

AP[®] ENVIRONMENTAL SCIENCE
2009 SCORING GUIDELINES

Question 3

(a) Multiple dams have been erected along the Colorado River. Identify TWO benefits other than agriculture and recreation that people derive from that system of dams.

A total of 2 points can be earned, 1 for each correct response. (Only the first two responses are scored.)

- Hydroelectric power/affordable (inexpensive) electricity
- Flood control
- Storage of water for domestic/nonagricultural use; municipal water supply (must specify a nonagricultural use)
- Provision of/increase in navigable waterways
- Employment/stimulation of local economy (dam construction, maintenance, operation)
- Reduced air pollution as hydroelectric power replaces electrical generation from fossil fuels

(b) Discuss TWO potential environmental consequences of damming a major river.

A total of 2 points can be earned, 1 for each correct response. (Only the first two responses are scored.)

- Habitat alteration; displacement or death of native species (e.g., fish, plants, birds)
- Population decline of migratory fish (salmon, etc.) or disruption of fish migrations
- Risk of flood from catastrophic failure of dam
- Sedimentation behind dam
- Downstream ecosystems deprived of sediments, nutrients, or water
- Reduction in amount of agricultural land
- Reduction of available water because of increased evaporative loss
- Scouring of channel downstream from dam alters habitat or destabilizes banks
- Increased risk of diseases associated with reservoir (e.g., Aswan dam and schistosomiasis)
- Release of mercury or other toxins from flooded soils
- Accumulation of toxins behind dam
- Methane produced by biomass decomposing in lake
- Humans displaced/local inhabitants forced to move, due to inundation/lake formed behind dam

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Question 3 (continued)

- (c) Competition for access to Colorado River water has increased dramatically due to increased population size and intensive agricultural use. Describe TWO conservation strategies for reducing agricultural water consumption.**

A total of 2 points can be earned, 1 for each correct response. (Only the first two responses are scored.)

Note: Correct answers must detail how agricultural water-use efficiency can be improved. Answers suggesting incentives or regulations to spur conservation are insufficient, unless they are linked to one of the strategies listed below.

- Employ microirrigation (drip irrigation; trickle irrigation)
- Choose crops that do not require irrigation in that climate
- Breed/select/develop crops for more efficient water use or drought tolerance
- Irrigate when evaporative loss is lower (e.g., at night)
- Level fields to improve delivery efficiency
- Carefully monitor soil moisture levels to reduce unnecessary irrigation
- Transport irrigation water in pipes or lined channels
- Direct sprinkler heads downward or place near soil
- Increase soil organic (matter) content
- Incorporate shelterbelts or windbreaks
- Use measures to reduce or slow runoff: contour planting, strip cropping, terracing, etc.
- Cover surface with mulch to reduce evaporative water loss
- Reduce meat consumption, because more water is used in animal production than in plant production

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Question 3 (continued)

(d) Identify TWO possible environmental consequences of climate change on the hydrology of the Colorado River system.

A total of 2 points can be earned, 1 for each correct response. The specific climate change must be paired with its effect on the hydrologic cycle. (Only the first two responses are scored.)

Specific Climate Change Phenomenon	Effect on Hydrologic Cycle
Warmer temperatures	<ul style="list-style-type: none">• Reduced snow(pack) in (Rocky) Mountains• Increased evaporation from bodies of water• Increased evaporation from soil• Altered plant transpiration rates• Timing of snow/melt
Increased precipitation	<ul style="list-style-type: none">• Increased surface water or groundwater inputs• Increased sedimentation in bodies of water• Increased aquifer recharge
Decreased precipitation	<ul style="list-style-type: none">• Decreased surface water or groundwater inputs• Decreased sedimentation in bodies of water• Decreased aquifer recharge
Increased frequency or severity of storms	<ul style="list-style-type: none">• Increased sedimentation• Increased flooding• Increased runoff volume

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Question 3 (continued)

(e) In addition to impacts on the Colorado River system, climate change is impacting the hydrology of coastal ecosystems. Identify and describe TWO possible consequences of climate change on coastal ecosystems.

A total of two points can be earned, one for each correct response. A correct response both identifies a climate change phenomenon and describes how that change affects the coastal ecosystem. (Only the first two responses are scored.) A single phenomenon may be paired with two different effects on ecosystems.

Climate Change Consequence	Effect on Coastal Ecosystem
Rising sea levels	<ul style="list-style-type: none"> • Terrestrial ecosystems are inundated, affecting biota • Shallow aquatic systems become deepwater habitats • Saltwater intrusion of water table inland • Saltwater intrusion into rivers/estuaries/wetlands
More frequent and/or severe storms	<ul style="list-style-type: none"> • Destruction of habitat • Increased mortality of coastal species
Warming/cooling of coastal waters	<ul style="list-style-type: none"> • Affects aquatic ecological tolerances or interactions • Disrupts spawning • Altered nutrient cycling dynamics • Reduced dissolved oxygen levels (in warmer water) • Increased dissolved oxygen levels (in colder water)
Increased or decreased rate of water cycling (change in precipitation or evaporation/transpiration)	<ul style="list-style-type: none"> • Riparian habitats altered (scouring, temperature, etc.) due to new flow regime • Altered inputs of freshwater, sediments, nutrients
Atmospheric circulation (winds) change	<ul style="list-style-type: none"> • Air or ocean currents are changed (new patterns) • Affects aquatic ecological tolerances or interactions • Disrupts spawning • Altered nutrient cycling dynamics • Changes in dissolved oxygen levels
Increased carbon dioxide (CO ₂) concentration in atmosphere	<ul style="list-style-type: none"> • Carbon dioxide dissolves in ocean, lowering pH (increasing acidity), which affects biota • Altered nutrient cycling dynamics

3. The Colorado River flows from the Colorado Rockies to the Gulf of California. The primary source of Colorado River water is melting Rocky Mountain snowpack. Once the river descends from the Rockies, it flows through a landscape that is dominated by desert. Colorado River water carries a high load of sediment.
- Multiple dams have been erected along the Colorado River. Identify TWO benefits other than agriculture and recreation that people derive from that system of dams.
 - Discuss TWO potential environmental consequences of damming a major river.
 - Competition for access to Colorado River water has increased dramatically due to increased population size and intensive agricultural use. Describe TWO conservation strategies for reducing agricultural water consumption.
 - Identify TWO possible environmental consequences of climate change on the hydrology of the Colorado River system.
 - In addition to impacts on the Colorado River system, climate change is impacting the hydrology of coastal ecosystems. Identify and describe TWO possible consequences of climate change on coastal ecosystems.

A. Dams provide a number of services to human populations other than agriculture or recreation. Dams also are a great provider of electricity to the surrounding areas around them. By using the water to move turbines, dams help ease electricity needs and combat global warming.

Dams also provide a viable source of drinking water to surrounding areas as well. By slowing down rivers and having somewhat large lakes throughout the desert region of the Colorado, dams ease the pressure urban cities put on local water resources.

B. A major set back of dams is the dam themselves. Because they no longer allow for sediment to flow down stream, essentially acting as a giant wall, they deprive the water down stream of important nutrients. Farmers as well as specific fish species do not get the specific nutrients they need.

ADDITIONAL PAGE FOR ANSWERING QUESTION 3

Another major environmental consequence of Dams is that they prohibit migratory fish to go upstream to spawn in the river. Again, acting as a gigantic wall, the fish cannot jump over them and it impedes them to allow to breed, causing some fish species to become threatened or endangered.

C. One way Agriculture can cut water use is drip irrigation. This form of watering ensures that the plants only get the required amount of water that they need and nothing else. As drip so water is not wasted simply soaking into the ground.

Another way for Agriculture to conserve on water is a increase in the use of GMs that are drought tolerant. By making certain vegetables or fruits grow with less water, this would lessen the demand agriculture has on our water systems.

D. If Global Warming is to take place it would affect the Colorado River greatly. Warming would cause less snow fall in the Rockies than in years past and would mean that the Colorado River would not have as much discharge as it has had in the past.

Furthermore, Global warming would affect the amount of water that evaporates off the face of the river itself as well as the many man made lakes across the Colorado, causing a drop in

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the amount of water available as well.

F. Global Warming is said to be the cause of the melting of the polar ice caps which if true would raise sea levels. This rise in sea levels would cause the ~~de~~ destruction of many wetlands and estuaries along the ~~oast~~ coasts and would affect many beach ecosystems as well.

Global Warming is also attributed to more violent storms across the Planet as well. These violent storms affect the coastal ecosystems in a horrific way, no longer allowing local vegetation and wildlife to recover between periods of harshness such as in the past.

3. The Colorado River flows from the Colorado Rockies to the Gulf of California. The primary source of Colorado River water is melting Rocky Mountain snowpack. Once the river descends from the Rockies, it flows through a landscape that is dominated by desert. Colorado River water carries a high load of sediment.
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 - In addition to impacts on the Colorado River system, climate change is impacting the hydrology of coastal ecosystems. Identify and describe TWO possible consequences of climate change on coastal ecosystems.

a.) One benefit humans gain from damming the Colorado River is a source of hydroelectric power for surrounding populations. Another benefit to placing dams along the river is to regulate the flow of water down river. This can be useful to regulate sediment erosion as well as water usage during times of drought or poor snowfall. i.e. the water can be used more conscientiously.

b) One major potential consequence to damming the river is the disruption of ~~river~~ fish migration. A dam inhibits the progress of fish swimming upstream. Another environmental consequence is that when a dam is put in place, flooding upstream occurs creating a reservoir. This is destructive to pre-existing animal habitats.

c) One strategy to reduce agr. water consumption may be to refine irrigation techniques. Instead of using a simple sprinkler system, a drip irrigation system could be installed to drastically decrease water usage. Another agricultural practice could be to change the ~~crop~~ crop from a high-water-needing crop to one that needs ~~less~~ to be irrigated less while still

flourishing.

d) Climate change leading to a warming of the ambient temperature can lead to an increase in water temperature all throughout the Colorado River system. Higher water temps could make the rivers and streams undesirable for certain fish species like trout that like colder waters.

Another way that climate change might affect the hydrology of the CO River system is that global warming would lead to decreased annual snowfall. If less snow is falling, then less snow is packed in the mountains during the wintertime. Once the smaller total amount of snow in the mountains begins to thaw + melt and runoff eventually into the CO River, there will be much less water in the river itself. The water level would be way down, which would mean less water for virtually all organisms in the watershed.

e) Climate change can be an issue for coastal ecosystems as well because with climate change can come increased frequency of tropical storms and hurricanes. ~~The~~ Just two negative consequences ~~that~~ that may occur in the Gulf of Mexico area of the U.S. due to increased storm frequency are as follows: The first: ~~with~~ with the rising level of the turbulent stormy seawater, the ~~estuaries~~ estuaries comprised of brackish water may become flooded with too much seawater. That ~~oversalination~~ oversalination can lead to mortality of organisms that need a healthy balance between

freshwater + saltwater. Another problem on the ^{Gulf} coast due to increased storm frequency as a result of climate change is that the storms are bound to destroy considerable amounts of property valued by humans. For example, houses + entire coastal towns alike and even erosion of sand on the beaches. That erosion can occur at a rate too quickly to ~~be~~ replace the sand to maintain beaches.

3. The Colorado River flows from the Colorado Rockies to the Gulf of California. The primary source of Colorado River water is melting Rocky Mountain snowpack. Once the river descends from the Rockies, it flows through a landscape that is dominated by desert. Colorado River water carries a high load of sediment.

- (a) Multiple dams have been erected along the Colorado River. Identify TWO benefits other than agriculture and recreation that people derive from that system of dams. **3C**
- (b) Discuss TWO potential environmental consequences of damming a major river. **1 of 2**
- (c) Competition for access to Colorado River water has increased dramatically due to increased population size and intensive agricultural use. Describe TWO conservation strategies for reducing agricultural water consumption.
- (d) Identify TWO possible environmental consequences of climate change on the hydrology of the Colorado River system.
- (e) In addition to impacts on the Colorado River system, climate change is impacting the hydrology of coastal ecosystems. Identify and describe TWO possible consequences of climate change on coastal ecosystems.

3a. Dams can be used to produce hydroelectric power. Another benefit of dams is that they can help in the process of diverting water to areas that are in great need, supplying water to homes and industry in areas where water is scarce.

3b. One environmental consequence of damming a major river is that it can disrupt the migratory patterns of the fish inhabiting the river. Another environmental consequence is that silt can build-up due to the ~~river~~^{natural} flow of the river being stopped.

3c. One conservation strategy for reducing agricultural water consumption is installing drip irrigation. Drip irrigation wastes less water than other irrigation methods. It uses pipes with holes that transport the water. It is less wasteful and more effective ~~is~~ in transporting water to crops. Another conservation strategy ~~is~~ is to grow crops that are more suited to the climate and require less water.

for optimum growth.

3d. One possible environmental consequence of climate change would be increased evaporation, which would deplete the water in the Colorado River system. Another potential environmental consequence could be death of fish in the River that would lead to increased BOD levels.

3e. Climate change ~~is causing~~ in coastal ecosystems is causing ~~exponential~~ algae blooms in the ocean. This can lead to a large die off of algae after in exponential growth, often referred to as a boom-burst cycle. This can lead to increased BOD levels. Climate change in coastal ecosystems can also force fish to change their migratory patterns. When fish change their migratory patterns, it can lead to ecosystems that rely on those fish, ~~to~~ to suffer or in extreme cases, completely collapse. Also, as the fish migrate to new areas, they will affect the ecosystems they enter, changing the balance and foodweb of the system. This can ~~lead to~~ cause other species to suffer or disrupt the equilibrium of a healthy ecosystem.

AP[®] ENVIRONMENTAL SCIENCE

2009 SCORING COMMENTARY

Question 3

Overview

This question tested students' knowledge of water resources, specifically the impacts and benefits of dams on rivers. The question also asked students to consider water-saving measures in agricultural production, to link climate-change phenomena to river hydrology, and finally to describe the linkage of climate change to hydrology and ecosystem dynamics in coastal areas.

Sample: 3A

Score: 10

This is an excellent response in that it incorporates all the major elements needed to earn points without extraneous detail. The response is laid out clearly and logically.

In part (a) the response earned 1 point for stating that electricity is generated by the moving water through the turbine and 1 point for stating that the dam provides "drinking water to surrounding areas."

In part (b) the response earned 1 point for stating that dams no longer allow sediment and nutrients to flow downstream to fish and 1 point for stating that dams prohibit fish migration.

In part (c) the response earned 1 point for stating that drip irrigation cuts water use and 1 point for stating that farmers could plant crop varieties that "grow with less water."

In part (d) the response earned 1 point for stating that warming could reduce snowfall in the Rockies, leading to reduced river discharge, and 1 point for stating that warming could cause increased evaporation off rivers and lakes.

In part (e) the response earned 1 point for stating that rising sea levels could destroy wetlands and estuaries and 1 point for stating that more violent storms could prevent coastal ecosystem recovery from storm damage.

Sample: 3B

Score: 8

In part (a) the response earned 1 point for stating that dams are "a source of hydroelectric power" and 1 point for stating that dams regulate river flow.

In part (b) the response earned 1 point for stating that dams disrupt fish migration and 1 point for stating that flooding from the reservoir destroys animal habitats.

In part (c) the response earned 1 point for stating that drip irrigation decreases water use and 1 point for stating that changing to a crop needing less irrigation conserves water.

In part (d) the first response, regarding water temperature affecting fish, is not related directly to hydrology and thus did not earn a point. However, the response earned 1 point for stating that global warming would lead to less snowfall, which would decrease runoff and river volume.

In part (e) the response earned 1 point for stating that climate change-related increase in tropical storm and hurricane activity leads to saltwater flow to estuaries and brackish systems, increasing mortality. The subsequent response regarding property damage is unrelated to ecosystems and earned no point.

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Question 3 (continued)

Sample: 3C

Score: 6

This response demonstrates an excellent command of basic concepts in water resources but some confusion regarding the nature and effects of global climate change.

In part (a) the response earned 1 point for stating that dams produce hydroelectric power and 1 point for stating that they provide water for homes and industry.

In part (b) the response earned 1 point for stating that dams disrupt fish migration and 1 point for stating that silts build up.

In part (c) the response earned 1 point for stating that drip irrigation reduces consumption and 1 point for stating the strategy of planting crops suited to the local climate without irrigation.

In part (d) the response does not indicate what specific climate change would increase evaporation, and the reference to fish is not related to hydrology. Thus the response earned no points.

In part (e) the response does not clearly indicate the climate change consequence and link it to ecosystem effects and thus earned no points.