

2002 AP® ENVIRONMENTAL SCIENCE FREE-RESPONSE QUESTIONS

4. Read the article below and answer the questions that follow.

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FREMONT DAILY GAZETTE

El Niño Linked to Disease Epidemics

Scientists have long realized the strong linkage between the ocean and atmosphere and the effect of this linkage on global climate patterns. Only recently however, have scientists established a possible link between climate change and health-related epidemics. Every few years a dramatic climate shift known as the El Niño-Southern Oscillation (ENSO) disrupts the normal interaction between ocean and atmosphere and alters the normal pattern of water temperatures and winds. ENSOs occur every 3 to 7 years and typically last from several months to over a year. During an El Niño, normal climatic patterns are severely disrupted and the longer the phenomenon lasts, the more disruptive it can be. When an ENSO lasts 12 months or longer it can also disrupt populations of oceanic and other aquatic organisms and set off a series of environmental problems

throughout the world. Recently scientists studying ENSOs established a link between the climate-related changes during an El Niño event and the spread of such diseases as cholera and yellow fever.

The linkage apparently is the result of changing surface temperatures during the event, producing conditions suitable for the rapid spread of various vector-transmitted diseases in affected areas. The same changing conditions are also linked to several other environmental problems.

Recently, scientists at the Max Planck Institute in Germany reported that, based on a computer simulated model, human-induced global warming affects ENSOs. The model predicts more frequent El Niño events with increases in greenhouse gases, and if this model is correct, then we can expect further increases in disease epidemics in various parts of the world.

- Describe what an El Niño is and clearly indicate where it occurs.
- Describe the connection between the climate change associated with an El Niño and the transmission of diseases. Explain whether the article is correct in its reporting of the various disease epidemics that occur in response to an El Niño.
- People in what part of the world would be most likely to be affected by this link between El Niño and disease?
- Clearly describe two other important environmental problems associated with ENSOs.

END OF EXAMINATION

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Question 4

Total Score 10 Points

- (a) Describe what an El Niño is and clearly indicate where it occurs.

What an El Niño is: (2 points)

If the student takes the description of El Niño directly from the article, then all characteristics in the description must be there in order to earn 1 point.

If the student does not use the description of El Niño from the document, but instead provides a separate description, 1 point can be earned for each characteristic of El Niño (up to 2 points).

Acceptable characteristics include the following:

- Development of warm ocean waters
- Depression of the thermocline, which cuts off the cold water upwelling (or, suppression of upwelling due to diminishing winds)
- Moving of rainfall patterns
- The Northeast and Southeast Trade winds diminish, and sometimes even reverse
- The Southern Oscillation (associated with El Niño) is a switch in atmospheric pressure associated with changing ocean water temperature
- Affects the entire globe/global weather and climate (NOT — “it occurs globally”)
- An explanation of the difference between El Niño and ENSO
- An increase in greenhouse gases (global warming) may lead to more frequent/stronger El Niño events (this is also in the document, but was separated from the main part of the definition enough so that it was felt that the student who could connect it to the earlier information should receive additional credit)

Where an El Niño occurs: (1 point)

The student earns 1 point if he/she clearly indicates where El Niño occurs.

Acceptable locations for occurrence of El Niño:

- Tropical Pacific Ocean
- Equatorial Pacific Ocean
- Tropical Pacific coast of South America
- Tropical eastern Pacific
- Central and eastern equatorial Pacific

Unacceptable locations include:

- South Pacific
- Southern Hemisphere
- tropical South Pacific
- eastern Pacific
- North America
- Pacific Ocean
- coast of South America

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Question 4 (cont'd.)

- (b) Describe the connection between the climate change associated with an El Niño and the transmission of diseases. Explain whether the article is correct in its reporting of the various disease epidemics that occur in response to an El Niño.

Connection between El Niño and the transmission of diseases: (3 points)

In this part of the question, the student can earn 3 points in several ways by making

- three connections between climate change and disease transmission (this could be a single climate change that can be associated with more than one mode of disease transmission)
- two connections between climate change and disease transmission, plus 1 extended discussion point (see below)
- one connection between climate change and disease transmission, plus 2 extended discussion points (see below)

Climate change: *wetter conditions* promote transmission of disease by:

- increasing the regions where mosquitoes breed — some mosquitoes are carriers of diseases such as malaria, dengue fever, or yellow fever.
- causing flooding, causing a problem because of sanitation (e.g., contamination of water sources with bacteria that may promote the spread of cholera, amoebic dysentery, giardia).

Climate change: *warmer water* promotes transmission of disease because:

- warmer water allows for increased growth of phytoplankton and zooplankton
- bacterial growth increases in warm water
- increased temperatures may mean increased breeding of insects

Climate change: *higher air/land temperatures* promote transmission of disease because:

- higher temperatures give insects (such as mosquitoes) a longer window of reproduction times
- increased temperatures may mean increased breeding and feeding of insects
- higher wintertime temperatures may mean insect populations that carry disease are increased since not as many will be killed by freezes

Climate change: *slightly drier conditions* promote transmission of disease by:

- causing streams to become stagnant, resulting in standing ponds of water that are conducive to increased mosquito populations. (One of the biggest outbreaks of dengue fever in Fiji occurred during the last major ENSO event when Fiji was unusually dry.)

Climate change: *drought* promotes transmission of disease by causing:

- deterioration in fresh water supplies (shortage of potable water; concentration of pollutants in shallow ponds) increases the probability of diseases such as cholera and other diarrheal diseases in places such as Papua New Guinea

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Question 4 (cont'd.)

The student can earn up to 2 points for extended discussion/additional information/elaboration such as:

- citing the article, linking global warming with increased ENSO events, that would increase the transmission of disease. The link between more frequent/stronger ENSO events and increased transmission of disease must be explicitly made in order to receive this point.
- if student gives a clear explanation of the differences between vector-borne transmission of disease and other modes of disease transmission

Explain whether the article is correct in its reporting of the various disease epidemics that occur in response to an El Niño: (1 point)

1 point for citing the article, in which “scientific evidence” links El Niño and the spread of disease

OR

1 point citing outside sources of information concerning the link of El Niño and disease (i.e., citing the CDC or other “authority”) — this can be either in support of the article or disagreement with the article

OR

1 point for noting that only one source is cited in the article and/or that there is not enough information in the article to determine whether or not it is correct

OR

1 point for the student presenting an argument based on their own logic, substantiated by additional information (may be based on the article or on the student’s own knowledge)

(c) People in what part of the world would be most likely to be affected by this link between El Niño and disease? (1 point)

Although an ENSO event can affect the globe, the areas most likely to feel the greatest impact of increased disease transmission due to climate change associated with ENSO are those areas where (1) the weather/climate changes are most extreme, and (2) health care and sanitation are marginal

1 point for specifying a reasonable area, such as:

Pacific coastal regions of South America and/or equatorial regions of South America (e.g., Peru, Chile, Brazil, Argentina), islands in the tropical Pacific (e.g., Papua New Guinea, Galapagos islands), Central America, Mexico, Southeast Asia, Malaysia, Indonesia, Burma, India, Bangladesh, Pakistan, southern Africa, Kenya

“Developing countries” is also acceptable IF it is coupled with either a reasonable location (e.g., “developing countries in the tropics”) OR if the student explains why people in developing countries are more vulnerable to disease (lack of medical facilities, unprepared to handle drastic changes in weather/climate, general population is often malnourished, sanitation is often a problem, etc.)

Unacceptable answers include: North America, Europe, Australia, New Zealand, Canada, United States, polar regions, Antarctica, Arctic (although these areas may be affected by ENSO events, they are not the most likely to be affected by increased disease transmission associated with El Niño)

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Question 4 (cont'd.)

- (d) Clearly describe two other important environmental problems associated with ENSOs.

(2 points)

Only the first two problems stated are graded. Since the question clearly asks for problems associated with ENSOs, the student must demonstrate the connection of the problem with ENSO/climate change. In addition, there must be a completion of cause/effect, and there must be a clear description of how/why this is an environmental problem.

The table below gives some examples of cause and effect. This table is not meant to represent the only ways in which students may make reasonable arguments for environmental problems associated with ENSO. That is, a student does not necessarily need a statement from each column below to make a complete argument. However, the student MUST at least refer to a reasonable change that may be brought about by an ENSO event and a resultant environmental problem. A student cannot, for example, simply say that there will be a loss of biodiversity. They must indicate why there may be a loss of biodiversity, and why the loss of biodiversity may be a problem.

ENSO may cause	Problems (e.g.)	Effects (e.g.)
Warming water (primarily ocean)	Habitat destruction Increased algal blooms Coral bleaching Disruption of migration No upwelling of nutrient-rich waters Die-off of species that cannot tolerate the warmth Lowered water-solubility of CO ₂ gas Increased storms/shift of zones where storms form	Starvation/die-off of species Loss of food for higher trophic levels Disruption of food webs Loss of biodiversity
Movement of warm ocean waters/increasing depth of warm surface water	Depression of thermocline Suppression of upwelling Disruption of migration Destruction of habitat	Nutrient-rich waters not available for fish Loss of food Starvation/die-off of species
Increased rainfall	Flooding Mudslides Erosion Nutrient leaching	Habitat destruction Plants unable to grow/loss of food production
Decreased rainfall	Drought/lack of water for living organisms Increased risk of fires Less plant growth	Starvation/die-offs Habitat destruction Starvation/die-offs

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Question 4 (cont'd.)

ENSO may cause	Problems (e.g.)	Effects (e.g.)
Increased land temperature	Species unable to adapt Drought	Habitat destruction Starvation/die-offs
Changes in ocean currents	Disruption of migration	Disruption of food webs
Flooding	Loss of habitat Contaminated water supplies Nutrient leaching from soils	Species die-offs Reduced potable water Poor/no plant growth
Drought	Increased risk of fires Lack of water for living organisms Decreased food production	Habitat destruction Decreased food Starvation/die-offs
Increased storms (number, frequency, or strength)	Flooding Increased coastal erosion by waves	Habitat destruction

Unacceptable answers include:

- General weather and/or climate changes that directly affect industries/commerce, such as:

Agriculture	Outdoor recreation
Construction	Snow equipment
Property losses	Commercial fisheries
Insurance services/financial institutions	
- Any purely economic problem