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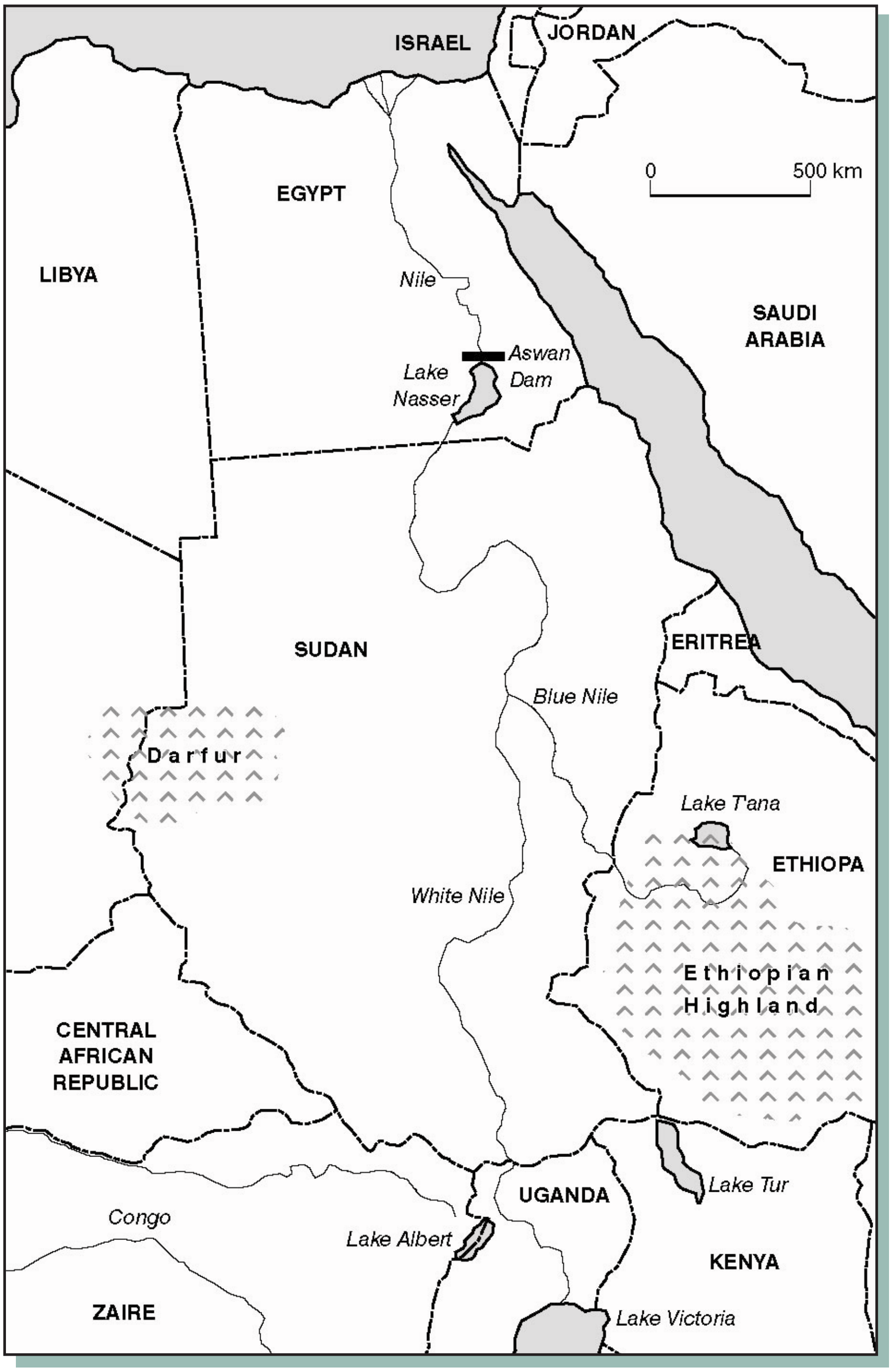
RIVER BASIN MANAGEMENT: THE NILE AND MISSISSIPPI

Introduction

Water is a precious resource, but it can be taken for granted in nations like Britain where there is normally an abundant supply. It is perhaps difficult for us to appreciate just how different the situation in some countries can be. For instance, Boutros Boutros Ghali (former foreign minister of Egypt and UN Secretary-General), speaking about north east Africa, has said: "The next war in our region will be over the waters of the Nile, not politics."

We will see in this **Geofile** how some rivers can have many competing demands for their water, sometimes from different nations. Rivers bring many benefits, but also problems, notably flooding, as experienced in Britain in the autumn of 2000. It is essential that rivers are managed to meet these competing demands and to reduce conflict; this is clearly illustrated by two of the world's largest rivers, the Nile and the Mississippi.

Figure 1: The Nile basin



The Nile

Background
The Nile is 6825 km in length from its source in Lake Victoria in Uganda and Tanzania to its mouth at the Mediterranean Sea. The drainage basin is huge: at 2.6 m. km^2 it covers about one-tenth of Africa and includes land from 10 different countries, although most of the basin is in Egypt. The regime of the Nile is influenced by the seasonal patterns of its three main tributaries, the White Nile, Blue Nile and the Atbara (Figure 1).

Causes of flooding
For thousand of years the lower reaches of the Nile flooded annually during August and September. This resulted from heavy rainfall in the Ethiopian Highlands in the Blue Nile's upper course in July and June.

Each year as the river flooded it deposited fertile silt on the floodplain, vital to farmers. This was particularly important in the Nile delta, which has some of Africa's most productive farmland. In addition, the Nile is important for transport and as a source of water for domestic and industrial uses. The flooding however has occasionally been very severe. In September 1998 the rainfall was exceptional; the Nile rose by 16m and burst its banks, causing the worst flooding in Sudan for 50 years. Many mud buildings collapsed and thousands of people were left without fresh water, food or shelter.

Management of the basin and responses to flooding
In 1960 work began on the construction of the Aswan High Dam (Figure 1). This was completed in 1968, at a cost of more than US$1 bn. Lake Nasser, the reservoir created by the dam, is one of the largest in the world, and it drowned many villages along the course of the river. The dam is a good example of a **hard engineering** approach to river

management (Figure 2). The dam controls the flow of the Nile and has prevented further problems downstream in Egypt related to flooding; other benefits include improved navigation on the Nile and HEP from the dam. There are however a number of disadvantages. The fertile silt formerly deposited by the Nile now accumulates behind the dam. Soil quality downstream is deteriorating because of the accumulation of salt from chemical fertilisers that have been used instead of the silt. The river also leaves behind mineral salts; without the annual floods to wash these away, salinisation has become a serious problem on the delta. Certain diseases like malaria and sleeping sickness have also increased, as a result of the still waters in the Lake and irrigation channels.

Water from the Nile is used for irrigation, and this use is expanding. By 2003 a new scheme along the coastal edge of the Sinai Peninsula should be completed. The "Northern Sinai Development Project" will turn 250,000 hectares of desert into productive farmland. New towns will be built there and it is hoped that this will eventually make it possible to resettle 1.5 million people from the overcrowded Nile valley, relieving some of the pressure on Cairo (population 16 million, 2000). The increased food production will redce Egypt's need to import food. Water for the project will be tunnelled from the Nile and transported along the 180 km long Salam Canal which includes tunnels under the Suez canal.

The international nature of the Nile basin means that extraction of water in one part of the basin affects use in another. Egypt and Sudan account for about 60% of the water taken from the Nile. In the future, the Sudd swamps in southern Sudan could be drained and the water moved north by a canal. This would represent an important additional water resource for Egypt and Sudan, but there would be considerable environmental impact.
Problems of poverty, civil war and debt have made it difficult for other Nile countries to use much water in the past. Gradually, however, more of these countries are industrialising and expanding agriculture, the demand for HEP is likely to increase and the competition for the water is growing. Ethiopia plans to build a

Figure 2: Hard and soft engineering approaches to river basin management

Hard engineering:	The use of structures such as dams, floodgates, barriers and levees to control the natural behaviour of rivers, particularly erosion and flooding.
Soft engineering:	Approaches to the problem which are natural and which seek to minimise environmental impact by working with river processes and other natural aspects of the environment, like vegetation, to control erosion and flooding.

dam near the source of the Blue Nile; this could divert 39% of the river's water. Egypt has already threatened to attack Ethiopia, which it claims is taking too much water from the Nile. In 1959 Egypt and Ethiopia signed a treaty on using the Nile, but in light of the rising tensions a new international agreement was needed. In February 1999 all 10 Nile Basin countries agreed to co-operate under the "Nile Basin Initiative" so that use of the water is fairer in the future, bringing benefits to all.

The Mississippi

Background

The management of the Mississippi concerns the battle against nature, rather than tensions between countries. The Mississippi is about 3,800 km long from its source in Lake Itasca to the Gulf of Mexico (Figure 3). The river drains a huge area of the United States, about 3,256,000 km2 between the Rockies and the Appalachians. There are about 250 tributaries, the main ones being the Ohio, Kansas, Red and Missouri rivers.

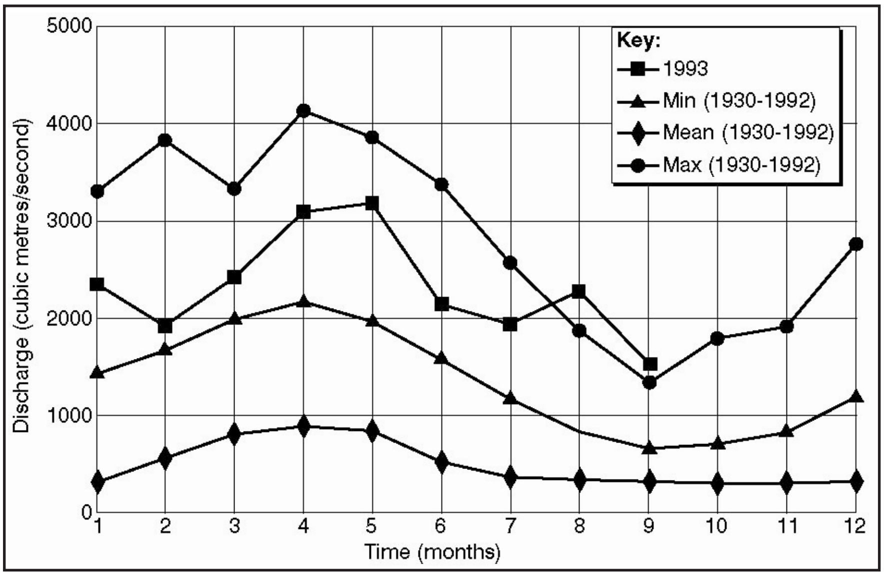
Causes of flooding

When settlers first came to the Mississippi valley they benefited from the rich soil and the abundant wildlife. The flood plain soon became densely settled and towns and cities developed. However, the Mississippi is prone to flooding. The upper Mississippi and its tributaries reach maximum flow between March and June; floods develop when melting snows are followed by early summer rains. Serious floods occurred in 1927 and 1974, and most recently in 1993 when discharge was exceptionally high (Figure 4). The 1993 floods killed 50 people, 62,000 families were evacuated, 55 towns were wrecked and $12 bn worth of property was destroyed in this part of the USA.

As people have settled on the flood plain, wetlands have progressively

Figure 3: The Mississippi Basin

Figure 4: Mississippi River discharge and the 1993 floods



been drained and areas of forest that once absorbed excess rainwater have been cleared, to accommodate settlements. Rivers have been channelled and land uses developed which also increased the speed and force of water flows across the land. Many believe that these human activities, by diminishing the ability of the land to absorb rainfall, have gradually contributed to more frequent and severe floods.

Recent floods have also been more costly, due to additional urban communities being built on the floodplain, often close to the rivers. In the past, only occasional farmhouses tended to be destroyed by floods, but now they affect valuable transport infrastructure and more valuable property.

The exceptional rainfall contributing to the floods of 1993 resulted from a high-pressure system in the south east forcing air from the Gulf of Mexico to move north which met cool north westerly air. The warm air rose over the cold, leading to heavy frontal rainfall.

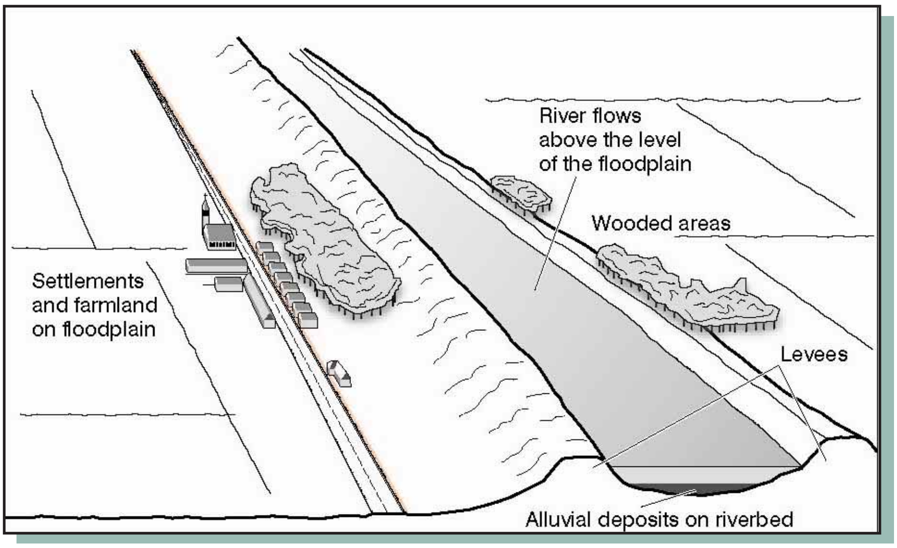
Management of the basin and responses to flooding

The approach to basin management of the Mississippi has involved hard engineering. The two most commonly used methods of flood control along the Mississippi and its tributaries are **reservoirs** and **levees**. Within urban areas there are additional measures, including **concrete walls, flood-gates** to protect particular areas, **drainage channels** and **pumping stations**. **Dredging** is also carried out, particularly after severe floods, to maintain navigability and to reduce river levels.

Flood control reservoirs are built well upstream of the main waterway, on the tributaries. The Upper Mississippi has 20 major flood control reservoirs, all controlled by the US Army Corps of Engineers. On a tributary that floods occasionally, floodwater is released from the reservoir after a flood, to prepare for any further influx of water during the same season.

Levees are low ridges or earthen embankments of soil, sand or clay, built along the edges of a river (Figure 5). They can occur naturally, but most of those in the Mississippi basin have been enlarged artificially. Man-made levees usually consist of an impermeable concrete wall surrounded by earthen material with grass (but not trees or shrubs) to reduce erosional damage.

Figure 5: Levees



In 1993, as had occurred in 1927 and 1974, inhabitants along the Mississippi were shocked when the protective network of levees was over-topped or breached and the waters unleashed on to the towns and farmland along its edge. Such events have prompted researchers since 1974 to ask to what extent levees and other human modifications to the river system have actually worsened the threat to humans and property when the inevitable large floods occur.

It has been suggested that levees and other channelled structures put in place over the last century or so have systematically confined the flow of flood waters and forced flood stages to grow higher and higher for the same discharge. However, other researchers have refuted these ideas. The issue lies at the heart of a political movement to abandon portions of the Mississippi floodplain, remove the levees and reduce the hazard posed not only there but along the river system.

Following the 1993 floods, the Army Corps of Engineers suggested that levee removal would not have a significant impact on lowering flood stages. Raising levees would not be very cost effective and could have adverse environmental effects. Flood reservoirs were stated as being particularly effective combined with levees. If the levees were to be removed, it has been estimated that there would be a reduction in water level but that the river would be about 10 miles wide and everything around the river would be ruined.
The construction of levees and dams, and the funding of flood insurance and federal relief to flood victims have in some ways encouraged

development in flood-prone areas. This in turn increases the cost of damage in subsequent floods. Today, many communities participate in the Federal Emergency Management Agency's (FEMA) Flood Insurance Program. Communities agree to prevent unwise development in flood-prone areas; only existing developed areas have access to flood insurance. If flood damage exceeds 50% of the pre-flood value of their homes, they are not allowed to rebuild on the same site. Local towns, cities, communities and counties have the authority to regulate development and it is their responsibility to enforce these policies.

LANDSAT (satellite) imagery has been used to assess the extent of damage from floods. This can help to establish areas that are particularly at risk from flooding and help future planning.

Conclusions

The problems and issues we have examined in this **Geofile** have arisen because people have chosen to live beside major rivers. In addition, people have modified the natural channels, the flood plains and also engaged in activities that have impacted on the tributaries feeding into these major rivers. To a degree, flooding and the behaviour of these rivers has been controlled, however people have often been lulled into a false sense of security. Particularly in the USA, where the technology and support systems are more sophisticated, there has been a feeling that it is possible to engineer complete protection from the consequences of flooding. However, flood controls which confine river water usually just displace flooding; more water is sent faster to communities downstream. And as we have seen, the protection schemes sometimes fail, with devastating consequences. Trying to prevent rivers from flooding is a battle against Mother Nature, and inevitably sometimes nature will win.

Figure 6: Flood levels on the Mississippi at Cape Girardeau, 1844—1996

Date	Inches above seasonal mean	Date	Inches above seasonal mean	Date	Inches above seasonal mean
1844 June	42.53	1939 April 22	36.1	1972 April 25-26	32.0
1857 June	37.2	1941 Nov 9-10	32.1	1973 May 1	45.6
1858	37.16	1942 July 2	36.8	1974 May 27	36.9
1892 May 22	36.0	1943 May 27	42.3	1975 April 30	36.3
1903 June 14	36.5	1944 May 3	40.7	1978 March 29	38.4
1904 May 1	34.1	1945 April 4	38.7	1979 April 17	44.4
1908 June 21-23	36.0	1946 Jan 15	33.65	1981 May 23	35.7
1909 July 18	35.0	1947 July 5-6	41.88	1982 Dec 10	43.5
1912 April 4	34.95	1948 March 29	37.8	1983 May 6	44.9
1915 Aug 24	34.3	1950 May 15	32.1	1984 April 27	38.93
1916 Feb 3	36.4	1951 July 24	41.8	1985 March 1	41.11
1917 June 16	34.2	1952 May 2-3	38.3	1986 Oct 11	42.06
1920 April 1	32.2	1958 July 26	33.9	1990 May 21	39.63
1922 April 22	38.0	1960 April 12	38.4	1992 Nov 27	33.7
1926 Oct 10	32.9	1961 May 13	39.5	1993 Aug 8	47.9
1927 April 20	39.95	1962 March 27	36.2	1994 April 17	41.89
1928 June 24	32.8	1965 April 19	34.5	1995 My 24	46.67
1929 May 22	37.4	1967 July 2	34.2	1996 May 17	40.60
1933 May 19	34.4	1969 July 17	39.2		
1935 June 11	36.4	1970 May 5	35.7		

Source: US Army Corps of Engineers

References

Nile
Bishop, V. and Prosser, R. (1995) Water resources: Process and Management, Collins Educational Ch. 4. (including useful activities for students).
Mississippi
There are a number of useful web sites dealing with flooding (enter "Mississippi+Flooding"):
http:/www.agu.org/sci-soc/walker:html
http:/www.jracademy.com/~mlechner/archive1999/report.html
Pictures of the 1993 Mississippi floods
http://svs.gstc.nasa.gov/imagewall/LandS.

Focus Questions

1. List the factors responsible for flooding on the Nile and Mississippi. Separate physical from human influences.

2. Identify reasons why demand for water is growing in the Nile basin.

3 (a) Discuss the possible consequences for Egypt if water shortages arise as a result of other countries extracting more water from the Nile.
(b) Can you think of any solutions to the problem.

4. Plot the data in Figure 6 on a line graph. Comment on the level for 1993 relative to the other levels on your completed graph.

5 (a) What are the gains and losses from dams for people living upstream and downstream?
(b) Try to research the continuing maintenance required by dams.

6. Use the internet to research the economic consequences of the 1993 Mississippi floods. Consider how different the consequences would be in an LEDC.

7. Do you think levees should be built along the Mississippi and its tributaries, to prevent flooding?

8. To what extent should development be allowed to take place on land that is at risk from flooding?

ESSAY
With reference to specific examples:
(a) Outline the physical and human factors which can lead to flooding.
(b) Evaluate management strategies used to regulate river flow and control flooding.