

AP[®] ENVIRONMENTAL SCIENCE

2015 SCORING GUIDELINES

Question 1

- (a) **Describe** how TWO human activities, other than those that result in anthropogenic climate change, have resulted in a decrease in the amount of freshwater flowing into the Everglades ecosystem.

(2 points: 1 point for each description of an appropriate human activity. Students have to describe, not merely identify, the human activity. Only the first two descriptions can earn a point)

- The water is diverted for irrigation of crops
- The water is withdrawn for domestic uses such as watering lawns, washing cars, drinking water, flushing toilets, etc.
- The water is withdrawn for industrial processes such as the production of goods, cleaning the facility or an additional appropriate use
- The water is diverted for flood control
- Road construction/development interrupts the flow of surface water
- Wetlands are filled in for agriculture, or housing developments and/or road construction

- (b) In addition to water quantity problems, the Everglades is faced with a variety of water quality issues. For example, phosphorus concentrations in the Everglades have increased since the 1960s.

- (i) **Describe** how one specific human activity contributes to increased phosphorus levels in the Everglades.

(1 point for a description of a human activity that has led to increased phosphorus levels in the Everglades)

- Runoff from fertilizer or pesticides* used in agriculture, residential lawn care or golf courses
- Seepage from septic systems located near canals
- Discharges from wastewater treatment plants that lack tertiary or advanced wastewater treatment
- Combined sewer overflows (CSOs) when rain volume exceeds wastewater treatment plant capacity
- Runoff of animal waste from feedlots
- Use of phosphate-containing detergents

**Pesticides are acceptable only if they are identified as an organophosphate.*

- (ii) **Explain** one way in which an increase in phosphorus levels can adversely affect the Everglades ecosystem.

(1 point for an explanation of how increased phosphorus levels adversely affect the Everglades ecosystem)

- Phosphorus can speed eutrophication and stimulate harmful algal blooms
- Phosphorus may give a selective advantage to invasive species, which displace native plants (native species are adapted to low levels of phosphorus)
- A specific example of a native species being displaced by a non native species (or a non endemic species, such as cattails, replacing the endemic sawgrass)

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Question 1 (continued)

(iii) Describe one step that could be taken to reduce phosphorus inputs from the activity you identified in part (i).

*(1 point for a description of a step to reduce phosphorus inputs, **must be linked to (i)**)*

- Buffer zones/retention ponds/waste lagoons around agricultural areas
- Swales/rain barrels/cisterns/rain garden/green roofs in residential areas
- Artificial wetlands created to capture runoff from agricultural areas (Storm water treatment areas (STA) are planted with cattails)
- Permeable pavements/permeable pavers to treat runoff
- Fertilizer used more efficiently/precision agriculture/more efficient irrigation techniques
- Restrictions on phosphate-containing detergents or pesticides
- Restrictions on the use of phosphate-containing fertilizers
- Wastewater treatment plants upgraded to remove phosphates from wastewater (tertiary or advanced treatment)
- Public education campaign about efficient use of fertilizers or alternatives to fertilizers
(Note: better use of fertilizers is not the same as efficient use of fertilizers)

(c) Climate change could have a variety of impacts on water quantity, water quality, and habitat. For EACH of these three factors, **identify and describe** one specific example of an impact on the Everglades likely to result from climate change.

(3 points: 1 point each for an identification with a correct description of an impact on water quantity, water quality, and habitat; the impacts can be positive or negative)

Acceptable responses may include the following:

Water Quantity	
<u>Negative</u>	<u>Positive</u>
Higher temperatures lead to increased evaporation, lowering water levels	Storm water runoff and flooding will help maintain water levels
Periods of heavy rainfall will increase storm water runoff and flooding	
Sea level rise will flood areas of the Everglades	

Water Quality	
<u>Negative</u>	<u>Positive</u>
Elevated air temperatures can raise water temperatures	Periodic flooding can dilute concentrations of harmful pollutants
Elevated temperatures cause dissolved oxygen levels to decrease	Periodic flooding will dilute salinity levels in areas affected by sea level rise
Increased evaporation will increase concentration of pollutants in surface water	
Pollutants are carried by storm water runoff into the Everglades, threaten aquatic life	
Sea level rise will lead to increased salinity and/or salt water intrusion into coastal wells	
Warmer water temperatures will lead to increases in algal blooms/rate of eutrophication	

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Question 1 (continued)

Habitat	
<u>Negative</u>	<u>Positive</u>
Due to changes in water quantity (rainfall): <ul style="list-style-type: none"> • Reduced runoff/drought dries out aquatic habitat • Flooding/storm water runoff floods previous semi-aquatic habitat 	Increased runoff/flooding helps maintain aquatic habitats
Due to sea level rise (salt water intrusion): <ul style="list-style-type: none"> • Increased salinity levels in estuaries can lead to a decline in populations for species not adapted to higher salinity levels • Nests of wading birds and other coastal dwelling animals may be destroyed • Salt tolerant communities (such as red mangroves) can move inland, displacing existing communities 	New habitat is created for organisms that are salt tolerant
Elevated temperatures favor invasive species	
Elevated temperatures push some species past their upper temperature tolerance limit (terrestrial or aquatic)	

(d) The article states that Governor Moss believes that the “preservation and enhancement of the Everglades, key goals of the restoration program, are absolutely essential for the continued environmental and economic health of the state.”

(i) Describe one way that restoring water quantity and water quality in the Everglades is expected to improve the structure and function of the ecosystem.

(1 point for a correct description of how the restoration of water quantity and water quality will improve the structure and function of the Everglades ecosystem)

- Re-establish biodiversity
 - By providing/re-establishing habitats (For example, wading birds will be able to re-establish their populations)
 - Re-establishment of native species/vegetation so that food webs/food chains become more stable (For example, apple snails will be able to lay their eggs and the food source for the Everglades Kite will be assured)
- Prevent degradation of adjacent coastal areas
- Less eutrophication leading to fewer algal blooms

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Question 1 (continued)

(ii) Describe one way that restoring the Everglades is expected to provide economic benefits to Florida.

(1 point for a description of an ECONOMIC benefit)

Acceptable responses may include the following:

- Increase tourism/recreation, (for example, increase the number of visitors to the Everglades National Park)
- Create jobs to work in the tourism/recreation/restoration industries
- Maintain clean water, so less money has to be spent on water treatment
- Attract businesses that provide tours of the area that will increase tax revenue

PAGE FOR ANSWERING QUESTION 1

a) The diversion of water flowing into the Everglades for agricultural and industrial uses ^{such as ~~irrigation~~ for irrigation} has dramatically reduced the water quantity in the ecosystem. Also, runoff including chemicals from industrial and agricultural development, has compromised the water quality, or purity, of water flowing into the Everglades. section A →

b) i) The increased usage of chemical ^{phosphate based} fertilizers has led to increased amounts of runoff of phosphorus contaminated water, which is then dispersed into the Everglades, raising its phosphorus levels.

ii) Since phosphorus encourages plant growth, higher phosphorus levels can lead to algal blooms, which block out light from reaching the plants at the bottom of the ~~the~~ water, thus killing them, creating dead zones, and thus hypoxic conditions.

iii) Farmers could use fewer chemically based fertilizers and instead use organic ones that don't release such high levels of phosphorus.

c) Water quantity- As climate change causes the Earth to warm, polar ice caps will melt thus causing ocean levels to rise. Higher sea levels have the potential to flood, or

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even completely submerge, coastal areas, including the Everglades (thus drastically increasing its water quantity)

Water Quality- Rising global temperatures will cause all existing bodies of water to warm up as well, decreasing the dissolved oxygen levels and thus killing off aquatic organisms within the ecosystem.

Habitat- An increase in global temperatures will also shift global biomes, and where they are found on Earth. Higher temperatures in the Everglades may not be suitable for all species within the ecosystem, thus drastically altering the biotic components of the habitat.

- d) i) Restoring water quality & quantity will recreate the environment in which the ecosystem thrived, thus reinstating ~~high~~ high biodiversity and genetic variation (improving resiliency & resiliency).
- ii) Restoring the Everglades will increase tourism to that area, thus increasing revenues for the state of Florida.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 1

a) The diversion of water for irrigation for agriculture has reduced the amount of freshwater flowing into the Everglades. Urban development has also reduced the water quantity because residential areas may divert water sources ~~of~~^{of} the Everglades to be used for drinking water.

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A. Agricultural development is a primary human activity that can result in the diversion of water — the intensive usage of freshwater to hydrate crops can decrease the amt. of water in the Everglades ecosystem. Secondly, human development of land (i.e. building roads and buildings) fragments the ecosystem and slows the flow and influx of water.

B.i. The usage of fertilizers containing phosphorus in lands around the everglades can contribute to increased levels of phosphorus because it flows into the water via runoff. This can adversely affect the ~~water~~ Everglades because it can lead to rapid eutrophication. The increased nutrient levels cause algae to grow that blocks sunlight and prevents plant and ecosystem growth. This can be easily avoided by limiting the use of phosphorus-containing fertilizers.

C. water quantity — the warming of global climates has led to melting of polar and glacial ice, which raises global waters

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levels. The ecosystem of the Everglades is a marshy wetlands, with many organisms requiring the presence of land. A rise in sea levels could ~~increase~~ submerge the ecosystem, damaging many organisms that cannot live submerged.

water quality - the rise in greenhouse gasses, particularly carbon dioxide, creates acidification of waters and damages water quality. Gasses above the surface react with the water to create carbonic acid, and a negative feedback loop results in acidification. This impaired quality can damage all life within the ecosystem.

habitat - rising ocean levels, resultant from melting glacial ice, can create extreme saltwater intrusion into the freshwater Everglades. Because many organisms cannot function in saltwater, this would be the death of the ecosystem.

D. 1 Restoring water quality and quantity would increase the function of the ecosystem because more organisms

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ADDITIONAL PAGE FOR ANSWERING QUESTION 1

could flourish, resulting in a largely increased biodiversity.

ii. In terms of economic benefits, the increased health of the everglades could attract tourism of people who want to see biodiversity. Increased travel in the area means better economy for Florida.

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[A] Humans clearing land for residential areas can block freshwater to the Everglades as well as building roads that block freshwater.

[B] i) runoff from fertilizers humans use on their lawns

ii) some plants can't tolerate soil with high levels of phosphorus therefore killing off plants or animals important to the ecosystem.

iii) using less fertilizers or ones with no phosphorus could reduce phosphorus inputs.

[C] quantity - rise in temperature could cause the water to evaporate more and decreasing the water supply.

quality - ~~the~~ climate change could cause the water to become warmer therefore less dissolved oxygen changing the water's make up.

habitat - climate change could cause plants that don't tolerate heat as well as others to die off.

[D] i) restoring quantity and quality of the water could improve the way water flows in the Everglades, more water could help local species.

1C2

ii) restoring the everglades would help the economy for Florida b/c no one wants to see a dead forest. The Everglades is a ~~is~~ tourist attraction in Florida.

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Question 1

Overview

This question was based on a mock newspaper article that discussed the Florida Everglades. The intent of this question was to have students demonstrate knowledge of the potential impacts of changing water quality and quantity on a wetland ecosystem. Students were asked to describe two human activities, other than anthropogenic climate change, that decreased the amount of freshwater flowing into the Everglades ecosystem. Students were asked to apply knowledge of the phosphorus cycle by describing a human activity that increased phosphorus levels in the Everglades and by explaining one way in which increased phosphorus levels adversely affected the Everglades ecosystem. Students were asked to describe a step that could be taken to reduce phosphorus inputs into this system. Students were asked to identify and describe a specific example that demonstrated the impacts of climate change on water quantity, water quality, and habitat in the Everglades ecosystem. Students could extrapolate general knowledge of the effects of climate change on coastal and/or wetland ecosystems to answer this portion of the question. Finally, students were asked to describe how improved water quality and quantity would improve the structure and function of this ecosystem and how the restoration efforts would benefit the economy of Florida.

Sample: 1A

Score: 10

Two points were earned in part (a): 1 point for describing that water is diverted for “irrigation for agriculture” as a human activity that decreases the flow of water to the Everglades and 1 point for “residential areas may divert water sources of the Everglades to be used for drinking water” as a second human activity that decreases the flow of water. Three points were earned in part (b): 1 point in (i) for describing that “usage of chemical phosphorus based fertilizers lead to increased amounts of runoff of phosphorus” as a human activity that contributes to increased phosphorus levels in the Everglades; 1 point in (ii) for explaining that increased phosphorus “can lead to algal blooms, which block out light from reaching the plants at the bottom of the water” as an adverse effect of increased phosphate levels; and 1 point in (iii) for describing that farmers “use fewer chemically based fertilizers . . . that don’t release such high levels of phosphorus” as a step that could be taken to reduce phosphorus inputs from fertilizer use. Three points were earned in part (c): 1 point for describing that “Higher sea levels have the potential to flood, or even totally submerge coastal areas” as an impact of increased water quantity; 1 point for describing that increased global temperatures will cause “existing bodies of water to warm up as well, decreasing the dissolved oxygen levels”; and 1 point for describing that “Higher temperatures in the Everglades may not be suitable for all species within the ecosystem . . . altering the biotic components of the habitat.” Two points were earned in part (d): 1 point in (i) for describing that restoration will “recreate the environment in which the ecosystem thrived, thus reinstating high biodiversity and genetic variation (improving resiliency and resistance)” and 1 point in (ii) for describing that “increased tourism” will result in “increasing revenues” for Florida as a result of Everglades restoration.

Sample: 1B

Score: 8

Two points were earned in part (a): 1 point for describing that “the intensive usage of fresh water to hydrate crops” for agriculture as a human activity that decreases the flow of water to the Everglades and 1 point for “(i.e. building roads and buildings) fragments the ecosystem and slows the flow of water” as a second human activity that decreases the flow of water. Three points were earned in part (b): 1 point in (i) for describing that “fertilizers containing phosphorus . . . flows into the water via runoff” as a human activity that contributes to increased phosphorus levels in the Everglades; 1 point in (ii) for explaining that increased phosphorus “can lead to rapid eutrophication” and “cause algae to grow” as an adverse effect of increased phosphate levels; and 1 point in (iii) for describing that “limiting the use of phosphorus containing fertilizers” as a step that

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Question 1 (continued)

could be taken to reduce phosphorus inputs from fertilizer use. Two points were earned in part (c): 1 point for describing that “A rise in level could submerge the ecosystem” as an impact of increased water quantity and 1 point for describing that climate change would cause “rising ocean levels” that would result in saltwater intrusion and that “many organisms cannot function in saltwater” as an impact of climate change on habitat. One point was earned in part (d). No points were earned in (i). One point was earned in (ii) for describing that “increased travel in the area means better economy for Florida” as a result of Everglades restoration.

Sample: 1C

Score: 6

One point was earned in part (a) for describing that “building roads” interrupts the flow of surface water as a human activity that decreases the flow of water to the Everglades. Two points were earned in part (b): 1 point in (i) for describing that “Runoff from fertilizers that humans use on their lawns” as a source of increased phosphorus levels in the Everglades and 1 point in (iii) for describing that “using less fertilizers or one with no phosphorus could reduce phosphorus inputs” as a way to reduce phosphorus inputs. No points were earned in (ii). Three points were earned in part (c): 1 point for describing water quantity would change because a “rise in temperature could cause water to evaporate more and decreasing the water supply”; 1 point for describing that water quality would change because water would become warmer “therefore less dissolved oxygen” would be in the water; and 1 point for describing that habitat will be affected because a warmer climate “could cause plants that don’t tolerate heat as well as others to die off.” No points were earned in part (d).