land

Preferable up to Development

Example
Selected Site

Center Site

- Characteristics:
  - With in the most suitable area according to the suitability index
  - Located in a strategic place (between different neighborhoods)
  - Available for development
  - Accessible both locally and nationally and by multiple traffic modes (pedestrian, private motorize and mass public transportation)

* Selected site in yellow
Evacuee Site

Accessibility

- Clear routes from assembly sites and access to mass transit facilities

* Selected sites in yellow
Evacuee Site 3 Stage Process

- Tent Camps (~4,000 p)
- Caravan Camp (~2500 p)
- Permanent Construction (Urban Sustainable Development)
Waste Management

Table of content

Waste management
- Why should it be included in the plan?
- Environmental implications

Solid Waste disposal
- Content of debris
- Large scale evacuation plan
  - Identification of open spaces and evacuation routes in cities
- Waste treatment

Case studies:
  - L’Aquila earthquake
  - The Northridge L.A.

Summary
Waste Management

Why should it be included in the plan?

“Earthquakes generate shock waves and displace the ground along fault lines. These seismic forces can bring down buildings and bridges in a localized area and damage buildings and other structures in a far wider area. Secondary damage from fires, explosions, and localized flooding from broken water pipes can increase the amount of debris. Earthquake debris includes building materials, personal property, and sediment from landslides.” (EPA, 1995).
Waste Management

Why should it be included in the plan?

- Disaster debris hold emergency services from reaching survivors.
- Untreated waste can pose a hazard for public health and the environment.
- Piles of waste will influence the social and economic recovery of the affected area.
- “On a psychological level, disaster waste can serve as a reminder to communities of the losses they have endured.” (Brown et al, 2010)

The first and most comprehensive national guidance on disaster debris management was USEPA’s “Planning for Disaster Debris”.

“The plan is an official document that often is filed with the state, and when regional solid waste services or facilities are involved, a copy often is provided to neighboring communities as well.” (EPA, 1995)
Waste Management

Environmental Implications

- One major implication for landscape is the overwhelming amount of debris and waste created by the destroyed buildings.

- Waste has major implications for the environment which is increasingly polluted with non-biodegradable waste. Furthermore, the embodied energy within the building material is completely wasted as new materials are manufactured and used to construct new buildings.

- Waste management is a huge sustainability issue that therefore crosses over as an implication for landscape and the state of the environment.

- The waste created in constructing cheap, temporary or quickly constructed buildings is of major concern to long term sustainability objectives.

- Waste treatment can also impact the environment when it takes over land, infiltrates to the ground, combusted, etc.
Solid Waste Disposal

Disposal of large amounts of debris from a disaster area is not an easy task. In order to be prepared for this part of the event a plan should be made. The plan should include:

1. Framework of management - Establishment of responsible teams Covering issues of decision making, legislation and active evacuation and treatment of the waste.
2. calculations of the estimated volume and content of debris. types of materials and their amounts.
3. Evacuation of debris – An existing land fill or an open space that is destined for this purpose. In addition, main routes and suitable equipment for the evacuation work should be designated.
Solid Waste Disposal

Framework of Management

Governments tend to have some kind of legal framework and funding system for an emergency disastrous event. In cases of no pre organization, the government will need to develop a new framework specific to the event. Waste management will be handled according to this framework and will have social, economic and environmental effects.

“The goal of any post-disaster decision-maker is to manage these potential effects to achieve a positive outcome.” (Brown et al, 2010)
Solid Waste Disposal

Framework of Management

A long term management plan should include detailed strategy for:

- Debris collection
- Temporary storage
- Recycling or direct reuse, when possible
- Disposal
- Hazardous waste identification and handling
- Administration
- Dissemination of information to the public

In addition, development of communication and mutual aid at the time of the event, can be discussed before hand. Along with issues of potential reimbursement options and goals of management.

( EPA, 1995)
Solid Waste Disposal

Content of Debris

Post earthquake waste includes large amounts of construction materials, sediments, green waste, personal property, wood, ash and different amounts of hazardous materials. The waste is usually highly mixed and does not allow for easy separation. The amounts of debris are often overwhelming (table 1). Furthermore, the piles of debris tend to be very heavy and make saving of particular belongings almost impossible. Authorities should be able to estimated the amount and characteristics of the potential debris by looking at the plans of the city and consulting with the engineers.

Table 1. Debris quantities in past events:

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Debris Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Haiti earthquake</td>
<td>estimated 23 - 60 mill tonnes</td>
</tr>
<tr>
<td>2009</td>
<td>L’Aquila earthquake</td>
<td>estimated 1.5-3 mill tonnes</td>
</tr>
<tr>
<td>2008</td>
<td>Sichuan, China</td>
<td>20 mill tonnes</td>
</tr>
<tr>
<td>1999</td>
<td>Marmara Earthquake, Turkey</td>
<td>13 mill tonnes</td>
</tr>
<tr>
<td>1995</td>
<td>Great Hanshin-Awaji Earthquake (Kobe Earthquake), Japan</td>
<td>15 mill cubic metres</td>
</tr>
<tr>
<td>1994</td>
<td>Northridge earthquake, CA, USA</td>
<td>2 mill tonnes</td>
</tr>
</tbody>
</table>

(Brown et al, 2010)
Solid Waste Disposal

Large-Scale Evacuation Plan

• “Evacuation modeling requires the details of the movement of vehicles and people, as well as the topography within the emergency planning zones, in order to realistically represent the situation.” (Rossetti and Ni, 2010). A graphic model which includes topography, main roads, compact areas (which are likely to suffer more) and destinations of waste evacuation need to be designed.

• Evacuation equipment needs to be prepared in advance. The required equipment should include light weight tools such as: chain saws, flash lights, cellular phones, portable generators. And heavy machinery for breaking, digging and carrying the debris.
An evacuation plan of a city or any large scale area should start from an areal photo which gives a general idea of the geographical layout. Evacuation of both people and debris is done from dense zone to a spaced area. Therefore, the primary areas to be identified are open spaces.

The plan requires spaces for:

- Assembly Area
- Secondary Evacuation
- Supporting Emergency Facilities
- Supporting Social Facilities
- Supply Distribution
- Construction Waste Collection Sites
- Sorting sites: Source of Martial for Rehabilitation
Large-Scale Evacuation Plan

Identification of open spaces and evacuation routes in cities

Figures 2 and 3 are suggesting a rough draft of space identification using areal photos. The large polygons in Fig 2 mark two elongated open spaces in the metropolis of ‘Gush-Dan’. The northern part is “The Yarkon park” which stretches along the Yarkon river from the sea front in the west until Rosh Ha’ayin in the east where the density of buildings decreases. And the south includes some agricultural fields and “Hiria” park. Small open spaces are no less important, especially in an urban area where it is harder to find a primary escape place. Fig 3 shows some types of in-city open spaces and highlights potential evacuation routes.

Figure 2. The metropolis of ‘Gush Dan’ – Including Tel Aviv and the surrounding cities

Figure 3. The city of Be’er Sheva
Solid Waste Disposal

Waste Treatment

Based on previous experience, the recommendation is to designate local temporary storage sites which can be used for processing the debris. The proximity of those staging sites will reduce travel time and allow for easier evacuation of the waste from the affected source. These temporary sites could also be used for the primary sorting of the waste – separating it to recycling and disposal - making the shift to the permanent waste sites more efficient.

“Select the sites based on planned activities, such as staging, collection, storage, sorting, recycling, landfilling, and burning of debris. Pre-selection of sites speeds the implementation of the debris management plan.” (EPA, 1995)
Case Study: L’aquila Earthquake

Date: April 6th, 2009  
Location: Abruzzo region in central Italy  
Magnitude: 6.3

Strong earthquake causing damage to a widespread area of reinforced concrete buildings. The volume of debris was estimated at 1.5-3 million cubic meters. Approximately 80% of the waste is aggregated construction materials.  
A unit of environmental protection was established following the event, in order to manage the waste treatment. The stages of action included:
1. Demolition work – by national fire corps  
2. Repair work – by private firms  
3. Minor repairs – by individuals

(Brown et al, 2010)
Most of the waste was deposited in regional sorting and disposal sites. New disposal sites were needed to contain the enormous amounts of debris. Some of which were temporary sites and some permanent. Many of those sites have not been approved by the government as the European environmental lows are very strict. Some have only been approved about a year later. As a result, the town remained covered with debris as people were struggling to go back to normal life.

A good debris management which includes recycling and reusing of the destroyed buildings, could reduce the environmental impact and save landfill space. The waste can be reused as construction material for buildings, roads or environmental remediation. As a result, the community could be gaining from faster and efficient rehabilitation.

(Brown et al, 2010)
Case Study: The Northridge, L.A.

Date: January 17th, 1994  
Location: Los Angeles, California  
Magnitude: 6.7

With no prior plan for waste management, the city of L.A. managed to recycle approximately 86% of the earthquake waste, after six months. Using the services of private contractors and negotiating with FEMA (Federal Emergency Management Agency).

“The amount of debris reached 3 million tons at the end of July 1995. Three months into the debris removal process, city officials decided to attempt to recycle as much of the debris as possible to conserve the remaining landfill capacity.”

The shift from waste disposal to recycling happened two months after the event with the approval of FEMA. Contractor shifted from just removing debris to separating it to the different materials.  

(EPA, 1995)
Case Study: The Northridge, L.A.
Recycling of different materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Process</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete and asphalt</td>
<td>Crashed, mixed with up to 15 percent dirt</td>
<td>Sub-base in roads</td>
</tr>
<tr>
<td>Dirt</td>
<td></td>
<td>Landfill cover and soil amendment</td>
</tr>
<tr>
<td>Bricks</td>
<td>Ground and chipped</td>
<td>Landscaping</td>
</tr>
<tr>
<td>Metal</td>
<td></td>
<td>Metal dealers</td>
</tr>
<tr>
<td>Wood</td>
<td>Ground and screened</td>
<td>Landscaping</td>
</tr>
<tr>
<td></td>
<td>To fine pieces</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>Ground and screened to coarse pieces</td>
<td>Cogeneration fuel or compost</td>
</tr>
</tbody>
</table>

(EPA, 1995)
Summary

Solid waste can have a major effect on the environment the psychological recovery and the progression of other processes that are dependent on the evacuation of spaces. The best way to efficiently treat solid waste is to pre-plan for the worst case scenario, as the actual scenario is difficult to predict. The waste management plan should include: 1) a geographic plan for the area of risk, 2) preparing and improving waste treatment facilities and designating potential sites for the evacuation of large amounts of debris, and 3) positioning a responsible team which will be in charge of all these procedures along with updating the plan according to statutory shifts, geographical changes and existing equipment. The responsible team will also be the body to consult decision makers during and after the event. Based on previous case studies, reusing the waste for reconstructing the city, has many benefits. It saves landfill spaces and the expenses of new construction materials. Both of these are contributing to the environmental, economic and social recovery.

“Of course, every community hopes it never has to use its disaster debris management plan, but when a disaster does hit, prepared communities can recover more quickly than other communities.” (EPA, 1995)
Introduction

Post-disaster environment can lead to unprecedented and exciting opportunities. This can be found in different cities that have suffered destruction. The impacts of earthquakes upon social systems are challenging our cultural globally recognized perception of the city as an icon for sustainability and resilience that reflects 21st century values, knowledge and technology.

Stakeholders, emergency managers, authorities, and the wider community has an effective role for the recovery and the landscape recovery period.

- The purpose of this part is to explore and provide insight to the current and potential design of landscapes in the earthquake recovery by exploring international landscape architecture practices.
Recovery Objectives

The main objective of disaster recovery is most commonly agreed upon by every stakeholder as being:

• Restoring of the damage to an acceptable function.
• Making the most of the opportunity to rebuild infrastructure.
• Regenerating communities and the environment in a way that is more resilient and superior to that which existed before the disaster event.

The debate between stakeholders is related to the main objective and how it can be effectively achieved. The questions that come up are: how the recovery framework should be managed? Who should make the decisions? How aspects of the recovery should be prioritized? And what level of public involvement?
The Post Disaster Stage

Emergency management is a relatively new discipline in the world of defined practices, although it has been done all through history. The post-disaster recovery stage involves setting up a plan or a system that will help rehabilitating communities while restoring the urban environments (Ayers, 2011). This stage of recovery is crucial for helping break the “disaster cycle”, by providing significant opportunities for future mitigation (Olshansky & Chang, 2009).
The Post Disaster Stage

In a number of observations of the recovery stage of cities it was found that:

- Cities are typically being rebuilt in the same location, in similar design that remains familiar to its residents, and usually safer techniques are used, but not as safe as they could be.
- Wealthy communities recover faster than those that are not financially stable before the disaster.
- There is a wide range of factors that influence the speed of recovery including availability of resources, leadership, community, consensus and the existence of prior plans.
- Ongoing urban trends such as sprawl tend to accelerate after disaster.

(Ayers, 2011)
Landscape Architecture Tool

Destruction can be utilized as a platform for improvement. It is crucial to identify the ways in which each discipline can most effectively contribute to the recovery. Landscape architecture as the science of natural and human processes throughout space and time, is well suited to planning and designing sustainable and resilient regions. This discipline includes both function and design of the landscape and keeps the balance between them. Cities, communities and neighborhoods in the process of rapid change need that balance in order to maintain a stable community.
Kongjian Yu defined the post destruction design as “the art of survival”

“Landscape architecture must define itself in terms of the art of survival, not just as a descendent of gardening. The profession must re-evaluate the vernacular of the land and the people, and lead the way in urban development by planning and designing an infrastructure of both landscape and ecology, through which landscape can be created and preserved as a medium, and as the connecting link between the land, the people, and the spirits.” (Kongjian Yu, 2006)
Landscape Architecture Tool

Landscape architecture is a patchwork design. For the master quilters, one of the most important things to do first is to make an assessment of the situation – analyze the true scale of the impacts and understand the implications of those impacts on the future of the quilt. In this way the master quilters are better able to gain a holistic picture of what actions need to be taken to ensure the big patchwork quilt is regenerated as best and as quickly as possible. (Ayers, 2011)
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The Civil Realm

The Civil Realm Cont.


The Civil Realm Cont.

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Appendix:
The Civil Realm
תוכנית "חוסן העיר" 

ברכת ראש העיר

עניבת קומית
מלוחמות לבגיני השישיות שבאים "עופות יוקה". בנוסף,-feedback הסביר שהBlocking זה מבוצע כל ימים בância הולך והתסייע. שבאים יוקה, בקופisFunction של חנויות בשגרירות ואלה נוספים. הקופיסטים וה寤ים יוחמים אתuples זה המיתוגים ומיתוגים בקופיסטים וב我々

עדיר בא-רב

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תוכנית "חוסן העיר" 

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מטורת חוכמת “ القدس יער”:

- שיפור ייעור העץ והיהו לשיחות האדרתית - קרה של הכהות מוסדת.
- מוסח שליטה אינדיבידואל - שדרוג כמות ייעור, מדליית עמדות, כפיפות, עמידות, ציון.
- הפריית ייעור מוסדת (нятие, ביטא, רמה).
- ייבות הבקרות הסולמות הקהילתיות (מינהל מורשת), ביטא והדילית ב-1-כפיפות.
- כר-רגולטיבי לק拜师学 העץ, חירום בודד ורוב במערבות, בארץ חורחרים.

ה主要领导ות בסיסי החינוך López ו-אף הוא מחזורים המורחב והقوي מחזורים.

ﹶא. חוסן אוכלפיית - חרות המגורות לפי הנדרים למחזור המכונה, וממדי-רגולטיבי, בשיקול הקיימות המנהלו ב-2-כפיפות, קיימת烟火 מנהלי החינוך, והאזרחים והאזרחים להאזרחים, ביכולתрам, וברוחה של חינוך החינוך המנהלי, ב-1-כפיפות.

- חוסן עיון - ייבוא מנהלי התמונותLOC ב-2-כפיפות, במזרחי ההומניטרי, בקר רכיב, והאזרחים והאזרחים ל-2-כפיפות, בálido החרפת החינוך, ב-1-כפיפות.

- חוסן הראה - חרות המגורי במגורי ב-2-כפיפות, והאזרחים והאזרחים להאזרחים, ב-1-כפיפות.

- חוסן בזאר - ב-1-כפיפות, בשתיית חינוך הארץ במגורי ב-2-כפיפות, והאזרחים והאזרחים ל-1-כפיפות, בlando החרפת החינוך, ב-2-כפיפות.

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- חוסן בזאר - ב-1-כפיפות, בשתיית חינוך הארץ במגורי ב-2-כפיפות, והאזרחים והאזרחים ל-1-כפיפות, בlando החרפת החינוך, ב-2-כפיפות.
הכרך ה tłונין - יום שני, י"ח בחשון 09:00-08:00 - 15:00.
שיעור התחלתם - יום שלישי, השתמשו במערכת הפיתוח מ"ג.
שיעור הלימוד - יום רביעי, המשך סדר פעילות הפיתוח מ"ג.
הע>{@"iosk חירר"} לאר-שובה

"hisos חירר" לסיפול באדס ובהתקנה בשעה הורם ואוסי להוניא

ייןול מקיים:

Professor Nathan Zuckerman
ב”ג סמר ספיר
ד”ר Zeit Zinger
ד”ר ג’ני מיטשל
מר ליאו לבית
מר אלברט אלברט
גב, טלי איסמן

השתלמות Мо’ 1
משש הענה – הערכה ביסות
בעתד ארז העיר מרבך הילברץ

مواد הapultלות: יומ ראשון, ה-8 לשבוע 2009; כ”פ, בשון, שב”ע.

sgiving מרכזות:

• הוענת "hisos חירר";
• הוענת "hisos חירר";
• ההעגה פרו התקינה בשעה שופר אוסי;
• עררה ראשתה נהיה;

השתלמות Мо’ 2
副教授 ראשתה בazor השדרה

مواد הälltלות: יומ שני, ה-16 לשבוע 2009; כ”פ, בשון, שב”ע.

sgiving מרכזות:

• מאפייני אורז הגירץ;
• גורם סוקט שוכנות השדרה;
•/story פורח הערגה בשעה הורה;
• מיסים של מתקררים אוסי;
השלまとות מס' 3
שברחית, אוכלוסית מחוזית

옵ויות מרכזיות:
- מקיפים ועקרונות היכרות עם אוכלוסיות מחוזית;
- ליזים נוער משני משבר ואופני;
- קשיש ומרבצי במעבי משבר אשראי;
- אופי מרחפת בטר "על מי מגרים".

השלまとות מס' 4
סות הלית יוזוח והדעה לפשפוח החוללים

옵יות מרכזיות:
-〆ה קשת;
- מטס אכלות;
- מבט תובע;
- נילימ: מסת הלית - פ"ע;
- המבנה המאפוי לפרסת משפטא אב-בייר;
- יוט_frmסה - גול "הכשלת פינאעימ".

השלまとות מס' 5
מרצוי קלייתו והמכלית

옵יות מרכזיות:
- ההתחום אוכלוסיות ברצבי קלייתו מחוזית;
- הערבות חותם ישפלו;
- הערבות, זרימה דירמלה בבר Zika אוכלוסית;
- יעד במרבי קלייתו מחוזית;
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<tr>
<th>ה召回משם 6</th>
<th>מרכז מידע &quot;וק- פתוחו&quot;</th>
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<tr>
<td>מועד ההשכלה:</td>
<td>יומי, ה-21 בדצמבר 2009; בבר, יש&quot;ע</td>
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<td>סרגיות מרכזיות:</td>
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<td>• עדשת המבנה בשתי טווחים</td>
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<td>• מבצעת התנערות אוכליסי - אתי גנום בשתי טווחים</td>
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<td>• נוצרת הפנילים &quot;בפנת&quot; בשתי טווחים</td>
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<td>• עדשה אינסופית הנעשית נמוכה.</td>
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<th>חוסן צהרי</th>
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<td>• חליפה בהפרדת עופי תרוממה עתירה</td>
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<td>• חוסן צהרי - תרוממה עתירה</td>
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<td>• מודל נארי בוועדות לחיתוך החסם האדום והקלחת</td>
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<td>• הא-אקטיבה קפלתית לעזר אסמי</td>
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<tr>
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<th>&quot;מי ידע את המצל&quot; - חינכה צוותית</th>
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<td>• תרגילים ומישורים ביצועי תיפוף, הולך והולך</td>
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<td>• פרטיקול לתערבות מעשית</td>
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<td>ממוקמ</td>
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mail: sapirba@br7.org.il
EARTHQUAKE PREPAREDNESS

The Emergency Supplies Kit

The earthquake kit provides the basic equipment and provisions needed to meet most of the initial challenges of a dangerous earthquake. Keep one at home, in your car, and another at work, unless your car is always directly accessible when you are at work.

It is impossible to include everything you might need for survival in one compact kit, but these suggestions cover the most basic survival supplies. If you must evacuate, you may have time to grab only one thing as you leave – make it your kit. If you are away from home, and the only way to get around is on foot, this kit may help you walk home safely.

The Container

A backpack is best, but small suitcase, duffel bag, or even a heavy cardboard box can serve as a container for the earthquake kit. It should be large enough to hold the equipment, but small enough for you to carry without difficulty.

Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>Flashlight</td>
<td>High quality with spare batteries.</td>
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<tr>
<td>Water</td>
<td>Store enough water for cooking and sanitary needs. One half gallon (or two litres) per person will provide drinking water for one day. Replace the bottles of water every three to six months.</td>
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<tr>
<td>Food</td>
<td>Pack one day’s supply of high energy, ready-to-eat food such as Supligen. Replace the food every three to six months depending on their exposure to heat and light.</td>
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<tr>
<td>First Aid Kit</td>
<td>A well stocked first aid kit, complete with first aid manual should be in your kit. The small commercial first-aid kits usually consist of not much more than a few bandages so it might be best to put together your own. Include: band aids, sterile gauze pads, soap, antibiotic ointment, antiseptic solution, chemical cold compress, small container of table</td>
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salt, aspirin tablets, anti-diarrhea medication, scissors, safety pins, tweezers, thermometer, tissues, matches, pocket knife, three-day supply of prescription medicine required and extra contact lens solutions if needed.

All liquids should be in plastic containers. Check annually or more often and replace as necessary. A smaller kit can be kept in your car and at work.

**Portable Radio and Batteries**

After a disaster, radio stations will broadcast emergency information as well as other facts that become available.

**Walking Shoes and Socks**

Comfortable, thick-soled walking shoes should be included in your kits especially in the car and at work. If the roads are blocked, the only transportation may be on foot. Be sure that your shoes are suitable for long distances and for walking over piles of broken glass.

**Local Map and Directions to Community Services**

Be sure that you know the best walking route between your home and work, and if applicable, to your child’s school. Also know the location and telephone number for your nearest police station, fire station and hospital.

**A blanket**

Severe injury can cause shock, but the fright of an earthquake experience might make a shock reaction even more likely. Blankets help prevent the loss of body heat, a factor that must be considered when treating shock victims.

**Sanitation supplies**

Include small and medium zip-lock plastic bags for human waste disposal, tissues, soap and sanitary napkins, bleach, disinfectant, toothbrush, toothpaste, shampoo, deodorant, comb and other personal hygiene supplies.

**Other provisions**
In addition to the provisions stored in your earthquake kits, the following items should be available in your home and at work to be ready in case of an earthquake:

**Fire Extinguisher**
Check with the fire department about which ones are appropriate for your situation.

**Extra Flashlights**
At least one working flashlight per person should be kept in the home and work place. Keep one at each bedside. Each should be kept in a location known to all, and in such a way that in an earthquake is not difficult to find.

To simplify battery replacement, all or most of the flashlight should use the same size battery.

Open flames, such as candles, matches, and kerosene lamps, should not be used following an earthquake because of the danger of gas leaks and other fire hazards. Aftershocks can also cause candles and kerosene lamps to topple over, increasing the risk of fire and other burns.

**Tools for Turning off Utilities**
All adults in the household should know the location of all the main turn-off valves for electricity and water for the home and how to operate them.

**HAZARD HUNT**

Especially in small earthquakes, which make up the vast majority of all earthquakes, most injuries and fatalities occur because the ground shaking dislodges loose objects in and on buildings.

Conduct a Hazard Hunt of your environment and eliminate objects that have the potential to cause injuries.

1. Store heaviest items on lower shelves of cabinets. Heavy things might break through a cupboard door, but they probably will not hurt anyone if they are at floor level. Store lightweight, non-breakable items on higher levels.

2. What-nots, wardrobes, freestanding closets, dressers and bookcases could topple over during an earthquake unless they are securely anchored to the wall. Either bolt directly through the back of the furniture into the wall or use steel angle brackets. Fallen furnishings could block your escape route, besides causing injury and damage. Free standing bookshelves, especially in an office setting, should be bolted to the floor and to ceiling posts.
3. Bookshelves – in addition to bolting the item to the wall, put guard rails or ‘fences’ on open shelves so that item can not slide off.

4. Tall, heavy lamps, vases, figurines – if you display fragile items on open shelves or tables use industrial Velcro to attach items to stands.

5. Hanging Plants and Mobiles – these tend to swing widely during earthquakes. Hang planters on hooks that can be curved over to form a circle so that the wire or cord cannot jump free. Use lightweight, plastic containers or baskets instead of heavy, ceramic ones that may cause serious injuries if they strike someone in the head.

6. Mirror on Wall – make sure that mirrors are securely bolted to walls.

7. Heavy objects on wall shelves - ensure shelves are securely bolted to walls. Adjustable shelves, the board of which rest on wall brackets, can be stabilized with clips or wire to connect the board to the bracket. Remember to use guard rails on shelves and do not place chairs, desks, beds etc. beneath shelves where items can fall on people.

8. Window Air Conditioners – make sure they are securely fastened and bolted into their spaces, so they do not fall out.

9. Hanging Lamp or Chandeliers – make sure they are securely fastened to the ceiling. Put a mesh or plastic guard around fluorescent bulbs to catch any splinters.

10. Unsecured TV, computer or cart with wheels – attach TVs and computers to their stands with industrial Velcro or bolt the items to the stand. Cart wheels must be able to be locked so cart will not roll around wildly.

11. Bed by window, heavy object on shelves above bed - locate bed near an interior wall, away from windows and hanging light fixtures or any item that may fall on you while in bed.

If the bed must be next to a glass window, install shatter-resistant plastic film, some what like the material used to tint windshields, over the glass which will hold shattered glass in place and prevent it from flying around the room. Another alternative is tempered glass, which breaks into tiny rounded pieces, but this is more expensive than the film.

Be sure that the bed is not on rollers, and if it is on bare floor, use plastic non-skid coasters to reduce sliding.
12. Heavy picture above bed — should be hung from fixtures that can adequately bear their weight. Items such as hanging pictures and items on shelves will weight twice as much when they fall. For example, if it weighs 2 lbs. on the wall, it weighs 4 lbs. when it hits, so do not place over beds, desks or chairs.

13. Cabinet doors not fastened — install proper latches on cupboard doors that will not open if the object tilts over or is shaken. Heavy objects inside your cupboards can lean or fall against the inside of the doors, and the latches must be strong enough to withstand this pushing. Be careful not to stand directly in front of cupboards as items lying against the doors can come crashing out on you.

14. Medicine cabinet doors not fastened — the primary hazard in the bathroom during an earthquake is broken glass. Mirrors, toiletries, and medicines can fall and break. Most personal care products are being packaged in plastic now, but liquid medicines, perfumes and colognes are sometimes supplied in glass containers. Select products in unbreakable containers where possible and make sure the doors of your medicine cabinet can be secured with a latch.

15. Unattached Water Heaters — are very vulnerable to earthquake damage. They are likely to ‘walk’ or even topple over disconnecting the utility lines, causing gas or water leakage, or electrical shorts, fires or explosions. To prevent the water heater from moving or toppling over, wrap it with two metal straps or chains, near the top and bottom and bolt the ends to the wall.

16. Gas Stove with Rigid Feed Line — use flexible gas lines that will not break during an earthquake releasing gas. Anchor the gas cylinder to the wall with chains and if you are cooking, turn off the stove before taking cover.

17. House not bolted to foundation — ensure that houses/buildings are properly attached to their foundations.

**WHAT TO DO AFTER AN EARTHQUAKE**

**At Home**

1. Wear heavy soled shoes. If you are bare footed, put on shoes before you walk anywhere after an earthquake.

2. Check for injuries. Check yourself and other family members for injuries and seek medical attention for serious conditions.

3. Do not use the telephones unless there is a serious injury. Rescue workers will need all available lines. If the receiver is off the hook, replace it. If you do not get a dial tone, DO NOT jiggles the hook; that could further jam the wires.
4. Check for fire. If possible one person or group should check for injuries while another immediately checks for fires. Don’t light matches or candles. Leaking gas and spilled flammable products can be ignited by flames, pilot light or electrical shorts.

If you smell gas or have reason to suspect that lines might be broken, immediately disconnect the cylinder.

5. Stairs may have weakened after an earthquake. When evacuating check these carefully before placing your full weight on them.

6. Check the building. Carefully inspect the interior and exterior of the building. Look for cracks in the walls, shifted posts or pillars and cracks in porches and sidewalks. If you see anything other than minor cracks, evacuate the building immediately and do not re-enter the building until it has been checked for safety by a professional.

7. Once your home is secure, check with your neighbours to see if they need assistance.

8. Listen to your radio for evacuation orders and other information.

Away From Home

If you are in your car, at a movie or store, or some place where you do not feel safe, you will probably try to go home. Stay where you are for a while and wait for aftershocks and information on the radio. Remember that aftershocks, particularly those following a big earthquake can cause a lot of damage. Overpasses, bridges and some buildings might survive the main shock, but fall during an aftershock.

After an earthquake that causes damage, drive only if you are away from tall building and bridges, and then your driving should only be to safety or to render assistance. The roads should be kept open for emergency vehicles.

When you arrive home, do not rush in. Look at the building from a distance for damage; if it looks okay make a closer inspection. If it still looks undamaged, open the door and smell for gas. If you don’t smell gas, enter and check for other fire hazards.

In the Darkness

If you find yourself alone in the dark after an earthquake, take a few minutes to recall the location of exits and the layout of the building. Plan your escape route and then move slowly, using your hands to guide you. If you heard the sound of breaking glass during the earthquake, wrap your hands in a jacket or other material to protect them. Carefully exit the building, take cover if there are any aftershocks and be alert for the smell of leaking gas.
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