Earthquake Risk in Bangladesh

TEACHER VERSION

PASSAGE FOUR

Tectonics and Sedimentation in the Delta

To understand the larger picture of what's happening in Bangladesh, scientists are looking beyond the region's tectonic forces. Bangladesh sits on the world's largest delta, so its rivers, sedimentation, and floods are also shaping the country. Scientists from different disciplines are investigating the interaction between these two systems: tectonics and the delta's river system.

How can earthquakes affect rivers?

Rivers change course over time, particularly in deltas. As a river flows, it deposits layers of sediment until its elevation is actually higher than a surrounding area. At some point, the water will naturally flow into the lower-lying area. Through time, rivers shift back and forth, constructing the largely flat, featureless landscape of the delta. Earthquakes and other tectonic activity can also steer a river or speed up its natural migration by changing the topography. As plates shift, some parts of the landscape may drop and others uplift. This can send rivers on a new path and flood low-lying areas.

"Our project is trying to understand the relationship between earthquake events and how they influence these large river systems that are building the landscape," says sedimentologist Steve Goodbred. "One way we can study that is to go to the sediment record." As rivers shift, they bring new and different sediments to an area. Over time, the layers of sediment build up across the delta, recording the history of its river systems.

The research team collect sediment samples from wells along the Sylhet Basin north of Dhaka. ©AMNH

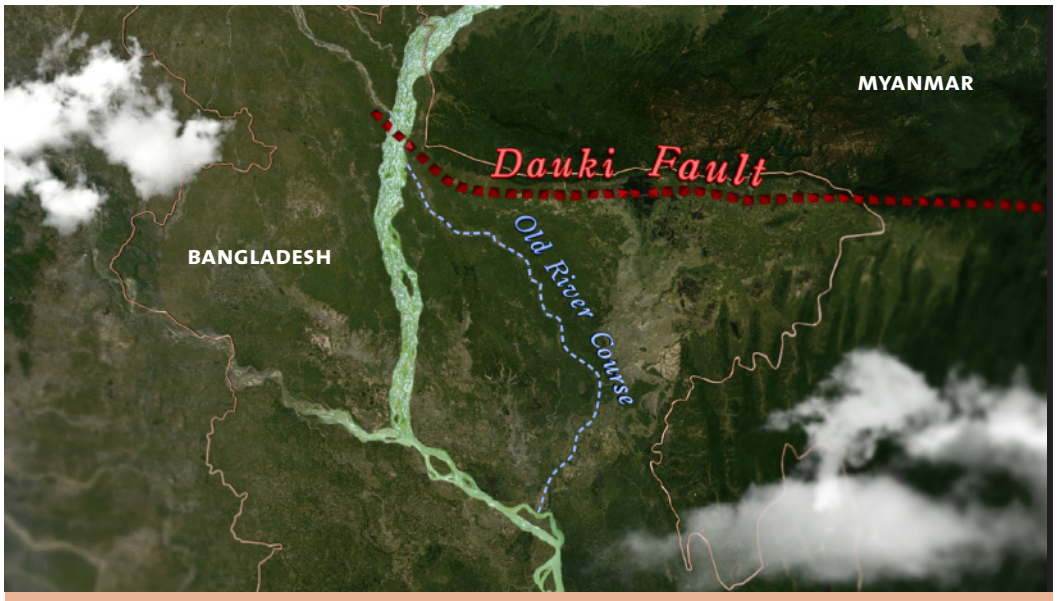
Clues in the sediment

Goodbred and his team have been investigating the delta sediments for evidence of river changes. Using local techniques, the team has dug nearly 150 wells around the country. As they drill, they collect sediment samples every few meters. By digging 50 to 100 meters down, they can piece together up to 20,000 years of the delta's history. Back in the lab, the sediments are analyzed for clues about the landscape's history:

- **Grain size** can reflect the river's power or the distance from the main river channel. Typically, sediment with larger grains, such as sand and gravel, signal a riverbed where water was strongest. Smaller grains, such as fine mud and silt, are spread more widely across the river plain.
- **Color** reveals the environment where it was deposited. Dark brown or black sediment holds lots of decayed plants, and is usually found farther from the

CONTINUED

Tectonics and Sedimentation in the Delta



This map shows the course of the Brahmaputra River before (in blue) and after (in green) the course change. ©AMNH

river. Tan or brown sediments are closer to the river.

- **Plant material** trapped in the sediment can be used to date when the layer formed.
- **Chemical composition** of the sediment tells which river deposited it. For example, sediment from the Brahmaputra River eroded from rocks in the Tibetan Plateau of the Himalayas, where it picked up traces of strontium – an element found in much smaller amounts in the Ganges River sediment.

"Those four attributes in these sediments give us great power in reconstructing the history of the entire landscape," says Goodbred.

Sediments also hold evidence of past tectonic activity:

- **Deformed sediment layers** occur in areas where rocks have been uplifted.
- **Sand dikes** form where fine sediment liquefied during an earthquake and squirted up through cracks in the rock.
- **Abrupt changes in the type of sediment** may be caused by a sudden event like an earthquake.

Evidence of past river changes

Based on the sediment, the team is piecing together the history of the Brahmaputra River. "We're able to really document the behavior of the [Brahmaputra] river over the last 10,000 years, and we can begin to develop a new set of hypotheses that are very targeted at asking whether those differences are tectonically induced and are tectonically controlling the behavior of the river," says Goodbred. "There's some indication that they are."

So far, the sediments have revealed that the river system in Bangladesh is extremely dynamic, constantly moving back and forth over the landscape. There's also evidence that some of these changes may be linked to tectonic activity. About 200 years ago, the Brahmaputra River changed its path in the decades following a moderate 1787 earthquake along the Dauki fault. Following that earthquake, the river shifted course by up to about 62 miles (100 kilometers).

Today, the Brahmaputra's path is actually higher than the

CONTINUED

Tectonics and Sedimentation in the Delta

Sylhet Basin, which is being pushed down by the weight of the Shillong Plateau. Scientists think the Brahmaputra could shift again, migrating back to this low-lying basin where it once flowed. "We think that there's some complex tectonic deformation that's actually preventing the river from moving through this shallow ground," says Goodbred. "And if there was an earthquake, it could force the river into that basin."

If the Brahmaputra River were to change course today, "it would be a truly catastrophic event," says Goodbred. Towns that now thrive along the Brahmaputra would be abandoned without the river to support them. "Perhaps more devastatingly, whole areas of flood plain would have a 10-km wide river flowing through it." It is this interplay between the probability of an earthquake event, weighed against the potential human consequences, that defines the level of ***risk*** it poses to the region.

Preparing for tomorrow

While most people think of Earth as a stable, unchanging place, geologists investigate the ways it is constantly in motion. Evidence of these changes are everywhere in Bangladesh, as rivers move, land grows in some places and is lost in others. Changes are occurring within the Earth's crust as well, as tectonic forces shape mountains, valleys, and plateaus. These systems also put an impoverished, crowded nation at risk. Scientists investigating the impact and interaction of these systems hope their work will help Bangladesh prepare for the future. "There is an obvious application to what we're doing here," says Seeber. "An urgent application."

STOP AND THINK

BASED ON THE TEXT:

1. **How are scientists investigating how river systems have been influenced by tectonic deformation?**
2. **How do they think an earthquake might affect the Brahmaputra River?**
3. **How do scientists define earthquake "risk?"**

FINAL DISCUSSION:

4. **What actions could be taken to minimize earthquake risk in Bangladesh?**
5. **Why would it be difficult for the people of Bangladesh to take these actions?**
6. **Considering all four passages and the science practices listed below, how does the investigation of earthquake risk in Bangladesh provide examples of how scientists work?**

PRACTICES FOR K-12 SCIENCE CLASSROOMS:

- **Asking Questions**
- **Developing and using models**
- **Planning and carrying out investigations**
- **Analyzing and interpreting data**
- **Using mathematics and computational thinking**
- **Constructing explanations**
- **Engaging in argument from evidence**
- **Obtaining, evaluating, and communicating information**