Environmental Science Institute
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Global death and construction: earthquakes on an urban planet with examples from India

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This file contains suggestions for how to incorporate the material for this CD-ROM into curriculum using the Texas Essential Knowledge and Skills for Science.

Science, Grade 8

(2) Scientific processes. The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:

> (E) construct graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate data [Have students examine the graphs, maps, and charts contained in the presentation (there's one on almost every slide). Have the students identify the parameters illustrated, their units, dimensions, and orders of magnitude, etc.].

(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

> (C) represent the natural world using models and identify their limitations [Slides 30-32 show a model of plate motion associated with the formation of the Himalayas. What type of model is this (2-D or 3-D, plane view or cross section, etc). What properties does it illustrate? How much detail is shown? Slide 40 - What is the approximate scale?];

(4) Scientific processes. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

> (A) collect, record, and analyze information using tools including beakers, petri dishes, meter sticks, graduated cylinders, weather instruments, hot

plates, dissecting equipment, test tubes, safety goggles, spring scales, balances, microscopes, telescopes, thermometers, calculators, field equipment, computers, computer probes, water test kits, and timing devices [The Weblinks document in this CD contains a link to the article "How to build a simple seismograph to record earthquake waves at home. Have students describe how seismographs measure earthquakes. Describe the Richter scale and define earthquake magnitude.What is the difference between magnitude and intensity?]; and

(B) extrapolate from collected information to make predictions [Slide 24 - Why is it hard to predict large, catastrophic natural disasters? Slide 20 – How accurately did scientists predict earthquake fatalities for the years 1998-2002? How long have humans been collecting information about earthquake intensity? Slides 23-24 – What type of mathematics is sometimes used to describe chaotic events such as natural disasters? What are the limitations of the patterns predicted by these models? Slides 32- 37 – What information to scientists use to decide which areas are likely to experience a major earthquake in the near future?].

(7) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to:

(A) demonstrate how unbalanced forces cause changes in the speed or direction of an object's motion [Slide 4 - Explain the elastic-rebound theory of the origin of earthquakes. What is an earthquake epicenter? Slide 6 – What types of plate motion are associated with earthquakes? Slide 7 – What type of motion mainly occurs along the San Andreas fault in California?] ; and

(B) recognize that waves are generated and can travel through different media. [Slides 3-6 show a cartoon of the propagation of a seismic wave. How are seismic waves generated? Through what media do seismic waves travel? How quickly do seismic waves travel? Describe the motion and velocity of three main types of seismic waves. Which of the seismic waves do not travel through liquids?]

(10) Science concepts. The student knows that complex interactions occur between matter and energy. The student is expected to:

(A) illustrate interactions between matter and energy including specific heat [What is convection? How are mantle convection currents related to plate movement? How can a deep ocean earthquake endanger coastal areas hundreds or even thousands of miles away?];

(14) Science concepts. The student knows that natural events and human activities can alter Earth systems. The student is expected to:

(A) predict land features resulting from gradual changes such as mountain building, beach erosion, land subsidence, and continental drift [Slides 7, 30-32 – What type of plate boundary exists along the San Andreas Fault? Why is San Francisco in danger of experienceing a major earthquake in the near future? What type of plate motion is responsible for the formation of the Himalayas? How often do rapid, catastrophic changes occur in the Himalayas? Slides 33-37 - Which areas of India are more likely to experience a large earthquake in the near future? Why? Slide 40 – What are the continental scale changes in the earth's landscape due to plate collision?] ;

Social Studies, Grade 8

(3) Geography. The student uses maps, globes, graphs, charts, models, and databases to answer geographic questions. The student is expected to:

(A) create thematic maps, graphs, charts, models, and databases depicting various aspects of world regions and countries such as population, disease, and economic activities [Slides 12, 14-17 – Where are earthquakes located? Where are the world's major cities located? How have population location patterns changed since the 1600s? Since 1950? Have students compare these maps and identify the relationships between urban area locations, earthquake locations, and earthquake destruction intensity.];

(B) pose and answer questions about geographic distributions and patterns for selected world regions and countries shown on maps, graphs, charts, models, and databases [Slides 12, 17 - Is there a pattern in the global distribution of earthquakes? Where is the "Ring of Fire"?]

(4) Geography. The student understands the characteristics and relative locations of major historical and contemporary societies. The student is expected to:

(A) locate major historical and contemporary societies on maps and globes [Slides 14-16 Have students identify the historical and contemporary urban agglomerations mapped in these slides];

(B) identify and explain the geographic factors responsible for patterns of population in places and regions [Slides12-17, 38-41 - There seem to be a lot of big cities located near the epicenters of big earthquakes. Does this mean that people like to move to where the earthquakes are? What other factors influence the location of major cities? Why would so many people move to locations that experience natural disasters?];

(6) Geography. The student understands the impact of physical processes on patterns in the environment. The student is expected to:

(A) describe and explain how physical processes such as erosion, ocean circulation, and earthquakes have resulted in physical patterns on Earth's surface [Slides 30-32 What physical patterns in the earth's surface are caused by plate motion? Slides 11 – What physical patterns and features are caused by earthquakes?];

(C) analyze the effects of physical processes and the physical environment on humans [Slides 9-10, 18, 22, 52-55 – What effects do earthquakes have on humans? What important scientific discoveries about the composition and motion of the earth have been made using information given by seismic waves?].

(7) Geography. The student understands the impact of interactions between people and the physical environment on the development of places and regions. The student is expected to:

(A) identify and analyze ways people have adapted to the physical environment in selected places and regions [Slides 14-17, 41 – Humans live in areas frequently disturbed by earthquakes. How have humans adapted to survive under these conditions? Slides 18-24 - Is it possible to adapt or prepare for rare, catastrophic events?];

(C) describe ways in which technology influences human capacity to modify the physical environment [Slide 56 - Fill in the blank: Earthquakes don't kill people, ____?____ do! Slides 46-57 – What building techniques allow us to build affordable structures that are resistant to deformation and failure due to earthquakes? What country has been in the forefront of earthquake resistant building architecture?].

Physics

(c) Knowledge and skills.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(C) organize, analyze, evaluate, make inferences, and predict trends from data [Slide 24 - Why is it hard to predict large, catastrophic natural disasters? Slide 20 – How accurately did scientists predict earthquake fatalities for the years 1998-2002? How long have humans been collecting information about earthquake intensity? Slides 23-24 – What type of mathematics is sometimes used to describe chaotic events such as natural disasters? What are the limitations of the patterns predicted by these models? Slides 32- 37 – What information to scientists use to decide which areas are likely to experience a major earthquake in the near future?].;

(E) graph data to observe and identify relationships between variables [Have students examine the graphs, maps, and charts contained in the presentation (there's one on almost every slide). Have the students identify the parameters illustrated, their units, dimensions, and orders of magnitude, etc.]; and

(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

(E) research and describe the history of physics and contributions of scientists [How have seismic data helped earth scientists learn about the earth's interior? When was the seismograph invented (http://inventors.about.com/library/inventors/blseismograph6.htm)? When did scientists begin to recognize the global effects of seismic waves? Slides 46-51 - How have seismic events affected how we build structures?]

(4) Science concepts. The student knows the laws governing motion. The student is expected to:

(C) demonstrate the effects of forces on the motion of objects [Slides 46-51 – Columns are built to withstand very large axial loads, however column failure is one of the most common causes of structural failure due to earthquakes. How is the load delivered to a column during an earthquake different from the load it normally supports? What structural devices do engineers and builders use to accommodate these unusual forces?];

(D) develop and interpret a free-body diagram for force analysis [Slides 46-51 – Draw a free-body diagram of the column illustrated in these pictures. What are the external forces? What are the internal forces and moments? What effect does the stirrup have on the distribution of internal forces in a concrete column? What effect do the stirrups have on the elasticity of the column? Why does this help prevent column failure?]; and

(5) Science concepts. The student knows that changes occur within a physical system and recognizes that energy and momentum are conserved. The student is expected to:

(A) interpret evidence for the work-energy theorem [Slides 3-5 – What evidence do earthquakes provide to indicate that there is deformation in the earth's crust?];

(B) observe and describe examples of kinetic and potential energy and their transformations [Slides 3-5 – Earthquakes are an example of the transformation of potential energy (deformation energy). Describe the atomic scale and the large scale interactions involved in the storage and transformation of energy. How do these interactions lead to earthquakes? Slides 30-32 - How can the properties of materials (the sustainable compressive and tensile stresses and strains of rocks and minerals) be used to predict earthquake frequency?];

(D) demonstrate the conservation of energy and momentum [Slides 3-5 – How do earthquakes demonstrate conservation of energy?].

(7) Science concepts. The student knows the laws of thermodynamics. The student is expected to:

(B) evaluate different methods of heat energy transfer that result in an increasing amount of disorder [How does mantle convection result in increasing entropy on the earth's surface? How does the theory of plate tectonics demonstrate dynamic equilibrium in earth systems?].

(8) Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:

(A) examine and describe a variety of waves propagated in various types of media and describe wave characteristics such as velocity, frequency, amplitude, and behaviors such as reflection, refraction, and interference [Slides 3-6 show a cartoon of the propagation of a seismic wave. How are seismic waves generated? Through what media do seismic waves travel? How quickly do seismic waves travel? Describe the motion and velocity of three main types of seismic waves. Which of the seismic waves do not travel through liquids? Which of the three seismic waves is the first to arrive? How can a deep ocean earthquake endanger coastal areas hundreds or even thousands of miles away? In 1946, a large 50 foot tsunami hit Hawaii from the north. Where was this tidal wave most likely generated? How can seismic waves "X ray" Earth's internal structure? What are seismic discontinuities and what do they reveal about the earth's interior? Describe how seismic waves indicate that the outer core of the Earth is liquid].

Geology, Meteorology, and Oceanography

(6) Science concepts. The student knows the processes of plate tectonics. The student is expected to:

(A) research and describe the historical development of the theories of plate tectonics including continental drift and sea-floor spreading [Slides 7, 30-32, 40 - Describe the concepts of plate tectonics theory that apply to earthquakes and earthquake related hazards such as submergence, and subsidence. How have seismic data helped earth scientists learn about the earth's interior? When was the theory of continental drift proposed? When was the theory of plate tectonics developed? How have these theories changed how we model the earth's interior?]

(B) analyze the processes that power the movement of the Earth's continental and oceanic plates and identify the effects of this movement including faulting, folding, earthquakes, and volcanic activity [How are mantle convection currents related to plate movement? How are earthquakes related to plate boundaries? Slides 3-8, 30-32 What type of plate motion occurs along the San Andreas Fault? What type of plate motion occurs along the Himalayas? Slide 40 – How does the collision of the Indian and Tibetan plates affect the shape of the entire Indian continent? Explain the elastic-rebound theory of the origin of earthquakes. Slides 3-8 - What is the focus of an earthquake? Describe the differences between the following types of earthquakes: shallow-focus, intermediate focus, deep focus. What is the epicenter of an earthquake? How is the location of the epicenter determined? What is meant by the term liquefaction? What other natural hazards are associated with earthquakes (landslides, tsunamis)? What is the relationship between areas of subduction and deep ocean trenches?]

(C) analyze methods of tracking continental and oceanic plate movement [See http://www.pbs.org/wgbh/nova/everest/earth/quake.html for an article about Mt. Everest, earthquakes, and Dr. Bilham's pioneering use of Global Positioning Systems to track pate motion and crustal deformation].

World Geography

(c) Knowledge and skills.

(1) History. The student understands how geographic contexts (the geography of places in the past) and processes of spatial exchange (diffusion) influenced events in the past and helped to shape the present. The student is expected to:

(A) analyze the effects of physical and human geographic patterns and processes on events in the past and describe their effects on present conditions, including significant physical features and environmental conditions that influenced migration patterns in the past and shaped the distribution of culture groups today [Slides 14-17 – How many of the major modern urban agglomerations are near or around those of the 1600's? What were and are the names of these cities? Do you think the inhabitants of the 17^{th} century world were considering plate tectonics when deciding where to locate major economic and political boundaries and capitals? When was the theory of continental drift proposed?]; and

(2) History. The student understands how people, places, and environments have changed over time and the effects of these changes on history. The student is expected to:

(A) describe the human and physical characteristics of the same place at different periods of history [Compare slides 14, 15, and 16]; and

(3) Geography. Such as student understands how physical processes shape patterns in the physical environment (lithosphere, atmosphere, hydrosphere, and biosphere), including how Earth-Sun relationships affect physical processes and patterns on Earth's surface. The student is expected to:

(B) describe physical environment of regions and the physical processes that affect these regions such as weather, tectonic forces, wave action, freezing and thawing, gravity, and soil-building processes [Slides 27-41 describe how earthquakes have affected the Indian continent over the past 500 years].

(4) Geography. The student understands the patterns and characteristics of major landforms, climates, and ecosystems of Earth and the interrelated processes that produce them. The student is expected to:

(B) relate the physical processes to the development of distinctive land forms [How is mantle convection related to plate motion? How is plate motion related to earthquakes? How are earthquakes related to other natural disasters such as tsunamis, landslides, subduction, and submergence? Slides 11, 40 – What distinctive landforms are associated with earthquakes, faulting, and plate collision?]; and

(6) Geography. The student understands the types and patterns of settlement, the factors that affect where people settle, and processes of settlement development over time. The student is expected to:

(A) locate settlements and observe patterns in the size and distribution of cities using maps, graphics, and other information [Slides 12-17 - Where are earthquakes located? Where are the world's major cities located? How have population location patterns changed since the 1600s? Since 1950? Have students compare these maps and identify the relationships between urban area locations, earthquake locations, and earthquake intensity. Why are large numbers of humans endangered by earthquakes?]; and

(8) Geography. The student understands how people, places, and environments are connected and interdependent. The student is expected to:

(C) describe the impact of and analyze the reaction of the environment to abnormal and/or hazardous environmental conditions at different scales such as El Niño, floods, droughts, and hurricanes [Slides 9-11, 22, 43-45, 52-55 – How do earthquakes affect cities? How does an urban environment react to an earthquake differently than a non-urban environment? What are the effects on structures and human property? What are the effects on human life? What caused most of the destruction during the San Francisco earthquake of 1906?]; and

(D) analyze statistical and other data to infer the effects of physical and human processes on patterns of settlement, population distribution, economic and political conditions, and resource distribution [Based on slides 12-17 and what you know about human geography, do you think earthquakes and natural disasters strongly affect patterns of settlement on the earth? How do these factors compare to the importance of other factors such as climate, vegetation, and availablilty of natural resources?].

(19) Science, technology, and society. The student understands the impact of technology and human modifications on the physical environment. The student is expected to:

(B) analyze ways technological innovations have allowed humans to adapt to places shaped by physical processes such as floods, earthquakes, and hurricanes [Slides 46-51 – What structural innovation discussed by Dr. Bilham has allowed for the construction of large, earthquake-resistant structures? What other technologies help humans live more safely in areas prone to earthquakes? What kinds of instruments are used to measure and predict earthquakes? How has earthquake detection technology changed since the invention of the seismograph in the 1870s. Begin by reading about the invention of the seismograph at http://inventors.about.com/library/inventors/blseismograph6.htm. Use the weblinks document to expand this search].

(21) Social studies skills. The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:

(C) construct and interpret maps to answer geographic questions, infer geographic relationships, and analyze geographic change [What relationships do the maps in slides 12-17, and 27-41 suggest regarding earthquake intensity and human population? Why is this important to how leaders and citizens prepare for natural disasters?];

(D) apply basic statistical concepts and analytical methods such as computer-based spreadsheets and statistical software to analyze geographic data [Slides 33-37 – What statistical concepts does Dr. Bilham use to predict the location and intensity of earthquakes? Where is the next large earthquake most likely to occur in India, according to Dr. Bilham's data?]