4.217/11.315 DISASTER-RESILIENT DESIGN

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This seminar was conceived during the period of the Haiti earthquake, Deepwater Horizon oil spill, and 2010 Indus River flooding. It was revised after the 2011 tsunami in Japan, and again after the 2012 Hurricane Sandy, 2013 Uttarakhand floods, and continuing “complex emergencies” in Afghanistan and elsewhere (ReliefWeb, 2013). In each case, we want to ask, how can designers and planners contribute to disaster risk-reduction, reconstruction, and resilience?

The range of environmental hazards is formidable. It encompasses rapid-onset geophysical events such as earthquakes, landslides, flash floods, tsunamis, and volcanic eruptions; technological disasters that include chemical accidents and spills; and long duration events that are sometimes referred to as creeping environmental problems (e.g., drought, erosion, and climate change). Some scholars include disease, violent conflict, and terrorism. In the wake of major disasters, design schools mobilize studios to address these events. While well-intentioned, that approach has limited prospects for building deep understanding, practical expertise, or long-term benefits for people and places at risk.

The field of disaster-resilient design is growing, but gaps remain between the professions of environmental design and natural hazards management. Few design and planning schools focus on hazards. Green building movements have devoted limited emphasis to hazards preparedness, mitigation, and reconstruction. For example, the LEED rating system has few credits for natural hazards preparedness (though USGBC is committed to changing that). Hazards research and management have given limited attention to design. This seminar seeks to prepare students for natural hazard design studios and workshops—in advance. Our long-term aim is to help
mainstream hazards research as an integral component of sustainable design (Mileti 1999). To some extent, these aims are embedded in our professional ethics, licensing, and codes, which are founded upon the “protection of health, safety and welfare.”


**Current initiatives in South and Central Asia:** The situation is equally dynamic internationally, with innovations that deserve close study by designers working in different regions, including the U.S.. This year we will have an opportunity to work with the Aga Khan Development Network’s Disaster Risk Management Initiative (DRMI), which encompasses four countries that face multiple hazards: Afghanistan, India, Pakistan, and Tajikistan. DRMI is developing a conceptual framework and knowledge system to guide village planning and built environment programs across the Aga Khan Development Network and that will have relevance for other multi-sectoral programs. These range from homes to schools, clinics, and historic settlements. Some of us will devote our case study work this semester to aspects of this current initiative.

We may organize regional working groups, e.g., a U.S. team, South Asia team, Central Asia team, etc. Each team will engage a wider network at MIT and other hazards research programs. Students may wish to organize hazard-specific working groups.

**Pre-requisites:** Graduate enrollment in MIT SMArchS, MCP, or PhD programs; or GSD equivalent. Previous coursework in environmental science and/or design.

**Learning Goals:** The main goal is to prepare students for disaster-resilient design practices in a hazardous world. It has the following objectives specific to the field of disaster-resilient design:

A. *Hazards Preparedness and Mitigation in Planning and Design:* This objective requires a working knowledge of the “normal” hazards of everyday life that are addressed in landscape ordinances, building codes, case law, and best practices. It includes design for hazards that
have relatively well-known probability distributions (risks), as well as unknown probabilities (uncertainties). It requires close analysis of existing building and site conditions, and attention to the differential and inequitable vulnerability of different social groups. It seeks a wise balance among prudence, experimentation, and risk in design. It cultivates this mentality long before disasters occur, and long after post-disaster media attention has subsided.

B. Retrofit of Existing Settlements and Landscapes: This objective seeks to reduce the vulnerability of existing structures, sites, and infrastructure before disaster occurs. Retrofitting involves creative adjustments in construction materials, structures, grading, drainage, etc. It seeks to balance structural and non-structural mitigation measures. It requires skills in visual assessment; mapping of soils, slopes and floodplains; and technical aspects of materials testing and construction techniques.

C. Recovery and Reconstruction after Disaster: The first task in an emergency is to organize temporary emergency shelter, which is a design problem as well as a practical, logistical challenge. It requires rapid appraisal of site conditions and constraints. Over the long-term, many victims rebuild in the same location with the same materials and patterns of vulnerability, often for logical reasons (e.g., it is the only site where they have a claim to land and materials, access to work, attachment to place, etc.). Sustainable reconstruction after disaster requires new ways of building that are more resilient, adaptive, and robust.

D. Resettlement of Displaced Peoples in Less Vulnerable Locations: Sometimes it is necessary or wise for people to relocate in less vulnerable places, and they need help identifying potential locations, laying out equitable, efficient, and satisfying settlements. Sometimes relocation is temporary, and sometimes temporary settlements become permanent, for better or worse. Resettlement resembles the design of new communities in some ways. Transitional settlement design strives to consciously transform temporary places into enduring settlements.

E. Commemorative Design. From antiquity to the present, designers have engaged in projects to memorialize the experience of, and response to, disaster. Such projects may include public spaces, monuments, rituals, heritage conservation, and/or erasure. Commemorative design proliferated during the late-20th century, raising questions about how social memory changes over time, and how it differs by type of disaster and cultural geographic context.

F. Integration of the Above: These five design problems are linked with one another, e.g., in places that face multiple-hazards and that employ multiple approaches to them. For example, earthquakes may disrupt water supplies, which increase infectious disease and fire hazards. Storms can trigger erosion, floods, and landslides. Reconstruction after disaster can entail some groups moving to new locations, with substantial preparedness, while others rebuild on post-disaster sites in less-vulnerable, retrofitting ways that include non-structural mitigation measures. A comprehensive approach entails integration of design measures across space, time, and social groups at multiple scales.

A New Conceptual Model: In addition to focusing on these forms of practice, we will strove to develop a conceptual model of their inter-relationships, stimulated by the emerging DRMI program and an effort to develop a “political ecology” of risk and hazards that includes design.
Learning Outcomes: Students will develop an ability to address and advance current debates in hazards mitigation through:

A. Expertise in hazards-focused bibliographic search and institutional mapping.
B. Working with a range of theoretical frameworks for hazards interpretation.
C. Rapid site analysis methodologies for hazards assessment.
D. Designing for risk, uncertainty, vulnerability, and resilience at multiple scales.
E. Expanding the range of alternatives through the innovations above.

Policies: Students who have disabilities should consult with the Disability Services Office and me. Students must strictly adhere to the MIT Academic Integrity policy. Students are encouraged to work with the MIT Writing Center when needed. Absence from class and extensions of time for assignments must be requested and approved in advance.

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COURSE SYLLABUS

Part I: Contemporary Environmental Hazards Planning and Design

Week/Date

0 Sept 5  National Research Council/WEF Webinar  
http://www.tvworldwide.com/events/nas/130905/

1 Sept 10  Course Introduction

I will offer a brief introduction to the origins, aims, and approach of the seminar. We will discuss historical, current, and as yet to be imagined hazards. We will also reflect upon various ways of framing these problems, and ask what designers and planners can contribute.

Consider: In 2012, a leading group of scholar-practitioners published a new Handbook on Hazards and Disaster Risk Reduction that runs some 875 pages with 65 chapters, none of which discuss the contributions of architects (there is a good chapter on planning). Thankfully, the AIA and APA have established disaster programs -- how can they be scaled up and more widely recognized?

In-class project: After an informal survey of student interests, aims, and backgrounds, we will dig more deeply into your specific concerns. We will draft one-page statements of interest in class (~200 words). Your statement should encompass a substantive category of hazards (as you define it); a design or planning approach that excites you; and something about the philosophical perspective that guides you. We
will discuss these drafts in class, and refine them over the course of the semester. Post them on our Stellar site by September 12th evening.

**Bibliography:** This year we will work together on rapid, intensive, bibliographic appraisals, which will sharpen your skills and enable us to compare notes on successful and unsuccessful search strategies. A sample search for natural hazards in Tajikistan is on-line at: [http://archnet.org/library/documents/collection.jsp?collection_id=1903](http://archnet.org/library/documents/collection.jsp?collection_id=1903). 

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**Assignment for Week 2.** Design a well-structured bibliographic search for your topic that includes the following online libraries: books (WorldCat); articles (Web of Science; Engineering Village; Avery); dissertations (ProQuest); specialized research journals (e.g., *Disasters, Environmental Hazards*), and natural hazards organizations (e.g., Government agencies, IGOs, NGOs...). You do not need to complete the search: just design and begin it, describing what you are searching for, where you are searching, how you will select and combine keywords, and how you will organize your results. See Kapur, 2009 for a full-scale example. Post this plan on Stellar by Wednesday, September 19th [Cf. Wescoat, 2012, bibliographic handout].

### 2 Sept 17 Perspectives on the Field

We will begin this session with a discussion of the AIA, Architecture for Humanity, U.N. Habitat, GFDRR, and NBM readings, concentrating on the ways in which they define hazards; how they trace the modern history of the field, and how they address issues of “design.”

We will compare these general readings with recent case study reports, again seeking to identify links and gaps related to environmental design.

The second half of the session will focus on bibliographic sources and methods. This practical topic will help introduce the rich array of hazards research and response organizations, from the Federal Emergency Management Agency (FEMA) in the U.S. and the Natural Hazards Research, Applications and Information Clearinghouse at the University of Colorado- Boulder (NHRAIC) in the US -- to the UN International Strategy for Disaster Reduction (ISDR), Global Facility for Disaster Reduction and Recovery (GFDRR), Asian Disaster Preparedness Centre (AIT, Bangkok), and FOCUS Humanitarian internationally.

When visiting the UNISDR site, we will discuss the *Hyogo Framework for Action, 2005-2015* and the *Global Assessment Report on Disaster Risk Reduction 2011* (some of these
resources are hyperlinked or posted on Stellar). We will also visit the Sphere Project ... Handbook on Minimum Humanitarian Standards (2011); and specialized disaster databases such as CRED EM-DAT; GAR, Dartmouth Flood Observatory, Relief Web, Munich Re, etc.

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Readings for Week 3: Each student will read one of the following:

- Hazards as extreme events: ICSU, 2008; Alcántara-Ayala and Goudie, 2010
- Risk perception and behavior: Kahneman and Tversky, ch 1
- Phenomenology: Kono, 2013; Miller, 2012, ch 4
- Sustainability: Mili, 1999
- Structuralism: Mustafa, 2005ab.
- Vulnerability: Cutter, 2006, 2010; Adger 2006

Assignment for Week 3: Completion of the rapid bibliographic appraisal posted by September 23rd evening for brief discussion in class.

Part II: Theory, Practice, and Methods in the Environmental Hazards Field

3 Sept 24  Theoretical Debates

We will discuss these readings with the aims of: (1) grasping their conceptual approaches in their own terms; (2) discerning their empiricist, utilitarian, marxist, and/or pragmatist sources; and (3) assessing their value for design inquiry.

How do these theorists define and deploy key concepts, e.g. of risk, vulnerability, resilience, or the “range of choice”? How are these conceptual frameworks evolving in relation to one another? Finally, how might these debates inspire, constrain, and help direct disaster-resilient design?

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Assignment for Week 4: Transform your initial problem statement into a research design proposal for discussion and review. Describe the combination of theoretical propositions, design inquiry, and quantitative analysis that you envision.

4 Oct 1

**Theory-Practice Relationships: The Aga Khan Development Network**

This week we will focus on theory-practice relationships, with a discussion of the Aga Khan Development Network’s new DRMI program. DRMI is theoretically informed and draws upon extensive field practice and local knowledge. It is engaged in the full spectrum of mitigation, preparedness, recovery, reconstruction, and resettlement activities considered in this seminar. We will try to organize a multi-site dialogue with DRMI and AKPBS which are involved in community-based disaster preparedness, seismic retrofit construction methods, microzonation, and safe haven design for schools and *jamaat khana*s; and AKCSP which deals with the conservation of historic buildings and settlements.

Come to class prepared with questions about the practice of disaster-resilient design in AKDN; and its potential relevance for your own research.

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Assignment for Week 5: Incorporate risk and uncertainty into your project document (it may be woven in, or a separate section). Use one or more disaster dataset for the region where you are working, e.g., CRE Data, GAR, Dartmouth Flood Observatory, etc.

5 Oct 8

**Analytical Approaches: Risk, Uncertainty, and Perception**

Discuss the basic principles of risk analysis, from simple calculation of recurrence intervals to more complex analysis of extreme value distributions; consider the effects of urbanization on the stationarity of environmental events; and the social perception and amplification of risk. Note the different definitions of risk in the engineering and hazards literatures.

This week’s work involves analyzing dimensions of risk and uncertainty in your projects; and identifying strategies for documenting, coping, and ultimately reducing and managing uncertainty.

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Common Readings for Week 7 (no class on week 6): Ben Joseph, 2005, ch 1; ASLA, 2003, pp. 17-41; Bruner and O’Connor, ch. 7; building code in the region where you are working.

Assignment for Week 7: Part I of your project is due on Tuesday, October 22nd. Part I
includes: Project title and cover sheet; problem statement and study area; theoretical question and literature relevant to it; and your design research approach (i.e., an expanded outline of your project). Post your draft document on Stellar.

6 Oct 15  Columbus Day -- No Class Damage Assessment across Social Spaces and Scales
A key task during and immediately following disaster is conducting rapid appraisals of damages to structures, infrastructure, socioeconomic, and ecological wellbeing at multiple scales. Socio-economic damage assessment poses different challenges from physical damage assessment. GIS and cartographic methods are increasingly sophisticated and useful for compiling, representing, and explaining the spatial and social distribution of losses.

Be prepared to discuss disaster data and damage assessments relevant to your project in this session.

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Part III: Six Types of Disaster-Resilient Design

7 Oct 22  Type I: Hazards Preparedness Planning: Codes, Ordinances & Design Frontiers
This session will focus on planning, design and construction standards driven explicitly by safety considerations. We will read about the evolution of codes (Ben Joseph, 2005). Some codes reduce risk, while others may increase it. Some places have codes on the books, but do not enforce them. Other places lack regulatory frameworks and have other ways of maintaining standards. Each student will consider how building codes, design safety factors, landscape ordinances, zoning plans, and professional design practices shape their project.

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Assignment for Week 8: Formulate a mitigation design concept that could dramatically reduce risks in your study area.

8 Oct 29  Type I: Mitigation in Site Planning and Design: Floods, Droughts, Climate Change
In addition to the hazards addressed in codes and ordinances, there are the specialized fields of floodplain, hurricane, landslide, and seismic preparedness, etc. But designing for one disaster can increase vulnerability to others (as occurred in Haiti). This week’s discussion addresses those special fields of planning, and then strives to envision a multi-hazards or all-hazards approach to sustainable site design.

Using your bibliographic search, select one or two readings on retrofitting relevant for your project, e.g., building seismic retrofit; landscape floodproofing, or water safety planning, etc.

**Assignment:** Generate one or more retrofit proposals that seem promising for your research.

**9 Nov 5**  
*Type II: Retrofitting Existing Buildings and Landscapes.*

Good site design systematically adjusts the built environment to reduce known hazards. It considers the value of traditional as well as new building methods. Visitor: Duncan Kincaid.

In the first hour, we will discuss retrofit methods with Duncan Kincaid, who spent several field seasons in northern Pakistan working on these issues. We will then return to, and refine, our proposals for retrofit techniques and social adoption in the final hour.


**Assignment for Week 10:** Study the “Japan 3-11 Rapid Visual Site Analysis” package; and Wescoat and Kanda, 2012. Prepare an outline indicating how you might adapt rapid visual site analysis methods for conducting a rapid post-disaster in your study area.

**10 Nov 12**  
*Type III: Reconstruction after Disaster*

Even with the best available knowledge, unanticipated hazards can lead to catastrophic losses, including on projects that we have helped plan, design, or occupy. This session will address short and long-term processes of reconstruction.

We will begin this session with a discussion of rapid post-disaster site analysis, using an MIT Japan 3/11 design workshop as a case study. That will lead to a discussion of potential extensions and refinements.
We will then consider the role of land tenure, land records, and land use change, which shape the initial phases of reconstruction and transitional settlement. And we will conclude with a discussion of the long-term processes of reconstruction as outlined in Vale and Campanella, 2005.


Assignment for week 11: Generate a resettlement scenario, process, or physical alternative for your project. The readings offer hard-learned lessons from human suffering associated with involuntary and ill-planned relocation.

11 Nov 19  Type IV: Resettlement of Displaced Populations in Safer Locations.

While there is a strong tendency to want to rebuild in the same location, some locations prove uninhabitable with current standards. What are the similarities and differences between designing for displaced populations and new communities that have not experienced disaster--the relationships between local “safe havens” and larger “safe settlements”? What are the similarities and differences between disaster relief and refugee camps?

Try out your ideas for new settlement design alternatives for displaced peoples with your classmates. Let’s see what creative extensions and forms the Human Rights Standards and related policies can take.


Assignment for Week 12: Drawing upon the readings, particularly Ken Foote’s Shadowed Ground, consider what forms cultural memory and memorialisation might take in your project.

12 Nov 26  Type V: Commemorative Design in Places of Reconstruction & Resettlement

Designers are often moved, or called upon, to memorialize places of disaster. At what point, if any, do these efforts become either profound, or obsessive, or objectionable, or empty of meaning? While escalating in frequency, these functions have taken many different forms from antiquity to the present.
According to Kenneth Foote, they range from “erosure,” to “preservation,” “memorialisation,” “sacralisation,” and “redevelopment.” Which of these categories, if any, resonate with your project. Are there others that should be considered? What forms and processes do your ideas entail?

Assignment for Week 13: Designers and planners often work concurrently on all five of the modes discussed above. Your initial project statement had an integrative structure – how would you now weave your specific ideas and experiments over the past five weeks into an integrative proposal for disaster-resilient design? This assignment requires a full editorial pass through your project document, as well as an integrative concluding perspective at the end.

13 Dec 3 Type VI: Synthesis of Types 1-V over space, time, and multiple scales.

This final seminar session weaves together the topics of risk and vulnerability with spatial and social processes of adjustment, equity, and cultural change. Collectively, these topics invite us to envision alternative futures – from the progressive and resilient to the apocalyptic and revolutionary.

Try out your integrative design proposals with your colleagues.

We will spend this session presenting our seminar projects, and helping each other strategically refine them for completion by December 10th.

14 Dec 10 Final papers and regional projects shared and due – post on Stellar by noon
[By Department rules, MARCH student papers will be due Dec 17]

Assessment: Grades will be based on the following four factors:
* Active weekly participation in readings and discussion – 20%
* Weekly assignments related to your final project – 20%
* Draft of the first section of your project -- Problem statement, conceptual approach, literature review, data, and design methods – 20% (Oct 22).
* Final design/planning document on one or more of the five research themes in a regional context – 40% (Dec 11)

READINGS AND RESOURCE MATERIALS (required common readings are on Stellar):


http://www.awwa.org/files/GovtPublicAffairs/PDF/AllHazardCMPNov2009FINAL.pdf


Dhar, O.N. et al., Hydrometeorological aspects of floods in India, Natural Hazards, 2003, 28, 1


Foote, Kenneth. Shadowed Ground: How Americans deal with Places of Tragedy. Austin:


IDEO. Human Centered Design. Field Guide; and Human Centered Design. Tool Kit. 2nd ed.


McRAM Flood Household Questionnaire. 10 page form.


________________. Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management (2007).

________________. Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery (2007).


Nirupama, N., Socio-economic implications based on interviews with fishermen following the Indian Ocean tsunami, Natural Hazards, 48 (2009: 1ff.


WEF_EC_DRP_NewDisasterResponseModel_Report_2010.pdf


**Aga Khan Development Network, Gilgit, Indus Basin & South Asia Case Study Materials**


Islamabad, November 2010.


AKDN. *Stemming the Tide: Relief, Reconstruction and Development in Coastal Andhra Pradesh.* Np. Nd.


_____________. “Building Hope: Towards a Proper Home.” CD. N.d.


_____________. Shergilla. Building plans and sections. N.d.


SAARC. Disaster Management Centre. Drought Risk Management in South Asia. 8-9 August


U.N. Habitat-Pakistan. Balochistan mud architecture poster. N.d.


**2011 Japan and 2004 Indian Ocean Tsunamis** – (see six-page MIT Japan 3/11 reference list on Stellar)


Tatsuhiko Saito,1 Kenji Satake,2 and Takashi Furumura. Tsunami waveform inversion including dispersive waves: the 2004 earthquake off Kii Peninsula, Japan


Comparative Seismic Hazards, Rubble and Debris Management, and Other Recent Materials:

Claire B. Rubin & Associates. “100 years of seismic safety in California.” Chart. 2006. FEMA.


FEMA. FEMA 154/155: Rapid Visual Screening of Buildings for Potential Seismic Hazards.
Washington, DC.


**Selected Web Resources:**

Alerting Humanitarians to Emergencies
Active Learning Network for Accountability and Performance in Humanitarian Action (ALNAP)
Architecture for Humanity
Asian Disaster Preparedness Center (ADPC)
Asian Ministerial Conference on Disaster Risk Reduction
Centre for Disease Control and Prevention
Disaster & GIS related Information
Disaster related News Service
Duryog Nivaram
Earthquake Related Information
Federal Emergency Management Agency
FOCUS Humanitarian
ICHARM – International Centre for Water Hazard and Risk Management [UNESCO]
Information about Emergency Planning & Response
Information about Tropical Cyclones
International Association of Emergency Managers
International Code Council
International Federation of Red Cross/Red Crescent
National Institute of Urban Search & Rescue
Natural Hazards Research and Applications Information Center (CU-Boulder)
Relief Web
Resilience Alliance, [http://www.resalliance.org](http://www.resalliance.org)
SAARC Disaster Management Centre, New Delhi
SEEDS-India
United Nations Development Programme (and OCHA)
United Nations International Strategy for Disaster Reduction (ISDR)