Earth's Changing Surface
Lesson 4: The Changing Delta

Grade: 4	**Length of lesson:** 60 minutes	**Placement of lesson:** 4 of 6 lessons

Anchoring Phenomenon: The Mississippi delta has grown over thousands of years.

Unit Learning Goal: At any given point in time, Earth's surface is both building up and wearing down. Some processes build up Earth's surface, while other processes wear down Earth's surface. These processes include weathering, erosion, and deposition and cause Earth's surface to look different in different places.

Lesson Main Learning Goal: Erosion and deposition are ongoing processes that continue to shape and reshape the land. People can also change where the rock and soil flow. This has positive and negative effects.

Science and Engineering Practices

Constructing Explanations

- Construct an explanation of observed relationships.

Crosscutting Concepts

Systems and System Models

- A system can be described in terms of its components and their interactions.

Stability and Change

- Some systems appear stable, but over long periods of time will eventually change.

Unit Central Question: What can cause Earth's surface to look the way it does?	**Lesson Focus Question:** What can cause a delta to shrink?

Science content storyline: Increased flooding and rainfall caused humans to build walls to manage the flow of the river. This caused a steadier flow of water for communities and transportation along the river but limited how soil and rock could be deposited in the delta. Over time, the land seems to "disappear," but really the soil and rocks are being swept away by the flow of water and wave currents faster than the land is deposited from the river. Human activity can have both positive and negative effects on natural processes.

Ideal student response to the Lesson Focus Question: Deltas can disappear when a dam is built up stream. When a dam is built on the river, it slows erosion and deposition in the river. Waves and water movement from the Gulf of Mexico wash away some of the soil and sand in the delta. Because erosion and deposition has slowed down, the land washed away from the ocean waves is not being replaced by new soil and rock from the river.

Preparation

MATERIALS NEEDED	AHEAD OF TIME
Teacher Resources • TE1.1 animation of the Mississippi delta • TE2.2 *Stream Table Setup Instructions* **Student Handouts** • HO1.3 *How does land change to form a delta?* (for students to revise) • HO2.1 *Lesson 2 Analogy Chart* (student copy for reference) • HO4.1 *The Changing Delta* (1 per student) • HO4.2 *Dams and Rivers* (1 per student) **Materials** • Use either 1 stream table setup as a whole-class demonstration or 5 stream table setups with students in small groups. • 1 or 5 blocks of wood, rocks, or folded foil into a thick 1”x4” rectangle (to be the dam) • Folded foil for the wave condition • computer and projector • chart paper and chart markers **Optional Materials (for easier cleanup)** • 1 large bucket with water (for rinsing hands or to carry water outside) • 1 sponge, paper towels to wipe up any spills • plastic trash bags to cover work areas • aluminum foil to line tray	• Review the *Content Background* document. • Gather a computer and projector and test playing the TE1.1 animation of the Mississippi delta located here: http://www.watchthedeltagrow.com/mississippi-river-paths. You will want to be close to the computer while playing this so that you can stop and pause it. • Use a stream table kit *or* prepare the stream table(s) using the teacher reference sheet provided with Lesson 2: TE2.2 *Stream Table Setup Instructions*. • Practice with the stream table investigation so you know what to expect as you or students try out different human activities that influence erosion and deposition. • Plan where to dispose of the sand, soil, and sandy water—not in a sink!!

Lesson 4 General Outline

Time	Phase of lesson	How the science content storyline develops
3 min	**Link to Previous Lesson:** Students review what they figured out in the previous lesson, revisit the DQB, and make predictions about a disappearing delta.	
15 min	**Lesson Focus Question and Setup for Activity:** Students rewatch an animation to the end about the Mississippi delta, showing what is currently happening to the delta. The teacher introduces the focus question, and students record it in their notebook. Students find out more about the delta through a short reading and learn that in recent times, people have put dams and levees on the river to control flooding.	Increased flooding and rainfall caused humans to build walls to manage the flow of the river. This causes a steadier flow of water for communities and transportation along the river, but it limits how soil and rock could be deposited in the delta. Over time, the land seems to "disappear," but really, the soil and rocks are being swept away by the flow of water and wave currents faster than the land is deposited from the river.
20 min	**Activity:** The class uses a stream table to investigate how a dam influences delta formation and considers the reasons why those changes occur.	
10 min	**Follow-up to Activity:** Students turn and talk with a partner and then individually write their ideas for why the delta might be shrinking. Students also consider the positive and negative effects of dams on a river.	Human activity can have both positive and negative effects on natural processes.
10 min	**Synthesize and Summarize Today's Lesson:** Students reconsider their initial models of delta formation and discuss what they have learned and how they might revise their initial ideas. The teacher records students' ideas for what they have figured out so far.	
2 min	**Link to Next Lesson:** The teacher links to the next lesson and to unanswered questions on the DQB.	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
3 min	**Link to Previous Lesson** Synopsis: Students review what they figured out in the previous lesson, revisit the DQB, and make predictions about a disappearing delta.		***NOTE TO TEACHER:*** *Have Lesson 3's focus question written in a place where students can refer to it again throughout today's lesson:* What can change how fast deltas grow? What did we figure out last time? So, let's look back at our DQB and our original questions. Do we have some new ideas that can help answer any of those questions? Can you now answer some of your questions about how the delta formed?	When there is more water or faster water, erosion of upstream materials and their deposition in the delta happen faster. **Do others have ideas?** When there is fine small sand, erosion happens faster and the delta grows more quickly. **Erosion happens faster—than what? What are you comparing it to?** Erosion of smaller pieces of sand happens faster than bigger pieces of rock and gravel. **Did anything you tested slow down erosion and deposition?** When there are a lot of plants, erosion happened slower. Yes! **Can you share some of your ideas?** All the dirt and soil carried in the Mississippi was deposited and made the delta bigger over time. **You said "over time". How much time?** Thousands of years. **What did we figure out about how fast or slow erosion and deposition happen?**
		Link science ideas to other science ideas (Link to previous lessons).		

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				Erosion happens faster when there is more water, more rain, steeper land, no vegetation, and looser material. This causes there to be more material to be deposited elsewhere. Erosion happens slower when there is less water, no rain, flatter land, more vegetation, and hard material. So then there is less material to be deposited.
			So, my wondering is, if we can form a delta and make it bigger or grow it faster, could we also find out if a delta can go away? Can we use what we learned last time to help us figure out if deltas can disappear?	
				We figured out we can change how fast erosion and deposition happens along a river.
				What is the connection between what you figured out and the delta?
				Well, if we can speed up erosion and deposition, then the delta should get bigger faster.
				And, if we can slow down erosion and deposition, the delta might stop growing or get smaller.
				Why would the delta get smaller?
			In the animation we viewed in Lesson 1 we saw the Mississippi delta getting bigger and changing. What do you think it is doing today?	I think the waves from the ocean would wash away the delta.
				I think the delta is still getting bigger.
			NOTE TO TEACHER: *The idea that the ocean waves can wash away (erode) the delta is an important one to*	I think there have been so many hurricanes lately that it is washing away.

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			come up in these discussions. Students may need to use this idea in their explanations later in the lesson. In today's lesson, we will build on our previous lessons, but this time we are going to figure out what can cause a delta to shrink.	I think it is about the same size**.** **Why do you think that way?**
15 min	**Lesson Focus Question and Setup Activity** Synopsis: Students rewatch an animation to the end about the Mississippi delta, showing what is currently happening to the delta. The teacher introduces the focus question, and students record it in their notebook. Students find out more about the delta through a short reading and learn that in recent times, people have put dams and levees on the river to control flooding. Main Science Ideas: Increased flooding and rainfall caused humans to build walls to manage the flow of the river. This causes a steadier flow of water for communities and transportation along the river, but it limits how soil and rock could be deposited in the delta. Over time, the	Set the purpose with a focus question.	When we watched the animation about the Mississippi delta before, I stopped the animation before it showed what is happening to the delta now. You made shared some ideas about what you thought was happening to the delta. Let's watch the full animation to see how it is changing currently. I will start at the beginning as before and I will tell you when the new part starts. ***NOTE TO TEACHER:*** *Show the full animation (*http://www.watchthedeltagrow.com/mississippi-river-paths*) and pause it at 00:33 seconds. Tell students that this is where you stopped the animation earlier. Show the animation to the end.* *Introduce the Lesson Focus Question by saying,* Our focus question for today is, *What can cause a delta to shrink?* ***NOTE TO TEACHER:*** *Write the question on the board for the class to see and then refer to it throughout the lesson. Ask students to write this focus question in their notebook and record their initial ideas. Invite a few to share out and record their ideas on the Lesson 4 Focus Question chart.* We are going to take a moment to read a bit more about the Mississippi delta because we know something changed recently.	**What did you notice happening to the delta?** It was changing a lot. **How was it changing?** It was shrinking--it looked like it was disappearing!

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	land seems to "disappear," but really, the soil and rocks are being swept away by the flow of water and wave currents faster than the land is deposited from the river.	Make explicit links between science ideas and activities (before activity).	***NOTE TO TEACHER:*** *Pass out HO4.1* The Changing Delta. *Have students either read this aloud as a whole class or in partner reading, or they can read individually. They can write on the reading handout, highlight important words or phrases, or note questions they have. Importantly, ask students to jot down their ideas for the "Stop and think" prompts. They should be prepared to discuss those as a class.* *When students finish reading, have them talk with their elbow partner about what they noted in the reading.* *Lead the class in a discussion by saying,* OK, let's talk about what we just learned from this reading. Can anyone tell me what a dam is? Has anyone seen a dam before? What are some of the benefits of having dams on rivers? Why would they build them in the first place?	The reading says it is a large structure across a river that controls the flow of water. **How do you think the dam controls the flow of water?** **What does the flow of water have to do with the delta?** I've seen one before. It was a big concrete wall that held water back but let water out of the bottom. **Can you tell me how it might do that?** Well, when it rains a lot, it can flood towns, and they build the dams to keep that from happening. **Can you describe your thinking around that idea?** The reading also said that dams can help make hydroelectric power.

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			What did you notice when you looked at the maps of the delta over time?	The land is going away! It is getting smaller. **What does this say about erosion and deposition?**
			So, do you think the ocean plays a role in shaping the delta?  *Listen to students' ideas. Are students considering how human activities might change the natural processes of a river system?*	**What do you think might be causing the delta to get smaller?** Maybe the ocean waves are washing it away. **How would the ocean do that?** Or maybe the land is sinking into the ocean? **Why might it do that?** Maybe the river is changing so the soil isn't going to the delta anymore. Maybe the water flow has slowed down. We learned that erosion slows down when the water slows down so there is less materials to be deposited. **What do you think is causing these changes in the river?** The dams might be catching all the soil so that it doesn't get to the delta.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
20 min	**Activity** Synopsis: The class uses a stream table to investigate how a dam influences delta formation and considers the reasons why those changes occur. Main Science Ideas continued: Increased flooding and rainfall caused humans to build walls to manage the flow of the river. This causes a steadier flow of water for communities and transportation along the river, but it limits how soil and rock could be deposited in the delta. Over time, the land seems to "disappear," but really, the soil and rocks are being swept away by the flow of water and wave currents faster than the land is deposited from the river.	Engage students in using content representations and models. Make explicit links between science ideas and activities (during activity).	Alright, so we have some ideas for how the river and delta might be changing. We know that people added dams and levees to the river to help protect towns from flooding and also, in the case of dams, to make power. But we think that maybe the dams also are doing something to change erosion and deposition in the river and delta. So, we are going to test this idea with our stream table. ***NOTE TO TEACHER:*** *Even though this activity can be done in small groups with multiple stream tables, you may instead decide to work with one stream table as a whole-class activity. Regardless of which way you set up the activity, start by displaying one stream table that already has a river channel carved into it. Show students the river channel.* What does this channel through the sand represent again? ***NOTE TO TEACHER:*** *Hand out HO4.2* Dams and Rivers *to each student. Give students 3–4 minutes to answer question 1. They can refer to the stream table to help draw pictures of what they think might happen.* What are some predictions we have about how the dam will affect erosion and deposition?	A river! The Mississippi. I think the dam will block the whole river. **So, do you mean there won't be a river below the dam?** Well maybe it won't block the whole river because we read that it lets some water through. **What do others think? Do you have any ideas about how erosion and**

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				deposition would be affected by the dam? I think erosion and deposition will happen slower. **Why do you think that?** Because when we tested the slope of the river–the higher slope made the water run faster. Faster water made erosion of upstream materials and deposition in the delta happen faster. So, slower water would make erosion happen slower.
		Engage students in analyzing and interpreting data and observations.	OK, let's try it and see what happens. ***NOTE TO TEACHER:*** *You can let the water flow freely at first to get the river going and then place the wood, rock, or piece of foil to dam the river (see TE2.2). Encourage students to record their observations in words and pictures on their handout. As you visit teams of students or as you do this as a whole-class activity, ask students what they are noticing. Probe their responses to find out more about what they are thinking. Ask students to connect what they are seeing to erosion and deposition. Sample dialogue is shown on the right.*	**What kinds of things are you noticing?** The water slows down. The sand is getting trapped behind the dam. **Do you notice anything at the end of the river—where it meets the ocean?** Not as much sand is being deposited. **If not as much sand is being deposited, how would that affect the delta?** The delta would stop growing. **What do others think?**
		Highlight key science ideas and focus question throughout.	*Remind students of the Lesson Focus Question,* What can cause a delta to shrink? *Connect back to the HO2.1* Lesson 2 Analogy Chart *to consider the delta system components (i.e., land, river, delta, ocean) and the*	

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			stream table models students drew in Lesson 2 to record their observations. Consider creating a system diagram as a class; label the components and add a dam. Invite students to use the system diagram to consider what might be causing the delta to shrink. Sample dialogue is shown on the right.	**What is causing the delta to shrink and not just stop growing?** Maybe it has something to do with the waves. **Something to do with the waves? Can you say more?** Maybe some of the ocean waves take sand away from the delta. **What do others think?** **How might we test that idea?**
			Use student ideas of how to test the effect of ocean waves on the delta (e.g., move a folded-up piece of foil back and forth in the water at the bottom of the stream table to create waves and observe what happens to the delta). Ask students, What do you notice?	The sand is leaving the delta! **Can you say more?** The sand is moving out into the ocean. The delta is getting smaller! **How might we use the words *erosion* or *deposition* to describe what we are observing?**
			OK, so we figured out how dams might change erosion and deposition and how ocean waves can affect the delta too. Let's put these ideas together and explain why a delta might be shrinking.	

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10 min	**Follow-up to Activity** Synopsis: Students turn and talk with a partner and then individually write their ideas for why the delta might be shrinking. Students also consider the positive and negative effects of dams on a river. Main Science Idea: Human activity can have both positive and negative effects on natural processes.	Highlight key science ideas and focus question throughout. Make explicit links between science ideas and activities (after activity).	***NOTE TO TEACHER:*** *Allow students a minute or two to turn and talk with a partner about their ideas for why a delta might be shrinking. Encourage them to use ideas from their reading and from the stream table activities. Then allow them 3–4 minutes of individual thinking and writing time to answer question 3 on HO4.2* Dams and Rivers. ***Embedded assessment task*** Our focus question today is, *What can cause a delta to shrink?* What are some of your ideas about how dams might be related to a delta shrinking? ***NOTE TO TEACHER:*** *Encourage students to share their ideas about how the dam is reducing or stopping the flow of sediments on the river while the existing land is being slowly washed away. Record student ideas on the Lesson 4 Focus Question chart, using the revised ideas chart marker color.* *Encourage students to consider how dams changing the rate of erosion and deposition can cause the delta to shrink.* ***Teacher Content Note:*** *In reality, there are additional processes that contribute to the delta shrinking. For*	The land is being washed away by the ocean, but the dams are blocking new land from forming. **Does anyone have a similar idea to that or something different?** I have a similar idea. There is less sand coming into the delta and the ocean is taking the sand away. **What do others think?** The ocean is making the delta shrink. **If the ocean waves were always there, why wasn't the delta shrinking before?** Before dams and levees were placed on the river, more sand and soil made it down into the delta, and so even though the ocean was taking some away, the delta still grew. **Would anyone like to disagree or agree or add more information?** I think that some new soil gets to the delta, but not as much as before. So, it is getting smaller because the waves are washing away more land than the river can build.

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			instance, some of the land is sinking below the water levels as a result of compacting on itself and becoming denser, and also rising sea levels result in loss of coastal land. Neither of these ideas are introduced at this grade level.	**How could we use erosion and deposition to describe what is happening to the delta?** When there is more erosion and deposition into the delta than erosion out of the delta into the ocean, the delta grows. **What about when there is less erosion and deposition of sand and soil into the delta?** When there is less erosion and deposition into the delta than erosion out of the delta into the ocean, the delta shrinks.
			OK, so we figured out a lot today about how dams can affect rivers and deltas, in good ways and in negative ways. Let's revisit some of our ideas for how dams can have positive and negative effects on rivers. Take a moment to jot down your ideas in number 4 on your handout. ***Embedded assessment task.*** *Questions 3 and 4 on HO4.2* Dams and Rivers *can be used as an assessment point to gauge how well students understand the connection between dam building and delta shrinking as well as the positive and negative impacts on rivers.*	

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			NOTE TO TEACHER: *Chart student ideas on a T-chart (similar to the table in the handout) at the front of the room.* Let's share some of our ideas for positive effects of dams being built on rivers. What about the negative effects of building dams?	Control flooding. Protects towns from flooding waters. Keeps boats more safe when it is flooding. Makes power. It changes the delta. **And how does it change the delta?** People who live on the delta might lose land. The animals that live there might lose their home. The delta is getting smaller. **How does building a dam or levee cause the delta to get smaller?** Dams cause the sediment to stop at the dam and not make it do the delta. Levees keep the land on the side of the river from eroding. So, there is less soil going down to the delta.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
10 min	**Synthesize and Summarize Today's Lesson** Synopsis: Students reconsider their initial models of delta formation and discuss what they have learned and how they might revise their initial ideas. The teacher records students' ideas for what they have figured out so far.	Engage students in making connections by synthesizing and summarizing key science ideas.	***NOTE TO TEACHER:*** *Have students look back at HO1.3* How does land change to form a delta? *from Lesson 1 and review their answers to the questions in part B. Once they have reviewed their initial ideas, discuss what they have learned and how they might revise those ideas.*	**How have our system diagram and investigations changed your initial ideas?** **What would we add to our drawings?** I would add that new land forms when sand and dirt are carried down a river and build up at the end to make a delta**.** **Why do you think that? What evidence do you have?** On our stream table we saw that the water carried the sand and dropped it where the river met the ocean. **What do others think about that idea? Can someone paraphrase what _____ said using the words *erosion* and *deposition*?** I agree with ____, and I would add that the land might go away if the sand is being blocked by something.
		Summarize key science ideas. Highlight key science ideas and focus question throughout.	Alright, so we have great ideas about how new land forms at the end of the river. We know from our investigations that ● sand and soil are carried down a river by water (erosion) and deposited at the end of the river. ● steeper land resulting in faster water flows, heavier rains, or a bigger river cause this to happen faster. ● flat land or slow water flow, not much rain, smaller rivers, or more vegetation can slow it down. ● if we block a river with a structure like a dam, we can also stop the flow of soil and sand to the end of the river.	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			• wave erosion carries sand and soil from the delta and deposits it in the ocean. • when there is less erosion and deposition of earth materials into the delta and wave erosion continues to carry sand away from the delta, the delta can shrink. ***NOTE TO TEACHER:*** *Record "Science Ideas We Figured Out" chart paper. Reference the Lesson Focus Question Charts as needed.*	
2 min	**Link to Next Lesson** Synopsis: The teacher links to the next lesson and to unanswered questions on the DQB.	Link science ideas to other	I have a wondering myself. Where did all this soil and sand come from in the first place? What ideas do you have? ***NOTE TO TEACHER:*** *Connect back to the DQB if there are similar questions students have asked prior to this lesson.*	It comes from the bottom of the river. From the sides of the river. From the land when it rains. **Has the sand and soil in the delta always been tiny grains like what we have been working with?** Well, if it washed away from the ground into the river, maybe it was already small. Maybe the river water broke it up. **How do you think water can break up rock?** Maybe it makes two rocks hit each other really hard and break? **What do others think?**

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
		science ideas (links to next lesson).	In our next lesson, we will try to figure out where all this sand came from that forms a delta.	

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Earth's Changing Surface

Lesson 4

What can cause a delta to shrink?

1

What have we figured out?

Lesson 3 Focus Question

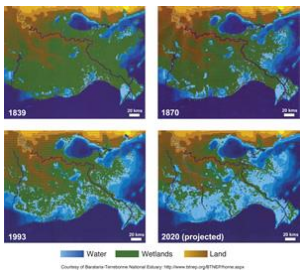
What can change how fast deltas grow?

Can we answer any questions on our DQB?

How did we answer this question in our last class?

2

Lesson 4 Focus Question

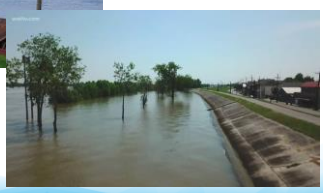


What can cause a delta to shrink?

3

Human-made Structures on a River

A dam on the Mississippi River



A levee along the banks of the Mississippi River

4

5

Turn and Talk with Your Partner

What are your ideas about how a dam changes a delta?

How do erosion and deposition change?

6

Return to the Focus Question

Lesson 4 Focus Question

What can cause a delta to shrink?

Share your ideas!

What are some positive effects of dams on a river?

What are some negative effects of dams on a river?

Record your ideas in #4 of your handout.

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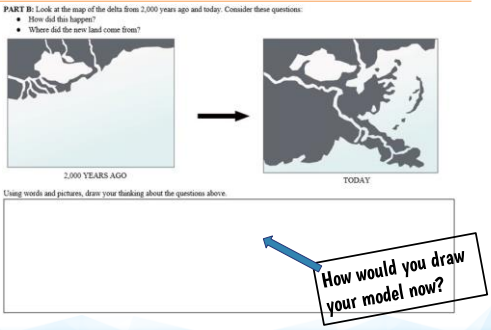
7

How have your ideas changed?



How would you draw your model now?

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8

What's next?

Where did all the sand in the delta come from?

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10

The Changing Delta

In the previous lesson, we learned about what causes a delta to form at the end of a river and grow bigger. In this lesson we are focused on what causes a delta to shrink or disappear. Read this short story and study the images closely.

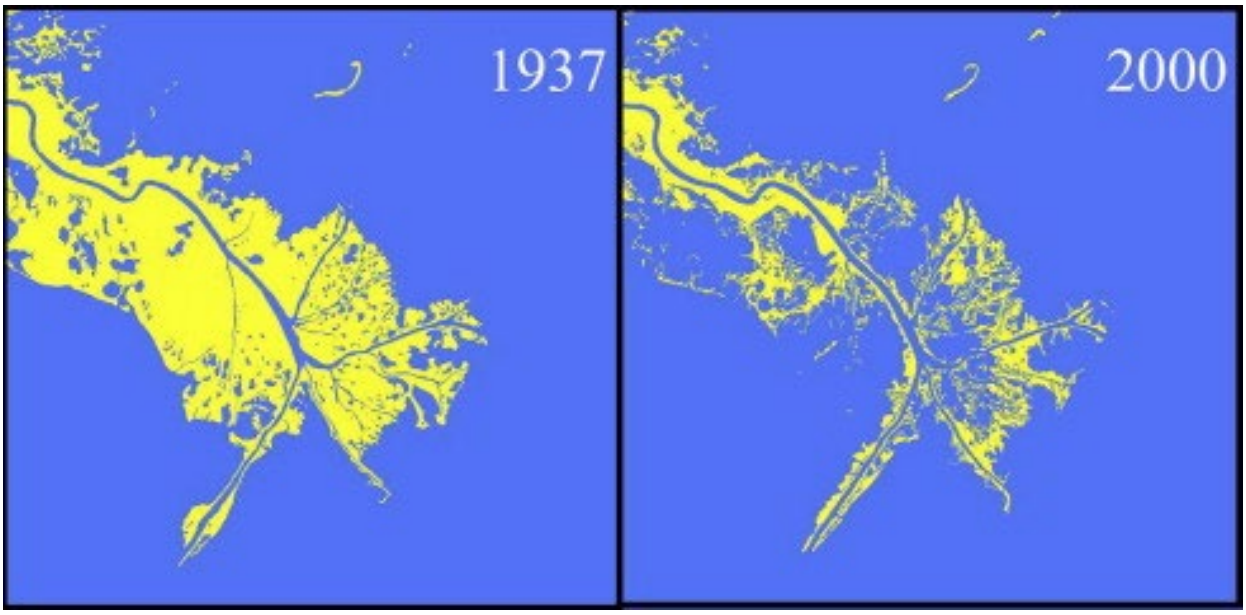
Today the Mississippi River is important for shipping goods in the United States. Large boats travel up and down the river, carrying goods to different ports. The river has many towns and cities along the banks. But it hasn't always been this way.

In the 1700s and 1800s, many settlers moved west across North America. They began to build towns along the Mississippi River and use the river to ship goods. It was faster to use ships than wagons over the land.

The Mississippi River can flood and disrupt the flow of ship traffic or flood the towns along the river. Starting in 1869, people built a series of dams and levees to control flooding on the river. Levees are built along the riverbed to prevent overflow. Dams are solid structures built across rivers. They control how much water flows downstream. People can release water from dams to produce hydroelectric power.

Stop and think: What benefits do dams have?

In recent decades, the Mississippi delta has started to shrink. It is estimated that the Louisiana coast loses about one football field of delta land per hour! Study the following maps:



Stop and think: What might cause the delta to shrink?

Dams and Rivers

Using a stream table, let's test what happens when a dam is built on a river.

1. **Prediction:** If we build a dam on our stream table, what do you think will happen to the flow of water and sediment? You can draw your thinking in words and pictures in the box below.

2. **Observations:** Study closely what is happening with the flow of water and sediment on the stream table. Use words and pictures to draw your observations.

3. How might dams be related to a delta getting smaller?

4. **Positive and Negative Effects:** What are the positive effects (benefits) of dams being built on rivers? What are the negative effects (disadvantages)?

Positive effects	Negative effects