

Global Warming and Floods in the Brahmaputra River

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Executive Summary

I have prepared a lesson plan based in Google Earth (hereafter GE) teaching students how global warming and flooding in the Brahmaputra river are linked. I go on to explain the effects of this flooding on those living near the river. You should be reasonably happy using GE to use this plan, tutorials can be found in the Links section. I have added tips on using GE within the plan, they are designed to help you as you work through the materials for the first time. The prime advantage of using GE in this example is that students automatically get a sense of orientation and scale as they move through the materials. Other advantages over a paper based lesson are the ability to drape images over mountains and embedded videos. A lesser, but still welcome advantage is that GE helps get and retain the attention of the students through the lesson.

Introduction to the Case Study

The population living close to the Brahmaputra river in India and Bangladesh is at increasing risk of flooding and droughts because of the effects of global warming. This problem is being actively studied by a consortium of NGOs and Universities in the Brahmatwinn project (including Southampton University, see links section for more information). This lesson plan uses that study as a case study of the effects of global warming on people.

Snow and ice in the Himalayas acts as a reservoir, precipitation in the area is highly seasonal due to the monsoon so the ice and snow moderates the flow of water into the Brahmaputra and other major rivers. Without this reservoir, flooding and low flow events in the river would be more pronounced. Global warming is melting the snow and ice which means there is less of a reservoir to store the precipitation.

Downstream of the Himalayas people live in the Brahmaputra valley, the river is woven deeply into their lives, they use it for fishing, washing and build huts from reeds that grow in it. However, it periodically floods which not only brings the risk of death by drowning it also destroys roads, crops, huts and water sources. The Brahmatwinn project aims to help the government of India target resources effectively to mitigate the effects of flooding.

Use of Google Earth

The lesson plan is also supported by materials written for Google Earth, in this context the tool is very useful at giving students a sense of relative location, scale and the 3D topography. In conversations with teachers I am aware that teachers may be unfamiliar with the tool in a teaching situation so I have not assumed a high level of Google Earth proficiency and have included tips throughout the plan. I recommend this lesson plan as a way to experiment with using Google Earth in teaching.

The lesson is designed to be taught by the teacher in 'show and tell', mode but use where students share a computer and follow similar instructions themselves in pairs, groups or singly would work well if computer facilities allow.

Limits of Knowledge about the Problem

What is interesting about this project as a case study for teaching is that there are aspects which are not well understood by the experts but which can also be easily explained to non-specialists. For example, would it be best to give aid to the poorest victims of flooding who are relatively well prepared for flooding or to the richer victims who are unprepared because they have not been flooded before? Exploring such issues could help the students understand that universities do not 'know all the answers'.

Aims

After this lesson students should be able to:

1. Explain the combination of factors that are causing a rise in the risk of flooding in the Brahmaputra.
2. Describe the effects that flooding has on the local population.

How this Lesson is Structured

I have designed the content of the lesson in two parts that roughly correspond to the two Aims. This is to ease stretching the material over multiple lessons and to help with other timing issues. I have also adopted a design with different levels of difficulty; the *basic level* is designed for weaker students and should represent the minimum level of attainment. The *medium level* contains some more advanced concepts and activities, finally the *extension level* contains advanced concepts to stretch high ability students. How these levels work for each of the two parts is discussed at the end of the content description for each part.

Style Conventions

Within this document I have adopted a number of styles:

- An 'Activity' is something done within GE, it may be a demonstration by the teacher or it may be done by the students on their own or in pairs. I discuss such issues in 'Technical Issues'. An activity is marked like so in this column:

| Activity:
| *Open GE*

Tip:

GE runs better on faster machines

I have added technical tips on how to operate GE as in the box to the left:

Part 1: Ice and Floods:

1.0 Set Up

Tip:

In the Places column a list of 'features' is visible in the 'Ice and Floods.kmz' folder. As the tour takes place elements in this folder will be automatically turned on and off. Which box is ticked will help you follow where you are in the tour

Tip:

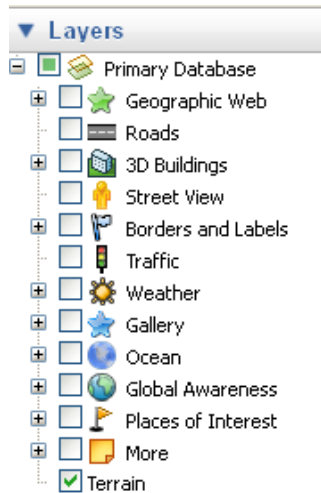
Download the latest version of GE from <http://bit.ly/8I8n>

Tip:

The tour will progress and then automatically pause at a certain view. When this happens you will be prompted to 'Press Play To Continue'. The tour is designed that you explain what is on screen to the students during the pauses.

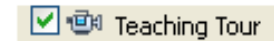
Tip:

If you think your students missed the action you can click the rewind button on the VCR control and the tour will run backwards until the previous pause. You can then click play again.



Activity:

Open GE. Open the 'Layers' panel (bottom left of the GE screen) by clicking the triangle. Untick all the boxes except 'Terrain'. (see diagram to left)



Open the 'Ice and Floods' GE file by double clicking the text of the 'Teaching Tour' element in the Places Column.

VCR controls open in the bottom left of the main screen and can be used to control the tour.



Check you can see buttons like those to the left on the top of your GE screen. If they are absent you will need to upgrade to a newer (5.0+) version of GE.

The first view you are shown is of India at high altitude. You should point out to students roughly where they are in the world, you could ask them to describe the boundaries of India for example.

1.1 Overview

Activity:

Press play on the controls in the bottom left of the screen.

The current view shows the rough position of the Himalayas (light blue), the Brahmaputra river (dark blue) and a glacier. You should point out to the students that the Himalayas are full of snow and ice and that when these melt they flow through several rivers towards the sea. The Brahmaputra is one of these and it and some of its tributaries are marked. In the next section we will examine the marked glacier.

1.2 Gangotri Top and Bottom

Activity:

Press play.

Tip:



The ruler tool (top middle of GE window) can be used to measure distances on screen

Tip:

A nice way to view 3D landscape in GE is to click and drag with the **mouse wheel**. Dragging up and down tilts the view, clicking side to side rotates the view.

Tip:

If the video does not play in GE then the link to the video on the web is: <http://tinyurl.com/6l56ms>
YouTube videos are banned in many schools, it is possible to download videos from YouTube see <http://tinyurl.com/64l98k> although I haven't used the service and am not sure of the legality of downloading videos.

The point here is that the red T (for top) balloon marks an area where snow falls on the glacier, turns to ice and flows down the glacier. The red B (for bottom) balloon marks the end of the glacier. If you are illustrating to a class at this point, , you may like to point out the scale of the view, the distance between balloons is about 17 miles.

1.3 Gangotri Glacier

Activity:

Press Play. You may like to explore the view (fly out or around) when the tour is pauses, this can be done, it causes no problem to the tour which just flies you back when restarted.

An image of the glacier appears and is draped over the landscape, it shows the retreat of the glacier with time due to global warming.

Activity:

Ask the students are they sure the retreat is down to global warming? Could another factor produce the same result? (Answer: Less snowfall at height could affect the outflow but measurements tell us this is not actually the case)

1.4 Flooding Explanation

Activity:

- a] Press Play. The tour flies back out to the overview and pauses. You should point out that you are back at this position.
- b] Press play again and icons appear showing the situation 'Pre Global Warming': Rain fell on the Brahmaputra valley but in the Himalayas fell as snow during this period.
- c] Press play and a 'medium flow' arrow appears illustrating that this locking up of water in snow and ice prevented excessive floods.
- d] Press play and the icons change showing showing the 'Post Global Warming' situation: some of the snow in the Himalayas now falls as rain.
- e] Press play again and it shows that because this water is no longer locked up as snow or ice it flows straight into the river causing more flooding.

If this explanation is not enough you could ask the stu-

Tip:

Google Earth can be used offline. To do this download the files and play the tour whilst connected to the web. GE downloads the data it needs to render (draw) the screen (e.g. the background images of the Brahmaputra) into a store on your hard drive known as the 'cache'. If you play the tours again, GE will render the screen using data in the cache rather than downloading again. This even works if you are not connected to the web.

Note that GE's relationship with the cache means it is a good idea to run the tour just before the lesson even if you have web access in your classroom as this will speed up the loading of the background data onto the screen. You will avoid 'fuzzy' images being displayed.

The GE cache runs on a LIFO (last in first out) system so that if you run through the tour of the Brahmaputra just before teaching then the cache works fine. However, if run the tour then fly around the Arctic then the cache fills with Arctic images pushing the Brahmaputra data out of the cache. So don't fly anywhere after pre running the tour.

dents to compare the Himalayas/Brahmaputra system with a reservoir/water supply system in the UK. Points that come to mind for me:

- They both have ways of stopping the water flowing away
- Both rely on being higher than the area they supply, gravity flow is the energy source.
- Both have a moderating effect on flow, without them there would be more floods but also more droughts.

1.4 Flooding Video

Activity:

Press play on the VCR controls then play the video that opens up.

To bring the first part of the lesson to a close there is a link to a video of flooding in Bangladesh in 1988. This country is downstream of the Brahmaputra river in India which we are considering but which suffers from flooding just as much.

Extension Activity and Levels.

Basic: In part 1 the basic level that students should achieve is to understand that the ice/snow in the Himalayas and the Brahmaputra river form a system so that global warming causes flooding in the river. I also think they need to grasp the size of the landscape, the scale of river and mountain are much bigger than they may be familiar with in the UK.

Medium: At this level I would hope that beyond the basic understanding of melting that they realise that the ice/snow forms a reservoir and that the same problem of melting ice is also causing more droughts.

Extension: For bright students I have provided further links in the 'further exploration' folder. This provides materials that are not part of a tour so students will need to know how to navigate in GE and have access to a computer themselves.

If exploring that is not enough you could challenge them to create their own tours. Its actually very easy so long as they don ' t try and record turning layers on and off.

Part 2: Effects of Flooding

Tip:

You may like to remove the Ice and Floods file from your places column to keep things tidy in the places column and speed up Google Earth.

2.1 Overview

Explain that now we are going to look at the effects of the flooding on the people living downstream of the Himalayas in two study areas. These areas are marked in red.

Activity:

Open the 'Effects of Flooding' Google Earth file.

Double click the new Teaching Tour, the first stop is an overview of the two study areas to remind students of the area under consideration. Point out to students that the red study areas are about 300 miles apart, about twice the distance between London and Manchester.

2.2 Fishing and Other Photo Placemarks

Tip:

If you roll your mouse over a group of tightly clustered placemarks and click they will fan out for easier viewing.

Activity:

Press play and the tour will pause over the photo tour area. Point out that the photos have been fixed where they were taken and we will tour to each of them pausing at each one.

You may like to point out that there are a set of photos in the far West of the area which are overlapping in this view.

Tip:

As you fly around the tour, it may help to point out to your students which direction GE is pointing when you view a picture and roughly which part of the study area you are in. This helps them avoid becoming disorientated.

I hope the photo tour is self explanatory, its purpose is to show some of the activities of the people living near the river. The river becomes friend and foe as you will see.

The tour flies from a photo back to the initial view of the photo area to help students understand where the photos were taken. I would be adding commentary along the lines 'and now we are flying to the East of the area' as the flight continues but I leave it up to your judgement.

Tip:

The photo tour was set up with the idea of having a narrative rather than flying to the nearest next photo. If you think it would be better the other way around, I'd be interested to hear from you.

The last image of the tour is the 'Flood house'.

Activity:

Ask students what the big rocks around the base are for. Answer: 'Rip-Rap', they prevent flowing water scouring away the foundations of the house as big rocks cannot be moved except by very fast flowing water.

Tip:

Imagery in Google Earth is usually less than 3 years old. When it is high resolution it is usually taken from aircraft based reconnaissance, when it is low resolution it is usually satellite data.

Tip:



It is possible to play around with historical data in more detail by using the historical data button. This could be something to let advanced students experiment with on their own.

Tip:

This video teaches you to navigate in Google Earth
<http://bit.ly/Hb1aZ>
The 1 is a 'one' not an 'L'

As an extra activity you could also ask what the students would build to help the locals with the flooding. Answers I would expect; Dams, boats, pumps and drains . Actually used in the study area; Dams, houses on stilts (not so different from boats in a way).

2.3 Roads to Nowhere and Old Images of the area

Activity:

Following the tour you are flown out to an overview of both study areas and then to the Eastern study area. A fuzzy image is shown which is the study area in 1975, the colours are different because it was taken by a different satellite. By ticking and unticking the '2.3 1975' element in the Places column you can show that a great chunk of land (about 2 miles square) has been washed away by the river.

You can point out that the river bank in the west of the area has not been washed away. Why this is so will be revealed shortly.

Activity:

Following the tour you are flown in further to be shown an image from 2005 with roads leading nowhere. This is then turned off leaving the roads showing the new bank.

2.4 Part of the Dyke System

Activity:

Next you are flown to view a dyke marked in purple. Ask the students why there is a dyke perpendicular to the main one. (Answer: This is a groyne, it aims to slow the river flow down to prevent scour of the river bank)

You should navigate around while the tour is paused as the GE imagery in this area is excellent and features such as houses being just on the landward side of the dyke are visible. The tour will restart without problem wherever you have flown to when you click play again.

You may also like to turn the '2.3 1975' image back on to show that the fixed river bank in this area we pointed out earlier has not moved because of the dyke.

Tip:

The tour can be controlled just with the play, rewind and fast forward buttons. If you want to zoom through a large part of the tour it is quicker to drag the slider button to the required position in the tour



Activity:

You are now flown (via the overview camera view) back to the photo tour area to look at another groyne sticking into the river.

After this you are shown rip rap on the side of the Groyne.

2.3a Groyne View

Activity:

You are taken to a high view and a video is opened. Watch the video from the 2.00 min point up to the 2.50 mins point (any more doesn't really add anything) which shows some relief work being undertaken in 2007. Note the video comes from Bangladesh again.

Beyond the risk of drowning, what effects will a flood have on the population?

2.4 After the Flood

Answers will be destroying; communications (roads, rail), crops, houses, contaminating water points (wells, streams), encouraging the spread of disease. These are more dangerous than death by flooding.

If you cannot access the video for whatever reason then I hope the photo will be enough of a point of conversation. If this is the case you could ask students what they think is happening in the photo.

For advanced students you could ask the to explore why there are 'stripes' in the imagery by zooming in closer (they will need access to their own computer for this of course). Answer: Its imagery from different satellites/ aircraft at different resolutions and/or at different times. Zooming in will show the difference in resolutions.

2.5 Sensitivity to Flooding: Far View

Tip:

This map was inserted into GE as a 'Ground Overlay'. This is a very useful feature for creating your own projects in GE. A video tutorial on how to create them can be found at <http://bit.ly/98CYR>

Tip:

The map uses red and green colouring which is difficult for colour blind people to see. I'm trying to get the original altered but do bear in mind some students may not be able to see the difference in the red and green.

Activity:

The tour takes you to the 'Sensitivity to Flooding' map. It shows villages, towns and cities as circles, the size of circle illustrates the population and the colour the vulnerability of the population to flooding as assessed by a local organisation working with Southampton University. They assessed vulnerability by asking the people living in the communities a series of questions. The map is designed to help the government target aid at the most needy communities.

Working in groups get the students to come up with 5 questions you would ask to a villager to find out how much their lives would be disrupted if their homes were flooded.

(Answer: the researchers asked tried to assess:

Type of farming: animals can be moved to safety, crops will be destroyed.

Poverty: People with savings can travel to live with relatives

Transportable Skills: People with developed skills can move elsewhere and make a living e.g. to a city

Preparedness: People who have been flooded before have knowledge how to survive, e.g. building flimsy huts that are easily rebuilt rather than brick houses that may collapse but are difficult to construct.

Age and Fitness: Communities with lots of children and the elderly will be more vulnerable.)

Note that the surveyors asked more than 5 questions to complete their assessment.

For Advanced students: Ask them who would they interview in the village?

(Answer: Usually Aid agencies concentrate on interviewing women as interviewing the 'head man' or men has been known to leads to exaggerations – often the head man wants the village to seem bigger, more important and more organised than it really is.)

2.6 Sensitivity to Flooding: Close View

Tip:

To prove the 'liable to flood' point you can open this Google Earth file: <http://bit.ly/BLIDE> which shows the extent of the flooding in September 2008.

Note it's a big file. I also don't like the red colour but it can't easily be changed.

Activity:

You are flown in closer to view two black circled areas. Why is the one closer to the river have more settlements sensitive to flooding?

(Answer: It is low ground likely to flood, so the poor and vulnerable live there while the rich live on higher ground to the South)

2.7 Bocastle Floods

Activity:

India is not the only country to be suffering more floods recently, you will be flown to Bocastle, Cornwall to view a flood video. Again, the photo should be used alone if viewing the video is not possible.

Should we be sending money to India when we could be spending it on protecting ourselves? What do you think the vulnerability of those living in Bocastle is when compared to those around the Brahmaputra?

2.8 Conclusion

Activity:

Click play to fly to the conclusion. You may like to roll over the elements with your mouse to make them expand slightly as you talk the students through what they have done.

I would talk the students through the lesson following the path of the water from the glacier, down into the river, past the dykes built to prevent floods, past the fishermen trying to make a living and on into the sea.

Extension Activity and Levels.

Basic: Students should grasp that the Indian government and people are already trying to mitigate the effects of the floods by use of dykes and groynes. Global warming is raising the probability of flooding so this work is more important. They should also grasp the idea that drowning is not the only danger from flooding, water, food and transport systems can also be badly damaged.

Medium: Beyond the basic understanding outlined above students at this level should understand the concept of vulnerability. Within this concept they should get the idea that it is a combination of factors and is not just about

poverty.

Extension: For bright students you could get them to consider the counter intuitive notion that the poor are not necessarily the most vulnerable. There are people in the area who tend to build flimsy huts to live in and keep livestock rather than crops as a response to living close to the river and being flooded. They are some of the poorest people in the area but are actually well equipped to cope with floods when compared to richer people living outside the 'normal' flood plain who live in brick buildings.

The academic team feel this is an area they did not capture very well in their survey. The idea that university researchers are unsure of some of the data they collect is possibly something advanced students could also consider.

Links:

Tutorials by Google: <http://earth.google.com/outreach/tutorials.html>

School of Geography, University of Southampton: <http://www.geog.soton.ac.uk/>

Design Points for your own GE projects: <http://googleearthdesign.blogspot.com>

GeoData Institute, One of the Brahmawinn partners: <http://www.geodata.soton.ac.uk/>

Brahmatwinn Home Page: <http://bit.ly/qvtTS>

Credits:

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