Curriculum Visions

The River Book

THIRD EDITION

Teacher's Resources Interactive PDF

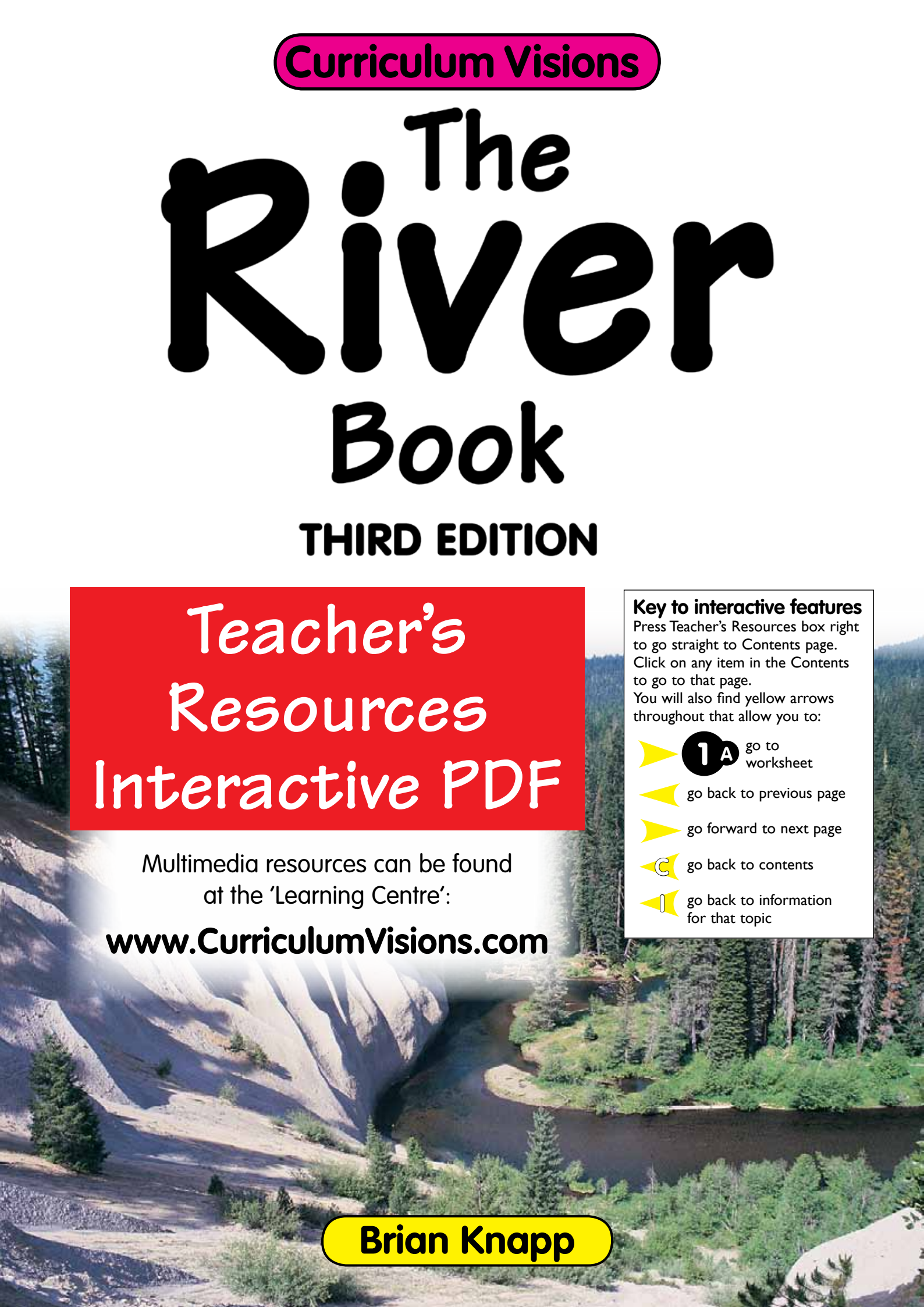
Multimedia resources can be found at the 'Learning Centre':

www.CurriculumVisions.com

Key to interactive features

Press Teacher's Resources box right to go straight to Contents page.
Click on any item in the Contents to go to that page.
You will also find yellow arrows throughout that allow you to:

- 1A go to worksheet
- go back to previous page
- go forward to next page
- C go back to contents
- I go back to information for that topic



Brian Knapp

Curriculum Visions

A CVP Teacher's Resources
Interactive PDF

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Contents

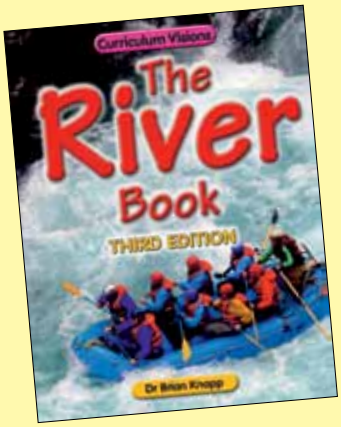
Section 1: Resources

Welcome to the Teacher's Resources for 'The River Book' Third Edition.

The River resources we provide are in a number of media:

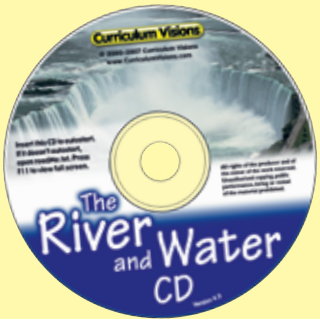
1

You can buy 'The River Book' Third Edition. This is 48 pages long and covers the geographical principles of rivers and river environments.



2

The River Mini-Movies CD contains information and examples that enhance the topics covered in The River Book and provides a virtual field trip experience for a variety of rivers and river features. Each mini movie is accompanied by pop-up field notes and a gallery of pictures to copy and paste.

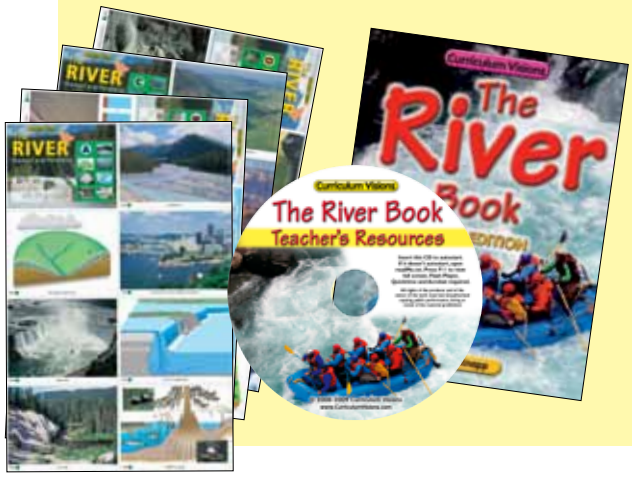


3

You can buy the River PosterCard Portfolio – four posters and a total of 28 A4-sized key diagrams/ photographs on two folded, double-sided and laminated sheets.

4

You can buy the supersaver pack that contains the student book and the PosterCard, and the Teacher's resources (what you are reading).



5

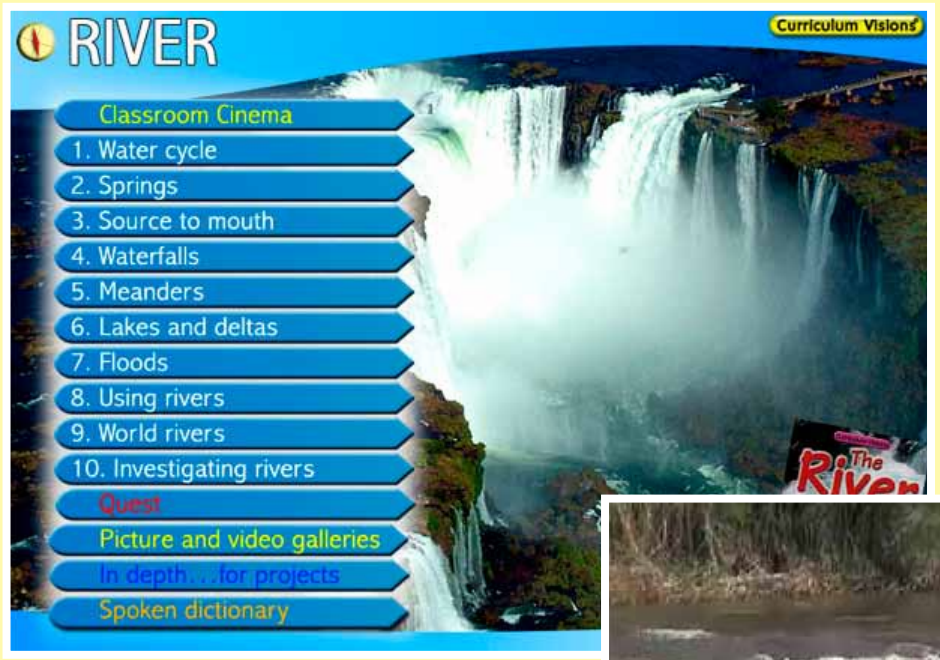
Our Learning Centre at
www.curriculumvisions.com
has almost everything you need to teach your primary curriculum in one convenient Virtual Learning Environment.

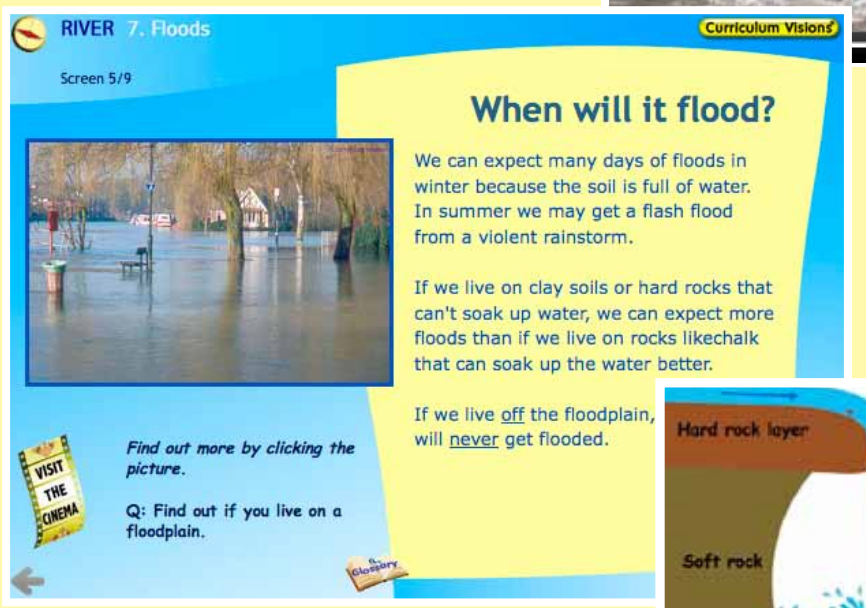
You can use support videos, e-books, picture and video galleries, plus additional Creative Topic books, graphic books called Storyboards, and workbooks. Together they cover all major curriculum areas.

All topics are easily accessible, and there is a built-in context search across all media.

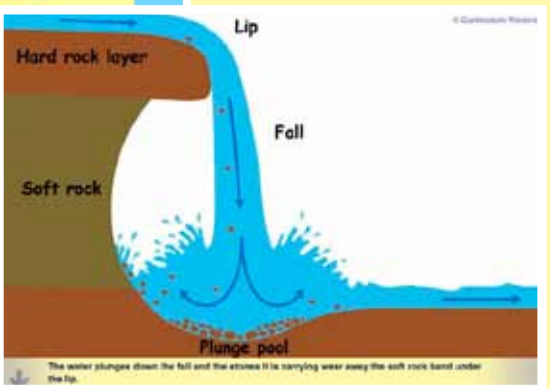
You can also use our printed student books online as part of your subscription to the Learning Centre. There page-turning versions of every printed Curriculum Visions book for use on your whiteboard.

▼ The River home screen





▲ Web site page



▶ Web site caption

Matching the curriculum

The pack is fundamentally built around the need to understand rivers as a part of the natural systems that create landforms, carry sediment, and are interlocked in both the Water Cycle and the Rock Cycle – part Earth Science.

Rivers are also a major part of our landscapes: we build our homes by them; we use their water for irrigation, drinking, and power; and we are affected by them in times of flood – part of Technology and Social Studies. All of these are compelling reasons for studying rivers.

While covering some of the subject matter of the curriculum, *The River Pack* also facilitates the development of a wide range of skills.

Learning objectives

The following curriculum learning objectives have been addressed:

How do rivers get their water?

How do rivers erode?

How do rivers carry sediment?

What are the main features created by rivers?

How do rivers shape valleys?

What are the characteristics of river habitats?

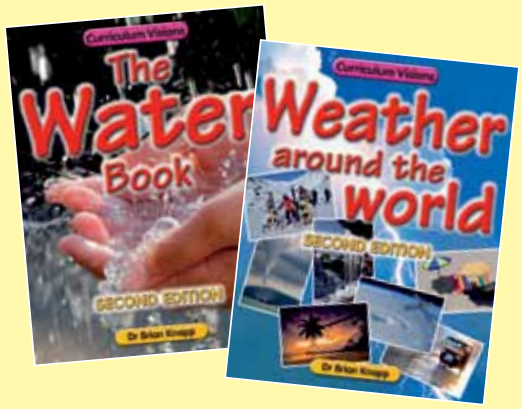
How do rivers flood?

What do the world's largest rivers look like?

An interdisciplinary resource

There are many opportunities to link this material with other subjects. For example, rivers form quite distinctive habitats for wildlife and so can be linked to life sciences. These can be investigated for upper courses, middle courses, estuaries and deltas.

Linked resources



Making use of the illustrations

Each text book spread includes diagrams and/or photographs. Photographs show the reality of a specific location, whereas diagrams show the main characteristics of an idealised feature. Both have important advantages.

First, make sure every student knows why each illustration has been included on the page. Make sure that each illustration is referred to and discussed. Students may need guiding around the illustrations.

Many students believe they can interpret a photograph, but they cannot usually interpret it as well as they think. Pictures are complex and students will need considerable assistance to spot the relevant features and connections.

Often they will tend to dismiss a picture as, for example, "a boat on a river", when what they need to be encouraged to do is to ask more detailed related questions such as "What kind of boat is it?" and "What are the implications? (navigable for large boats, small boats, etc)". And "What is happening on the banks behind the main feature? For example, is the bank dyked, is the river wide, is it meandering, what kind of vegetation is there and what could this tell us?"

The pictures have been presented in as large a size as possible to help you to discuss them in a meaningful way. Many are replicated in the *River PosterCard Portfolio* where there are some additional images too, and even more pictures are on *The River Picture Gallery*, *The River and Water CD*, or can be downloaded from the Curriculum Visions web site.

One valuable way to help students to interpret a picture is to make an annotated sketch of it. Although they may not be good at drawing in perspective, by making a sketch they will have had to think carefully and systematically about every part of the picture. Also, by looking at their sketches you should be able to spot which features they did not see.

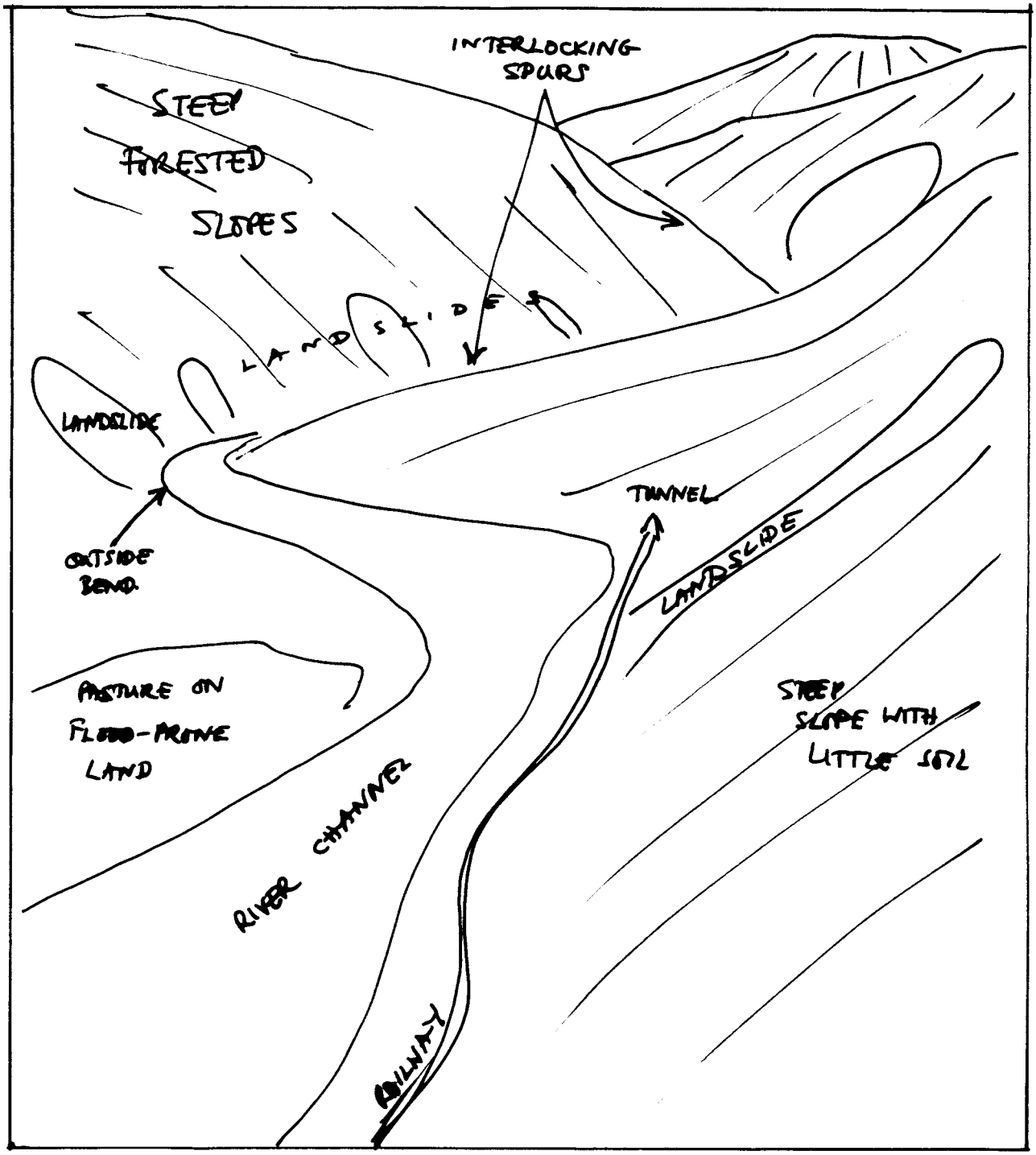
A sketch of a picture is shown opposite as a guide.

Diagrams in the student book are produced in colour. The worksheets in this *Teacher's Resources* contain the line versions of these diagrams, so that students can relate book to worksheet and add their own annotations. Again, writing on the diagram and colouring it in helps to reinforce appreciation of every part of a diagram.

It is also helpful to ensure that the questions posed about the illustrations are designed to check the students' comprehension and their ability to connect the illustration with the text.

The posters that are available with the pack provide an opportunity to summarise important points about rivers and can be permanently displayed on a classroom wall.

▼ Sketch of upper course of a valley. You will find many sketches like this in the mini-movies section of .

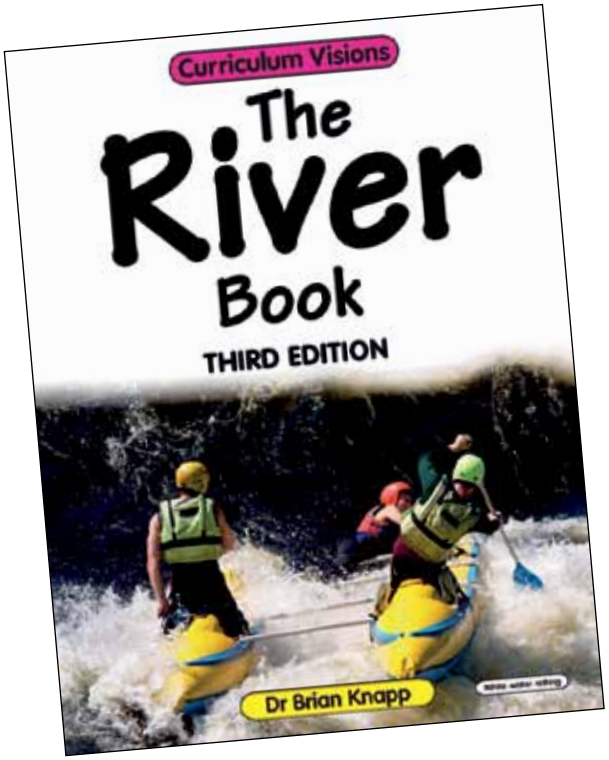


Section 2: 'The River Book' explained

Although the student book – *The River Book* – is clear and simple, a great deal of care and thought has been given to the structure and the content of each double-page spread. The worksheets in section 3 of this *Teacher's Resources* also link directly to the pages in the student book.

It is possible to use *The River Book*, and section 3 of the *Teacher's Resources*, without reading this section, but we would strongly recommend that you take a short time to familiarise yourself with the construction of the student book.

The River Book begins with a quick visual introduction to the physical and man-made river environment. This is followed by sections on how rivers work, river features, valleys, and the way that rivers impact on, and are impacted by, people. The last section gives watershed maps and information to enable students to begin a project on a selection of important rivers. More information is available on the web site.



▲ ***The River Book* title page.**

Safety

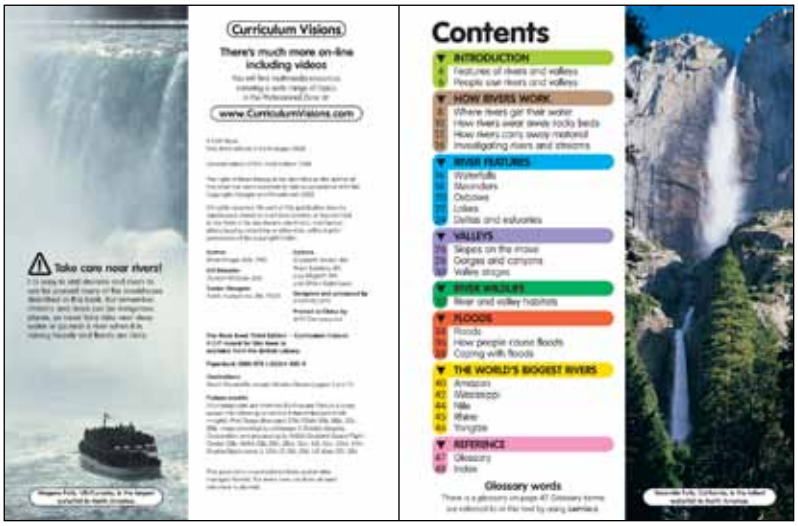
Please note that on page 2 of *The River Book* there is a passage about river safety.

It is important students know that rivers are interesting and exciting environments, both for sport, such as canoeing, and simply for walking by.

However, it is equally important that students are made aware of the fact that people who are unfamiliar with an environment often unwittingly place themselves in hazardous situations. Indeed, many accidents would not happen if people always took note of the landscape and weather, and avoided danger.

One of the values of geographical studies is to explain, in a very matter-of-fact way, the nature of river processes. This enables students to work out for themselves that some parts of the environment are hazardous. If they learn in this way, they may be more careful about putting themselves in situations where they could be at risk from floods, slippery river banks and so on.

Contents



The book is organised into chapters and subdivided into double-page spreads. Chapters are shown on the contents page and are colour-coded. Matching coloured headers run across each spread. The concept is paralleled by the pages on the web site.

Each spread has a heading, below which is a sentence that sets the scene and draws out the most important theme of the spread. The main text of the page then follows in straightforward, easy-to-follow, double column format.

Words highlighted in **BOLD CAPITALS** in the student book are defined in the glossary on page 47. The majority are technical words important to the subject, but some are simply difficult words.

The glossary definitions help to reinforce the meaning of a word that may be slightly ambiguous if taken out of context. Many technical words used by geographers and scientists are also used in everyday situations where they may have a different meaning.

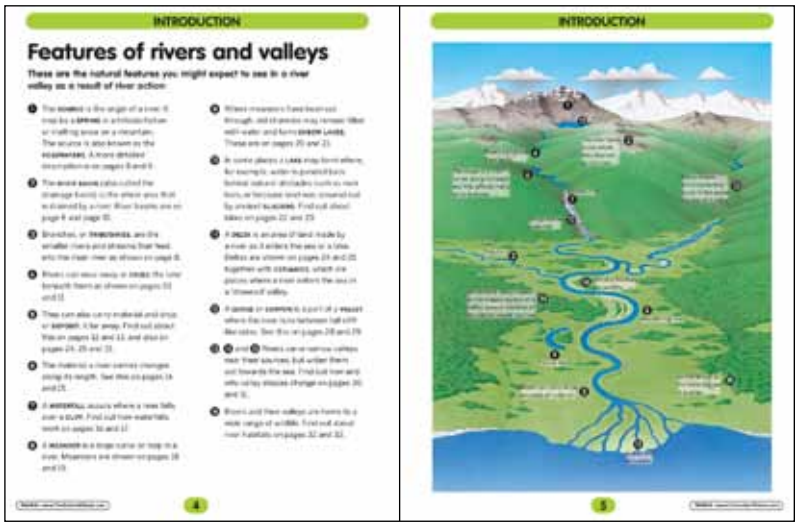
The glossary words are highlighted on the first page where they are encountered. They may be highlighted again on subsequent pages if they are regarded as particularly important to that page or spread.

Please note that some pictures have been especially chosen from various parts of the world. Thus, one spread may have examples from the UK, the next may be from America and the next from Asia. In this way, students will automatically be exposed to a number of contrasting environments, both at home and abroad.

Chapter 1: Introduction

The first two spreads set the scene for the rest of the book, giving the opportunity to describe what students are about to discover and how each part relates to the others. The spreads can be used both as an introduction and as a summary. They include most of the glossary words in context.

Spread 1 (pages 4-5 of The River Book)



Features of rivers and valleys

This unit provides an introduction to the features of rivers and valleys.

The points identify landscape features and processes of rivers and their valleys.

Each of these features is linked to:

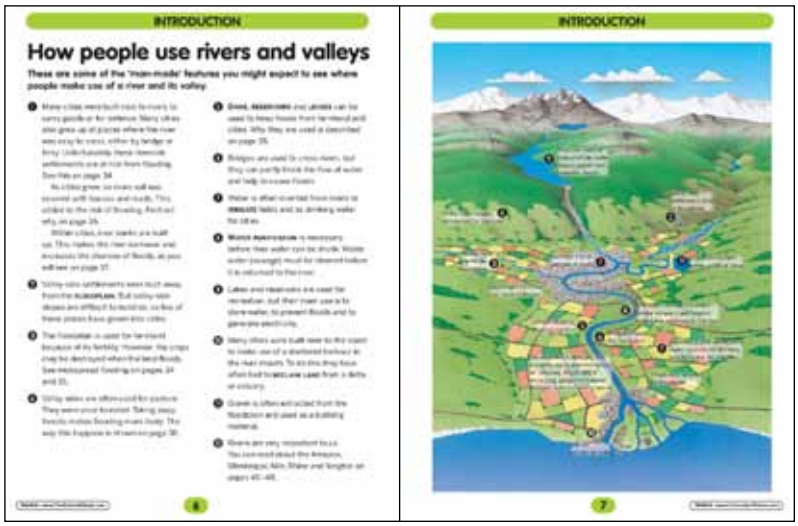
- A unit further on in the student book.
- Photocopiable worksheets and activities in section 4 of this *Teacher's Resources*.
- The CDs.
- The web site.

The picture on page 5 of the student book (shown above) or the colour version, which is downloadable from the web site, should be used to reinforce the principles encountered as you go through the book. It also provides a focus for review at the end.

An outline version of this picture is given on page 44 of this *Teacher's Resources*.

Many of the words shown on page 4 are highlighted as glossary entries (the meaning of each word will become more apparent when it is encountered on the relevant page later, in the context of the supporting explanation and information).

Spread 2 (pages 6-7 of The River Book)



2

People use rivers and valleys

The second introductory spread is in the same format as the first spread. It includes a diagram which is the same as that on page 5 except for the fact that the human impact has been overlain on it. Students can therefore make a comparison between natural and human environments by flicking back and forth between pages 5 and 7.

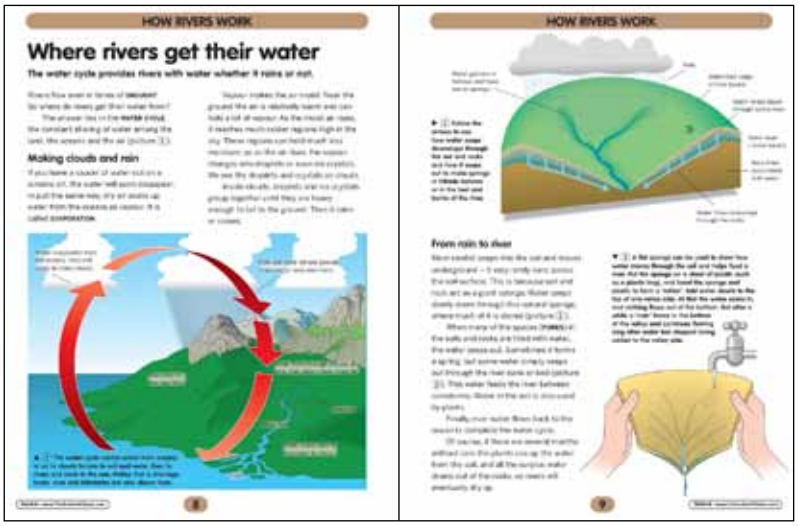
An outline version of this picture is given on page 45 of this *Teacher's Resources*.

Terms relating to flood, water supply and purification are also introduced. More information on water supply will be found in the companion book *The Water Book*. The Curriculum Visions web site and *The River and Water CD* also contains more information on water supply.

Chapter 2: How rivers work

This chapter explains the fundamental processes at work in rivers. It underpins all of the chapters that follow.

Spread 3 (pages 8–9 of The River Book)



3

Where rivers get their water

This unit begins with an introduction to the water cycle. This will be required for understanding the sources of water, and also the human impact on rivers later in the book. It is important that students are given time to get to grips with all of the parts of the water cycle before proceeding.

(You may find that some books use the term hydrological cycle instead of water cycle. This is simply a more technical term for the same thing.)

Conventionally, the water cycle is described from the evaporation of water from oceans, and back to the flow of water from rivers to oceans. The simplest steps are: evaporation, condensation (in clouds), precipitation (rain and snow from clouds), seepage of water through soils and rocks to riverbanks, and the return of water through river flow.

It is extremely important in this section that students do not get the impression that river flow is caused by rain falling into rivers. The amount of water which falls directly into rivers is tiny, and there has to be a mechanism for the storage and slow release of water to rivers during periods without rainfall.

The water cycle is complicated by the role of vegetation. This produces a "secondary" cycle, in which water in the soil is sucked up by plant roots and transpired (but the simpler word "lost" can be used) back to the air. Many tropical rain forests are sustained mainly by this local recycling. The uptake, by plants, of water from soils, is the reason soils dry out in summer and why they can hold more rain in summer than winter.

Finally, make sure that students understand that rivers are sustained by water flowing in along the banks, and not just water coming from springs. Springs are actually a very minor part of most river flows. Instructions for the demonstration illustrated in picture ③, page 9, are given in the unit 3 activity on page 52.

Spread 4 (pages 10–11 of The River Book)

4A

4B

How rivers wear away rocky beds

This page begins to describe the processes of erosion with a look at the way rivers can erode their beds and banks.

This is a concept easily understood by all students, although it is important to make clear that it only works where the river bed is exposed, that is, where the bed is rocky. As a result, this form of erosion is limited to those parts of rivers where the course is very steep.

The unit shows examples of how material such as pebbles can knock into the bed rock and so chip it away. At the same time, it chips itself away (a process called attrition) because all of the rocks are about the same hardness. The result is that large pebbles become rounded and gradually get smaller. This is an important idea because later on we will have to explain why sediment gets smaller from river source to river mouth.

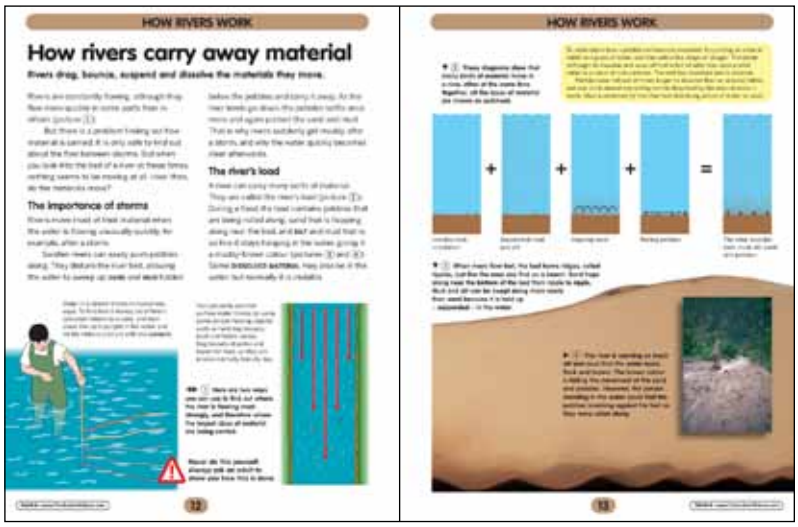
Notice that this unit is connected to rapids and waterfalls which are described later.

There are many student activities that support this unit.

One of the simplest is to get students to knock wet pebbles together. After a few good knocks, some attrition will be obvious. Equally important is the size of the material produced by this process. It is very fine sand or silt (mud cannot be produced by physical action, it is the result of chemical weathering).

Students might take particular notice of the way that eddies in the water cause stones to spin around and around. In this way, they begin to drill holes in a sediment-free river bed and, in extreme circumstances, they create deep holes called potholes. Examples of these are on the CurriculumVisions.com web site.

Spread 5 (pages 12–13 of The River Book)



5

How rivers carry away material

In the previous units we have concentrated on the way that rocks wear rocks away by physical means. Here we turn our attention to how those materials are moved, and also begin to think about how rivers erode downstream where the beds are covered with fine calibre material – sediment.

The first, and most important, part of the unit begins by reviewing the fact that erosion creates a variety of sizes of material. A look back to page 11 will remind students of this.

It should be easy for students to understand that bigger, and therefore heavier, material can only be carried by faster flowing water, and that the largest pieces may be so heavy that they can only be pushed along.

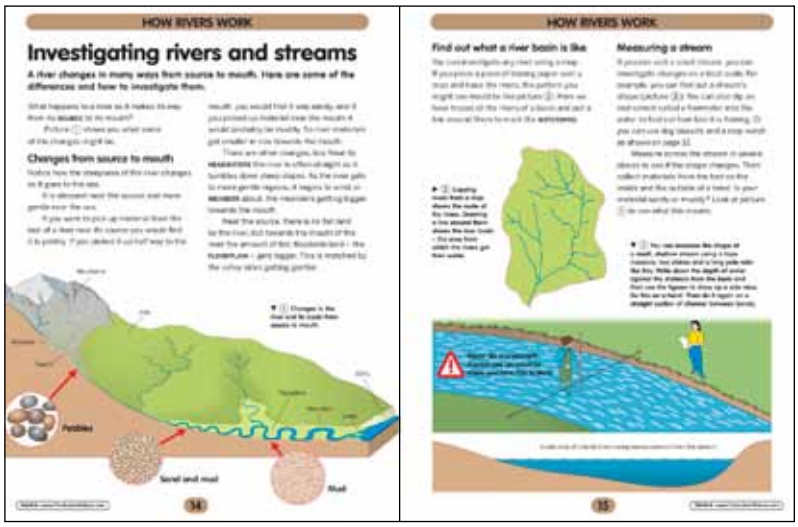
Having got this far, you can introduce the way that smaller particles move, perhaps by swirling some sand around in a jar. This will show that, as the water speed increases, some sand grains are lifted from the surface. In a river, these particles often hop along during times of flood.

Most difficult of all is to explain that when stones stand in water for a long time they begin to rot and parts of the rock dissolve in the water. This dissolved material is invisible and so, of course, is hardest to believe in. The demonstration suggested on page 39 of this *Teacher's Resources* uses an antacid tablet to show how solids can turn into dissolved materials.

As sediment is moved, the sand forms patterns on the river bed. These include ripples, and are shown in the tank model. They are easily obtained by using a tank and rocking it to and fro to create waves. As ripples are also common on beaches, students can begin to see that some features are common and a result of process (i.e. processes such as rapid water movement).

The diagram of sediment = rolling + bouncing + suspension + dissolved matter summarises it all very nicely and allows you to say that even when the river water appears clear, erosion is still occurring.

Spread 6 (pages 14–15 of The River Book)



Investigating rivers and streams

This spread gives an opportunity to discuss field work, mapping and other techniques. It is best dealt with using the mini-movies on *The River and Water CD* (the project CD) and by printing out the project work accessed from the bottom bar of the home screen on the same CD. These give virtual field trip experiences.

The first part of the spread shows the sorts of things you might be able to investigate with a visit but no equipment. You should identify headwaters, meanders, sediment size and other properties and correlate them to the position along the river's course.

The second part focuses on map work. You can trace your local basin and map river channels as in picture ②.

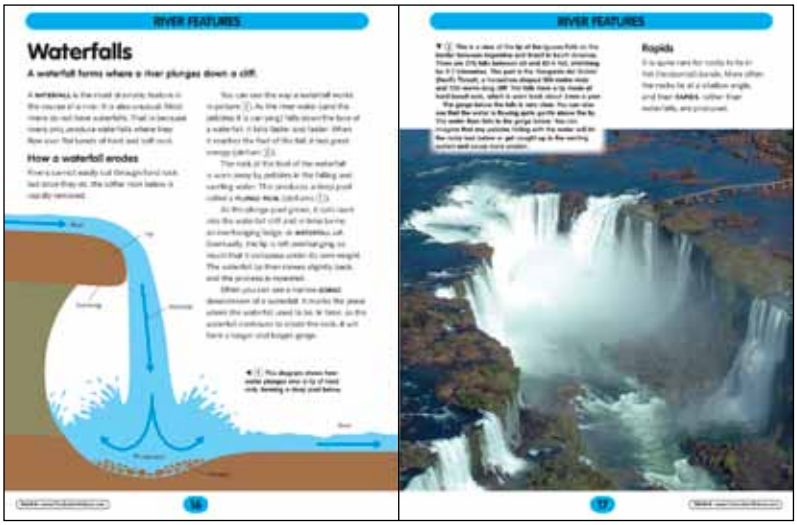
The third part gives an introduction to using simple equipment. Notice the caution symbol on this section.

See other field and class investigation techniques on pages 12 and 18 of *The River Book* and 'Section 3: Activity work' in this *Teacher's Resources*.

Chapter 3: River features

Here we look at some of the prominent river features such as waterfalls, meanders, oxbows, swamps and deltas.

Spread 7 (pages 16–17 of The River Book)



7

Waterfalls

Waterfalls are steps in the otherwise smoothly changing course of a river. They have two origins: as features of rivers that flow over horizontally bedded rocks, and also of mountainous areas that have been glaciated. Since understanding the effects of glaciation can be difficult, this unit mainly concentrates on waterfalls produced by bands of varying hardness. However, students need to be made aware that the majority of mountain waterfalls are formed from recent glaciation. The main result of this is that they will often not find a band of hard rock forming a distinctive lip. There are examples on the web site and on *The River and Water CD*.

Picture ① shows the main features of a waterfall formed in bands of rock with different hardness. The diagram gives the opportunity once again to show the importance of the abrasive action of pebbles – in this case in the plunge pool. The pool is kept clear of all but the largest pebbles by the impact of the water.

Many waterfalls are major tourist attractions and are well known, such as the Iguazu Falls featured on page 17 of the student book. There is therefore an opportunity for students to use the Internet to find out about specific waterfalls. A variety of waterfalls is given on our web site, but extra information can be found for waterfalls such as the Angel Falls (the world's highest), Niagara (held up by a hard rock band), Yosemite (the third highest, but as with other Yosemite falls, the result of glaciation), and High Force on the Upper Tees (the lower falls has a hard rock band for its lip). The fall line on the eastern slope of the Appalachians provides more examples, for example, the falls of the Potomac near Washington, D.C., USA.

The other way that a river's course is interrupted is by rapids. Rapids are produced by hard bands of rock that lie at an angle to the bed, rather than being horizontal ledges, as is the case for waterfalls. The Nile cataracts are famous examples. There are rapids and waterfalls on most Appalachian rivers in the US and the Clyde has further good examples.

Spread 8 (pages 18–19 of The River Book)

Meanders

This unit looks at the pattern of river meanders. It is important to know that meanders are a feature of flowing streams and will form, for example, on the surface of a glacier or on a sloping table top. They are not the result of random obstructions.

You may wish to do a demonstration of meanders in a sand tray, but the demonstration on a plain board shows that sand is not needed for meandering to happen. It is actually the angle of slope of the board. It also shows that meandering will occur until the slope is increased too much, and when this happens the pattern will suddenly change and become braided.

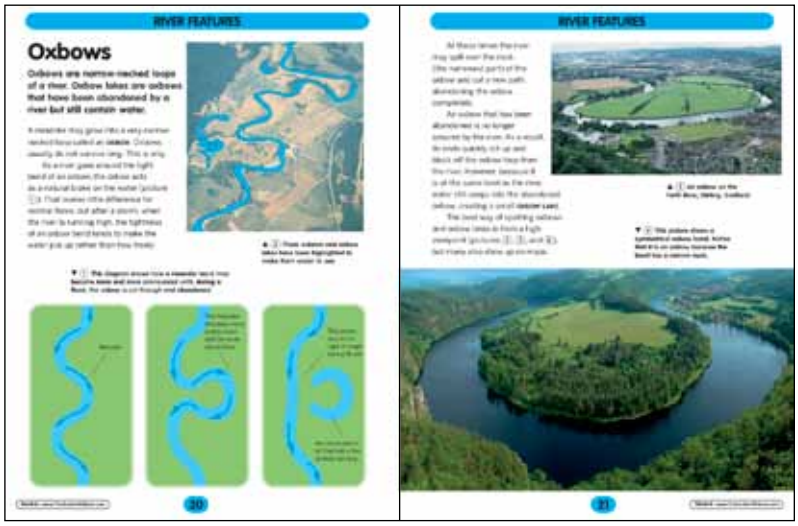
It is best to focus on the pattern of the meander and not on its origin. This is the first river feature shown in the book that has not been formed in rock. Instead, many meanders are formed in sediment. As a result, the bed and banks of a meander are made of soft sediment that is easily moved.

From the cross section, students can see that the outside bank of a meander bend is deepest, and is also the place where erosion is greatest They should also notice that the inside bank is where the water is slackest and where deposition occurs. As a result, rivers may change shape, but the channel always remains the same width.

Later on we shall show that, because rivers erode one part of their channel and deposit in another, the course of the river is always changing. In time, this causes the river to swing across the whole of the valley floor, creating a floodplain.

Sometimes meandering rivers get interrupted in their action and so do not produce floodplains. Some of the most spectacular meanders occur in Utah and are part of the Colorado River system. These are entrenched meanders, formed by rivers once meandering on a plain and then cutting into their beds when the land of the Colorado Plateau began to rise. Examples are given in the next unit in connection with oxbows.

Spread 9 (pages 20–21 of The River Book)



Oxbows

An oxbow is a meander where the loop has developed to such an extent that the river doubles back on itself and leaves a narrow neck which is vulnerable to being cut through during floods.

Oxbows are essentially connected with oxbow lakes, and the two features are shown in the diagrams and photographs.

It is often helpful to show that both ordinary meanders and oxbows occur on the flat floodplain land at the valley bottom.

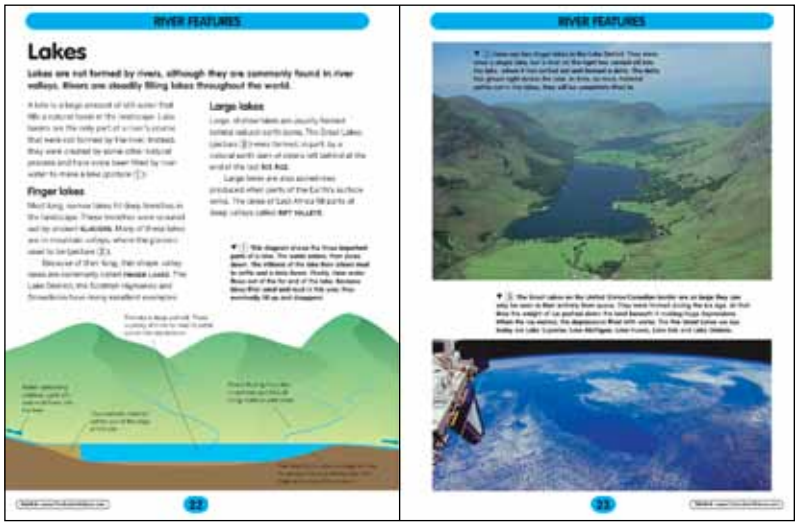
We have included here some entrenched meanders because they are spectacular. They are examples where the natural course of development of the river has been arrested by the rapid uplift of the land. Indeed, they are among the best examples that show that many parts of the United States are rapidly changing height even today.

In Scotland, one of the best observed oxbows is on the River Forth and can be viewed from the Wallace memorial (Picture ③).

The Mississippi River is renowned for its oxbow lakes, and satellite pictures of the Mississippi River reaches below Memphis show them well. In the past the floodplain was a vast swamp.

Below Greenville the oxbows of the Mississippi River were so tortuous that they made navigation slow, and as a result the Corps of Engineers removed many of them and straightened the course of the river. However, this was not entirely successful because the straight river now flowed in a steeper gradient and began to erode its bed. At the same time the river flow increased, making it difficult for all but the most powerful barges. The oxbows really did have a role in the river, no matter how inconvenient they might have seemed.

Spread 10 (pages 22-23 of The River Book)



Lakes

Lakes are features often connected to rivers, although, strictly speaking, they are nothing to do with rivers, since rivers cannot create the basins in which waters pond up. The role of rivers is to destroy lakes by filling them in.

This is a good opportunity for students to be told, or reminded, that there are other forces of nature beside rivers.

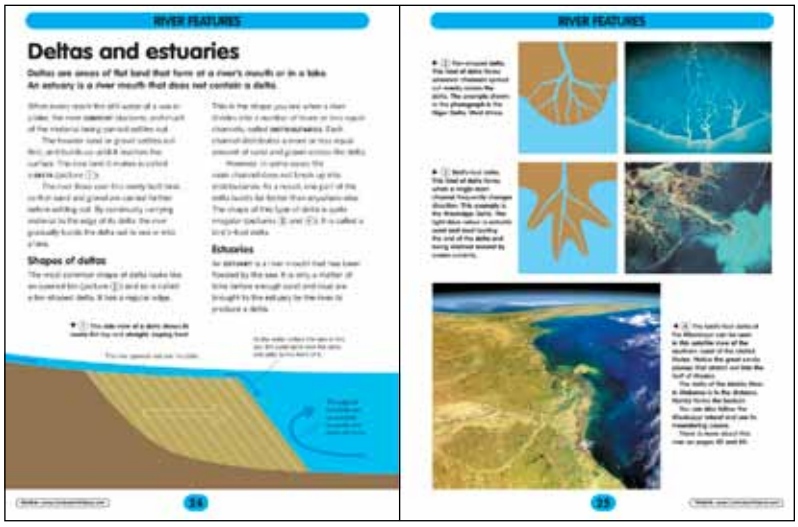
The largest lakes in Europe and North America all have a connection with the last Ice Age. The Great Lakes were formed as a result of the downwarping of the continental interior due to the weight of ice. The margins of the Great Lakes are often shaped by natural dams of ice-deposited materials called moraines.

The Lake District is made up of a group of narrow, glacial lakes and finger lakes are also commonplace throughout the highlands of Scotland.

There are also a small number of crater lakes, of which Crater Lake, Oregon, is the largest. Indeed, this lake serves to illustrate very clearly that lakes are not necessarily connected to any form of river action.

Because lakes are still bodies of water, sedimentation occurs at the margins and on the bottom. The picture at the top of page 23 shows this very clearly. Students should notice a delta growing across the nearest lake, midway along the lake. It is growing from left to right and will, in time, divide the lake. The land that divides the two main lakes is now farmland but was once a delta. This picture is from the English Lake District, possibly the greatest concentration of finger lakes in the world. The lakes in this area spread out like the spokes of a wheel from a mountain summit and represent a time when a glacier once sent tongues of ice from the mountain into the former river valleys.

Spread 11 (pages 24–25 of The River Book)



11

Deltas and estuaries

Deltas are wedges of material deposited by a river when it flows into a body of still water. At this point it drops the sediment it is carrying, largest first and finest last

Deltas typically produce two contrasting delta shapes. Both of the common delta shapes are shown. The fan-shaped delta is the result of deposition from distributaries of similar size, the bird's foot delta is the result of a few dominant distributaries.

Students should look back to the unit on lakes to see that rivers fill in lakes by forming deltas, just as they do by the sea.

The web site contains many further examples of deltas.

Students may need to be led carefully around picture ④ which shows the southern coast of the United States. This picture not only shows the Mississippi Delta, but it illustrates the way that sediment plumes from the river are drifting with ocean currents.

Furthermore, it is possible to trace back the course of the lower Mississippi River as it crosses the coastal plain. Further, smaller, deltas can also be seen in the distance.

Deltas are major locations of sediment and are places where new rocks are forming. As a result, they are an important part of the rock cycle. From the diagrams, students can see that the sediment is laid down in layers, hence it makes sedimentary rock.

Deltas are not common in the UK because of changes to the land at sea level caused by recent glaciation.

Chapter 4: Valleys

This chapter explains the reasons for the shapes of valleys, and how both river erosion and hillside processes are involved. In this way students learn that many parts of nature are the result of several processes working at the same time.

Spread 12 (pages 26–27 of The River Book)

12

Slopes on the move

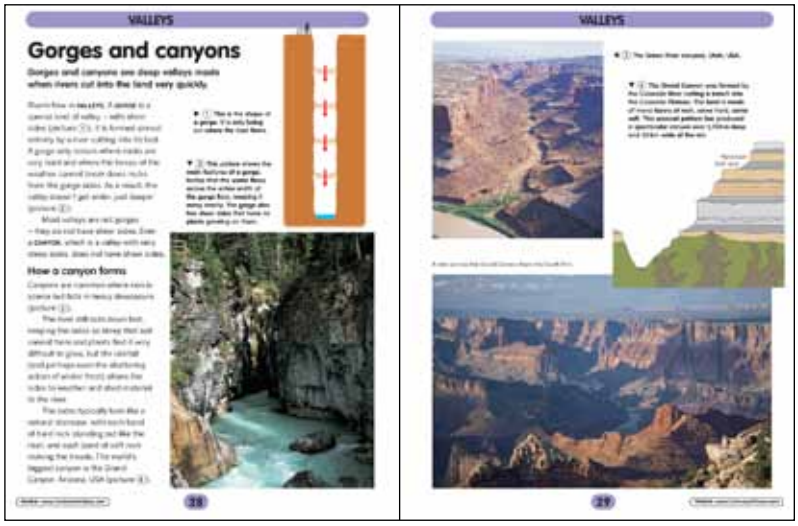
In order to see how valleys form, we have to look at the processes at work on hillslopes. In this unit, all of the major processes are shown, with emphasis placed on rockfalls and landslides because these are the easiest for students of this age to understand.

What is also important at this stage is for students to notice that hillsides have soils on them. They should observe that something (for example, the weather) breaks down the surface rock into fine particles that we call soil. Once the rock has been broken down into smaller pieces, it moves more easily.

Notice that the unit also reintroduces the idea of a solution as an erosive agent.

Students may think that soils and rocks move on hillsides only during floods, and that the material is washed down the slopes. This is only true for some bare slopes and even then only under torrential rain conditions. To demonstrate how soils can move, you can place some sand on a board and then tilt the board until the sand moves. Now wet the sand and repeat. This demonstrates the effect of cohesion because the sand will remain unmoved until the angle is much steeper than before. If you add water to the body of the sand (by pouring water onto a sponge that is placed against the sand on the uppermost part of the board) then you can see that, as sand (and soil) become saturated (without water running over the surface) cohesion is lost and this is why both mudflows or landslides can also happen on gentler slopes.

Spread 13 (pages 28-29 of The River Book)



13

Gorges and canyons

Valleys have many shapes. This unit looks at the most dramatic shapes of valleys, those with the steepest sides – variously called gorges, ravines, arroyos, canyons, etc.

A gorge has vertical sides. It provides a useful start in the study of valleys because it demonstrates what the river's role is in valley formation.

A gorge is produced when the river can cut down much faster than the sides can widen out. As a result, it is clear that the river cuts into its bed. Rivers by themselves, therefore, could never cut valleys – they can only cut gorges.

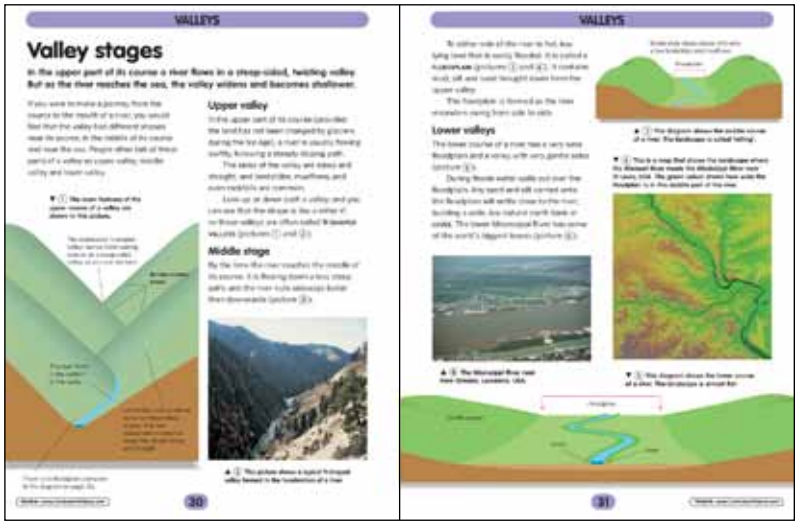
This is an important first step in getting students to see that something else has to cause the slopes to widen out. If you run water down a slope in a sand tray, you will see the way the river cuts a channel. There is little sign of a valley forming.

Lydford Gorge in Devon is an excellent demostration of this. Pictures are on the web site and in the project CD – *The River and Water CD*.

In contrast with a gorge, a canyon has very steep, but not vertical, sides. Canyons have sides that are bare of vegetation and soil because they are too steep.

This is an ideal opportunity to make a project study of the Grand Canyon, and to bring in aspects of the way that differences in rock hardness have led to a natural staircase down the canyon side. The treads are always formed by the softer rock, and the risers by harder rock.

Spread 14 (pages 30–31 of The River Book)



14

Valley stages

Valley shapes are a result of the different balances between river downcutting and hill slope widening. In upper valleys the steepness of the slopes means that rivers can cut into their beds quickly. The result is a pronounced, narrow V shape.

Students might be asked to notice that the valley goes right down to the river side (there is no floodplain).

These valleys are normally found in tributaries on steep slopes or in mountainous terrain where glaciation has not had a large effect.

By its middle stage the river is cutting down relatively less quickly because much of its energy is being used in transporting sediment delivered from upstream or from neighbouring hill slopes. This gives a chance for the hill slopes to widen out and for hill slopes to become gentler.

The sediment that the river cannot immediately carry away is deposited in the valley bottom and sent further down the valley during each flood. The deposited material fills the bottom of the valley and as a result a floodplain develops.

Students should not think that a river cuts a floodplain. There is no solid rock in the bottom of rivers in these kinds of valleys.

The idea of river floodplains is important for studies of human-river interaction in later units. It is simply defined as the flat land in the valley bottom that the river floods over – even occasionally.

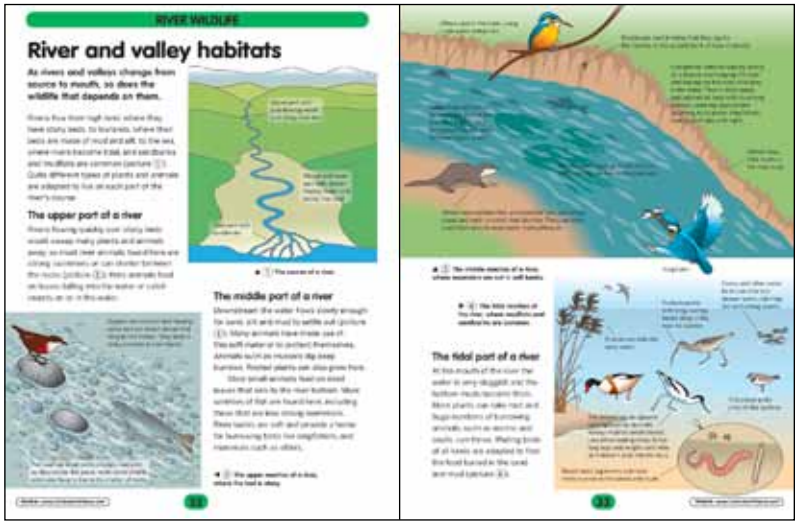
Most settlement is on lower valleys close to rivers, and so they are important from a human-river interaction standpoint. However, because these valleys are rather featureless, attention tends to focus on levees. Students should note that levees only form where the material carried in a flood is mainly silt and sand. They do not form where it is mainly mud.

This unit provides an opportunity to look at large river valleys such as the lower Mississippi River, featured in the pictures and diagram. More pictures are on page 42 of *The River Book*.

Chapter 5: River wildlife

This is a short section about river habitats to provide a cross-curricula link to world habitats or science. The Curriculum Visions books *Living things in their environment* and *Caring for our environment* provide extensions to this topic.

Spread 15 (pages 32–33 of The River Book)



15

River and valley habitats

Now that students have completed a study of rivers and valley shapes, they can see how these provide a wide variety of habitats that wildlife can make use of.

This unit allows an interdisciplinary approach to river study and can combine aspects of life sciences with environment, ecology, and environmental protection.

The unit begins by reshowing the whole of a river valley and its river, reminding students that valley shapes change and rivers become more meandering. They can be reminded of upper, middle, and lower valleys, meanders, oxbows, swamps, lakes, and deltas. Students can then remind themselves of how the sediment and river speed is different in each case. From here they can go on to look at the wildlife.

The wildlife examples shown here are chosen because of their widespread distribution. But you can introduce many more local species, both animals and plants.

Students may need to be taken very carefully over this page and use it as a basis of a project. They could, for example, find other species that occupy the habitats and add them to their own project page. These diagrams, which are on the web site, can be used as a starting point, with others added from Internet investigations or by using field guides, and so on.

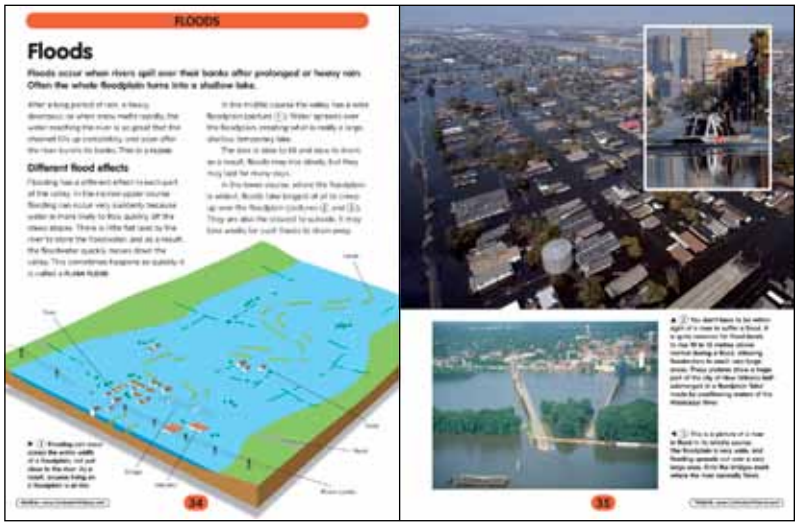
You may find it helpful at the end to ask whether we commonly find these species in our cities, and therefore imply that development changes the habitat and can threaten wildlife. Students can then ask whether it is possible to think of ways of improving the riverside habitat without compromising on the land use for people. There are many examples of this.

Chapter 6: Floods

This chapter explains how people cause floods, and are affected by them.

It is an important topic area, bringing together a whole range of issues concerned with land use and natural processes. You can link to other Curriculum Visions titles such as *Caring for our environment*. Also the *River Stories* on the web site under 'In-depth... for projects' or *The River and Water CD* provide another approach.

Spread 16 (pages 34–35 of The River Book)



16

Floods

Because students will have been told about the origin of floodplains from earlier studies, they will now be able to apply that knowledge to understand that it is perfectly natural to expect the lower part of a valley to flood.

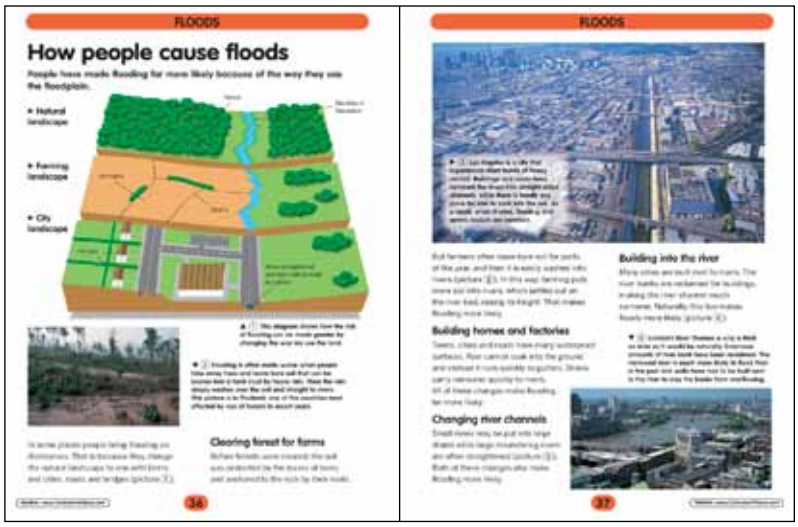
Being some distance from the river is no protection, because the floodplain is flat.

Students can begin to see the conflict caused between a desire to build by the river because it is convenient (and to use the flat land for building, industry, and farming), and the natural tendency for a river to use its floodplain as a temporary lake for floodwaters the channel cannot handle.

Students should notice the disruption to communications as well as housing. In picture ③, students' attention might be drawn to the fact that the bridges are not flooded. It is the bridge approaches that have been inundated.

Here is also an opportunity to correlate the information in this book with the *Weather aound the world* book in the Curriculum Visions series.

Spread 17 (pages 36–37 of The River Book)



17

How people cause floods

Floods are a perfectly normal part of a drainage basin. They happen when the amount of water flowing to the river as a result of rainfall is greater than the rivers can carry away. However, people can change the frequency of flooding by their actions and they can certainly change the size of floods. Many urbanised areas are now twice as likely to flood as they were a century ago. This is not a weather-related effect, but is due to the alteration of the land.

Remind students about the water cycle and the fact that rainwater naturally seeps into soils and reaches rivers this way. Soils and rocks are natural sponges. Then get them to look at picture ①, which shows the way that the rain is increasingly diverted from percolation to the soil and taken to drains and culverts instead. These are smooth-sided, efficient channels which carry water to rivers far more quickly than nature. As a result, the river has to cope with much higher water peaks than it would naturally. The answer is to reduce this trend to carrying water as fast as possible to rivers and think of more environmentally friendly ways to manage rainfall.

The effect of deforestation is an important factor in many developing countries, primarily due to the need to cultivate more land (as is the case with China), or the need to sell timber (as in Thailand). Deforestation is also an important feature of the Amazon basin.

Urbanisation can affect flooding by the diversion of water from roads and roofs to rivers. The pictures of Los Angeles taken from the air show the extent of this urbanisation. You can match the pictures on page 37 with the diagram on page 36 quite easily. The lower photograph is of the Thames at London which is now a third as wide as it was in Roman times (link to History) due to reclamation.

You may be able to get aerial photos of your own local city and investigate how far the river has been narrowed and obstructed by urban development.

Spread 18 (pages 38–39 of The River Book)

18A

18B

Coping with floods

In the previous units students will have seen how extensive floods can be and why they are now more severe than in the past However, irrespective of the reasons, people do want to protect their property and lives, and so there have to be measures in place to help them do this.

Students' attention should be drawn to the fact that floods contain mud and that mud can do as much damage as water.

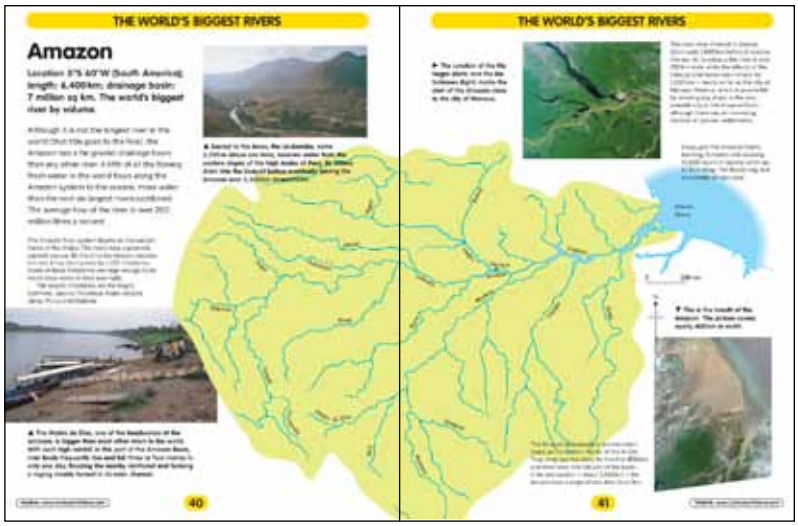
Simple types of short term protection include sandbags. Longer term protection includes embankments and reservoirs, designed to trap the water before it reaches the populated parts of river valleys. A field trip could investigate what flood control features are in place locally. Using the web, students could also look at preventative and remedial measures. FEMA (www.fema.gov) gives extensive information on this topic.

Many rivers have flood control reservoirs. Students might be able to find out how much the reservoirs in your local basin are used for flood control as opposed to irrigation and power uses. This is a good opportunity to link to *The Water Book* in the Curriculum Visions series.

Chapter 7: The world's biggest rivers

This chapter is concerned with the great rivers of the world. Each river can form the basis of a major project. Space restricts what can be done in the book, so information is presented that can act as a starting point to three rivers: the Mississippi River, as our largest river basin; the Amazon, as the world's largest river by volume; and the Nile, the world's longest river. Hundreds more rivers (and much more detail about the rivers shown in the book), together with many pictures, are given on the Curriculum Visions web site (Geography/River/Rivers of the World) and *The River and Water CD* – from the home screen choose 'World rivers'.

Spread 19 (pages 40–41 of The River Book)

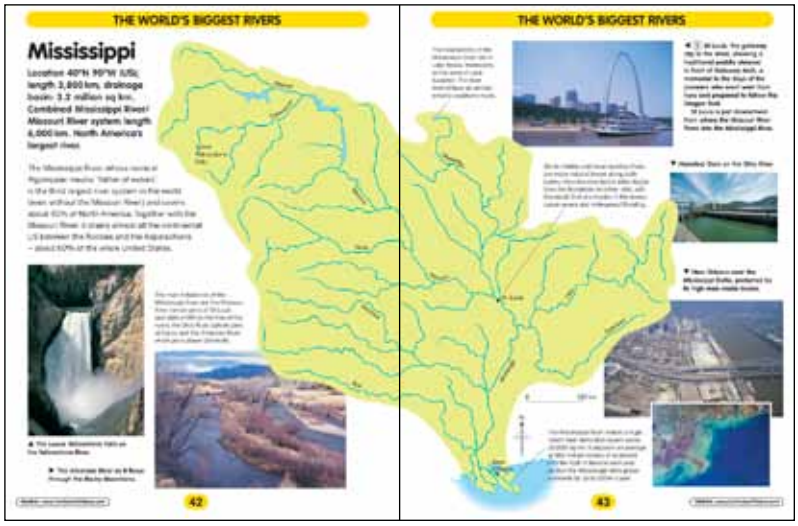


19

Amazon

Widely known about, it is surprisingly difficult to get detailed information about the Amazon. Use the web site or *The River and Water CD* to begin, or as the basis of a project.

Spread 20 (pages 42–43 of The River Book)



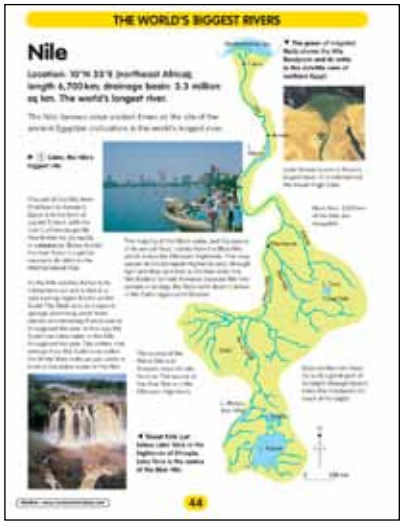
Mississippi

Many students might be interested in a river that drains 60% of the United States. A watershed map is given here as a starting point. A photocopiable version is given on page 95 of this *Teacher's Resources*.

Only some major rivers have been put on this map. Ask students to add other rivers, developing atlas skills to find the answers.

Use *The River and Water CD* to find out much more about the Mississippi River.

Spread 21 (pages 44 of The River Book)

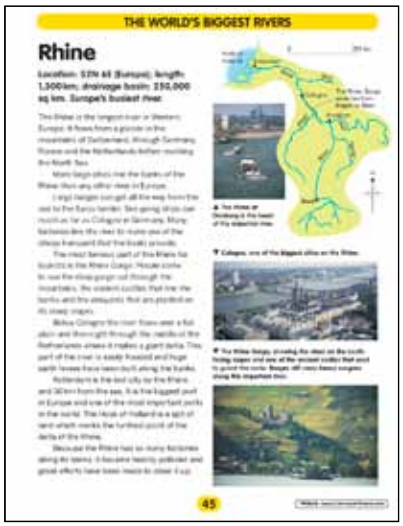


Nile

This river is linked to the ancient Egyptian civilisation in many minds, and so can be used as a basis for interdisciplinary work with history. The basin has an unusual shape with very few tributaries. This is because, similar to the Colorado, it flows through extensive desert regions where there is no contribution to the main channel.

The web site or the *The River and Water CD* gives more information as the basis of a project.

Spread 22 (page 45 of The River Book)

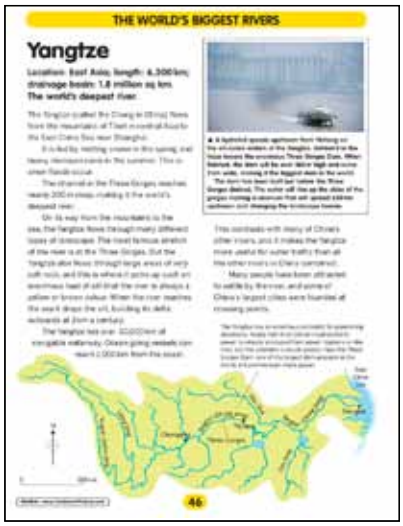


22

Rhine

This is the most important commercial river in Europe and links a wide variety of EU countries both directly and via canal connections.

Spread 23 (page 46 of The River Book)



23

Yangtze (Chang)

Asia has many large rivers. The Yangtze (Chang) is of special significance because of the construction of the Three Gorges Dam, one of the world's most contraversial projects.

Reference

The last two pages of the book contain the glossary and the index.

Glossary (page 47 of The River Book)

The entries in the glossary are listed in alphabetical order. The short definitions are given in simple language for the context in which they are used. They are, therefore, not necessarily the same as definitions given in an encyclopedia or dictionary.

Where necessary, more breadth is given to a definition (to make it encompass other meanings, or make the definition more general).

Index (page 48 of The River Book)

A comprehensive index allows specific subjects to be found.

The index can be used to encourage research skills.

Section 3: Activity work

Safety first!

Before any kind of classwork or fieldwork, please make sure you have thought through the appropriate safety precautions, especially those laid down by your local education authority.

(a) Classwork

Find your own basin

Everyone lives in a river (drainage) basin – even if the land appears flat – so it is always possible to add a local flavour to river studies.

One local study would be to find out what area the local river basin actually covers. Start by using a map and tracing paper to mark out the river network. The river basin divide can then be sketched in by drawing a line half way between the headwater tributaries of 'your' basin, with the neighbouring basins.

If the land has significant relief, you will find that the divide corresponds to ridges and other topographic features. It also allows you to introduce or reinforce the concept of contours and mapwork.

Make a desktop river

The most striking feature of a lowland river is a meander. It is also one of the features most readily seen on a floodplain. But although students may be able to see it, it will have much more meaning if somehow they can interact with it. Two activity suggestions are given here, one that can be done in a classroom and one that can be done in a small river under proper supervision.

Meanders occur because of the way water flows. You can demonstrate this using the board experiment in class.

You need a flat board about 1.8m (6ft) long. It is easy to get a sheet of white-faced board that is about 15cm (18 inches) wide from a hardware store.

Place the board with one end on the floor in a large bowl or bucket. The bowl will collect the river you make on the board.

Prop up the other end of the board on the seat of a chair or a box. The board now makes the (rather steep) floodplain. You will probably need to vary the slope to get the best effect. The effect of changing the slope forms part of the demonstration.

Now, add a little deep blue water-based paint to water in a large jug or watering can. This will be the river.

Pour the water steadily from the jug onto the DRY board (see opposite). You may have to experiment quite a lot and be confident about how you pour, but a steady stream on the right slope will give a pattern of meanders. A flow lacking in confidence will probably fail. If you then get students to look carefully at the water as it is flowing, they can see the water flowing fastest around the outside of the bends. They can also see how the meanders shift down slope, especially if you increase the rate of flow during the demonstration.

The river is held on the board by surface tension. This is how you can get a river on a board. It also shows that meandering is a property of the flowing water, and not due to local landscape effects.

While this is happening, get the students to imagine how the shifting river channel reworks the soil on a floodplain, making the floodplain flat (from side to side – it will, of course, have a downstream slope). This demonstration also shows the way that meanders migrate down a slope. It is great communal fun in a classroom, and a good scientific demonstration at the same time.

From this demonstration, you can talk about how rivers shift material about, transferring it from the outside bank of one meander to (mainly) the inside bank of the next meander. Then take the conversation further to explain how rivers shift material downriver to the sea, mainly in times of flood.

Any one particle of sediment may take hundreds or thousands of years to make its way through a floodplain. Much of its time is spent as part of the floodplain: having been deposited on the inside of a bend, it awaits the return of a meander to scour that part of the floodplain again.

To help students understand the nature of sediment transport, you can mix up soil and water and then watch it settle. The sand, and any stones, will settle almost immediately, indicating that a fast current is needed to

▼ **A 'desktop' river.**

carry large materials, while the mud will remain in suspension for a long time. But when the mud has settled and the water cleared, has all of the soil separated from the water? The answer is no, because there will still be material dissolved from the soil. This is material that can be transported in even the gentlest of currents.

To demonstrate such things as river basin, and the way that springs form, use a thick kitchen sponge. Get one with as big a surface area as possible. Pour water onto the top of this and get students to notice that no water flows out from the bottom for a while. This lag explains the time difference between rainfall and storm runoff by the river. Making a cone shape of the sponge will concentrate water in the centre of the cone. This 'hillside hollow' gives rise to a spring.

(b) Fieldwork

Visiting a river can be exciting and fun, provided the obvious safety precautions are taken and that all students have well-defined tasks to achieve before they go.

It is difficult to work with large rivers. These are usually less accessible, and interesting features will be far apart. A stream or river a few to tens of metres (yards) across would be ideal. But not all such rivers have access, so it is important to find one with access from a public bank. This kind of river is also likely to fit within a single map, allowing its drainage basin to be examined in class.

A number of short, well-defined tasks are better than one long project. This is especially true for the less able and the younger student, but there is generally more satisfaction for all students in having hunted around to complete a number of tasks, rather than getting bored with one long task.

Conclusions should be clear and not subjective. Again, then students should know when they have succeeded.

Become aware of safety through river study

Many students are unaware of the need for safety. One way to introduce the idea of safety is to play 'Pooh sticks' or 'Pooh biscuits' (an environmentally-aware version of Pooh sticks that adds a dash of colour for tracing purposes – see next column). You can also get students to read *Winnie the Pooh* by A. A. Milne, and discuss the story in the context of rivers.

The idea of safety can be emphasised through suitable questions. That is, if you set the Pooh biscuits task and get children to observe the river speed at various points, they will find out for themselves which are the more dangerous places. By dropping Pooh biscuits from a bridge, they could also find out that bridge piers create eddies and fast currents.

Of course, it is never safe to take a party to a river site when rain or snowmelt is forecast, or at times of high flow. It is not only dangerous, but with a full river you cannot see much of the bed or banks.

Visit your basin

If you can, organise a field trip to follow part of the basin divide so that students can grasp what this really means. Is the divide clearly defined, for example? How close is it to the school? Do you cross it on your way to school? (This works even for major cities whose landscapes may at first appear to be flat – you will find that they are not!)

Another activity is to find out who in the class lives closest to the divide and who lives closest to the river. Then you can find out the distances from divide to river using the map.

Find out if any roads run along the divide, and which roads, if any, run along the side of the river. The point here is that the drainage basin is a rather abstract concept, but everyone knows the location of their home, town centre, and local roads. They can then begin to relate the drainage basin to the features of the mental maps of their home locality.

More advanced students can find out the size of the drainage basin by placing squared paper over the map and calculating the drainage basin area.

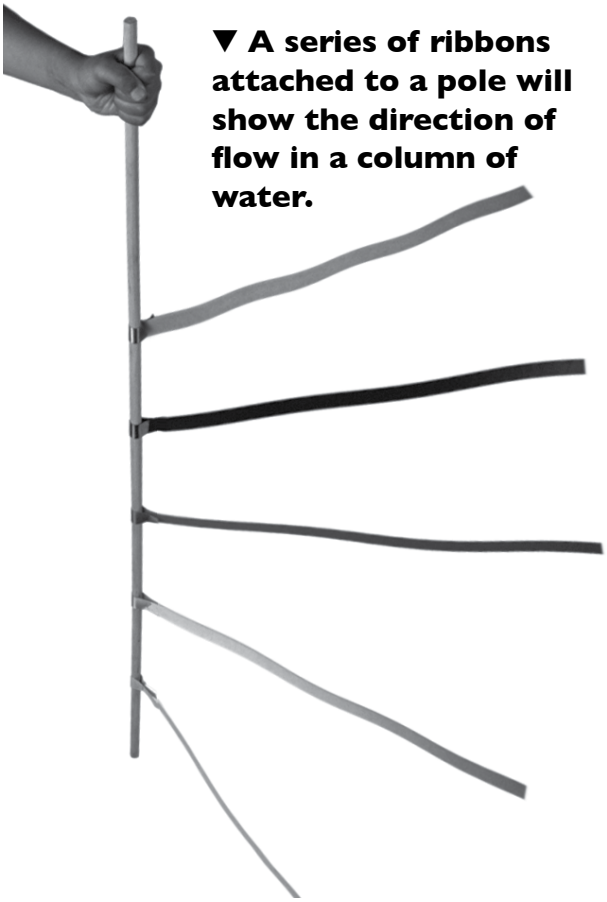
Pooh sticks/biscuits

Rivers are easy to look at, but it is not always clear what is happening in them. It is important, for example, to make sure that students appreciate that the water flows fastest around the outside of a bend, and it is here that the water is deepest and the energy is greatest.

One way to begin to get an appreciation of the variations in water speed in a river is to use differently-coloured floating objects thrown into the water. Dog biscuits make good floating, yet environmentally degradable, Pooh sticks. A number of different coloured biscuits can be released from a bridge by students, and the position of the river currents and eddies, etc., observed.

Pooh biscuits, of course, can be used in many ways. You can, for example, pull a surveying tape (or a rope knotted every metre) across a small stream as a way of introducing quantitative measurements. Students can stand a metre apart and drop their Pooh biscuits to make a fair test of relative current speed.

▲ **Pooh biscuits!**



▼ A series of ribbons attached to a pole will show the direction of flow in a column of water.

Streamers

Streamers are a direct way of observing that the flow of water at depth is not the same as the flow near the surface. If students can see this, they are more inclined to believe that water flows in a corkscrew motion around a meander.

You will need a garden cane, together with a number of thin ribbons of different colours. Tie one ribbon 15cm (6 inches) from one end. Tie another 15cm (6 inches) further along, and so on until you have four or five ribbons. Waterproof package tape could also be used for fixing the ribbons.

Place the streamer in the water and the ribbons will stream out in the directions of the water currents. A teacher can wade into a river to place the streamer, and students can still see the results standing safely on a bank.

▼ The water weed in this section of a river shows the direction of the current as it passes through the bend.

This streamer will show you how the water is moving, but you must only do it in a small, safe river where the water is no more than knee deep. You can place this 'detector' in many places in the river to find out how the water flows.

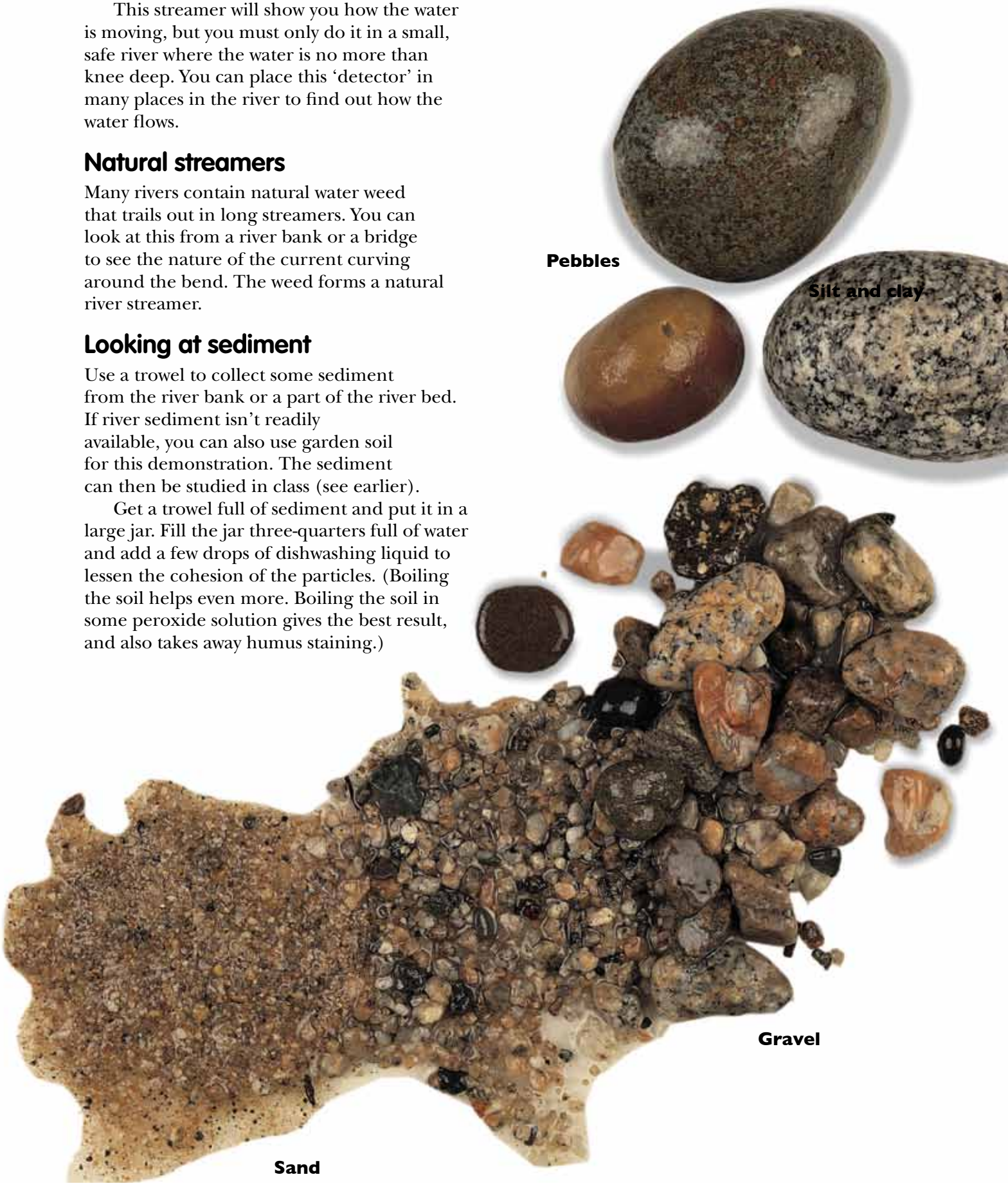
Natural streamers

Many rivers contain natural water weed that trails out in long streamers. You can look at this from a river bank or a bridge to see the nature of the current curving around the bend. The weed forms a natural river streamer.

Looking at sediment

Use a trowel to collect some sediment from the river bank or a part of the river bed. If river sediment isn't readily available, you can also use garden soil for this demonstration. The sediment can then be studied in class (see earlier).

Get a trowel full of sediment and put it in a large jar. Fill the jar three-quarters full of water and add a few drops of dishwashing liquid to lessen the cohesion of the particles. (Boiling the soil helps even more. Boiling the soil in some peroxide solution gives the best result, and also takes away humus staining.)



Shake the soil and water until it is all swirling strongly. Now place the jar where the class can see it and watch. The coarsest material will settle out first, the finest later. The result is that the jar will show all of the different grades of material as they settle. Several important points can be made:

1. The soil (like the floodplain, river bed, and river bank) is made of a mixture of materials. All are carried by strongly flowing water.
2. The heaviest material settles first, so that pebbles and gravel are carried only short distances in a flood. The clay (mud) may take days to settle in the jar, showing that it readily moves in suspension, can flow over the floodplain in times of flood and only later be deposited to form fertile soil, etc.

Studying river beds

You can examine the bed of a small, shallow river at times of low flow. If you look at many beds, you will see that they have a surface of large pebbles. Look carefully and you should be able to see the way the larger pebbles are orientated with their flat sides angled against the river flow. They also have their shorter side against the flow. This is a good study of fluid dynamics (the watery version of aerodynamics: pebbles turn around until they face the flow and present the least resistance).

These large particles armour the bed, that is, they protect the fine material underneath. This is another reason why so little fine material flows between floods; it is buried below the armouring. However, as soon as the large pebbles begin to move in the fast waters of a flood, or near flood, all the material they have been protecting is exposed and the amount of sediment in the river increases dramatically. This is why rivers suddenly turn muddy.

Solution in the classroom

You can show the process of solution in class by using an antacid tablet. Everyone in a class can do it for themselves, or with their parents at home. It also reinforces the link between earth science and materials science.

It is best to choose an antacid tablet that is chalk based, rather than one that dissolves away completely. Many soluble aspirins can be used in the same way, because they nearly all use a base of insoluble material to act as the filler for the tablet. The purpose is to show that chemical weathering (chemical reaction) usually produces a precipitate of fine-grained sediment (clay, mud) as well as taking material into solution.

Studying water in soils and rocks

Although the water cycle is an essential core topic, it can also seem very abstract. This is particularly so because most of the components of the cycle are invisible. There are two objectives to making the water cycle more comprehensible. The first is to make the various parts of the cycle visible by relating them to everyday experiences. The second is to put the parts of the cycle into a logical order.

Evaporation: Most children will agree that a saucer with water in it will dry as water is soaked into the air.

Transpiration: Ccan be seen by noting the way the soil in a potted plant dries out over a few days.

Condensation: There are two ways to show this. One is to show that steam from a kettle is a cloud in miniature; the second is to show that water comes out of the air when it is cooled by observing the condensation of water on a glass of ice-cold liquid.

Aquifers: Use a flat dishwashing sponge. Make it damp, wring it out, and drape it over a

sloping board. Fill a jug with water and add a few drops of food colouring to make the water easier to see. Pour the water onto the top of the sponge.

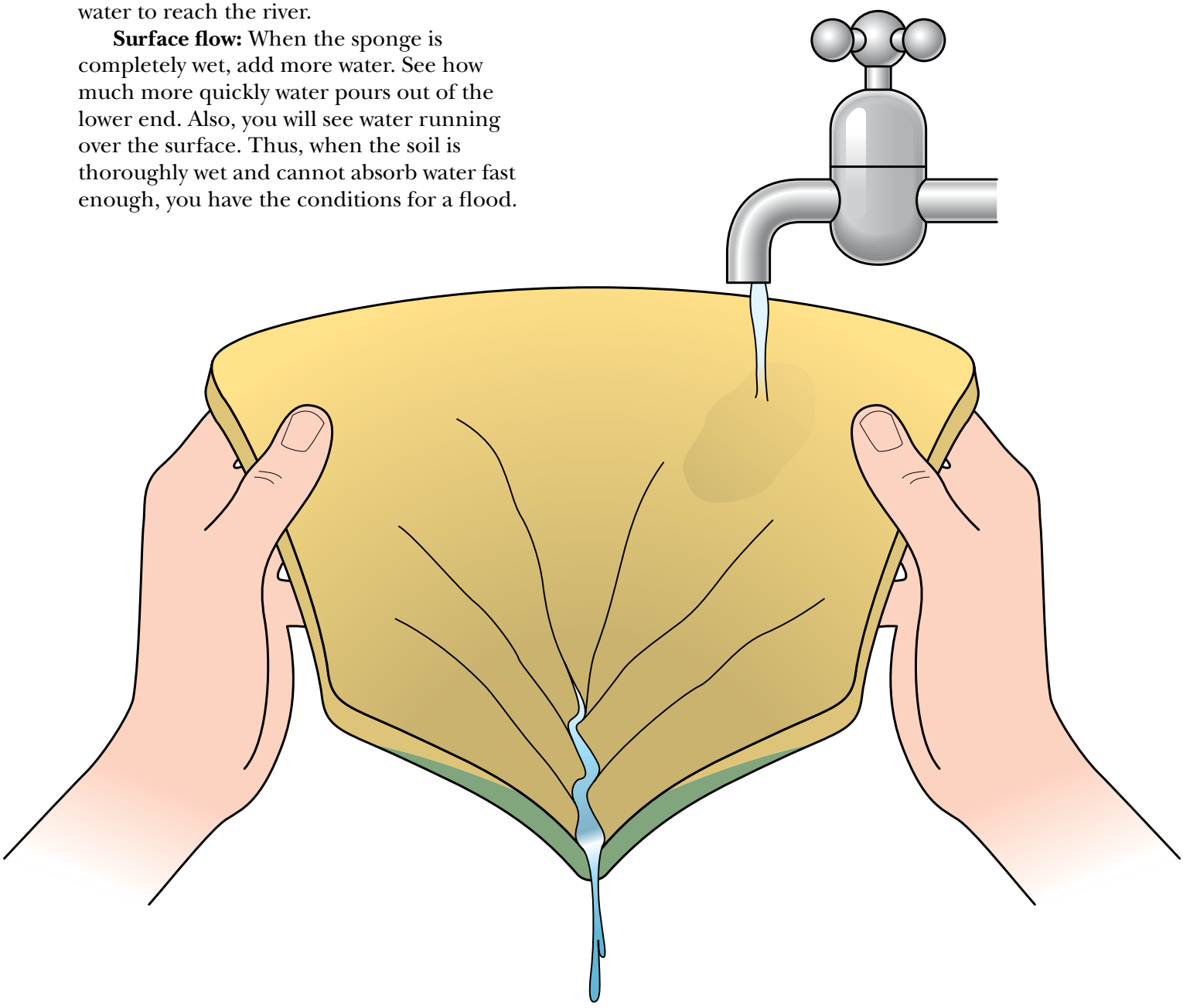
The progress of the water becomes obvious by the movement of the wet edge of the water (even without dye). Stress that it takes time for water to move through soil and rock. Students can see this for themselves simply by noting how long it takes before water drips out of the bottom of the sponge.

Link to maths: If the sponge was several kilometres long (a real hillside) just think (or even work out) how long it would take for water to reach the river.

Surface flow: When the sponge is completely wet, add more water. See how much more quickly water pours out of the lower end. Also, you will see water running over the surface. Thus, when the soil is thoroughly wet and cannot absorb water fast enough, you have the conditions for a flood.

Drainage: Don't forget to get students to time how long it takes for the water to stop flowing out of the bottom of the sponge after no more water is added. This explains how rivers receive water and keep flowing even after rainfall has stopped.

You can repeat the demonstration with a thick sheet of sponge, representing a thick permeable rock. Of course, water takes longer to emerge and drains for longer. Thus, the thin sponge might represent a soil on impermeable rock, the thick sponge might represent an aquifer.



(c) Research projects

It is possible for students to become experts on the world's major rivers, by getting groups or individuals to use the library to find out about the Mississippi River, the Amazon, the Nile, and so on. Brief information for such a study is also available from the Curriculum Visions web site (www.CurriculumVisions.com). Groups can give talks and presentations to one another on their chosen river. Such tasks will take several lessons or homework sessions.

Similarly, students can become experts on river features, such as oxbows and levees. These more restricted tasks can be accomplished within a lesson.

Section 4: Photocopiable worksheets

Introduction

The photocopiable worksheets in this *Teacher's Resources* have been designed to be a fast and efficient way of working through the study of *The River Book* book.

It is intended that you photocopy each worksheet and distribute the photocopies for students to complete. The questions are on all the worksheets.

At the head of each worksheet are the relevant pages of *The River Book* book. 'See pages 8 and 9 of The River Book', means that the answers to all of the questions can be found by using pages 8 and 9 of the student book. 'Based on pages 8 and 9 of The River Book' means that the worksheet is more of a practical activity based on the subject in the student book.

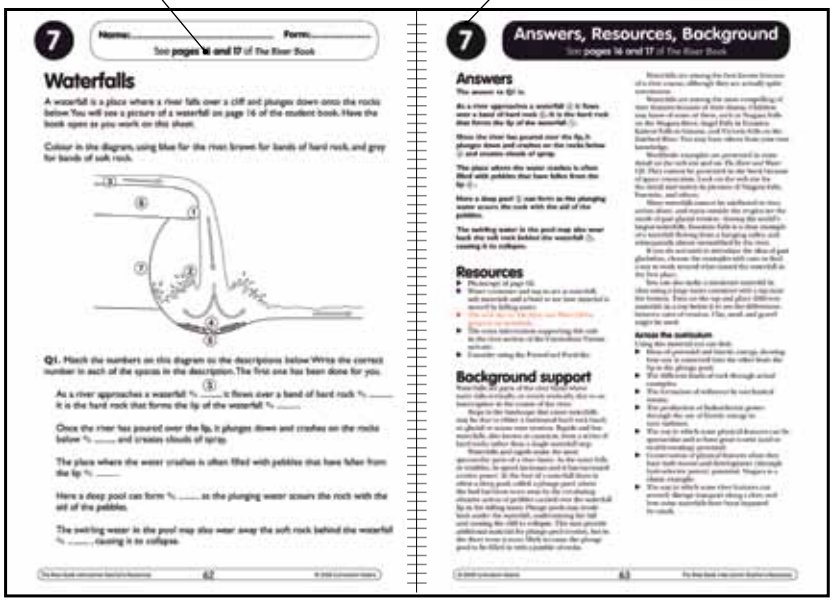
Each worksheet has been given a unique number, which is in a circle at the top of the page. If there is more than one worksheet per spread of the student book, then they are labelled **A**, **B**, etc.

The answers, if appropriate, face each worksheet. Here you will also find additional information that may help in class discussion.

NOTE: the sheets on pages 44 and 45 contain simple diagrams that can be used for making up your own worksheets.

Refers to the page numbers in the student book to which the worksheets relate.

Worksheet number – may be labelled A, B, C, etc.



The left-hand page is to photocopy and hand out to pupils.

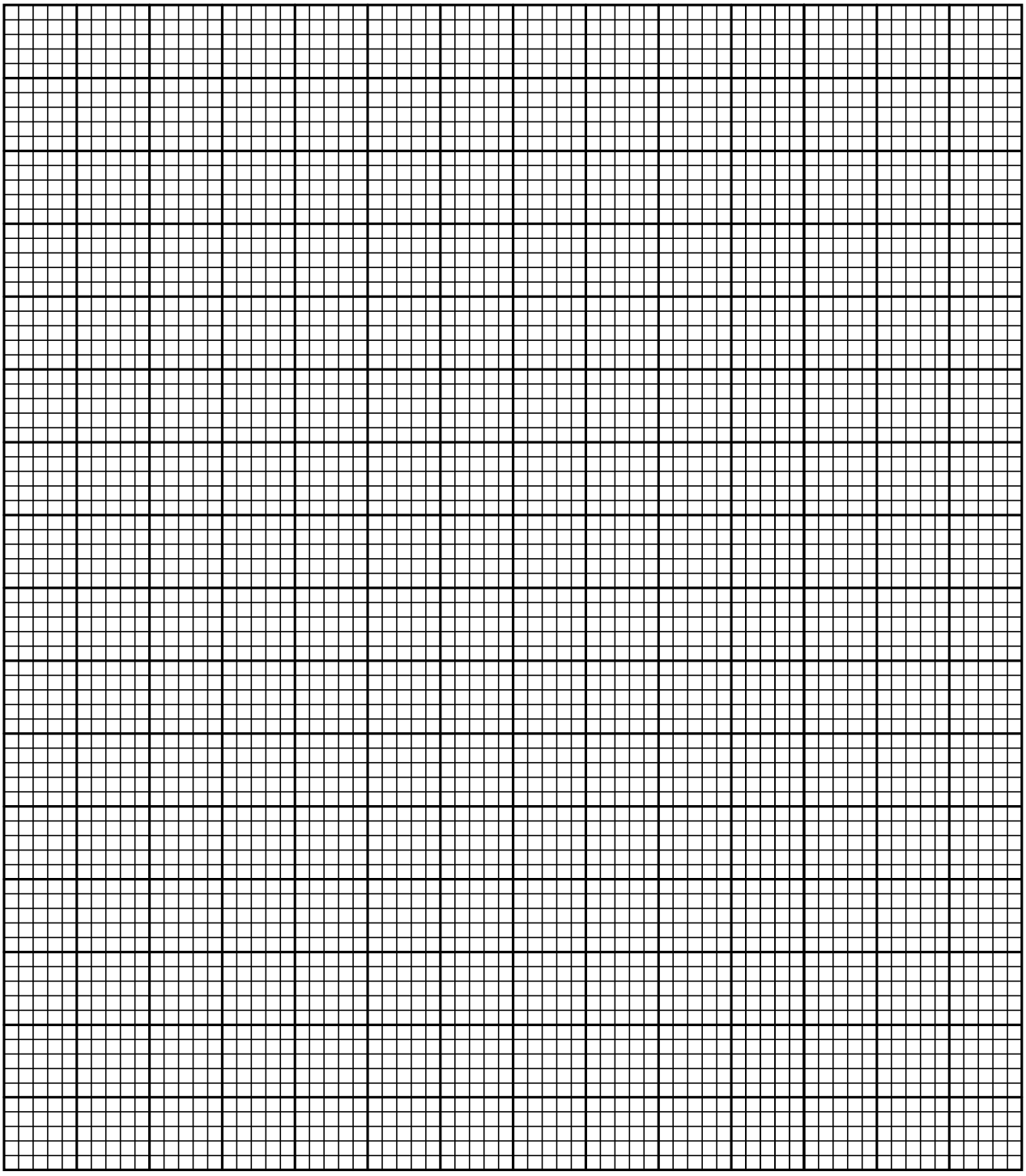
The right-hand page provides the answers and teacher's notes.

Student instructions

Make sure you write your name and class at the top of each sheet.

✎ This symbol indicates where you should write your answers.

Graph paper



Name:..... Form:.....

Features of rivers and valleys

People use rivers and valleys

C 1

Name:..... **Form:**.....

See **pages 4 and 5** of *The River Book*

Features of rivers and valleys

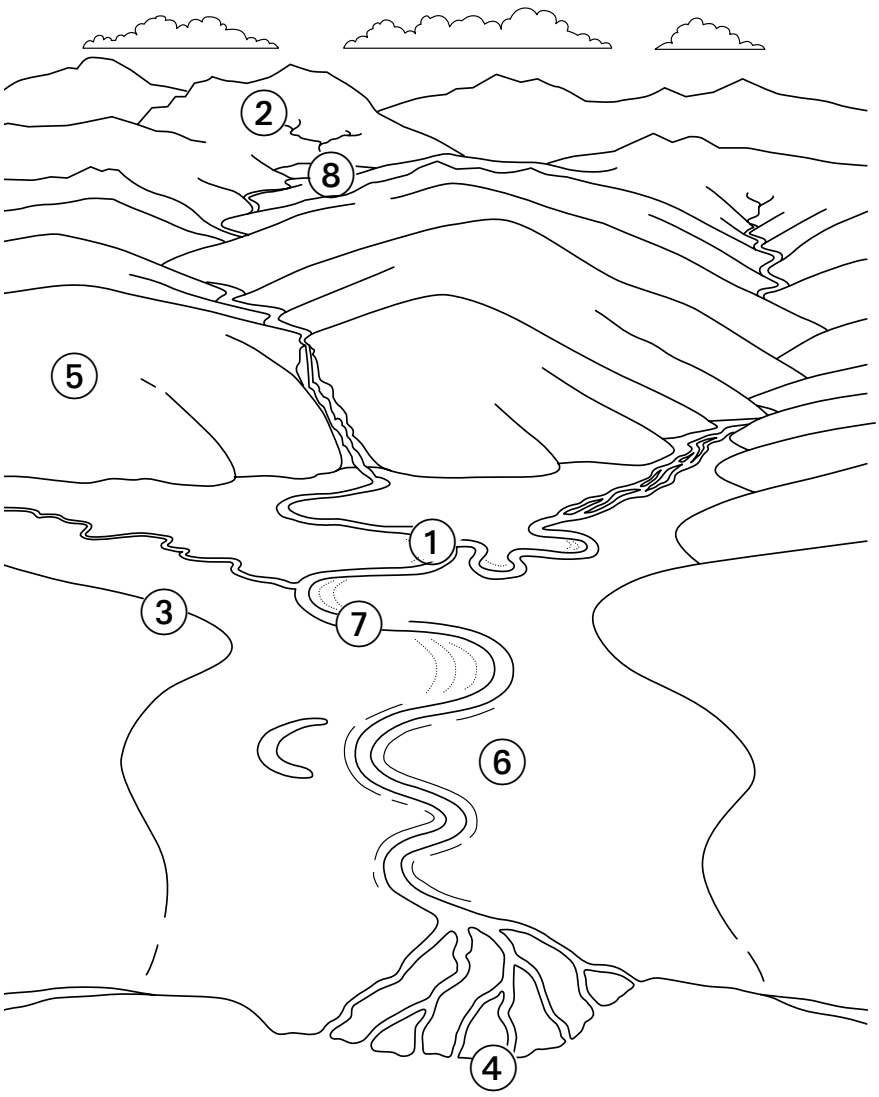
Rivers and valleys go together. The picture below shows you how this works.

A river flows in the bottom of the valley. There may be flat land on either side of the river that floods after long rainy periods.

On either side of the flat land are hillsides, land that is steeper and that does not flood. Places close to where the river begins often have steep slopes, while places close to where the river ends often have more gentle slopes.

Begin by colouring in the rivers, the lake, and the sea.

Q1. Can you label this picture with each of its main parts? Write the correct number from the diagram against each of these descriptions:



✎ ..... (7) river

✎ ..... lake

✎ ..... steep slope

✎ ..... gentle slope

✎ ..... flat land that may flood

✎ ..... river source

✎ ..... river mouth

✎ ..... junction of rivers

1 Answers, Resources, Background

See **pages 4 and 5** of The River Book

Answers

The answers to Q1 are:

⑦ **river**

⑧ **lake**

⑤ **steep slope**

③ **gentle slope**

⑥ **flat land that may flood**

② **river source**

④ **river mouth**

① **junction of rivers**

The objective of this sheet is to make sure that students can recognise the elementary parts of a river and its valley, and have a grasp of some of the words that will lead them on to more detailed examination of features.

Some students may also find it useful to colour in the river and the lake. This way they have to follow the shape of the river system and notice that it consists of branches (tributaries) and that its course is not straight.

Resources

- Photocopy of page 46.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

A drainage basin, or river basin, contains all the land drained by a river network. Its boundary is called a watershed; it forms the highest land that separates neighbouring basins.

(i) Drainage pattern

Rivers are a part of a river basin. Within the basin is a network of tributaries which gather water from all parts of the basin, gradually bringing it to the central trunk, or master river.

The river systems in drainage basins commonly form into two patterns, called dendritic if they look like the veins in a leaf, or trellis if the tributaries meet the trunk river at right angles.

The dendritic pattern is common where the underlying rocks are similar. It is the most common form of drainage pattern. If the rocks in a drainage basin form bands of varied hardness, then the soft rocks will be eroded before the hard rocks, and the tributaries flowing over the soft rocks may grow quickly, cutting through the hard rocks in steep-sided valleys or gorges. This produces a trellis pattern.

(ii) Supplying the river system

The river network normally occupies less than 5% of the total drainage basin, and even in times of flood it is rare for surface water to cover more than a fifth of the basin.

Rivers receive their supplies of water mainly from soil and rock, or from water running over the ground surface. Very little water is supplied by rain that falls on the channels. Over the year soils and rocks provide about a third of the water flowing in a river. The rest is provided by water running over the surface, often at times of high water, or flood.

The number of tributaries depends on the size of the basin, and also on the rocks and climate. Limestone rocks, for example, can be dissolved by water; the tributaries then form underground so that there are few surface watercourses. In clay, and other rocks into which water cannot enter, the number of tributaries is high.

(iii) Influence of basin shape

The shape of the basin will affect the chances of the trunk river flooding. In long narrow basins, the tributaries enter the trunk river at regular intervals, so that storm waters from each tributary do not coincide and are less likely to give flood problems. But in a more rounded basin, the tributaries may deliver their storm water to the trunk river close to each other, increasing the flood risk.

River and valley features

As the river network develops, it produces a number of distinctive channel and valley features. Using this worksheet and the book, students can see, right at the start of their investigations, many of the larger-scale features they need to learn. At the same time, it gives them a summary they can use during exam review.

The diagram also puts all the features into their relative contexts, and thus the location of each feature can quickly and easily be referred to at any point in the study. The introduction on page 4 of the student book also includes references to pages where each topic is dealt with more fully. Thus, this page can also be used as a visual index.

The features on page 4 have been arranged so that (in general) the student reads from the source toward the mouth of the river. Of course, many features, such as waterfalls and meanders, may occur at many places, and so it is useful to remind students not to be too rigid in relating all features to specific places in a river system.

The river and valley shown here are idealised to make sure that the important features are covered and it may be helpful to tell students that they probably will not find every feature on any one river they study.

C 1 **2**

Name:..... **Form:**.....

See **pages 6 and 7** of *The River Book*

People use rivers and valleys

Rivers are very important to us all. Fill in the missing words to explain why.

Q1. What word do we use for water that has untreated sewage or chemicals in it?

✎ P.....

Q2. Why do farmers like to use a floodplain?

✎ Because the soil is f.....

Q3. What is the main danger from living on a floodplain?

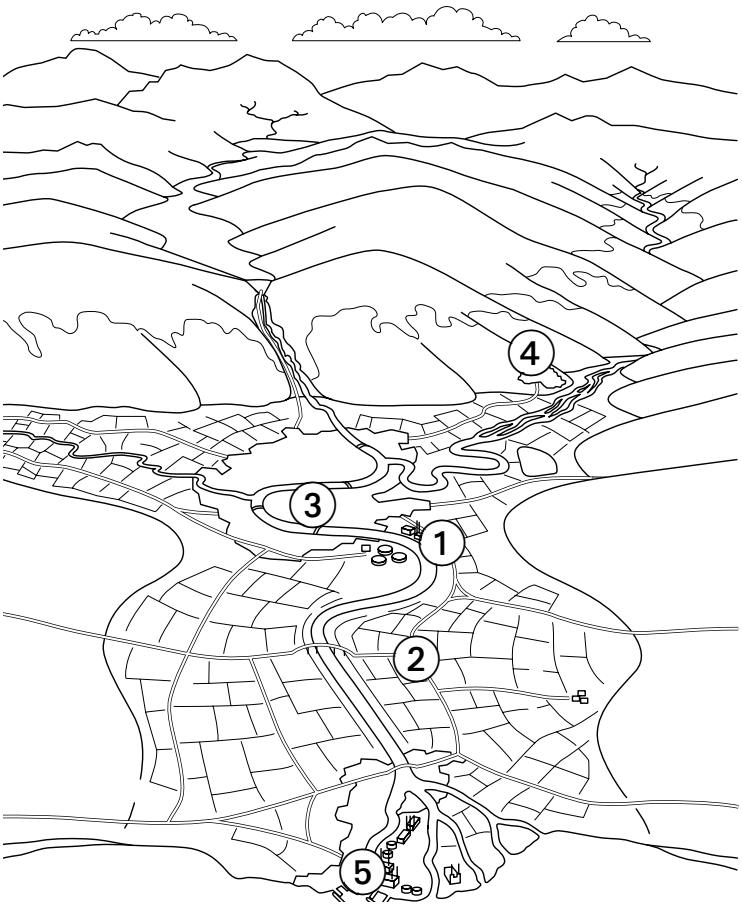
✎ There is a risk from f.....

Q4. What is difficult about building cities on valley sides?

✎ They are s.....

Q5. What is the main reason people build cities close to the mouth of a river?

✎ To use the river as a h.....



2 Answers, Resources, Background

See **pages 6 and 7** of The River Book

Answers

Q1. Pollution

Q2. Fertile

Q3. Flooding

Q4. Steep

Q5. Harbour

Resources

- Photocopy of page 48.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Rivers are both a benefit and a handicap to the way people want to use the land. Rivers can:
(i) provide easy communications;
(ii) provide a water supply;
(iii) cause disastrous flooding; and
(iv) be an obstruction to travel.
People can
(v) increase the flood risk; and
(iv) cause pollution.

If students can grasp these six facts, they will be well on the way to successfully understanding the main results of people using rivers.

As they get more familiar with rivers and valleys, students will probably find endless examples of the way that people interact with them (for example, meander cutoffs, irrigation canals, navigation canals, aquifers to neighbouring basins…). However, the purpose of this page is to introduce and begin to categorise the wide range of examples that will commonly be found in curricula, and which can act as a core of knowledge for exam learning.

Below you will find some more detail about each of the main categories. However, as you will appreciate, it is most common for two or more of these categories to interact, as outlined below. How far, and at which point, you introduce this extra layer of complexity is best left to your judgement with your particular class.

Crossing points and trading sites

People have historically wanted to be near to rivers because of their usefulness for river communications. Thus many settlements are ports. On the other hand, people have found rivers obstacles to travel and difficult to cross. For this reason a limited number of crossings occur on major rivers. It is this restriction on communication that often focused road (and later rail) networks and provided an opportunity for trade and hence allowed a settlement to grow.

Some settlements are, of course, both ports and crossing points. The terms associated with this are upper limit of navigation (the farthest inland that the river could be used for carrying goods) and lowest bridging point (the closest to the sea that a bridge could be built; usually just up river of the point where the estuary or delta begins).

Using rivers as a focus for where people live gives good links to history. There are some very striking examples of bridging points: Gloucester is the lowest bridging point of the Severn (but not the highest point of navigation; that is much farther up river close to the first iron bridge in Ironbridge Gorge. London was the lowest bridging point on the Thames. The first bridge was a wooden trestle construction built by the Romans close to modern London Bridge. Again, London was not the highest point of navigation. That was in Oxfordshire. Stockton, on the Tees, was the lowest bridging point, which is why it developed as a market town. When coal was shipped from the Tees, the first railway was built from Darlington to Stockton because, for all practical purposes, Stockton was the highest point of navigation. But notice that these two properties were separated by many hundreds of years. As you can see from these examples, there are many interesting facts that can be associated with the founding of settlements and river use. There are sure to be interesting examples close to where you teach.

It is also worth noting that, due to the nature of scouring activity on the outside bend of a meander, the early ports were almost always situated on the outside bend of the meander (as the possible long-term rate of erosion at this site was not a consideration to those founding the settlement).

Settlements are common close to the estuary of a river (although more rarely next to a delta, due to the shallowness of the distributaries). The river mouth provided a sheltered harbour. Some island sites at the estuary provided defensive trading sites. Manhattan Island, New York, is a classic example.

Defensive sites

Because rivers are difficult to cross, they can be used as a line of defence. Many settlements used the river as a defensive barrier, often using the river water to fill a moat to surround the settlement. York is a classic example of this.

In some cases the shape of the river plan provided an almost encircling defence. This is the case with Durham.

A good cross-curricula link with history can doubtless be made in your local area.

Answers, Notes, Background

See **pages 6 and 7** of The River Book

Floodplain sites

The main problem with riverside locations is their vulnerability to flooding. In general people therefore chose sites where river terraces (which are above flood levels) came close to the river. (River terraces are a more complex topic, however, and may be skipped, simply making the point that people may have looked for slightly higher land close to the river.)

In a few cases levees were used as settlement sites. Calcutta was one such – a decision that led to great problems as the city expanded.

Very often bridging points or port locations were adjusted to take the flood hazard into account. Get students to look for the sites of old churches to help provide clues. Reading's abbey and its nearby medieval town, for example, were built on a strip of terrace beside the River Kennet, and here the Kennet was forded and used as a port for cargoes being transported on the nearby Thames.

People could, of course, choose to live well away from the river on land that was never likely to flood. This would have meant choosing a valley-side location. These locations were seldom as successful as those next to rivers, as important communication lines rarely followed the valley sides.

Traditionally, floodplains have been used for farming. Because the land is flat, moisture remains in the floodplain longer than in any other part of a valley, so plants can survive summer drought for longer; floods provide natural replacement of nutrients; floodplain sediments are finer and thicker than valley side soils.

On the downside, floodplain farmland stays colder and wetter longer each spring and may even remain waterlogged in a wet year, preventing crop growth; and it is more vulnerable to flood damage.

In fact, the earliest peoples found floodplains difficult to clear. The extra moisture means floodplains tend to have a more dense natural vegetation than other parts of a landscape. So, for example, early farmers in neolithic Britain tended to cultivate uplands, and even into Dark Age times the valley soils were often regarded as too heavy and wet for cultivation. This is one reason why so much Dark Age settlement took place in unreclaimed lowland forests. So floodplains needed more sophisticated farming techniques than were available to the first primitive farmers. Ploughing using a heavy plough and strong teams of animals or tractors, together with an eye to soil drainage, are the keys to successful valley farming.

Exactly how people viewed the valley depended very much on climate, however. If you want to introduce some contrast, then ask students to consider those people who traditionally lived in semi-arid or arid areas, such as the North American Indians of the western deserts or the North Africans. Here water is always in short supply, so that even the earliest farmers chose the valley floor, planting immediately after a flood to make the maximum use of the available moisture. This is an interesting theme that can also be developed to show how environmental factors such as rivers and climate could influence the cultural development.

Using hillsides

Hillsides can be contrasted in their properties with floodplains. They are not subject to floods, but they may be too steep for ploughing. Soils can also be thinner and more stony. For this reason only a limited number of steep slopes are cultivated. In places where there is a high density of population and valley sides are invariably steep (such as Bali, Indonesia, the loess hills of China, or the valley sides of the Rhine in Germany) the traditional way to cope with this is through the use of terraces. There are also remains of many ancient terraces in Britain, many close to hill fort sites.

Hillsides can be cleared of their natural vegetation, but this often has disastrous effects. Natural vegetation both binds the soil to the underlying rock and provides a porous soil that helps heavy rainfall to soak in. Later in the book, you will find sections on how removing vegetation increases flooding by allowing more water to run over the surface. Without the anchors of roots, the slopes are also more liable to suffer from mudflows or landslides.

Building activity

Some of the structures people build may also change the natural movement of river water and cause problems. Bridge piers, for example, can partially block river channels, causing flood water to pond up-river of a bridge in times of high water. This was especially true of old bridges with their many arches, and thick stone or brick piers.

Because people want to make use of the river, they commonly encroach on the channel, reclaiming the banks and in the process making the channel much narrower. The Thames at London, for example, may still seem a wide channel, but it is only a third of the width of the natural channel that the Romans saw when they first colonised the site. London's famous embankment was just a culmination of a process that had been going on for centuries. It was built in part to reclaim land along the river. A huge swathe of river channel was narrowed as a result. Other rivers, where quays have been built or where the pressure on land is intense, have similar problems.

Another point that can be introduced is the way in which expansion of a town often puts people into conflict with a river. For example, a settlement can be sited on land which, at the time, was seen to be perfectly safe. This may, for example, have been a piece of river terrace. Then, perhaps many centuries later, the settlement expands and the safe

higher land is quickly used up. As the settlement expands, it has to use the surrounding lower, and therefore more flood-prone, land. Thus, for the first time, the river becomes a serious hazard to people. It is not necessarily that the river flow pattern has changed, but that people have put themselves more at risk.

Flood protection

People try to compensate for some of the changes they make, or protect themselves from living in vulnerable places through the use of artificial structures. The long low earth ridges called dikes (levees) that stretch along the banks of flood-prone rivers are striking examples. In Britain these are often built to help protect from flooding due to high sea tides along stretches of river close to estuaries.

Today there are many schemes to try to prevent flooding that are more sensitive to the water cycle and the environment. Dams, for example, can be used to store potential flood water and the water allowed to flow in rivers when the flood threat is past. Large reservoirs created in this way are not, however, particularly environmentally friendly and are used only when other water needs, such as water supply, irrigation or hydroelectric power are required.

There are, in fact, convenient and environmentally friendly ways that a modern urban environment can store water. Some of these are given in a later worksheet (number 19) so that they can form the basis of a class discussion. In fact the most environmentally friendly system is to encourage water to sink in to the ground locally. Many homes have had their rainwater gutters run to soakaways for decades. But the trend to connect storm-water drains and main drains has increased the flood risk considerably.

Drinking water

Rivers are also the main source of drinking water in most countries in the world. Modern purification plants ensure that the water is safe to drink, no matter how polluted it may have been. It is far cheaper to allow natural rivers to carry water as close as possible to where it is wanted for use, than to use canals or aqueducts. Thus, in a country with a dense system of drainage basins, few aqueducts are in use. In other parts of the world, for example semi-arid and arid regions, aqueducts are far more common. The best documented example of a vast canal system is in California, USA, many of whose major cities are in semi-arid regions long distances from a reliable water supply. In fact, an interesting project can be made out of the methods that people used to carry water from sources to demand in the past The Persians, for example, constructed very long underground tunnels from sources of water in mountains, to their cities on the plains. These tunnels reduced the amount of evaporation loss compared to an aqueduct. But they needed a large amount of dangerous servicing. The Romans used aqueducts and as a result had to build spectacular structures. Very much larger surface aqueducts have been built in California.

Pollution

Finally, there is the topic of how the activities of people cause pollution. There are two aspects to this: the first concerns the danger that pollution causes to human health, and the second is the much broader concern of the environment and the health of plants and animals that cannot protect themselves by water purification systems.

Name:..... Form:.....

See **pages 8 and 9** of *The River Book*

Activity: Where rivers get their water

Here is a demonstration of why it takes time for a river to begin to rise after a heavy rainstorm.

You need a sheet of sponge for this. The sponge should have quite small holes (pores).

1. Use a large water container with a tap near the bottom and place this on the table. Turn on the tap so that you have a slow stream of water running. It should be just slightly more than a drip, and enough to give a continuous flow of water.

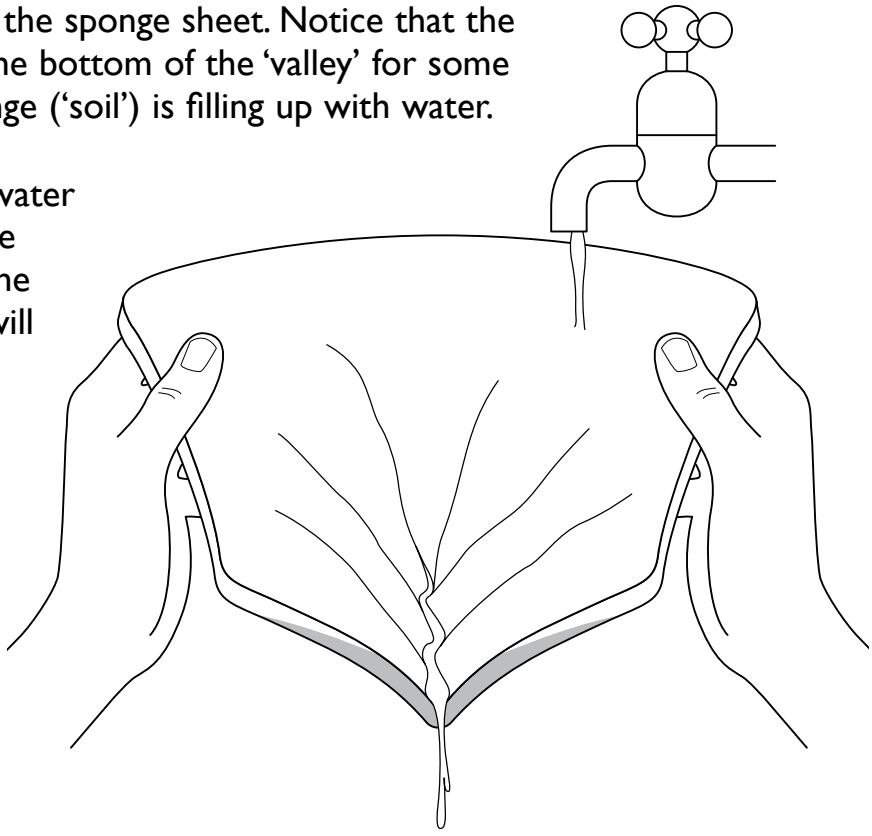
2. Now place one hand on each side of the sponge and bend it into the shape of a valley. It works best if the sponge is more folded close to you, and more open on the edge away from you.

3. Tilt the 'valley' so that it is at a very steep angle.

4. Move the 'valley' so that one of the 'valley' sides is below the tap and the lowest part of the 'valley' is still over the sink, as shown in the diagram.

5. Watch the water soak into the sponge sheet. Notice that the water does not flow out of the bottom of the 'valley' for some time. This is because the sponge ('soil') is filling up with water.

6. After a while, you will see water pour out of the bottom of the 'valley'. This is your 'river'. If the sponge is big enough, water will actually flow over the surface of the sponge in the bottom of the 'valley'.



7. Now get a friend to turn the tap off. The 'river' will continue to flow even though the 'rain' has stopped. This shows how rivers continue to flow between rainstorms.

3 Answers, Resources, Background

See **pages 8 and 9** of *The River Book*

Resources

- Photocopy of page 52.
- Large tank for water with tap and tubing; sponge; bowl to collect water.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

This demonstration uses the simplest of materials and yet shows one of the most complicated parts of the water cycle very clearly.

It is worth spending some time before a lesson making sure that you have the stream of water running from the tap at just the right flow to get the bottom of the sponge saturated without water flowing over the surface where the water hits the sponge.

To make the movement of the water clearer, you might like to consider using a few crystals of potassium permanganate, or food dye, on the surface of the sponge. The coloured trails will help show how and where the water is flowing.

You can also change the shape of the 'valley' to see what effect this has.

It is important that the 'valley' is kept steep so that water flows inside the sponge and does not flow out of the bottom of the sponge until the water reaches the lowest point.

Across the curriculum

Using this material you can link:

- Physical processes, such as evaporation and condensation;
- Weather phenomena, such as rain and clouds;
- The formation of soils, their porosity, and their permeability;
- The change in river flow with time, which requires the production of graphs such as hydrographs;
- The way that suitable materials can be used for models.

Name:..... Form:.....

See **pages 10 and 11** of *The River Book*

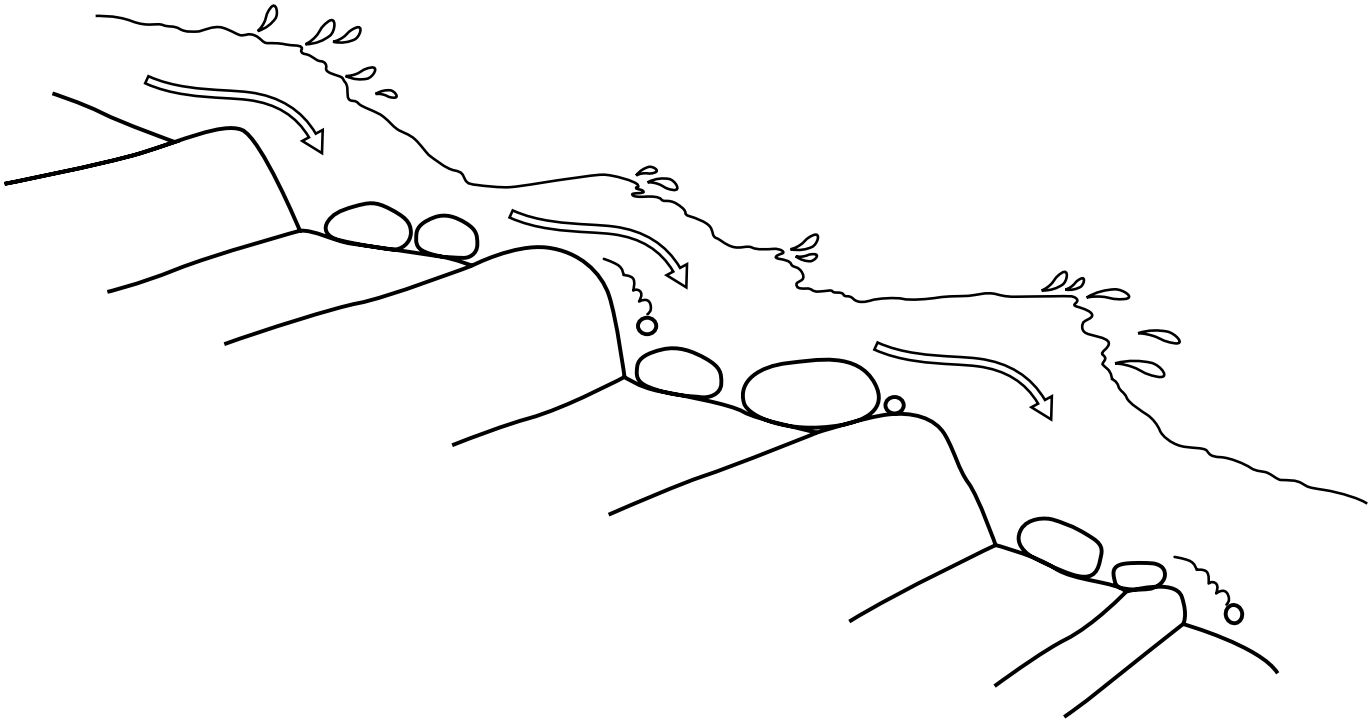
How rivers wear away rocky beds

Rivers use many tools to wear away their beds. One method is simply to dissolve the rock away, and another is to use pebbles, gravel, and sand that are carried by the water as a kind of liquid sandpaper.

Q1. Write the single word that means 'wear away'.

✎ E.....

Q2. This picture shows a side-on view of part of a river bed. Not all the rock is the same hardness. If rivers can wear away softer rocks more easily than hard rocks, mark where you think the soft rock is.



Q3. Describe how the water moves the pebbles along.

✎ .....

.....

.....

.....

4 A Answers, Resources, Background

See **pages 10 and 11** of *The River Book*

Answers

Q1. Erode/erosion

Q2. The soft rock corresponds to the places where the pebbles have eroded the bed most, that is the 'treads' on the rocky staircase.

Q3. The answer to this is found in the caption to the picture ② on page 10 of *The River Book*: "The plunging and swirling water lifts the pebbles, then lets them fall back to the bed. Sometimes very big pebbles are just rolled along."

Resources

- Photocopy of page 54.
- Pictures of rapids from the web site and *The River and Water CD*.
- Two soft (for example chalk or soft sandstone) pebbles for each student to run together or knock together.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

The processes of erosion all follow from the observations on how water moves. The key to this is to spot that white water is a sign that water is moving fast enough to trap air bubbles. White water can therefore be associated with 'a lot of energy' in the context of moving sediment (pebbles, gravel, sand, silt, and clay).

The pictures have been chosen for the way they show water swirling between large rocks, and tumbling over rocky ledges. The key idea is that water flowing around and over obstacles is very turbulent and will have fast-flowing threads of water in it which can move large sizes of material.

For now, once the idea of turbulence has been established, it is also useful to discuss the fact that rocks vary in their resistance to erosion. This can be simplified, if necessary, by referring to greater resistance under the simple term 'hard rock', and less resistance to erosion through the term 'soft rock'. In this context, the diagram shows sloping bands of hard and soft rock. In effect, the diagram shows rapids (and this can be returned to later to make a comparison with waterfalls).

Another useful way of talking about the differences that are produced by alternating bands of hard and soft rock is to compare the cross section (referred to in the book under the expression 'side view') to a staircase, with treads and risers, or steps and ledges, or whatever terms seem most appropriate to you.

Clearly, the risers in the rapids are made from hard rocks, while the treads tend to be soft rocks.

Scouring action can often produce wide treads, over which water flows with less energy than when it is cascading down a riser. In this way energy is concentrated on the risers, which are then eroded. As risers erode, water again flows faster on the treads, again leading to erosion of the soft rocks. In practice, a kind of equilibrium sets in that maintains the shape of the staircase.

The rocks on the treads represent material carried by the river in times of flood (and therefore times of highest energy), and left behind on the places with the least energy as the flood subsides.

Erosion

Erosion actually occurs in two stages: weathering (the breaking of the rock *in situ*), and transport to somewhere else. In a river these two stages happen together, but on a hillside they may be separated by hundreds of years (for example, a rock is frost shattered (i.e., cracked and loosened) by frost, but doesn't fall away until many years later).

River erosion processes are solution, corrasion, and attrition. Solution is a chemical process whereby water and the substances it has in solution react with the materials of the bed and bank, creating new products, which are usually clay (which is insoluble) and some invisible soluble products. Clay is always the result of a chemical process; it cannot be produced by mechanical action. Solution is a slow process. But overall it is at least as important as mechanical effects (and in hot humid climates, very much more important).

Corrasion is a mechanical effect produced by the abrasion of rocks by gravel and sand as they are carried by the water. Pebbles may have some effect as they are rolled and bounced along river beds in times of flood. Many people call this process by the general name of 'scouring'. The effect is to abrade the bed and bank materials. Corrasion sounds a little like corrosion and you may think it is better to use the term 'abrasion'.

Attrition is the mechanical effect of transportable sediment (boulders, pebbles, gravel, sand) becoming smaller, either because they are involved in corrasion or because they collide with each other during transport. Attrition can reduce boulders to sand and silt; however, it cannot reduce material to clay size; that is a chemical process.

Across the curriculum

Using this material you can link:

- Rocks and minerals, discussing a selection of actual rocks and minerals, and experimenting to find out which will wear others away, linking through to measures of hardness;
- Ideas of (kinetic) energy;
- The difference between mechanical and chemical weathering, and the formation of soils.

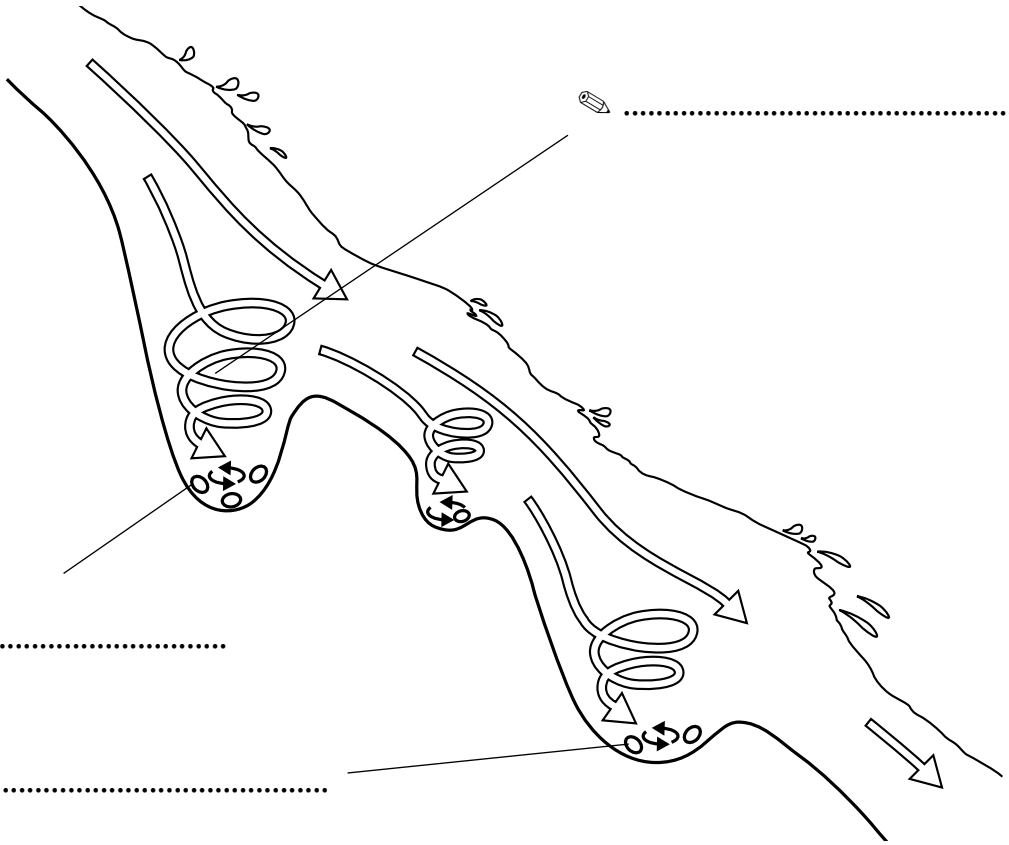
Name:..... Form:.....

See **pages 10 and 11** of *The River Book*

Potholes

Potholes are special features that occur in some fast-flowing rivers with rocky beds. They show very clearly the way that the river bed is erode.

Q1. Label each of the features marked.



✎ .....

✎ .....

✎ .....

Q2. How best would you describe a pothole: (a) a hole in the ground through which water sinks, (b) a deep bowl-shaped pit in the river bed, or (c) a black hole filled with water?

✎ .....

Q3. Why do potholes form?

✎ .....

.....

Q3. In what kind of river bed would you look for potholes?

✎ .....

4 B Answers, Resources, Background

See **pages 10 and 11** of *The River Book*

Answers

Q1. (Top to bottom) Eddy, Pothole, Pebbles.

Q2. (b) A deep bowl-shaped pit in the river bed.

Q3. The continuous swirling of pebbles in an eddy causes potholes to abrade the rock.

Q4. Those with rocky beds (i.e. no covering of sediment).

Resources

- Photocopy of page 56.
- Pictures of potholes from the web site or *The River and Water CD.*
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Potholes are a dramatic feature of some rivers with rocky beds. They often provide fascination for younger students and so they are given a full spread here.

A river pothole (which is not the same as a pothole, meaning cave entrance) is produced in somewhat unusual circumstances, which is why the features provide such curiosity.

The condition required for a pothole to form is a pattern of eddies on the water that allows pebbles to remain circulating long enough to begin to erode a depression in the bed. Once this is established, the depression alters the flow of water and reinforces the swirling motion. It may be that local weaknesses in the bedrock also encourage some parts of the bed to erode faster than others, and thus influence the location of eddies.

The real value of eddies is that they dramatically show the way that pebbles can erode by abrasion. The nature of water movement in a pothole can be illustrated in class by swirling pebbles around in a glass jar partly filled with water.

The way in which pebbles become worn away as they rub against each other (until they are small enough to escape from the pothole) can be illustrated using a pebble polishing machine.

Ask students to look closely at the shape of the sample pebble shown on page 13 of the River Book, so they can appreciate that the pebbles are often substantial, and their rounded shape shows that they are worn down themselves as the pothole is formed (abraded).

The sequence of potholes shown in the photograph on page 13 are in Lydford Gorge, Devon, UK, a National Trust area that is often used for field trips. Potholes also occur in many of the rivers in the Yorkshire Dales National Park. (The examples on page 13 of the student book come from California, USA.)

Across the curriculum

Using this material you can link:

- Rocks and minerals, discussing a selection of actual rocks and minerals, and experimenting to find out which will wear others away, linking through to measures of hardness;
- Ideas of (kinetic) energy;
- The difference between mechanical and chemical weathering, and the formation of soils.

C1 **5**

Name:..... **Form:**.....

See **pages 12 and 13** of *The River Book*

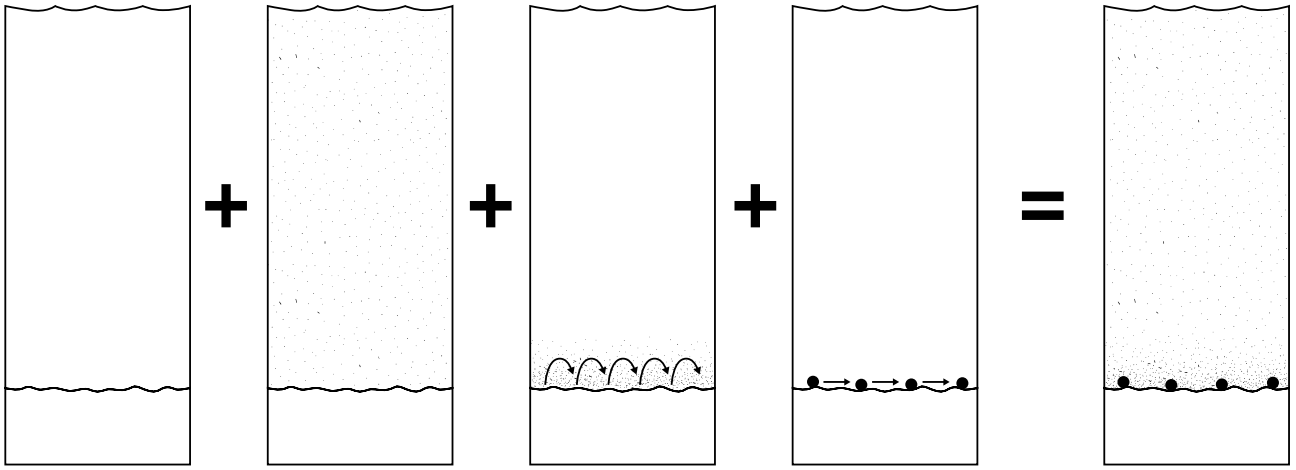
How rivers carry away material

Rivers carry material of all sizes during a flood. Normally they are all mixed together, but they have been separated in the diagram below.

With each column, match one or more of these words: solution, mud, silt, sand, pebbles. Write the word(s) above the column.

Below each column, write a sentence that describes how the material is moved.

Q1. ✎ ..... ✎ ..... ✎ ..... ✎ ..... ✎ .....



Q2. ✎ ..... ✎ ..... ✎ ..... ✎ .....

....

....

....

Q3. What is the only kind of material that moves even when the water appears clear?

✎ .....

Q4. Why does a river suddenly become muddy during a flood?

✎ .....

.....

5 Answers, Resources, Background

See **pages 12 and 13** of *The River Book*

Answers

These questions concentrate on the diagrams that show how rivers carry a variety of sediment. The important point to make is that many kinds of transport are involved, and that sediment, or alluvium if you prefer the word, is made of many kinds of material.

Qs 1 and 2. From left to right: solution (material carried in solution); suspension (mud and silt is suspended in the water); hopping (saltation) of sand close to the river bed; and rolling of pebbles along the bed. No caption should be placed below the last column.

Q3. Material in solution.

Q4. Material will only move when the water speed is high enough to move the armouring pebbles, gravel, etc., that cover the bed between floods. Then all grades of material will move, including the clay that makes the water muddy.

Resources

- Photocopy of page 58.
- Large glass jar with soil and water in it. This is to be shaken up and allowed to settle to show that soil, for example, contains many sizes of material.
- A rectangular tank and some fine sand to make a rocking tank and recreate ripples.
- A glass with vinegar and an antacid tablet.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

You may want to introduce the words 'sediment' and 'alluvium' for the material moved and deposited by a river. It is best not to use the word silt too regularly because technically it describes just one size of material (between clay and sand), and doesn't emphasise the variety of material sizes that may be on the move.

For much of the year, the energy of the water is only sufficient to carry dissolved material. This is an invisible process, which is why rivers often look clear. If they are cloudy, then some clay, and possibly silt, is being carried in suspension. Dipping an empty jam jar in a river will make it easy to see just how sediment-laden the water really is.

Solution and suspension are important processes and carry material between floods. However, their effect is minor when compared with the amount of material moved when the river is nearly full and flowing swiftly. During these rare times, the extra energy causes many other types of material to move and also allows more mud to move in suspension. The extra processes at work are the rolling of pebbles, and the bouncing and hopping of sand grains. In general sand, silt, and clay are the only materials carried by suspension no matter how fast the flow. Sand is mainly carried by hopping and bouncing (saltation).

It is important to stress that most material is carried by rivers during floods. This is why field trips are usually unsuccessful in demonstrating transport of sediment. When it is safe to visit them, most rivers are clear.

Across the curriculum

Using this material you can link:

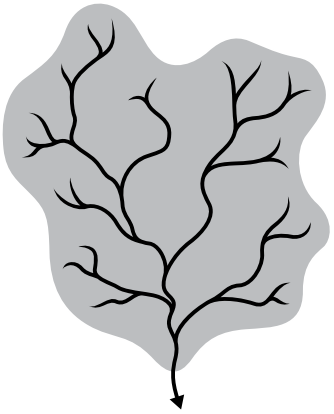
- Physical processes, such as buoyancy, viscosity, resistance of sediment, and its shape – flat pebbles align themselves with the direction of greatest force, for example;
- How to make a variety of test equipment;
- Chemical action to cause solution;
- Making physical models to examine phenomena;
- Concepts of safe working in the field.

Name:..... Form:.....

See **pages 14 and 15** of The River Book

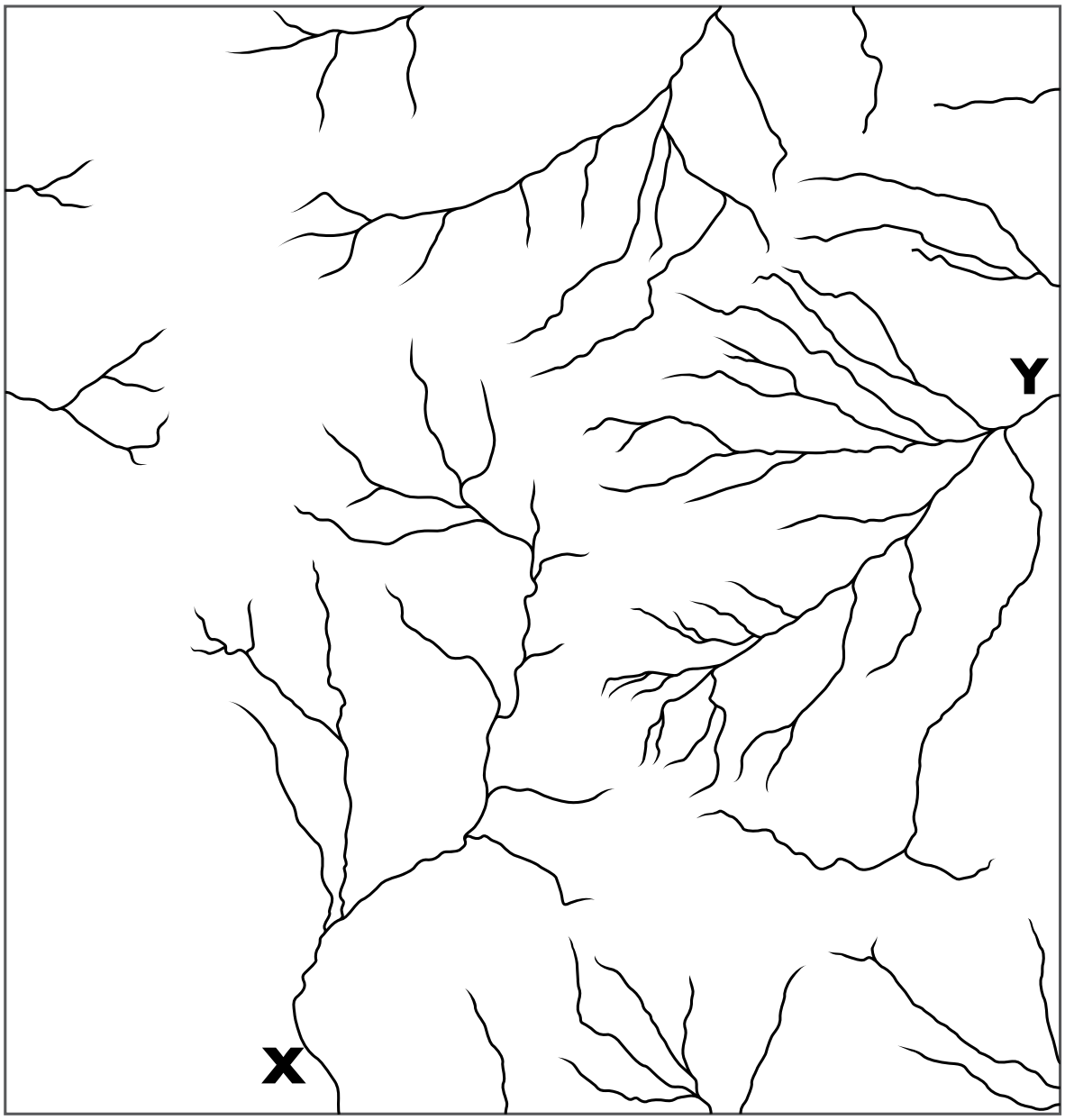
Investigating rivers and streams

A river basin is the area drained by a river.



The diagram on the right shows what a river basin looks like. It is the area containing all of the streams that drain to a chosen place.

Look at the diagram below which shows the streams in an area. Draw a line around the streams that drain to point X. This is the basin for X. Now do the same for Y to find the basin to point Y.

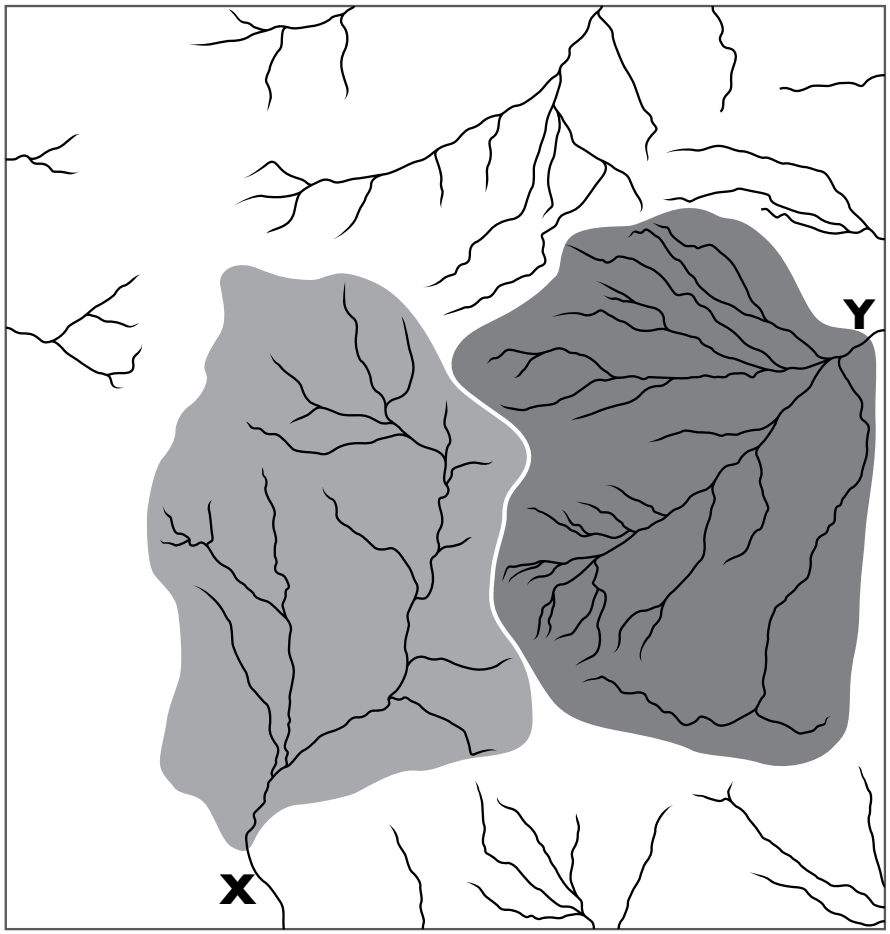


6 Answers, Resources, Background

See **pages 14 and 15** of *The River Book*

Answers

see map below



Resources

- Photocopy of page 60.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

A drainage basin is the most fundamental unit of a river system. Rivers drain all of the area within their basin.

Students can find out the basin by looking at all of the streams that drain to a certain point and then putting a line around them as shown in the example at the top of the page.

When students do this exercise they should not leave gaps between basins. It does not matter if the less able do not follow this, but the more able should be encouraged to understand that the whole of an area has to drain to the rivers that run across it.

With the more able you may also want to find the basin for the area covered by your local map. When doing this it is important to choose a fairly large area, say from a 1:250.000 (4 inch) map, so that a whole basin can be found. A 1: 50,000 (approx 1 inch) map can also be used if you use a tributary of a main river. The aim is to keep the size of the basin down, so you will have to choose a basin that does not take up a whole roll of tracing paper. Hilly and mountain country maps are often better to use than lowland.

The benefits of this exercise are in getting students to work with a map and to extract information from it that can be applied to particular purposes. Many students are not familiar with interpreting maps and will need a lot of assistance. A road atlas may be easier to use that an OS map if you think the extra information on an OS map may be confusing to students.

7

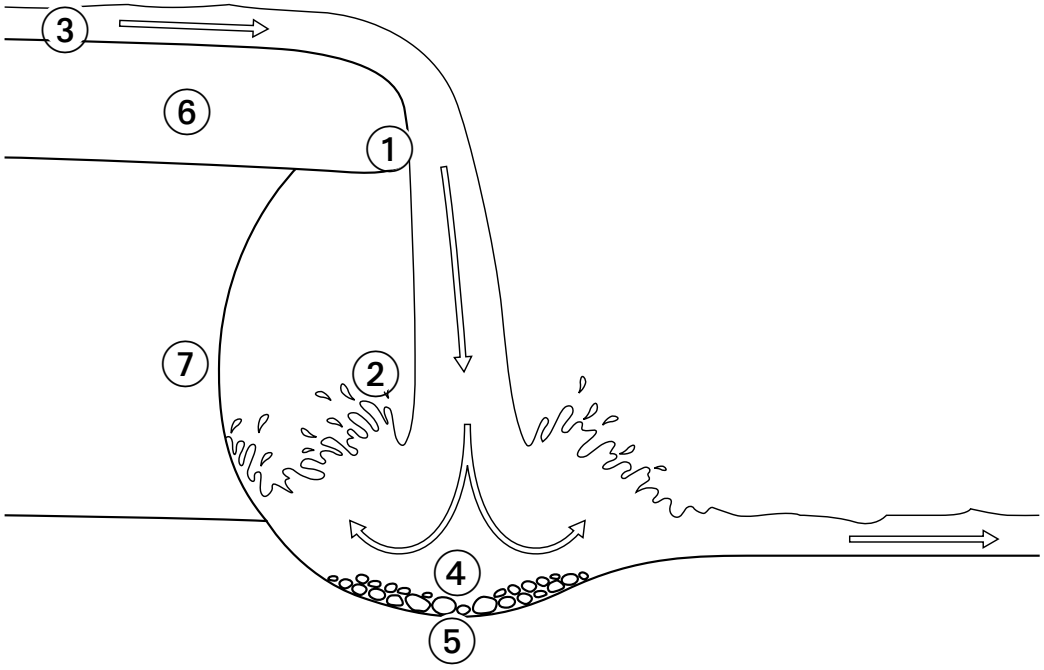
Name:..... Form:.....

See **pages 16 and 17** of *The River Book*

Waterfalls

A waterfall is a place where a river falls over a cliff and plunges down onto the rocks below. You will see a picture of a waterfall on page 16 of the student book. Have the book open as you work on this sheet.

Colour in the diagram, using blue for the river, brown for bands of hard rock, and grey for bands of soft rock.



Q1. Match the numbers on this diagram to the descriptions below. Write the correct number in each of the spaces in the description. The first one has been done for you.

As a river approaches a waterfall ✎ (3) ..... it flows over a band of hard rock ✎ ..... It is the hard rock that forms the lip of the waterfall ✎ .....

Once the river has poured over the lip, it plunges down and crashes on the rocks below ✎ ..... and creates clouds of spray.

The place where the water crashes is often filled with pebbles that have fallen from the lip ✎ .....

Here a deep pool can form ✎ ..... as the plunging water scours the rock with the aid of the pebbles.

The swirling water in the pool may also wear away the soft rock behind the waterfall ✎ ..... , causing it to collapse.

7 Answers, Resources, Background

See **pages 16 and 17** of *The River Book*

Answers

The answer to Q1 is:

As a river approaches a waterfall ③ it flows over a band of hard rock ⑥. It is the hard rock that forms the lip of the waterfall ①.

Once the river has poured over the lip, it plunges down and crashes on the rocks below ② and creates clouds of spray.

The place where the water crashes is often filled with pebbles that have fallen from the lip ④.

Here a deep pool ⑤ can form as the plunging water scours the rock with the aid of the pebbles.

The swirling water in the pool may also wear back the soft rock behind the waterfall ⑦, causing it to collapse.

Resources

- Photocopy of page 62.
- Water container and tap to act as waterfall, soft materials and a bowl to see how material is moved by falling water.
- The web site or *The River and Water CD* for projects on waterfalls.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Waterfalls are parts of the river basin where water falls vertically, or nearly vertically, due to an interruption in the course of the river.

Steps in the landscape that cause waterfalls may be due to either a horizontal hard rock band, or glacial or ocean wave erosion. Rapids and low waterfalls, also known as cataracts, form a series of hard rocks rather than a single waterfall step.

Waterfalls and rapids make the most spectacular parts of a river basin. As the water falls or tumbles, its speed increases and it has increased erosive power. At the foot of a waterfall there is often a deep pool, called a plunge pool, where the bed has been worn away by the circulating abrasive action of pebbles carried over the waterfall lip in the falling water. Plunge pools may erode back under the waterfall, undermining the fall and causing the cliff to collapse. This may provide additional material for plunge pool erosion, but in the short term is more likely to cause the plunge pool to be filled in with a jumble of rocks.

Waterfalls are among the best known features of a river course, although they are actually quite uncommon.

Waterfalls are among the most compelling of river features because of their drama. Children may know of some of them, such as Niagara Falls on the Niagara River, Angel Falls in Ecuador, Kaiteur Falls in Guyana, and Victoria Falls on the Zambezi River. You may have others from your own knowledge.

Worldwide examples are presented in some detail on the web site and on *The River and Water CD*. They cannot be presented in the book because of space constraints. Look on the web site for the detail and variety in pictures of Niagara Falls, Yosemite, and others.

Many waterfalls cannot be attributed to river action alone, and many outside the tropics are the result of past glacial erosion. Among the world's largest waterfalls, Yosemite Falls is a clear example of a waterfall flowing from a hanging valley, and subsequently almost unmodified by the river.

If you do not want to introduce the idea of past glaciation, choose the examples with care or find a way to work around what caused the waterfall in the first place.

You can also make a miniature waterfall in class using a large water container with a tap near the bottom. Turn on the tap and place different materials in a tray below it to see the differences between rates of erosion. Clay, sand, and gravel might be used.

Across the curriculum

Using this material you can link:

- Ideas of potential and kinetic energy, showing how one is converted into the other from the lip to the plunge pool;
- The different kinds of rock through actual examples;
- The formation of sediment by mechanical means;
- The production of hydroelectric power through the use of kinetic energy to turn turbines;
- The way in which some physical features can be spectacular and so have great tourist (and so wealth-creating) potential;
- Conservation of physical features when they have both tourist and development (through hydroelectric power) potential. Niagara is a classic example;
- The way in which some river features can severely disrupt transport along a river, and how some waterfalls have been bypassed by canals.

Name:..... Form:.....

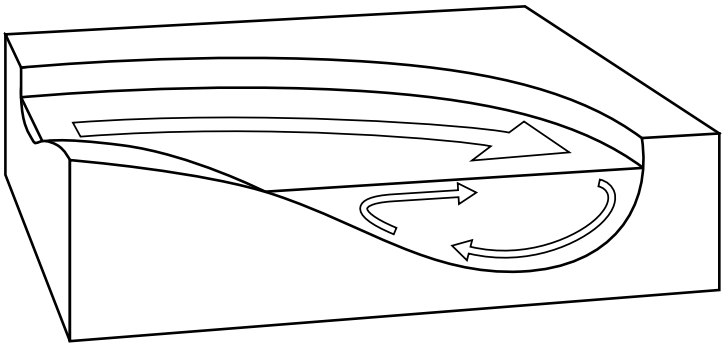
See **pages 18 and 19** of *The River Book*

Meanders

Most rivers follow a winding path made of many bends and loops of differing sizes.

Q1. Write the name for a river bend. ✎ M.....

Q2. The diagram below is a side view of a large river bend and river bed.



(a) Colour the river in blue.

(b) Which side of the bend has the deeper water, the outside or the inside?

✎ .....

(b) One river bank is steeper than the other. Is the steepest side on the inside or the outside of the bend? ✎ .....

(c) The faster the flow, the easier it is for the mud and silt to be washed away. Which side of the bend can mud settle out on? ✎ .....

(d) What does the large arrow show?

✎ .....

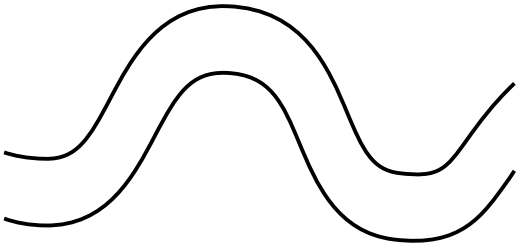
(e) The smaller arrows on the side view show how water moves from one bank to the other, as well as flowing to the sea. Complete this sentence, which describes what the effect is:

As the water flows around the outside of the bend it scours the bank. The scoured material is then carried

✎ .....

✎ .....

Q3. On the diagram on the right, draw arrows where erosion is most powerful.



8 Answers, Resources, Background

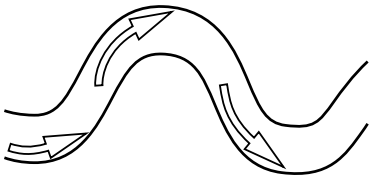
See **pages 18 and 19** of *The River Book*

Answers

Q1. Meander

Q2. The purpose of this question is to make sure that students have thought carefully about each part of the bend.
(a) Outside
(b) Outside
(c) Inside
(d) The arrow shows the path of fastest water (and thus how it hugs the outside of the bend, causing scouring).
(e) This is an extension question. The most complete answer will be along the following lines: 'As the water flows around the outside of the bend it scours the bank. The scoured material is then carried **across the channel to the slacker water on the inside of the bend, where it may settle out and build up the bank.'**

Q3. The answers to Q2 should allow students to accurately draw an arrow that hugs the outside of a bend, then crosses the river in the straight section after the bend, before hugging the outside of the next bend.



Resources

- Photocopy of page 64.
- Board, tap or jug of coloured water, and collecting bowl. This will make meanders.
- See pages 34–35 of this *Teacher's Resources* and page 18 of student book.
- The web site or *The River and Water CD* for projects on meandering rivers.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Meanders are some of the most obvious river features and can be seen readily on many maps. Introduce the term meander carefully through the use of more common words. For example, introduce a meander as a curved part of the river, or as a river bend, then proceed through the term 'winding' to meandering. Then point out that not all bends are meanders, so that it becomes a challenge to spot a meander and identify it from an isolated bend.

The key to this lies in the fact that meanders are regularly sweeping curves rather than irregular and random bends in a river which is otherwise more or less straight. Then focus on the fact that meanders are produced by the natural flow of water in a river (rather than chance obstacles, hard rock bands, and other special factors).

Rivers cut channels in rock, but they form meanders and braided patterns in a floodplain. A floodplain, a more or less flat strip of land either side of a river, is a depositional feature made of sediment left behind by a river. It is not an erosional feature in the sense that it is not cut into rock. Meanders, braids, and many other features of a river floodplain are formed in sediment; only in exceptional circumstances are they cut into rock.

Two types of channel are most common:

Deep, winding, or meandering single channels occur in places where most material carried is fine sediment such as silt and clay. These channels form most easily when the floodplain consists of fine material, such as clay, which sticks together when it is wet. Most meandering river channels change their courses gradually.

Shallow, wide, braided channels occur where the material is mainly sand, gravel, or pebbles.

Meanders

As mentioned above, it is vital to help students to differentiate between 'aimless' twists and turns of a river on very flat land, and the regular graceful river twists and loops (meanders and oxbows). Rivers on very gentle slopes often change course randomly. Meanders occur where rivers have a pronounced gradient. (Here 'gentle' and 'pronounced' are relative terms and 'steep' may still only mean a gradient of 1 metre/km.)

As water flows around a meander, it moves to the outside of the bend. Here, material is abraded (scoured) from the bed and banks, especially at times of high water. By contrast, on the inside of a meander the flow is much slower, and this tends to set up a corkscrew flow of water whose result is to transfer scoured sediment from the outside to the inside of the bends.

Over time, this pattern of erosion and deposition causes a river to migrate over the floodplain without changing width.

Rivers flow in channels which, for the most part, are made by the rivers that flow in them. Most of the channel-shaping takes place when the channels are full or in flood. This happens about once every two or three years. For the rest of the time little change occurs.

Do also try out the generation of meanders described on pages 34 and 35 of this *Teacher's Resources*. All ages find it fun – teachers, too!

C
1

9

Name:..... Form:.....

See **pages 20 and 21** of *The River Book*

Oxbows

Oxbows are special kinds of loops in a meandering river.

Because they have narrow necks, oxbows are often cut through and oxbow lakes are created.

Q1. Use these diagrams to explain how oxbow lakes form.

Stage 1

✎ .....

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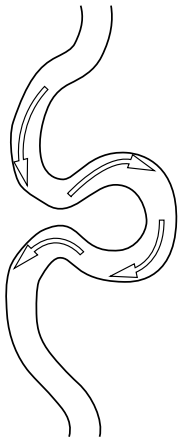

Stage 2

✎ .....

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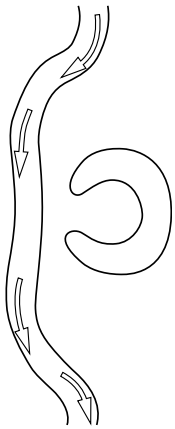

Stage 3

✎ .....

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9 Answers, Resources, Background

See **pages 20 and 21** of *The River Book*

Answers

Q1. Stages 1 to 3. These are essay questions for which there is no single answer, but students should relate their answers to the features they see in the diagrams. See the background information and page 20 of The River Book.

Resources

- Photocopy of page 66.
- From the web site or *The River and Water CD*: the Mississippi River shows many oxbows.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Sometimes meanders become very looped and are known as oxbows. The region between two meanders is reduced to a 'neck' of land. If erosion erodes the neck, the river cuts off one of its loops. Such abandoned loops often remain as 'oxbow lakes' until fine sediment settling out in their calm waters finally fills them in.

Meanders are a dynamic feature of a river. If an oxbow is cut off, a new meander will begin to grow nearby to maintain the average river pattern appropriate to the size of river and its gradient.

Oxbows (probably named after the shape of the halter used on ox-ploughs) are among the most memorable feature of a floodplain, but they can be hard to find. This is because the looping meander bends required before cutoffs can occur require special conditions for their formation. The Mississippi River has many of the best examples.

The question may arise as to when a meander is an oxbow. The answer is when the meander produces a narrowed neck of intervening land.

In general, rapid changes in meander shapes and cutoffs occur when rivers are flowing down relatively steep courses. On gentle gradients the river moves around much more aimlessly, there is little erosive energy for change, and curved reaches of the channel are not actively scoured on their outer edges. On relatively steep paths (by which we might mean just a few centimetres per kilometre on very large rivers!), the energy for erosion is greater.

There are many names for oxbow lakes, of which 'billabong', used in Australia, is possibly the most colourful.

Oxbows are just part of a continual process of change, whereby meandering increases the river length until it is unsustainable for its environment, then cutoffs occur, shortening the river again, and allowing nearby meandering to increase. This repeating cycle is part of the complex sequence of processes that eventually produce floodplains.

Across the curriculum (for both meanders and oxbows)

Using this material you can link:

- Physical processes, such as the way that centrifugal force moves material flowing in a curve to the outside, and also makes the water level higher;
- The historical movement of meanders, and so county, and even state, boundaries change with time;
- The way that meanders and oxbows can severely disrupt navigation, and so prompt people to try to cut the oxbows through;
- The way that meanders can be found in all materials and even over flat surfaces. Meanders are thus a result of the hydraulic nature of water, not a feature of the bed over which they flow;
- The way that suitable materials can be used for models;
- The way that meanders and oxbows contain both sediment and water;
- The places you might choose to build a river harbour (outside bank with deep water), and the problems this might bring (continual erosion of harbour site);
- The places you might choose as a fording or bridging point (straight stretch not bends with deep water), and how this has affected the nation's routeway system.

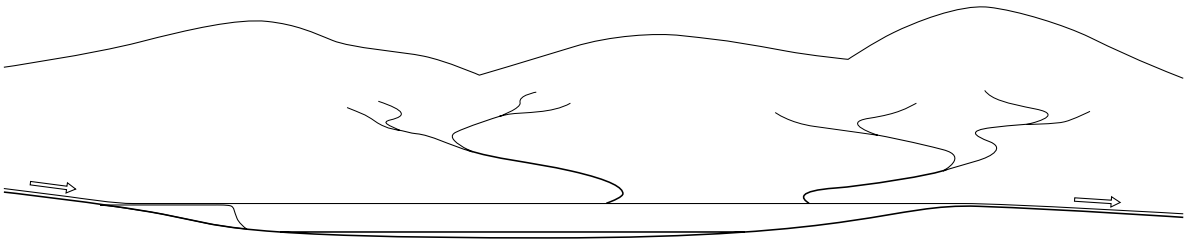
Name:..... Form:.....

See **pages 22 and 23** of *The River Book*

Lakes

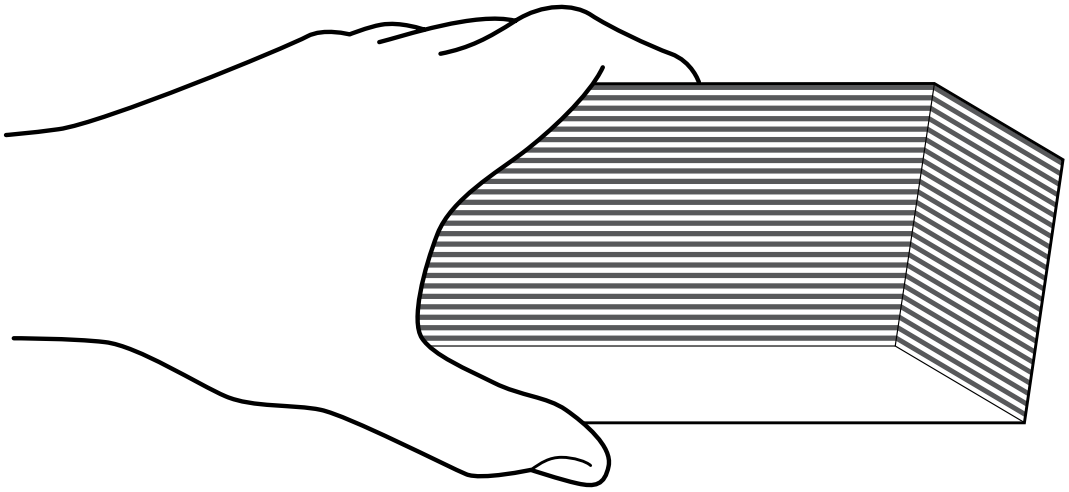
Lakes are eventually filled in by the materials brought down by rivers. The process takes a long time, but you can spot some of it happening, for example, in marshy land along the lakeshore. This is where plants are trapping mud at the lake edge.

Q1. Mark the position of a delta on the diagram.



Q2. Mark where you think mud will settle out in the lake on the diagram.

Q3. The diagram below shows a piece of lake bed. The dark layers show what was laid down in winter, the light bands show what was laid down in summer. So, every two bands mark the amount of material deposited over the year. How many years did it take for this piece of lake floor to be laid down?



✎ .....

Q4. The section of lake bed above is about 10cm thick. How long would it take to fill up a lake that was 10m deep?

✎ .....

10 Answers, Resources, Background

See **pages 22 and 23** of *The River Book*

Answers

Q1. The delta is on the left.

Q2. The mud settles out in the bottom of the lake.

Q3. This worksheet concentrates on trying to imagine how long a lake might take to fill in, and showing how we can make useful conclusions from simple measurements. Here maths and geography readily yield an interesting result. There are 50 bands in the diagram, thus it took 25 years to lay down 10cm of thickness. (This is fast by many lake standards and really only applies to small lakes.)

Q4. If 10cm takes 25 years, then 10m will take 25 x 100 = 2,500 years. Not long in geological terms, but over two millennia to us.

Resources

- Photocopy of page 68.
- Pictures of lakes from the web site and *The River and Water CD*.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Lakes (other than the small features called oxbow lakes) are features of some valleys, but they are not formed by a river. Rivers fill up lakes with sediment just as they 'silt up' reservoirs. So, lakes are a window on an historical event that is now being altered. Many lakes are the result of glacial erosion. The lakes of the English Lake District are the result of glacial overdeepening by valley glaciers, combined with damming by glacial moraines. Rift valley lakes, such as the East African Rift Valley, and crater lakes, such as Crater Lake, are even more obviously not formed by a river.

So, although lakes are interesting and spectacular, and they are most easily taught alongside river studies, they are a temporary feature of a river valley and will eventually be filled in with sediment, as the example in the English Lake District clearly shows.

Across the curriculum

Using this material you can link:

- Physical processes, such as evaporation;
- The nature of sedimentation and the formation of strata in geology;
- The different kinds of flora and fauna that live by the lake shore and within it. (Much more information on this topic is found in the companion Curriculum Visions book *Living Things in Their Environment)*;
- The way that lakes have provided important sources of water which can be used instead of making reservoirs;
- The way that lakes provide good means of transport. The huge volume of cargo moved over the Great Lakes is a good example, as is the way that lakes were used as part of the Klondike routeway during Gold Rush days (for information on this see the Curriculum Visions title: *The Mountain Book*).

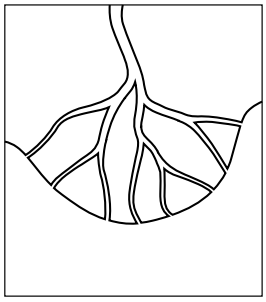
Name:..... Form:.....

See **pages 24 and 25** of *The River Book*

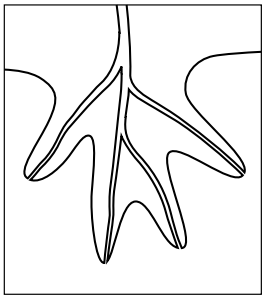
Deltas and estuaries

When rivers finally reach their mouths, the material brought to the ocean or lakes builds up further and further in the still water until it forms a wedge of sand and silt called a delta.

Q1. Deltas are often described as being fan-shaped or like a bird's foot. Write the appropriate word against deltas (a) and (b) below.



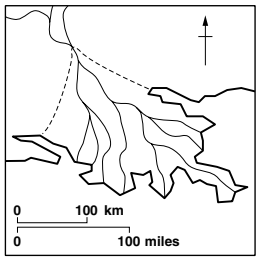
(a) ✎ .....



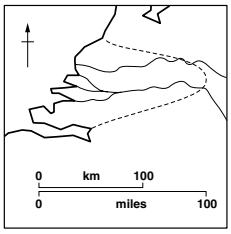
✎ .....

Q2. Use an atlas to find each of the deltas shown below. The index at the back of the atlas will tell you which pages to look on. Then draw a line from each delta to show its position on the world map. Next to each one write whether it is a fan-shaped or a bird's-foot delta.

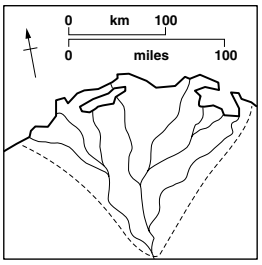
(a) Mississippi ✎ .....



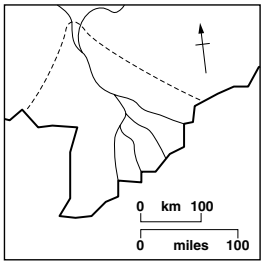
(b) Rhine ✎ .....



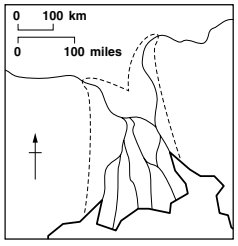
(c) Nile ✎ .....



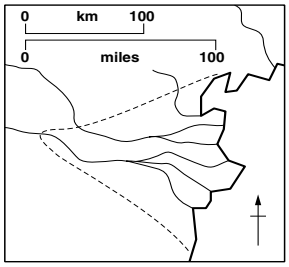
(d) Mekong ✎ .....



(e) Ganges ✎ .....



(f) Po ✎ .....



11 Answers, Resources, Background

See **pages 24 and 25** of *The River Book*

Answers

Q1. (a) fan-shaped
(b) bird's-foot

Q2. (a) bird's-foot
(b) fan-shaped
(c) fan-shaped
(d) bird's-foot
(e) fan-shaped
(f) fan-shaped

The Nile and the Rhine have the most obvious fan-shaped deltas. Most of the others are bird's-foot deltas, although some are complex (for example the Ganges/Brahmaputra delta).

Resources

- Photocopy of page 70.
- Pictures of deltas from the web site and *The River and Water CD*.
- A sloping sand tank with the lower part full of water and clear of sand. Watch a river create a delta in it.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

It is common to categorise deltas as fan-shaped or bird's-foot, depending on whether the front of the delta has an even or a crenulate edge. In general, fan-shaped deltas have many distributaries which transfer water and sediment evenly across the delta front, whereas bird's-foot deltas have one main channel that sends all the material in one direction before changing abruptly (often in a flood) and sending all of its water out in a new direction.

All distributaries tend to be contained within natural levees (low broad ridges parallel and close to the channel banks), and bird's-foot deltas can change shape rapidly if there is a breach in a levee wall, allowing the water to spill sideways and therefore make a shorter journey to the sea. At this point a new channel and new direction of buildup occur.

It is worth noticing that deltas can be very fertile because of the deposition of fine sediment. Thus, the Nile delta is heavily populated, as is the Mekong, the Ganges/Brahmaputra (which together comprise the land of Bangladesh), and so on. Others are used less intensively, sometimes for conservation reasons, as is the case with the Mississippi Delta and the Rhone Delta.

There is some confusion as to why not all rivers have deltas. For a delta to form, sea level must remain stable long enough for sufficient sediment to build up to the surface. The river must also bring considerable quantities of silt and larger material to the sea. Further, the coastal currents must be weak enough for the material to be allowed time to settle.

In places which were under ice sheets during the last Ice Age, recent glacial events have made this combination of requirements impossible. During glacial times, sea levels fell and rivers trenched into their beds. Also, the presence of ice often depressed the land. Subsequently, the sea level has risen and flooded these valleys, forming estuaries, rias, and sounds (fjords). Some estuaries (often called bays) are almost totally filled with sediment, but there has not yet been time for deltas to form beyond the coastline. This is too complex an idea for many students, but it is best to know, so that the difficulty can be addressed if needs be.

Across the curriculum

Using this material you can link:

- Physical processes, such as sedimentation;
- Wetland habitats, such as swamps, and also saline wetland habitats;
- The history of the Ice Age and after;
- The way that deltas have both helped and hindered people. Many settlements were initially formed on levees (Calcutta, India, New Orleans) and have subsequently spread to more risk-prone land;
- The way that deltas can provide fertile land but that such land is often hazardous. Over a third of Bangladesh, for example, is made of land that can flood when a typhoon carries storm surges from the Bay of Bengal on to land.

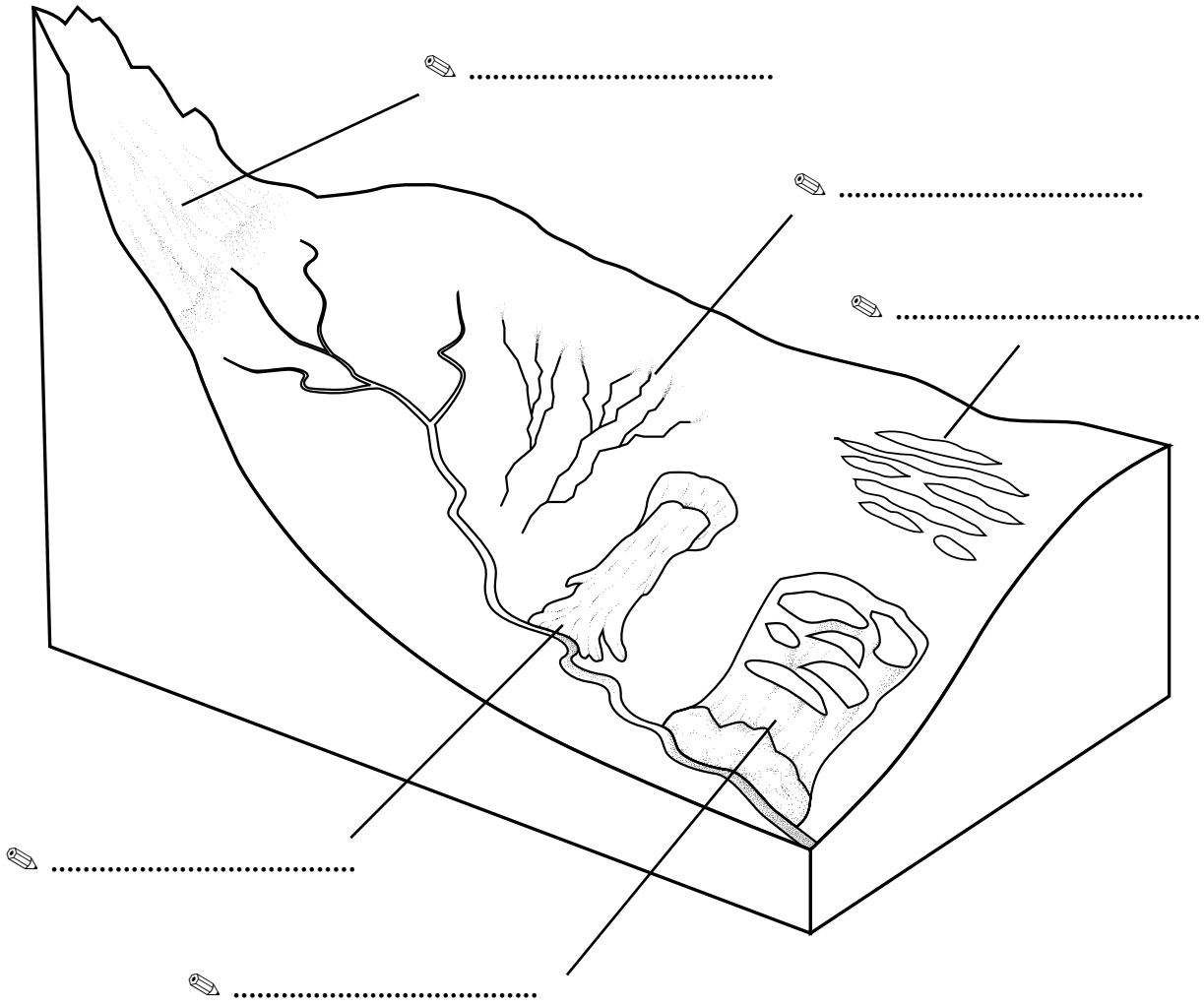
Name:..... Form:.....

See **pages 26 and 27** of *The River Book*

Slopes on the move

The material that moves down a hillside to the river plays an important part in shaping a valley. Some of it is shattered rock, but much of it is soil.

Q1. On the diagram below, label each of the ways material is moved on a hillside.



Q2. Explain what is meant by frost shatter.

.....

.....

.....

Q3. What causes a scar?

.....

12 Answers, Resources, Background

See **pages 26 and 27** of *The River Book*

Answers

Q1. The labels on the diagram are the same as those on page 26 in the student book.

Q2. Frost shatter is the process of breaking up and loosening small pieces of rock due to frost action during wet weather. It only works on steep, bare rock surfaces such as mountain cliffs. Overnight, any water held in the surface cracks of a rock will freeze. As ice occupies more volume than water, the rock will be pushed out of place as the ice forms. The next day, when it melts, the rock will fall away from the cliff.

Q3. A scar is left behind when a slab of soil moves as a landslide.

Resources

- Photocopy of page 72.
- A sand tray with dry and wet sand. Tilt the tray to see when landslides occur in the two types of material.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Rivers are only partly responsible for shaping most of the Earth's land surface. Indeed, they directly shape only a tiny part of the landscape – the part within the flat floor of the valley – a region called the floodplain. If rivers were the only agent eroding the land, then all landscapes would consist of gorges.

Valley processes

The majority of valley shapes depend on slow weathering of the land into soil and its transfer to rivers for removal.

In a valley, a number of processes occur at the same time. For example, over the centuries, as a river cuts into the land, rain and frost erode the rocks of the landscape, reducing them to soil. Rainwater 'dissolves' rocks, leaving clay behind. Frost turns rainwater in rocks into ice that expands and breaks up the surface. Together, these and similar processes are called weathering.

On steep slopes, materials may slither and slide down the slope. This is common in areas where there is little vegetation to bind the material together. On all other slopes, the material sometimes moves slowly, a process called soil creep, and at other times moves more quickly, as landslides and mudflows.

In a landscape with gentle slopes, rivers have little energy to erode and only solution is at work on hillsides, so the rate of landscape change is often slow.

Rivers also act as natural conveyor belts, carrying sediment to the sea. So valley shapes are a combination of river action and hillside processes.

Rivers are most effective at transporting materials during floods. Floods do not last very long, so most of the material is not carried right through a river basin, but only for a short distance within it. At the end of the flood, as the water level falls and the water flow slows, the sediment being carried is dropped onto the river bed or the valley floor, making the flat area by the river called the floodplain. As a result, in most river banks there is no hard rock to be seen, just material deposited from previous floods.

Rockfalls, landslides, and mudflows

Whereas rivers are an obvious source of erosion, the processes at work on slopes are not. Thus it is probably easiest to introduce the idea of slope processes through the more dramatic sources of erosion, such as landslides and frost shattering, than through the more usual chemical erosion that goes unnoticed within soils and rocks.

The first distinction to be made between different slope processes is between those that work on soil and those that work on shattered rock. Only cliffs, or slopes above the angle of stability of material (say 40 degrees), are altered by frost shatter. All other slopes are covered by soil and are altered by the two stages of weathering (chemical rotting of rock) to form soil, and then the gradual movement of soil to the river bank for further transport.

The most common kinds of landslides and mudflows are movements of soil. Slopes above 10 degrees are most vulnerable. The main requirement is that the soil becomes saturated. Thus, the time when most landslides and mudflows occur is after a prolonged period of rainfall (rather than after a single downpour). This time is usually, but not exclusively, toward the end of winter. The water does not act as a lubricant, but rather it takes up part of the weight of the soil, allowing its particles to unlock and move (it is a buoyancy effect).

Landslides and mudflows need a surface to slip over. Shale rocks, for example, are impermeable and so water stays within the soil and is liable to become saturated and slip more easily than soil on permeable sandstone.

The difference between a landslide and a mudflow relates to the kind of bonding in the soil. A mudflow happens when water gets between the soil particles and pushes them apart – that is, the soil liquifies. The whole soil and water mass can then move as a liquid. Landslides move as sheets of material because there is a weak subsoil layer that, on becoming saturated with water, allows the soil to slip over it. When landslides begin, the whole soil is shaken and this may shake violently enough for the soil to liquify and turn into a mudflow.

Gullies are the result of a stream of water flowing over the surface, and are found where violent and heavy thunderstorms are common.

Soil creep is a slow, down-slope movement of soil in wide ridges, almost like wide, shallow landslides. However, the movement is caused by a sawtooth movement of clay soils as they expand on wetting and shrink on drying.

Name:..... Form:.....

See **pages 28 and 29** of *The River Book*

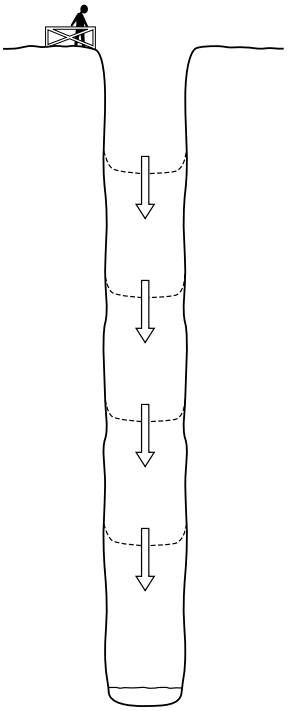
Gorges and canyons

Gorges and canyons are the steepest kind of valleys, but only gorges have sheer sides.

Q1. In which direction is the river eroding in the gorge?

✎ .....

.....



Q2. What is the difference between a gorge and a canyon?

✎ .....

.....

.....

.....

Q3. Name a famous canyon, then draw a side view of it in the space at right. Explain what has caused its shape.

✎ .....

.....

.....

.....

13 Answers, Resources, Background

See **pages 28 and 29** of *The River Book*

Answers

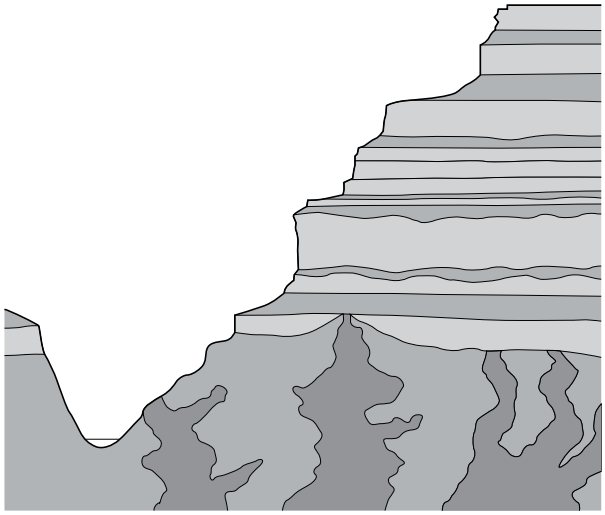
Q1. Downward

Q2. A canyon is a V-shaped valley with sides that are bare of soil or plants.

Q3. A floodplain

Q3. The Grand Canyon

(Its profile is caused by the way that erosion has picked out soft from hard rock bands, creating a steep staircase profile to the canyon.



Resources

- Photocopy of page 74.
- Pictures of canyons from Arizona Rivers, Utah Rivers, and so on, on the web site and *The River and Water CD*.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

The section on gorges and canyons emphasises the role that a river plays in the formation of a valley, and gives an excellent opportunity to show that, when rivers are the dominant erosive process, they simply cut a slot (gorge) in the landscape.

Gorges can occur in humid mountain areas but more often in deserts (such as the southwestern United States, where they are called canyons, or North Africa, where they are called 'wadis'). Many gorges are also found downriver from waterfalls.

The real usefulness of starting a topic on gorges is to provide a way of moving from a purely river process to a balance of river and slope processes that results in the valley shapes we can find.

Canyons are spectacular, and the Grand Canyon makes a good focus for a project. There is a profile of it in the student book.

A canyon demonstrates that valley slope processes are quite strong, so that the valley is able to produce shattered rock (in the case of the Grand Canyon mainly by winter frost shatter), and as the river carries this sediment away, some of its energy is used up in transport. This, in turn, gives more opportunity for valleys to widen out. Right at the bottom of the Grand Canyon, however, there is a gorge because here the river is cutting into very hard rock which has few fractures and so is not as subject to frost shatter as the limestones, sandstone, and shale rocks in the upper canyon.

Across the curriculum

Using this material you can link:

- The way that canyons have been exploited successfully by Native Americans, for example in Mesa Verde, Canyon de Chelley and elsewhere in North America. The reliable supply of water and deposited silt allowed successful farming to occur in otherwise desert terrain. Canyon de Chelley is still successfully farmed;
- Historical themes, such as the exploration of the Colorado by Powell;
- Transport themes, such as how canyons provide major transportation obstacles. This is shown dramatically by the Grand Canyon and the road distance of nearly 300 km needed to get around the canyon from the South Rim to the North Rim. The two rims are actually only 30 km apart directly across the canyon.

Name:..... Form:.....

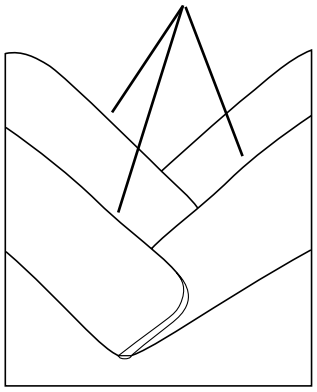
See **pages 30 and 31** of *The River Book*

Valley stages

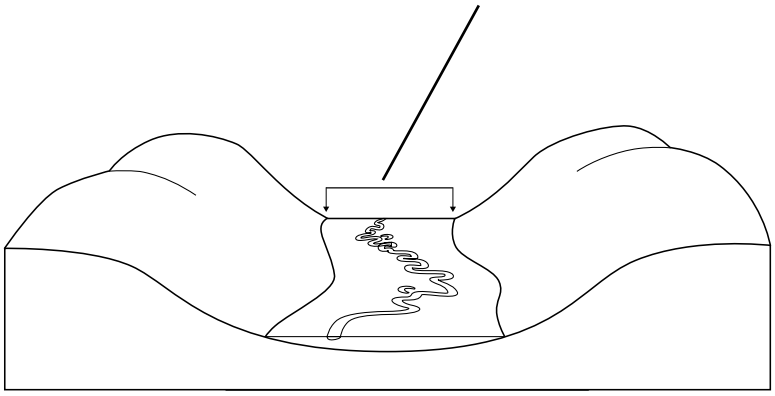
Valleys change shape dramatically between their sources and their mouths. The three diagrams on this sheet give the main changes that you can expect to see.

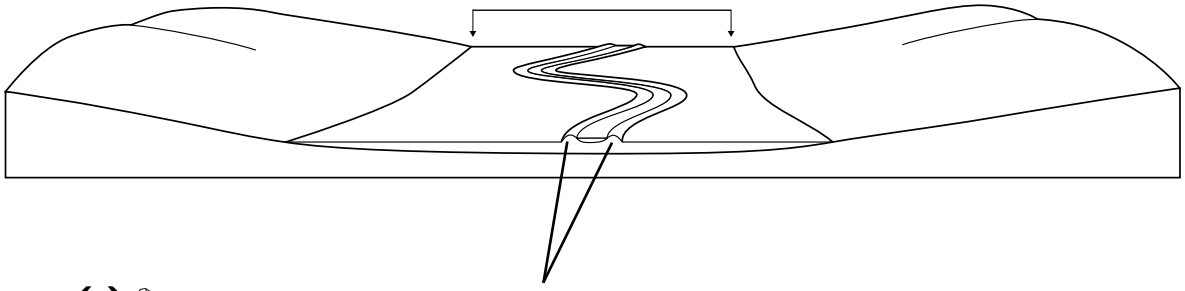
Q1. On each of the diagrams below, write in the words for each of the features labelled.

(a) ✎ .....



(b) ✎ .....





(c) ✎ .....

Q2. What name is usually given to the shape of a river valley?

✎ A ..... valley.

Q3. What is missing in the upper valley that is present in the middle and lower valley?

✎ .....

Q4. What type of material must rivers be carrying to build large levees?

✎ .....

.....

14 Answers, Resources, Background

See **pages 30 and 31** of *The River Book*

Answers

Q1. The labelled features should be:
(a) Interlocking spurs.
(b) Floodplain.
(c) Levees.

Q2. V-shaped.

Q3. A floodplain.

Q4. Silt. Levees are most common in rivers that carry a heavy sediment load of silt.

Resources

- Photocopy of page 76.
- Pictures of valleys on the web site and *The River and Water CD*, especially levees.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Valley shapes reflect the balance of processes working together. Here, we use the very traditional approach of classifying valleys into upper, middle, and lower. Really, we are talking about regions where the river gradient is, respectively, steep, moderate, and gentle. In many river basins, and especially in those affected by glaciation, there is a complex mixture of all three, so it is always helpful to choose examples that are most straightforward. These are short and steep and so have many obvious slope processes as well.

The distinction made is that the upper valley is dominated by vertical erosion of the river into its bed, keeping slopes steep and not providing the opportunity for floodplain development. Middle and lower valleys, where river gradients are less steep and where rivers are carrying a greater sediment load from upriver, and so have less energy for added local erosion, will cut down less readily into their beds. Instead, they will tend to redistribute material laterally. The focus of much of the energy is in the form of abrasion as water flows quickly around the outside of meander bends. Thus, the outer bends tend to be the most rapidly changing part of a river.

The width of the floodplain varies with the size of the river, larger rivers having wider floodplains.

Furthermore, middle and lower valleys are drained by a greater number of headwaters than upper valleys and so have a larger volume of water, although its speed may be lower than in upper valleys. As movement energy is related to the product of both speed and volume of water, the result is that deep, wide rivers in middle and lower valleys have considerable amounts of energy available for the transport of fine-grained material.

The size of material moved depends on the fastest speed that the river can flow, so coarse material will be moved by upper valley rivers, a feat that cannot be matched by middle course rivers. As a result, coarse material accumulates in middle valley floodplains until it can be reduced in size by weathering. It is then moved further down slope as the floodplain materials are reworked by the river at times of flood.

Throughout this unit it is helpful to show that floodplains are actually regions that are created by floods and this is why they have nearly level surfaces. This is an important concept needed in later units.

Across the curriculum

Using this material you can link:

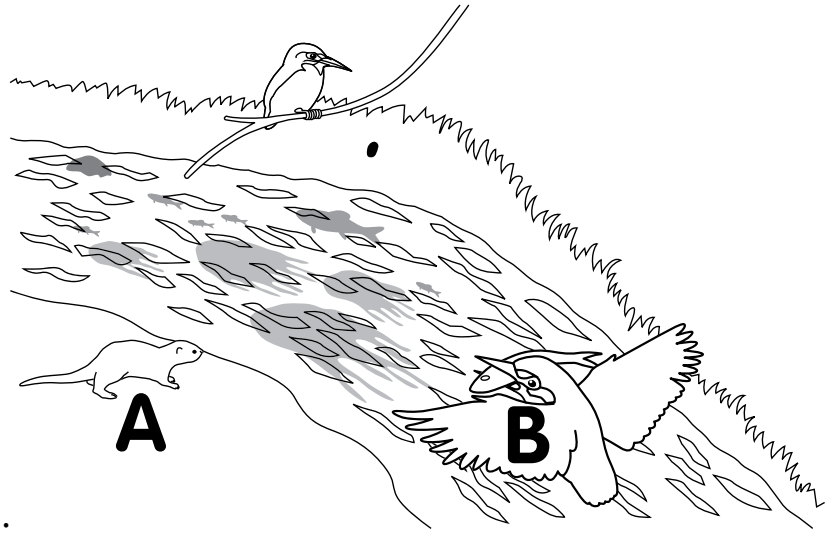
- Physical processes, such as the balance between downwearing and lateral erosion;
- How it is often difficult to establish settlements in upland valleys because of their lack of floodplains and thus space to build houses, and so on;
- How floodplains in middle and lower valleys are used for farming, and how transportation routes often follow the valleys;
- The way that many settlements have been formed at confluences between major rivers.

Name:..... Form:.....

See **pages 32 and 33** of *The River Book*

River and valley habitats

Rivers often begin as fast-flowing streams with rocky beds, then get slower and flow over muddy beds as they near the sea. As a result, rivers contain many different types of life.



Q1. (a) What is animal A?

✎ .....

(b) State three ways in which its body is adapted to its way of life.

✎ .....

.....

.....

Q2. (a) What is animal B? ✎ .....

(b) How is its beak adapted to catching its food?

✎ .....

.....

Q3. Why are there only a few plants in the upper part of a river?

✎ .....

.....

Q4. How is the tidal part of a river different from the middle reaches?

✎ .....

.....

15 Answers, Resources, Background

See **pages 32 and 33** of *The River Book*

Answers

Q1. (a) Otter.
(b) Webbed feet, waterproof coat, sharp claws and teeth to catch fish, closes its ears to keep water out.

Q2. (a) Kingfisher.
(b) Beak is strong and pointed for stabbing fish.

Q3. Because the water is fast flowing and there is a rocky bed which does not allow roots to grow.

Q4. It has mudflats and sandbanks which contain large numbers of animals. Large numbers of plants grow there. The water is salty.

Resources

- Photocopy of page 78.
- Web site pages such as the Google News. Go to google then type these keywords in to the search box: environmental, protection, UK.
- The extra information supporting this unit in the river section of the Curriculum Visions web site – click on page 32 of the contents list.
- Consider using the PosterCard Portfolio.

Background support

The three parts of the river form three different river habitats. In the upper part, the water is very cold. This allows it to take up more oxygen as it splashes over the rocks. The animals that live here are very sensitive to a high oxygen concentration and would perish if swept lower down where the oxygen level is lower. The animals here are adapted to clinging to rocks and feeding on items that fall into the river. Some caddis flies spin nets to catch small food particles as they are carried along with the current. The dipper is capable of walking underwater to feed.

In the middle part, the water is warmer and holds less oxygen. Plants that grow here are adapted to withstanding the currents. They have strong roots which grip the bank. Those plants immersed in the water have flexible stems that move with the water currents, and leaves which overlap, and point in the direction away from the current source, so they are not pulled off the stem.

In the tidal part of the river the water is somewhat salty and brackish. Plants and animals that live here must be adapted to the brackish conditions. Animals swept here from higher up the river would die.

Across the curriculum

Using this material you can link:

- Ideas of conserving areas of each type of habitat as national parks or similar. You may want to discuss what makes an area worth conserving in addition to its habitat;
- The impact of pollution of towns, industry, and farming whose wastes may get into the river water. Students might consider chemical changes to the water, and also temperature changes, such as those that occur near to power plants;
- The way that many habitats are lost as river floodplains are turned over to cultivation, or upland valleys are dammed for flood control, hydroelectric power, or irrigation.

Name:..... Form:.....

See **pages 34 and 35** of *The River Book*

Floods

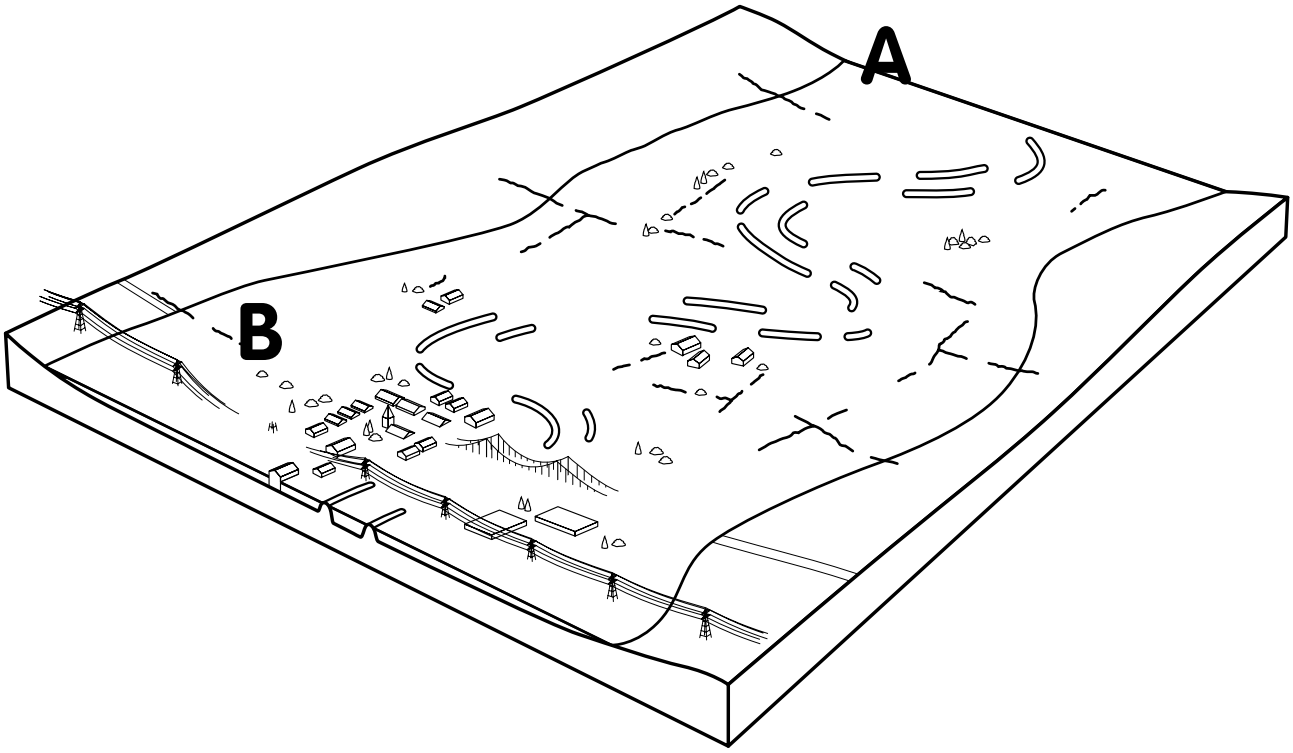
Floods can turn an entire floodplain into a lake. The diagram on this page shows some of the ways people might be affected.

Q1. What has happened at **A** ?

✎ .....

Q2. What has happened at **B** ?

✎ .....



Q3. Put a circle around a farm that has been affected by flooding. Describe some of the problems that might affect the farmer.

✎ .....

.....

.....

.....

16 Answers, Resources, Background

See **pages 34 and 35** of *The River Book*

Answers

Q1. The levees have been breached.

Q2. Power lines have come down.

Q3. Farms are severely affected by flooding. Not only are crops waterlogged and potentially destroyed, but animals may be cut off or even drowned. Farms readily become isolated, and they have the special task of feeding and looking after animals. It is often very difficult to move animals away before flooding occurs because suitable grazing or pen areas have to be found, and these are not readily available.

Resources

- Photocopy of page 80.
- Pictures of floods from the web site and *The River and Water CD*.
- Web sites such as FEMA (www.fema.gov).
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Soils, and especially rocks, can store large amounts of water, and this constant seepage keeps rivers flowing between rainstorms. But soil water is also available to plants, and they often take the lion's share of the rainfall. Thus, about a third, or less, of rainfall eventually reaches rivers, the rest is transpired back to the air by plants.

Under normal circumstances rain seeps into the ground, filling up the soil and rock pores, and – over time – pushing water out at the stream banks.

Water can flow over the surface when the soils are full of water. This usually happens in winter when plants are dormant and not using water to transpire. At these times, the soils and rocks fill with water and rainfall will not be able to enter the soil, but will have to run over the surface. Most winter floods are produced this way.

There is another way of producing localised floods. If the rain falls too heavily to seep into the soil, as is often the case with severe thunderstorms, then the water that cannot seep into the soil flows over the surface and reaches the rivers quickly. This may produce flash floods.

Whatever the case, it takes time for rainwater or snowmelt to seep into soils and rocks, or even run over the surface of the ground, which explains why the main part of a flood always occurs some time after, and not at the same time as, the period of heaviest rainfall.

Floods and the floodplain

The flat strip of land that occupies the centre of a river valley is called a floodplain. Flooding happens, on average, once every two to three years.

Floodplains, like so many parts of the landscape, change during periods of flood. The water flows very fast in a channel during a flood, but the water that floods out of the channel spills over the floodplain as a thin sheet. In effect, it makes a large lake, but because the water does not flow quickly, it cannot carry the same calibre, or amount, of material that it was able to carry in the channel. So the material that reaches the floodplain slowly settles out and builds up the floodplains. This is why people affected by floods notice that their lives are disrupted by two effects: water and mud. This process accounts for the fertile soil that farmers have relied on for centuries and explains why farmers are often at risk in times of flood.

The amount of material that is laid down depends on the river basin. Some rivers, like the Nile in Africa, the Huang He in China, and the Mississippi River in North America, carry very large loads of material and they can raise their floodplains by more than 10mm (0.4in) a year. However, in many rivers floodplains will be raised far less than this. Of course, the distance the material travels in water flooding from the channel depends on the size of the material. Sand and silt, which are heavy, will not travel very far. In some sand-laden rivers, such as the Mississippi River, large amounts of sand and silt are laid down close to the banks. Eventually these form long ridges of material known as levees.

Levees build up the channel walls, making flooding less likely. They also make people more likely to live on flood-prone land. But when the levees are broken down, or breached, then the impact of flooding will be far worse than in rivers without levees.

The effect of flooding will vary greatly depending on the ability of rescue services to cope with flood emergencies. Far more detail on this subject is available on the web site and also in worksheet A for unit 18, 'Coping with floods'.

Across the curriculum

Using this material you can link:

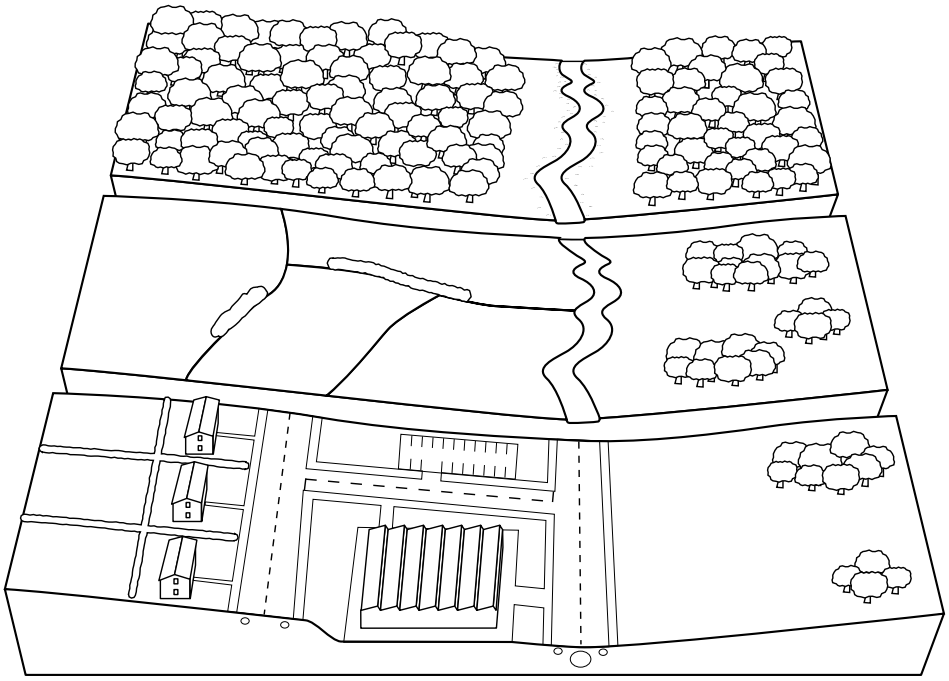
- Historical patterns of flooding to see how many people have been affected on a selected river;
- Ideas about the cost of protecting homes built on the floodplain, as opposed to the cost of moving people permanently to safer ground;
- The reasons that people choose to live and remain on a floodplain;
- Why some poeple may not be aware of the flood risk (newcomers to an area, those a long way from the river, those who have not experienced an extreme event in their lifetimes, and so on).

Name:..... Form:.....

See **pages 36 and 37** of *The River Book*

How people cause floods

People change the landscape quite dramatically. Usually they don't realise they are adding to the risk of floods, because each person makes just a small change. But the results can be very severe.



Mark this part of the diagram for Q2.

Describe how a farmer can make changes that increase flooding. Mark these changes on the diagram above.

✎ .....

.....

.....

Describe how the growth of a city can cause flooding. Again, mark the changes you discuss on the diagram above.

✎ .....

.....

.....

17 Answers, Resources, Background

See **pages 36 and 37** of *The River Book*

Answers

This worksheet invites quite long answers and benefits from discussion. It can also involve school-based field work.

The key points to address in thinking about how people cause flooding is to help students to realise that many small, apparently unconnected events cause a big change. It is worth looking out of a classroom window, or taking a short trip around the school building, just to give a realistic idea of how far the changes have gone. For example, many areas were once forested, so get students to imagine what the school site was once like (a forest) and then look at it today.

Q1. For farmland, changes of land use from forest to pasture reduce the amount of seepage, but as grass transpires less than trees, the soil does not dry out to as great a depth, and so less water is needed before it is saturated. Farmers also tend to plough fields up and down slopes, creating natural drains across field. They also install subsurface drains. Furthermore, the constant movement of machinery on a farm tends to compact the subsoil, making it harder for water to seep down to rocks.

Q2. For built-up areas there will not only have been a change to the vegetation (for example, trees replaced by playing fields, etc.) but also a change in the way that the water moves. Thus playing fields are usually drained so that they are usable for longer. This means water flows away from the fields to storm drains and rapidly reaches rivers, where it would have seeped slowly and naturally through rocks.

The same process is even faster for roofs and roads. Rainwater passes rapidly into drains shaped to carry water as efficiently as possible.

Resources

- Photocopy of page 82.
- Possible walk around the school perimeter or drive around the neighbourhood to see how much of the ground has been altered.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

The impact of people on their environment is of concern to everyone and a good topic for class discussion and project work.

In fact, people have innumerable effects on the natural flow of a river basin and the chances of flooding. It is best to think of these effects in terms of

(i) changing land use;
(ii) reduced permeability of land;
(iii) physical changes to the river bed and banks, such as concreting a river channel or making it narrower and straighter.

Across the curriculum

Using this material you can link:

- Physical processes, such as the way that water moves through soils, the storage capacity of a soil, the maximum infiltration rate of a soil;
- The hydraulic properties of a pipe and an artificial channel, compared to a meandering stream with a rough bed through the use of sand tray models and the use of pieces of guttering;
- The way that change happens gradually, so that people are not aware of the impact they might have;
- The way that small changes taking place over a large area can result in cumulatively large changes. This is important in the context of local and regional planning;
- The way that some communities now have flood relief and flood abatement schemes, including various forms of soakaways or retention ponds for floodwaters;
- The way that flood risk might be different in places experiencing sudden torrential thunderstorms, such as Los Angeles, and those experiencing long periods of winter rainfall, such as London.

Name:..... Form:.....

See **pages 38 and 39** of *The River Book*

Coping with floods

People have to cope with floods as soon as they arrive. Read this advice from a government agency:

Flood safety tips

• Do not walk through flowing water. Drowning is the number one cause of flood deaths. Six inches of water can knock you off your feet.

• Use a pole to make sure the ground is still there before you go through an area where the water is not flowing.

• Do not drive through a flooded area. More people are drowned in their cars than anywhere else. Don't drive around road barriers, the road or bridge may be washed out.

• Stay away from power lines and electrical wires. Electrocution is a major killer in floods. Electrical current can travel through water.

• Report downed power lines so they can be made safe.

• Turn off your electricity supply when you return home after a flood, or while the flood is happening. Don't use appliances that have become wet until they have been thoroughly dried.

• Watch for animals that have been washed out of their homes and may have taken refuge in yours.

• Look before you step. After a flood the ground is covered with debris, especially slippery mud.

• Be alert for gas leaks; do not use gas or charcoal fires indoors for temporary cooking without adequate ventilation because you may become affected by carbon monoxide gas.

• Clean everything that got wet. Floodwaters are not clean waters. They WILL have picked up sewage and chemicals from roads, farms, factories, and storage buildings. Spoiled food and flooded cosmetics and medicines are health hazards and should be thrown out.

Steps to recovery

• Take care of yourself first

• Disinfect everything that the floodwaters touched.

• Protect homes from further damage. Get fresh air moving through the home. Patch holes. Repair sagging floors and roof sections. Remove debris. Check for broken or leaking water pipes. Drain the basement carefully. Hose down the house and its contents.

• Get organised. Call the insurance agent and list the damage, then check for structural damage.

• Dry out your home. Floodwaters affect a house in three ways: water damages materials such as wallboards; they will disintegrate if they stay wet too long. Wood will swell, warp or rot. Mud, silt and pollutants in the water will contaminate everything that got wet. Dampness promotes the growth of mildew, a mould or fungus. To cure these things, lower the humidity by opening doors and windows, use a fan, use dehumidifiers (but with care). Dry the ceilings and walls. Finally, dry the floor. Restore the utilities (power, water, etc).

• Tackle one room at a time.

Rebuild and floodproof.

Don't just rebuild, build it back better. Use one of these: increase the elevation, relocate, build floodwalls. Develop a flood response plan. Keep sandbag materials available.

18A Answers, Resources, Background

See **pages 38 and 39** of *The River Book*

Resources

- Photocopy of page 84.
- Pictures of floods from the web site and *The River and Water CD.*
- Web sites such as FEMA (www.fema.gov).
- Any local newspaper reports of past events.
- A bowl with soil and water stirred up. Place objects in it and then drain the water off and let everything else dry. Then try cleaning the objects.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

There are three stages to dealing with a flood: immediate response while the flood is happening, initial cleanup, and long-term recovery.

After disasters, government agencies and private organisations provide direct assistance to individuals, families and businesses with their most immediate medical, food, clothing, and housing needs. A wide range of volunteer organisations can also usually help in cleanup efforts. In addition, social service agencies, local, and national governments can provide temporary housing and counselling.

The material in the worksheet is based on information on what to do about flood disasters given by FEMA (US Federal Emergency Management Agency). It can be used as the basis of a project or class discussion. There is room for much more to be made from this material. No questions are provided on the sheet to allow you to use the material as flexibly as you wish.

Starting questions might be:

1. Why is electricity especially dangerous during a flood? (electrocution)

2. Floodwaters contain mud. What else might they contain that will be a problem? (pollution)

But there are many social questions that follow, including the need to be insured.

Disaster Assistance programs

Most governments only provide assistance for the most severe events when major disasters are declared. More than 9 out of 10 disasters are not declared by governments and so people cannot claim relief. Even so, when a government declares a disaster and, for example, makes a loan, it has to be repaid, usually with interest

The amount of money any one person can get is limited. And when loans are made, the time it takes the average family to pay them back is over 15 years and the repayment amount per month is more than the private insurance policy premium that could have been taken out beforehand, usually by a factor of at least ten.

If students think their home is not going to be flooded, remind them that eight out of ten disasters include flooding. And because more buildings, roads, and parking areas are being built over land that was once natural soakaway, such as meadows and forests, the risk of flooding is increasing, even for those people who have never experienced a flood before. Insurance puts the homeowner in control, and then they don't have to wait for assistance, but can get on with rebuilding their lives immediately.

What does local government do in an emergency?

The local government agencies are the first to respond in an emergency. First on the scene are the police, fire, search and rescue, and ambulance services. Equally vital are the communications, transportation, and public works departments.

It is the long-term recovery phase of disaster that places the most severe financial strains on a government, especially the damage to public facilities such as sewerage systems, roads, and bridges.

Across the curriculum

Using this material you can link:

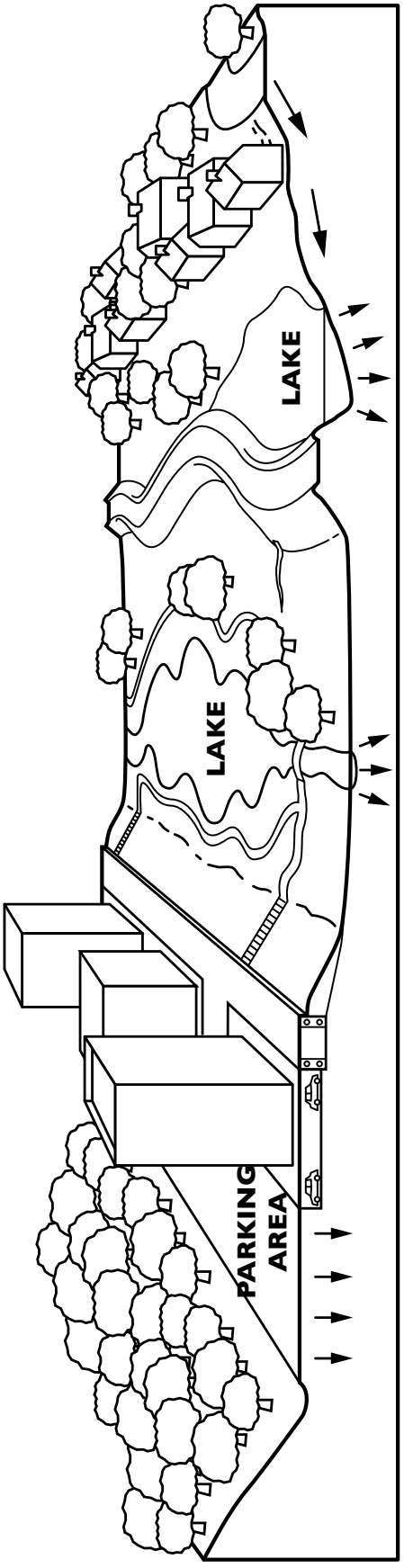
- Physical and chemical means of clearing up. The need for disinfectants and other disease-preventing materials;
- The way that the threat of disaster can bring a community together;
- The need for people to work together;
- The cost of coping with a flood, in terms of insurance costs, and also costs to the government for those people who do not have flood insurance.

Name:..... Form:.....

See **pages 38 and 39** of *The River Book*

Preventing floods

This diagram shows some of the ways in which local changes could be very helpful in reducing the risk of flooding, and also making the environment more attractive for both people and wildlife. (The arrows show places where water could seep into the ground.)



Q1. A small dam could be built in the valley to make a lake. How would a lake prevent flooding?

✎ .....

.....

.....

Q2. A surface parking area could be made so that water seeped through into the ground. How might this make flooding less likely?

✎ .....

.....

.....

Q3. Choose one other way of reducing flooding and describe how it would help.

✎ .....

.....

.....

Answers, Resources, Background

See **pages 38 and 39** of *The River Book*

Answers

Q1. The key to all of the measures is to prevent rainwater reaching the main river at the same time. The small lake not only provides recreational opportunities, but is good for encouraging wildlife. Water flowing down the river after a storm ponds up in the lake and only flows out after the lake level has risen. Thus a short peak river flow is turned into a broad lesser flow of longer duration.

Q2. Parking area surfaces do not have to be impermeable, but can be built of materials that allow water to seep through. An obvious example is by using gravel as a surface instead of tarmac.

Q3. Levees are traditionally used to keep water confined to the river, but they can be used in reverse. If the area close to the levees is left as pasture or communal land, then the storm drainage water from local urban areas can be directed to it. It will pond up here and make a temporary lake and slowly recharge the soil.

In fact, soil recharging is used in most local schemes. Recharge is good for flood prevention, and it also ensures that rivers are supplied with water for longer during droughts. Indeed, it is worth mentioning to students that water lost through flooding cannot be used for supply at other times of the year. And, just as people have noticed a 50% increase in flooding due to urbanisation, they have also noted that considerably more rivers dry out in summer.

Resources

- Photocopy of page 86.
- Pictures of floods from the web site and *The River and Water CD*.
- Web sites such as FEMA (www.fema.gov).
- Any local newspaper reports of past events.
- A bowl with soil and water stirred up. Place objects in it and then drain the water off and let everything else dry. Then try cleaning the objects.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.
- Consider using the PosterCard Portfolio.

Background support

Floods are not only potentially life threatening to people, but they can also cause tremendous amounts of damage which cause the victims of flooding considerable hardship. It therefore makes sense to try to prevent flooding as much as possible.

In the student book, the main suggestions regarding flood prevention concern dams and reservoirs (to hold back headwater flows until the main storm waters have passed through the river system) and levees (direct earth banks alongside river channels). By contrast, this worksheet concerns some other small scale measures which can form the basis of discussion of how people can help prevent flooding through local planning and building design. Many of these are being implemented by local authorities and your local planning department could probably tell you where to find examples.

Name:..... Form:.....

See **pages 40 and 41** of *The River Book*

Amazon

Q1. Is the Amazon River the biggest river in the world, the biggest in the Western hemisphere, or the biggest in South America?

✎ .....

Q2. How much of the entire flow of the world's rivers comes from the Amazon?

✎ .....

Q3. Which mountains form the western limit of the Amazon basin?

✎ .....

.....

Q4. How many tributaries join the Amazon?

✎ .....

Q5. Which city is at the head of the tidal bore on the river?

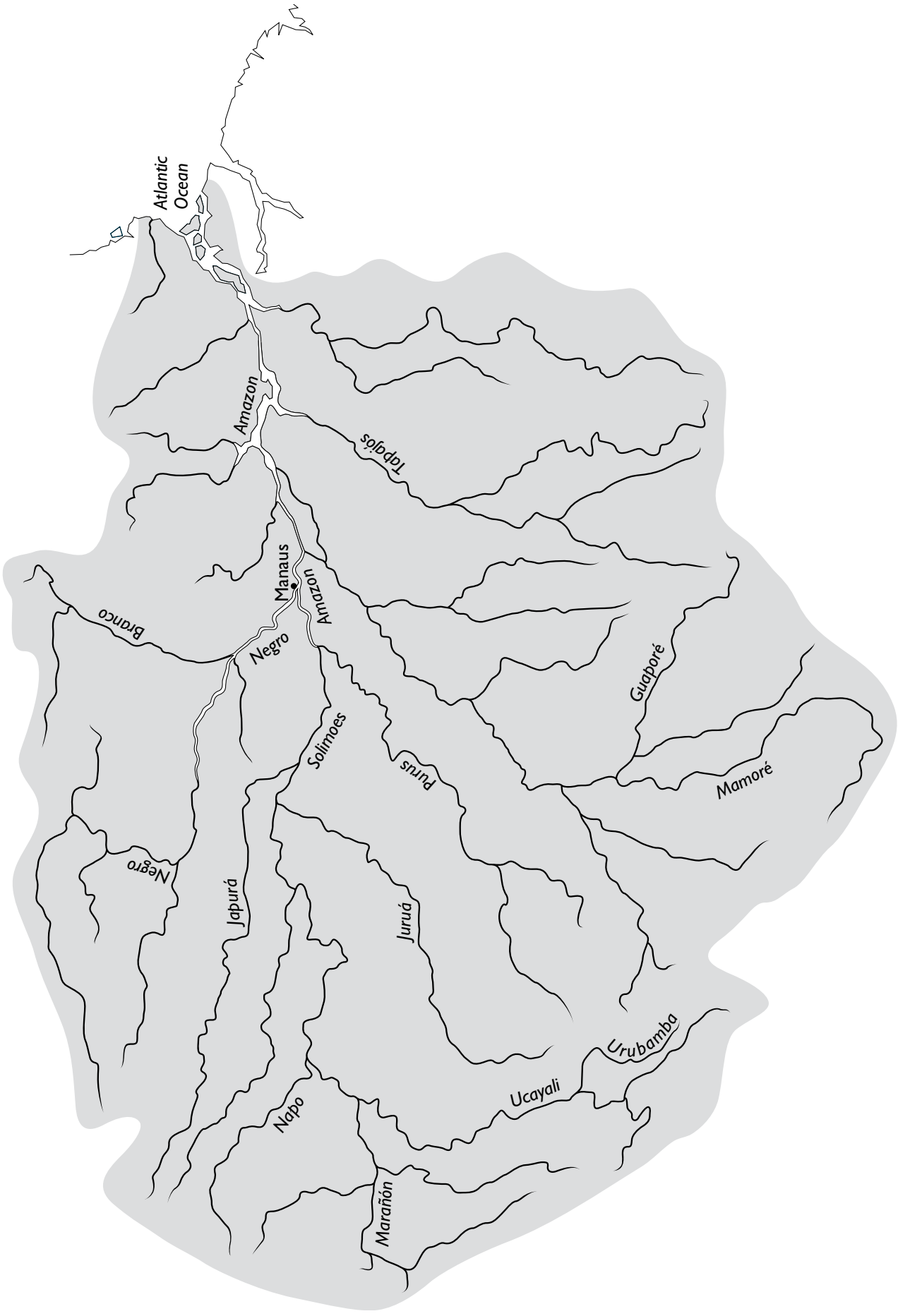
✎ .....

Q6. How wide is the Amazon at its mouth?

✎ .....

Name:..... **Form:**.....

On this map of the Amazon, write the names of as many of the unnamed tributaries as you can. Use an atlas to help you.



Name:..... Form:.....

See **pages 40 and 41** of The River Book

Answers

Q1. It is all three.

Q2. One fifth.

Q3. The Andes Mountains.

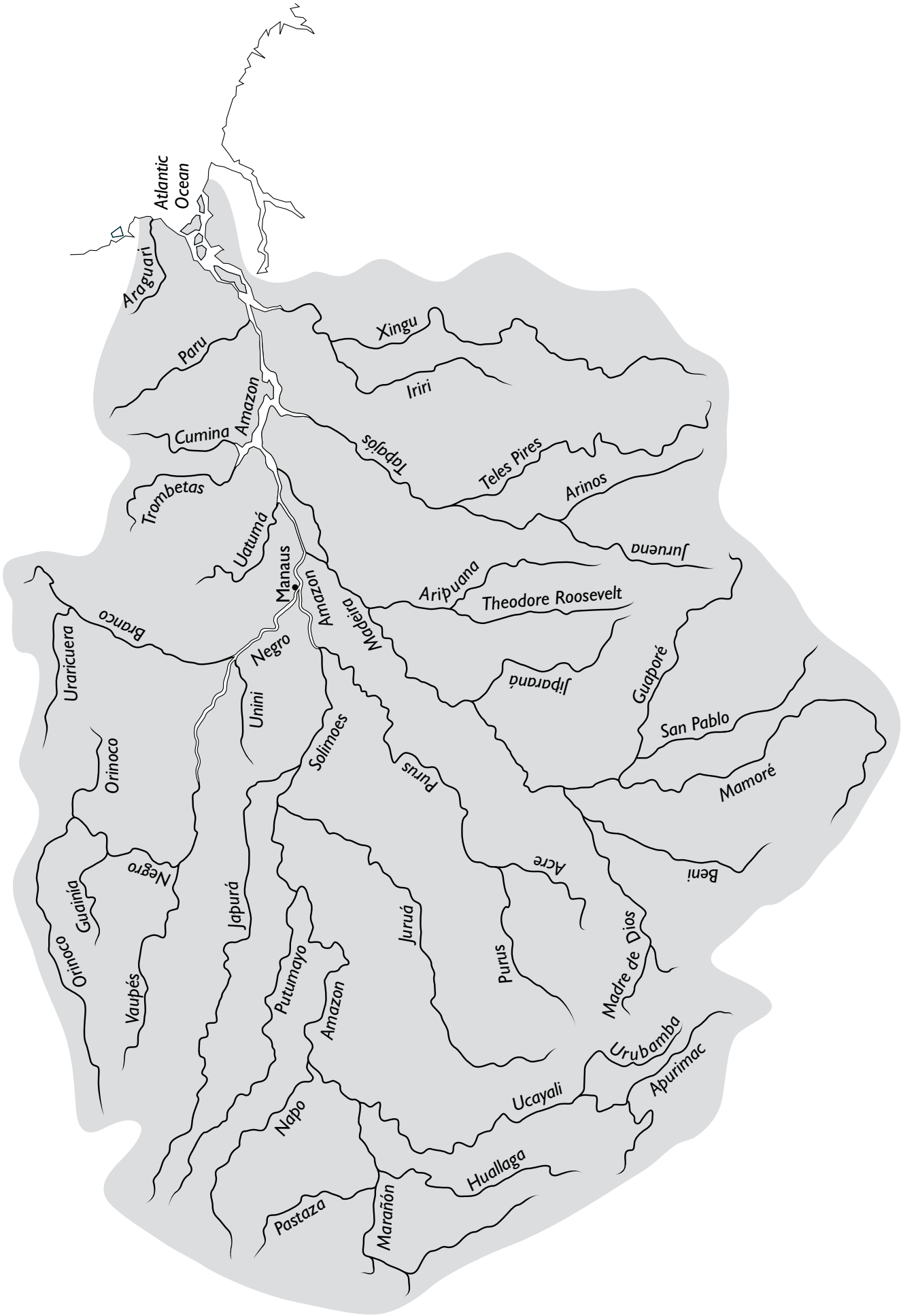
Q4. 1,100.

Q5. Manaus.

Q6. 250km (155 miles).

Resources

- Photocopy of pages 88 and 89.
- The web site (River/Rivers of the World/ World Rivers) or *The River and Water CD* under 'World rivers'.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.


Atlantic Ocean
Araguari
Paru
Xingu
Iriri
Amazon
Cumina
Tapajós
Teles Pires
Arinos
Trombetas
Uatumá
Manaus
Amazon
Aripuana
Theodore Roosevelt
Madeira
Branco
Uraricuera
Negro
Unini
Jipparaná
Guaporé
San Pablo
Mamoré
Orinoco
Solimoes
Purus
Beni
Acre
Negro
Guainia
Orinoco
Japurá
Juruá
Purus
Madre de Dios
Vaupés
Putumayo
Amazon
Urubamba
Apurimac
Ucayali
Napo
Huallaga
Pastaza
Marañón

Name:..... Form:.....

See **pages 42 and 43** of *The River Book*

Mississippi

Q1. Is the Mississippi River the largest river in the world, the largest in the Western hemisphere, or the largest in North America?

✎ .....

Q2. How much of the United States does the Mississippi River drain?

✎ .....

Q3. Which mountains form the western limit of the Mississippi River basin?

✎ .....

.....

Q4. What is the name of the biggest tributary to the Mississippi River?

✎ .....

Q5. Which large city is close to the place where this tributary joins the Mississippi River?

✎ .....

Q6. Which city is close to the Mississippi River delta?

✎ .....

On this map of the Mississippi River, write the names of as many of the unnamed tributaries as you can. Use an atlas to help you.

Name:..... Form:.....

See **pages 42 and 43** of The River Book

Answers

Q1. The largest in North America.

Q2. About 60%.

Q3. The Rocky Mountains (Rockies).

Q4. Missouri.

Q5. St Louis.

Q6. New Orleans.

Resources

- Photocopy of pages 92 and 93.
- The web site (River/Rivers of the World/ World Rivers) or *The River and Water CD* under 'US rivers'.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.


Allegheny
Ohio River
Kanawha
Muskingum
Tennessee River
Miami
Ohio River
Wabash
Wisconsin River
Rock
Illinois River
St. Louis
Mississippi River
New Orleans
Gulf of Mexico
Black
White
Mississippi River
Cedar
Missouri River
Osage
White
Arkansas River
Ouachita
Minnesota River
Des Moines
Kansas River
Neosho
James
Missouri River
Platte
Arkansas River
Cimarron
Canadian
Red
Grand
Cheyenne
Niobrara
North Platte
South Platte
Republican
Missouri River
Yellowstone
Powder
Big Horn
Milk
Missouri River

Name:..... Form:.....

See **page 44** of *The River Book*

Nile

Q1. Is the Nile River the biggest river in the world, the longest in the world, or the only one that flows through a desert?

✎ .....

Q2. Why doesn't the Nile have tributaries for much of its length?

✎ .....

Q3. Which mountains provide the source for the Blue Nile?

✎ .....

Q4. Which tributary is responsible for the annual flood?

✎ .....

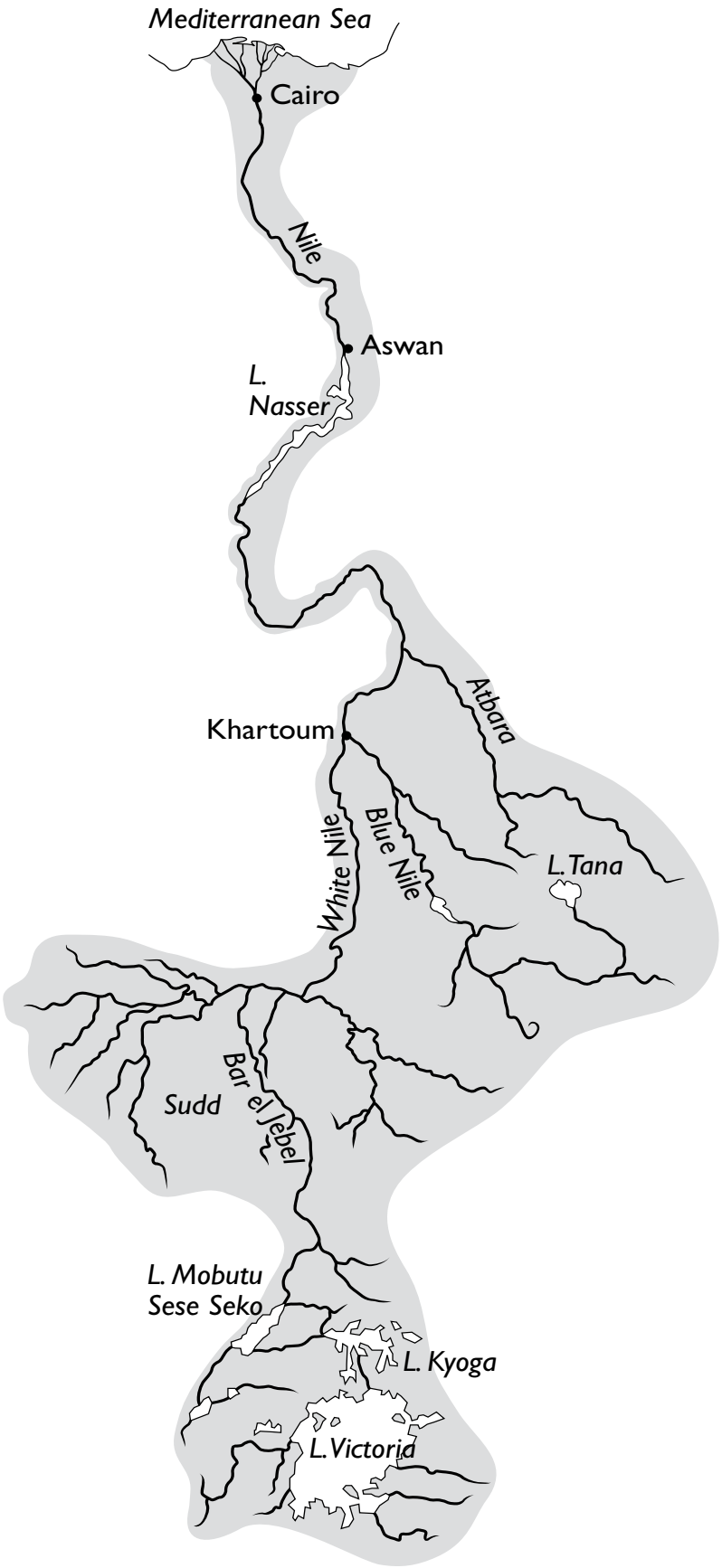
Q5. What is the name of the big swamp in the Nile basin?

✎ .....

Q6. What is the name of the biggest city on the Nile?

✎ .....

On this map of the Nile, write the names of as many of the unnamed tributaries as you can. Use an atlas to help you.



Name:..... Form:.....

See **page 44** of The River Book

Answers

Q1. The longest

Q2. Because it flows through a desert.

Q3. The Ethiopian Highlands.

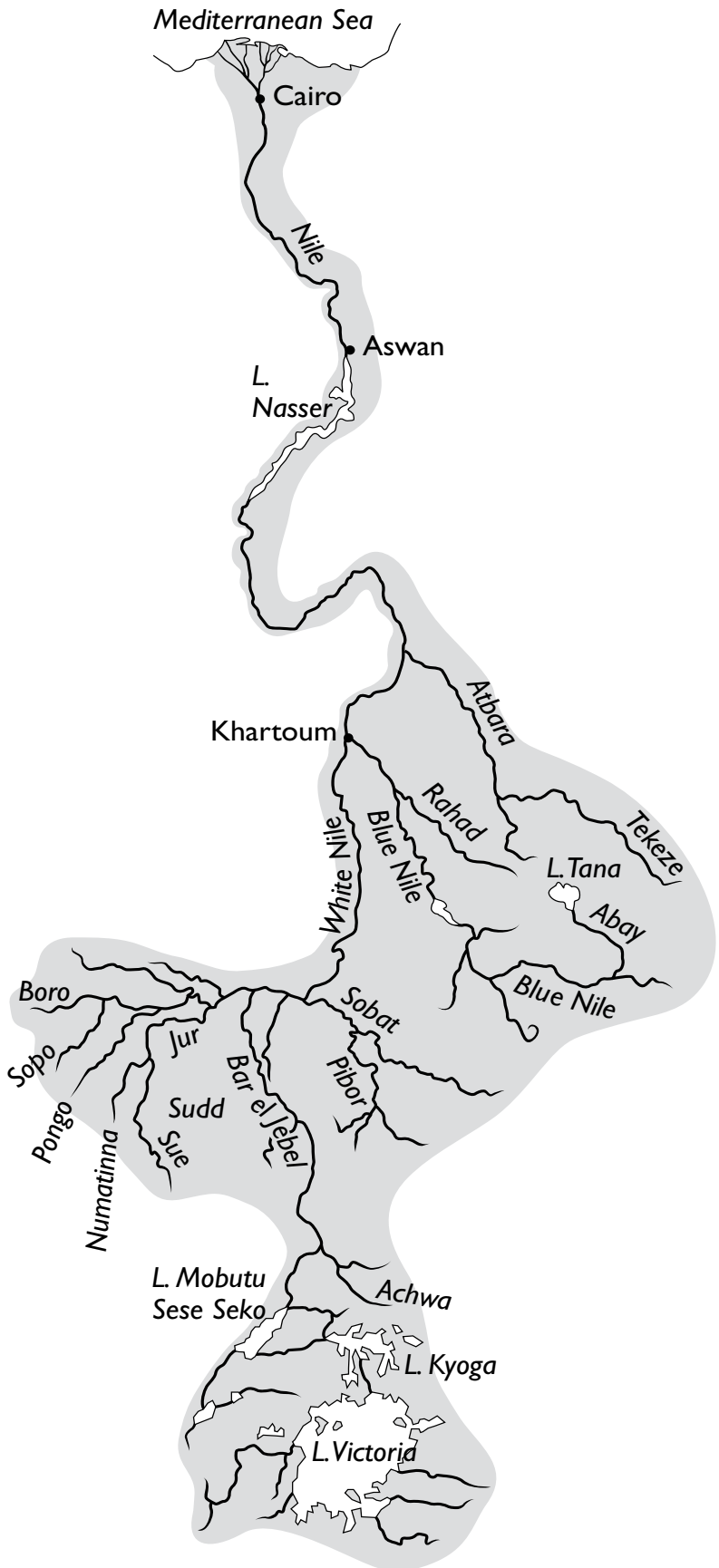
Q4. The Blue Nile.

Q5. Sudd.

Q6. Cairo.

Resources

- Photocopy of pages 96 and 97.
- The web site (River/Rivers of the World/ World Rivers) or *The River and Water CD* under 'World rivers'.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.


Mediterranean Sea
Cairo
Nile
Aswan
L.
Nasser
Khartoum
Atbara
Rahad
Blue Nile
White Nile
Tekeze
L. Tana
Abay
Blue Nile
Sobat
Boro
Sobo
Jur
Bar el Jebel
Pibor
Pongo
Sudd
Sue
Numatinna
L. Mobutu
Sese Seko
Achwa
L. Kyoga
L. Victoria

Name:..... Form:.....

See **page 45** of The River Book

Rhine

Q1. Is the River Rhine the biggest river in the world, the longest in the world, or the biggest river in western Europe?

✎ .....

Q2. Which is the biggest tributary of the Rhine?

✎ .....

Q3. Which is the main industrial river?

✎ .....

Q4. Which is the part of the Rhine which is famous for castles?

✎ .....

Q5. Which city can sea-going ships reach?

✎ .....

Q6. In which country does the Rhine have its source?

✎ .....

On this map of the Rhine, write the names of as many of the unnamed tributaries as you can. Use an atlas to help you.

Name:..... Form:.....

See **page 45** of The River Book

Answers

Q1. Biggest river in western Europe

Q2. Meuse

Q3. Ruhr

Q4. Rhine Gorge

Q5. Cologne

Q6. Switzerland

Resources

- Photocopy of pages 100 and 101.
- The web site (River/Rivers of the World/ World Rivers) or *The River and Water CD* under 'World rivers'.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.


Ijssel
Lek
Waal
Maas
Rhine
Ruhr
Meuse
Rhine
Lahn
Rhine
Main
Main
Nahe
Rhine
Moselle
Neckar
Rhine
Saverne
Meuse
Moselle
Ill
Rhine
Aare
Rhine

Name:..... Form:.....

See **page 46** of *The River Book*

Yangtze (Chang)

Q1. Is the Yangtze River the biggest river in the world, or the most useful in China?

✎ .....

Q2. How much of the Yangtze can be used by boats?

✎ .....

Q3. How far inland can ocean-going ships reach?

✎ .....

Q4. Which is the most famous part of the Yangtze?

✎ .....

Q5. What is happening that will alter this part of the river?

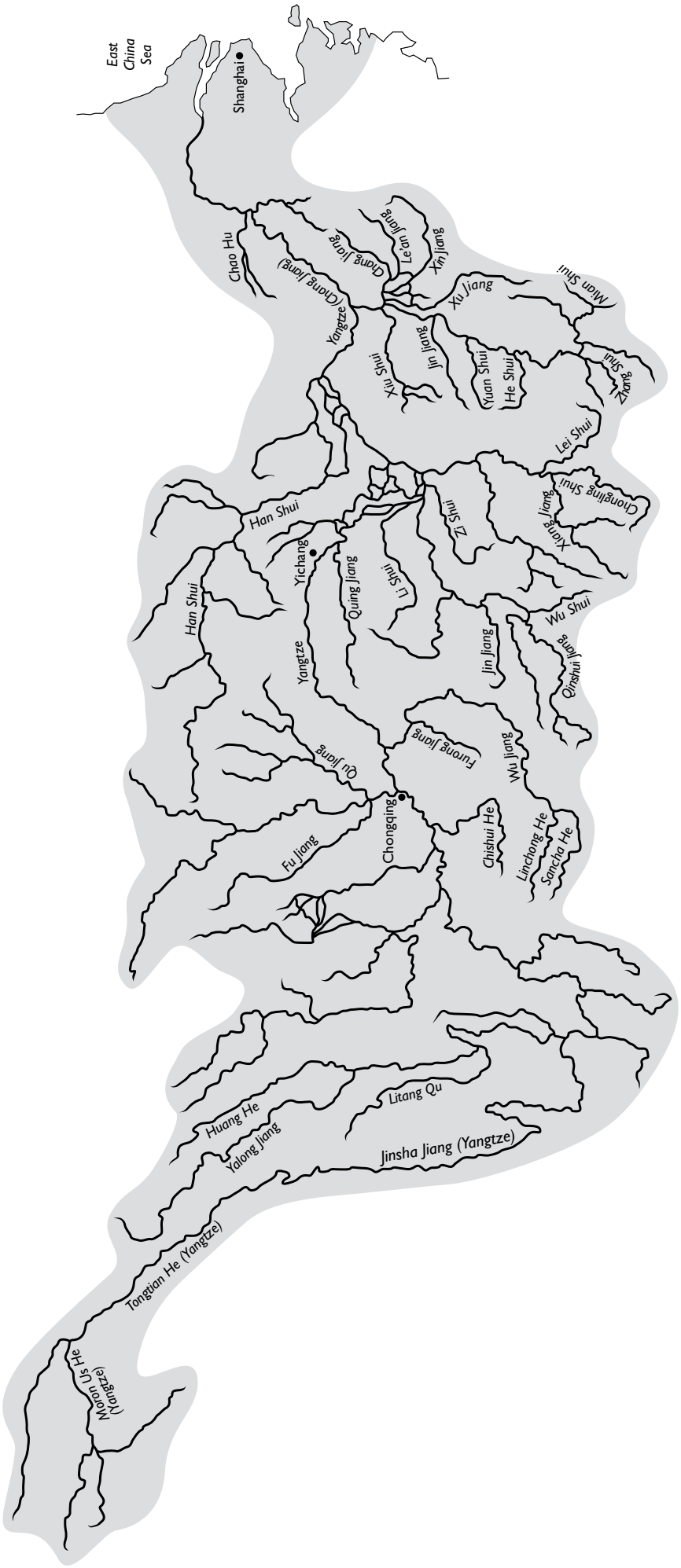
✎ .....

Q6. Why is the river a yellow or brown colour?

✎ .....

Name:..... **Form:**.....

On this map of the Yangtze, write the names of as many of the unnamed tributaries as you can. Use an atlas to help you.



Name:..... Form:.....

See **page 46** of The River Book

Answers

Q1. China

Q2. 30,000km

Q3. 1000km

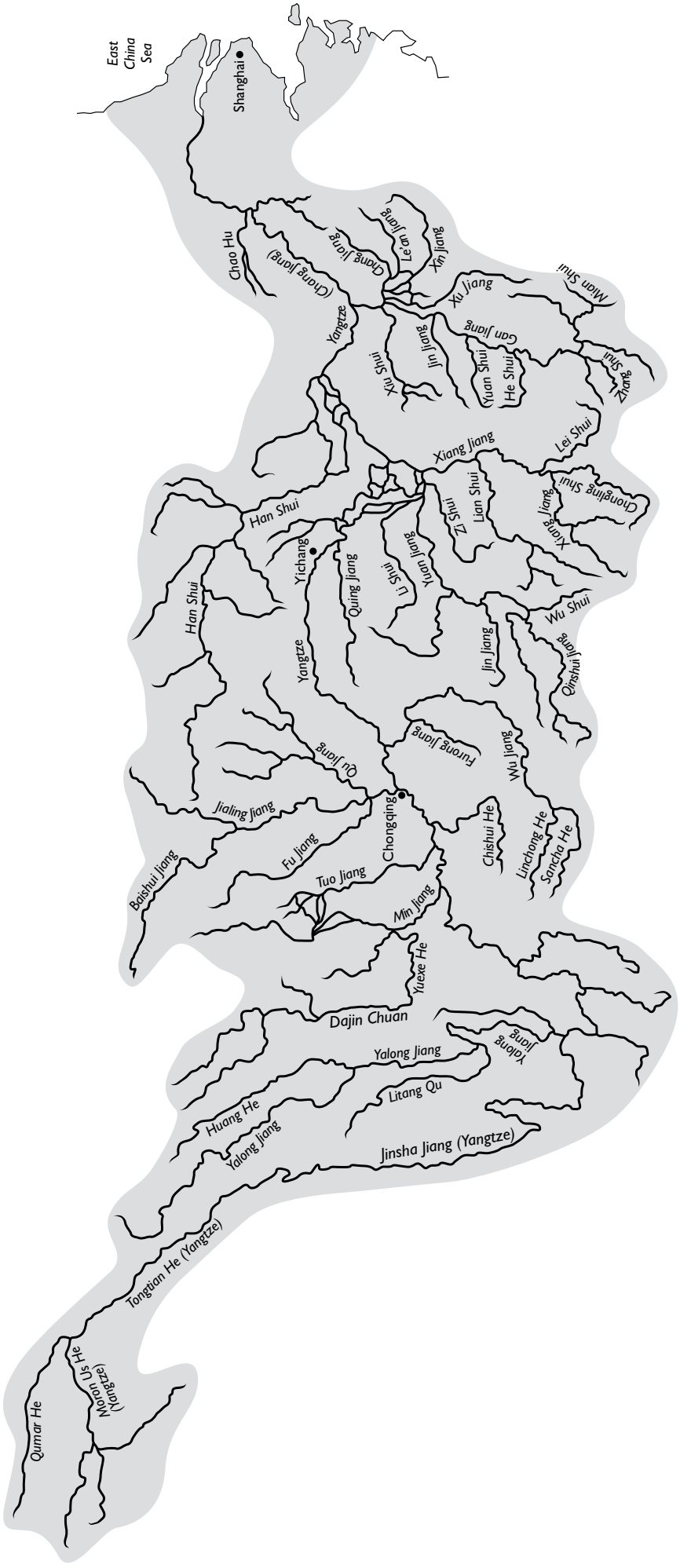
Q4. The Three Gorges

Q5. A dam – the Three Gorges Dam – is being built

Q6. The colour is caused by the large amount of silt that the river carries.

Resources

- Photocopy of pages 104 and 105.
- The web site (River/Rivers of the World/ World Rivers) or *The River and Water CD* under 'World rivers'.
- The extra information supporting this unit in the river section of the Curriculum Visions web site.


East China Sea
Shanghai
Chao Hu
Chang Jiang (Chang Jiang)
Yangtze
Le'an Jiang
Yix Jiang
Yix Jiang
Gan Jiang
Jin Jiang
Xiu Shui
Yuan Shui
He Shui
Miao Shui
Zhang Shui
Lei Shui
Xiang Jiang
Chongling Shui
Xiang Jiang
Lian Shui
Z Shui
Yuan Jiang
Li Shui
Han Shui
Yichang
Quing Jiang
Han Shui
Yangtze
Jin Jiang
Wu Shui
Qinshui Jiang
Furong Jiang
Wu Jiang
Qu Jiang
Jialing Jiang
Chongqing
Chishui He
Linchong He
Sancha He
Fu Jiang
Baishui Jiang
Tuo Jiang
Min Jiang
Yuexe He
Dajin Chuan
Yalong Jiang
Yidong Jiang
Litang Qu
Huang He
Yalong Jiang
Jinsha Jiang (Yangtze)
Tongtian He (Yangtze)
Qumar He
Moron Us He (Yangtze)

Name:..... Form:.....

River crossword 1a

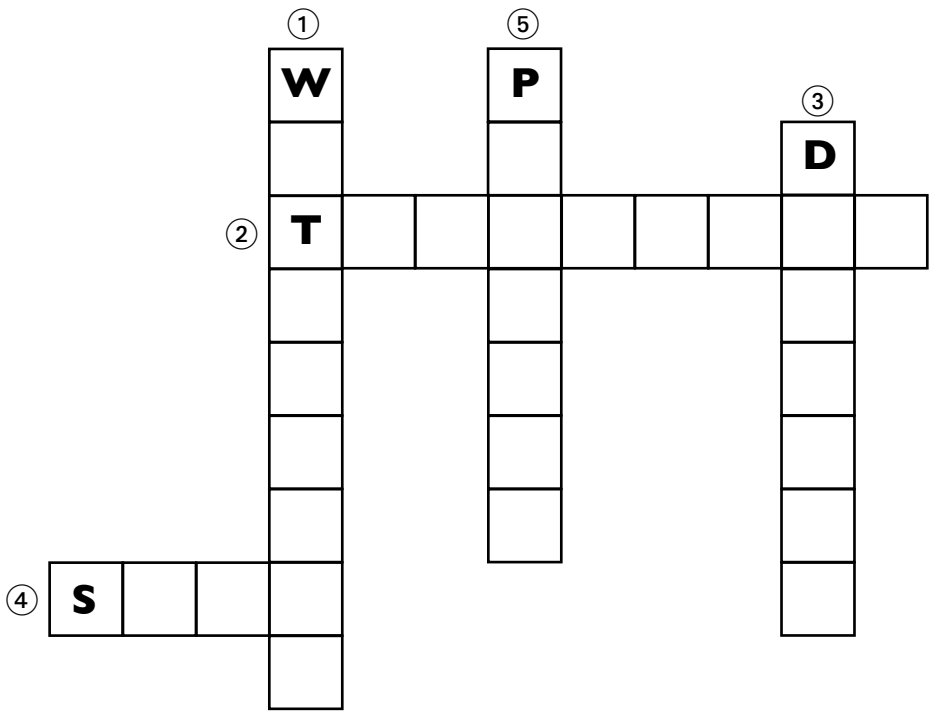
① (down). A river falling over a cliff (page 4)

② (across). The name for a small branch of a river (page 4)

③ (down). A period when there is no rain (page 8)

④ (across). The thin surface layer of ground that acts like a sponge (page 8)

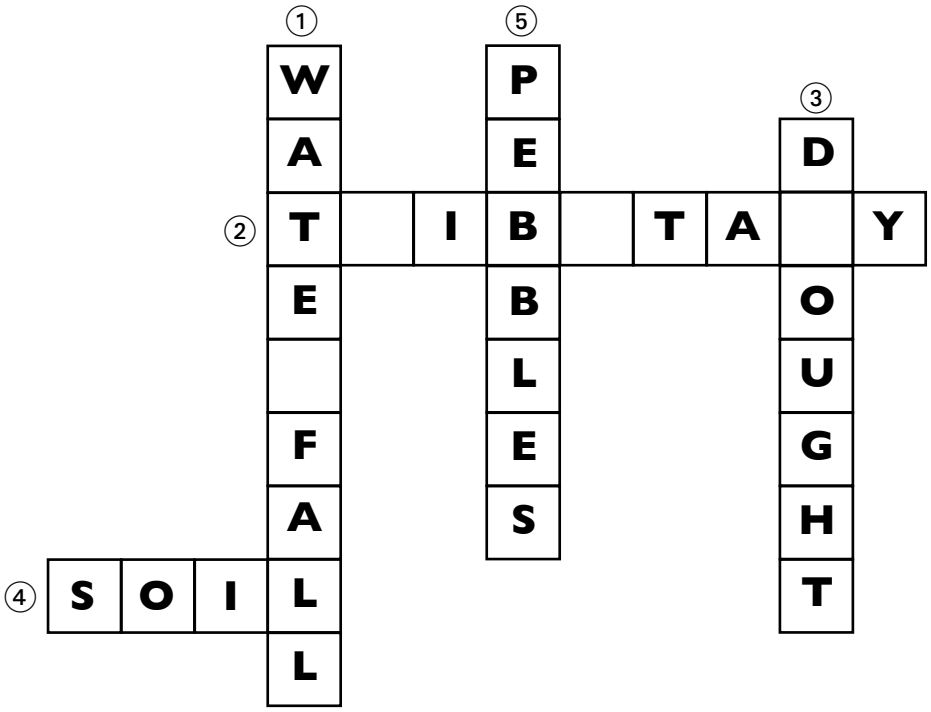
⑤ (down). Swollen rivers can easily push these along (page 10)



Crossword Answers

Answers to crossword 1a

This crossword is simpler than 1b but covers the same material.



Name:..... Form:.....

River crossword 1b

① (down). When water vanishes into thin air (page 8)

② (down). Spaces in soils and rocks (page 9)

③ (across). The way pebbles are worn down (page 11)

④ (across). Cycling water (2 words) (page 8)

⑤ (across). Lack of rain (page 8)

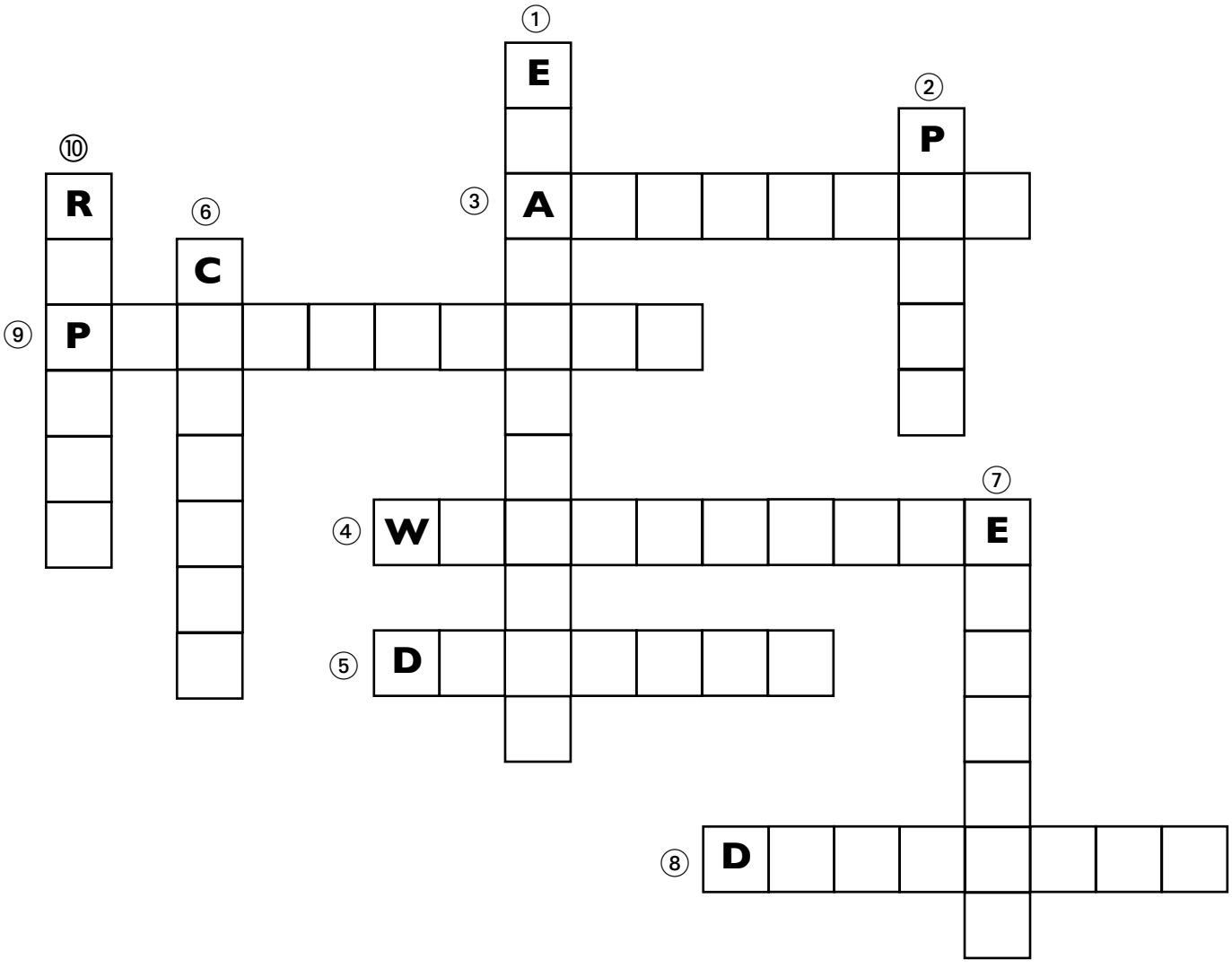
⑥ (down). The swiftest part of a stream (page 12)

⑦ (down). Wearing the land away (page 10)

⑧ (across). Word for 'solution' (page 12)

⑨ (across). The pool of a waterfall (2 words) (page 16)

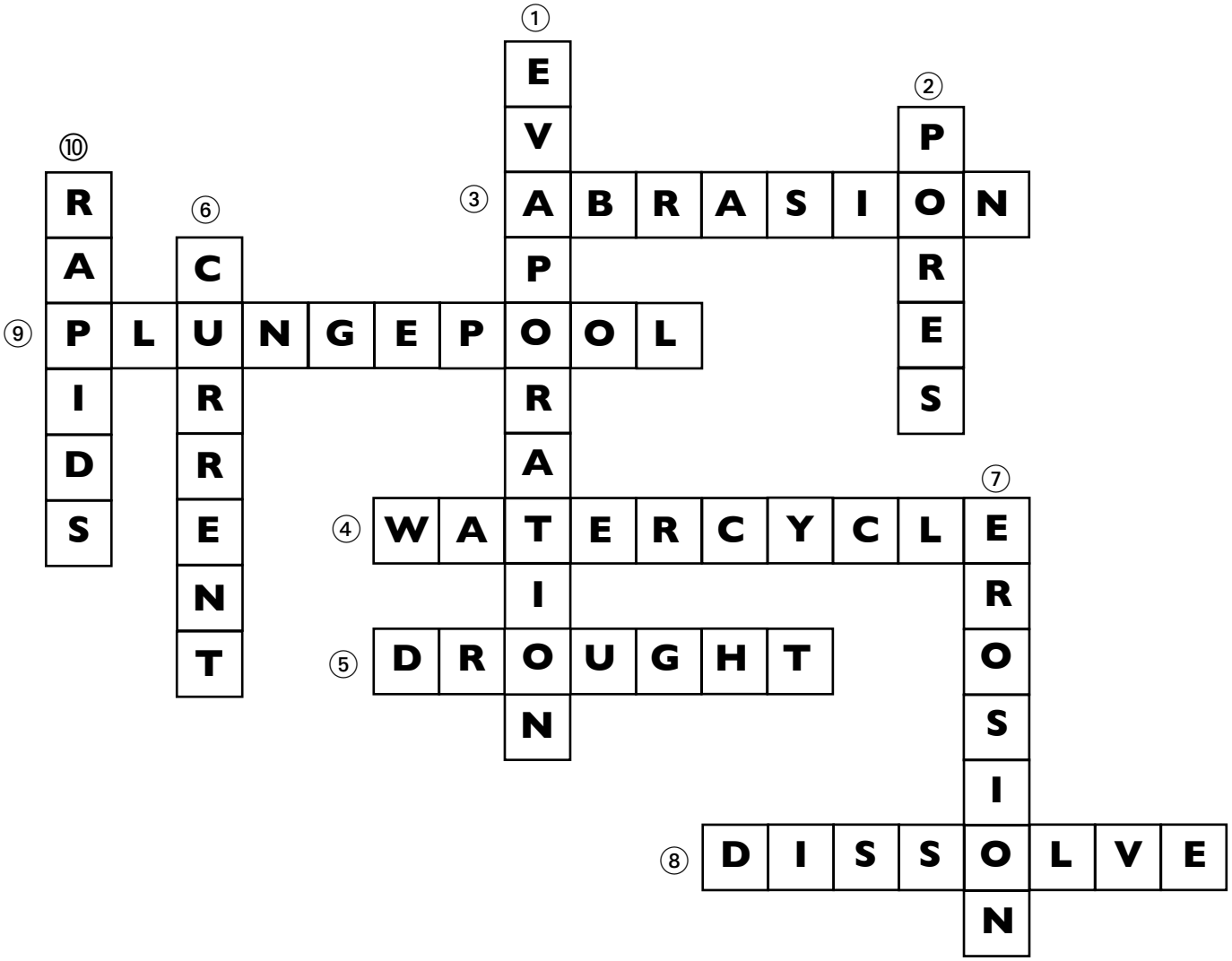
⑩ (down). Steep foaming part of a river (page 17)



Crossword Answers

Answers to crossword 1b

This crossword is more difficult than 1a but covers the same material.



Name:..... Form:.....

River crossword 2a

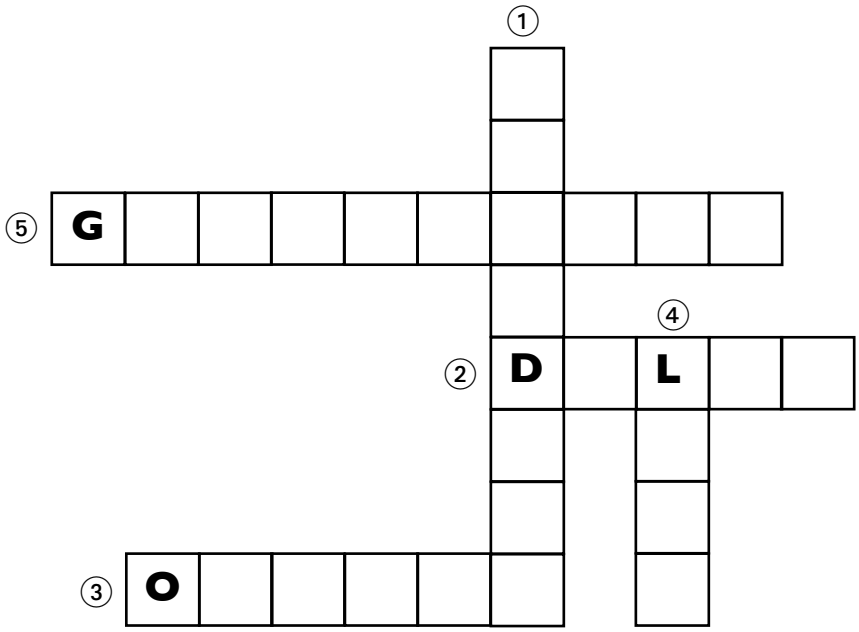
① (down). The name for curves in a river (page 14)

② (across). The place at the mouth of a river where new land is made (page 24)

③ (across). Very pronounced river bends (page 20)

④ (down). A large volume of still water (page 22)

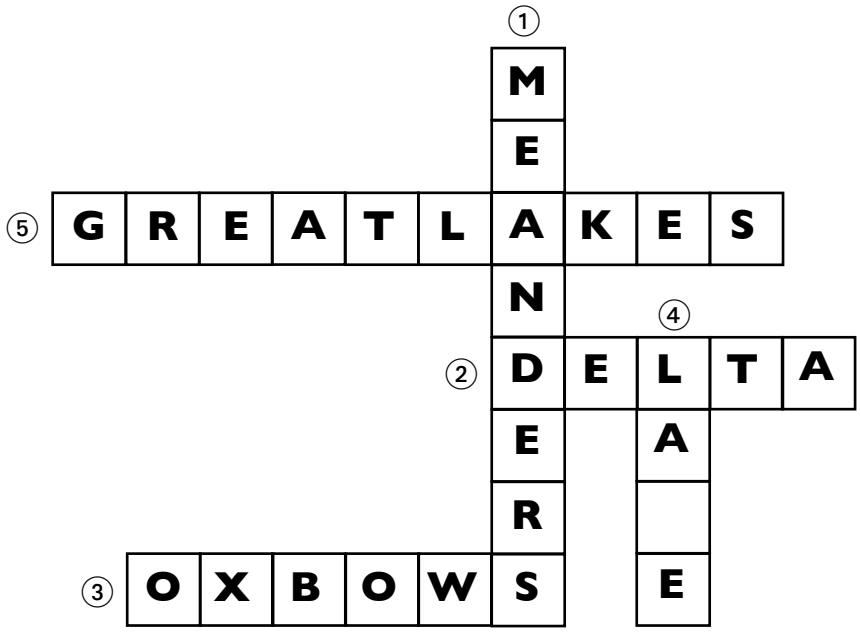
⑤ (across). The world's biggest lakes (two words, page 22)



Crossword Answers

Answers to crossword 2a

This crossword is simpler than 2b but covers the same material.



Name:..... Form:.....

River crossword 2b

① (down). The name for bends in a river (page 14)

② (across). The place where sediment is dropped at the river mouth (page 24)

③ (down). Body of still water (page 22)

④ (down). Meanders with necks (page 20)

⑤ (across). Boundary of a drainage basin (page 9)

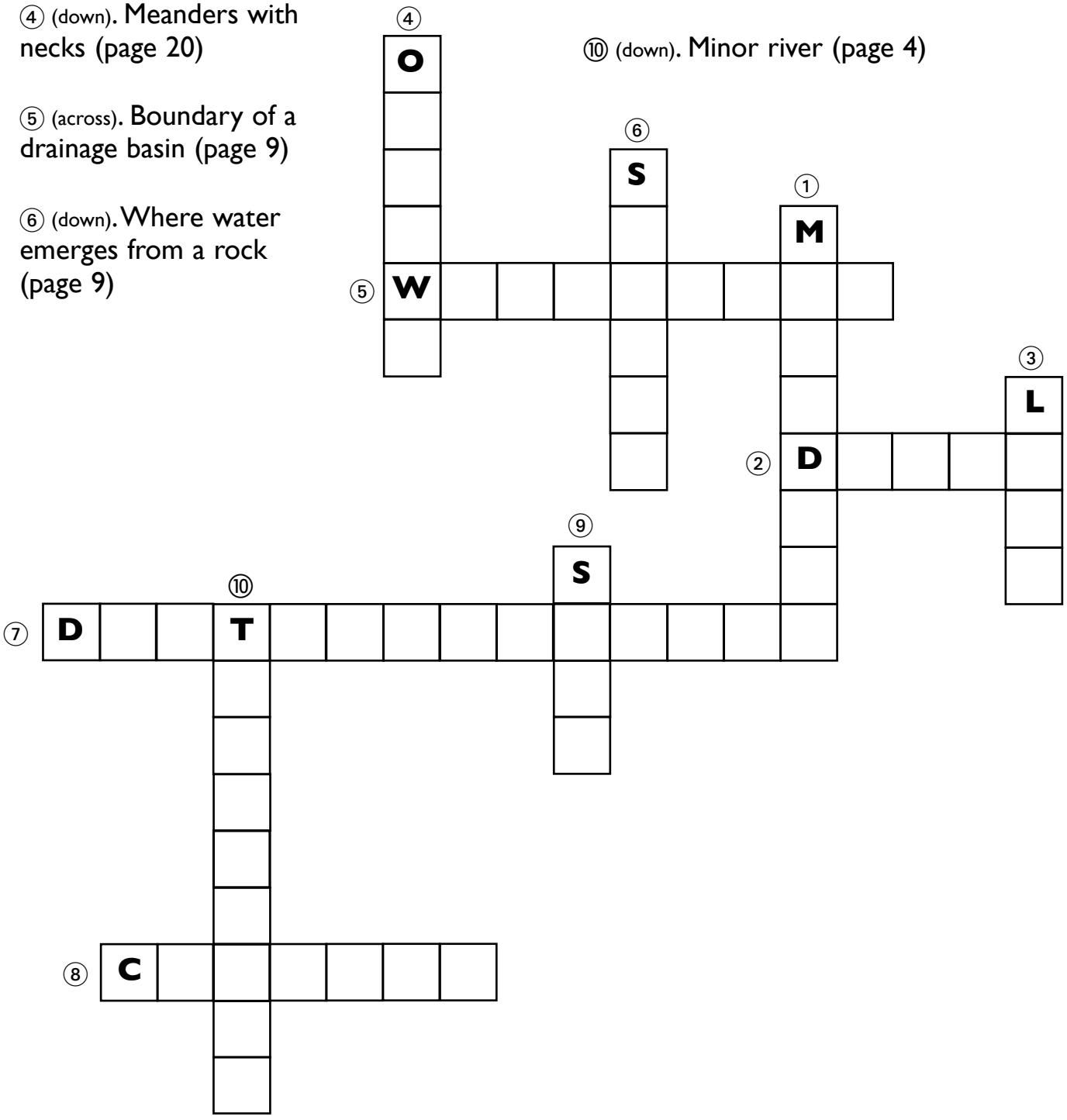
⑥ (down). Where water emerges from a rock (page 9)

⑦ (across). Small channels flowing over a delta (page 24)

⑧ (across). The name for where a river flows (page 18)

⑨ (down). This material is found in rivers and on beaches (page 11)

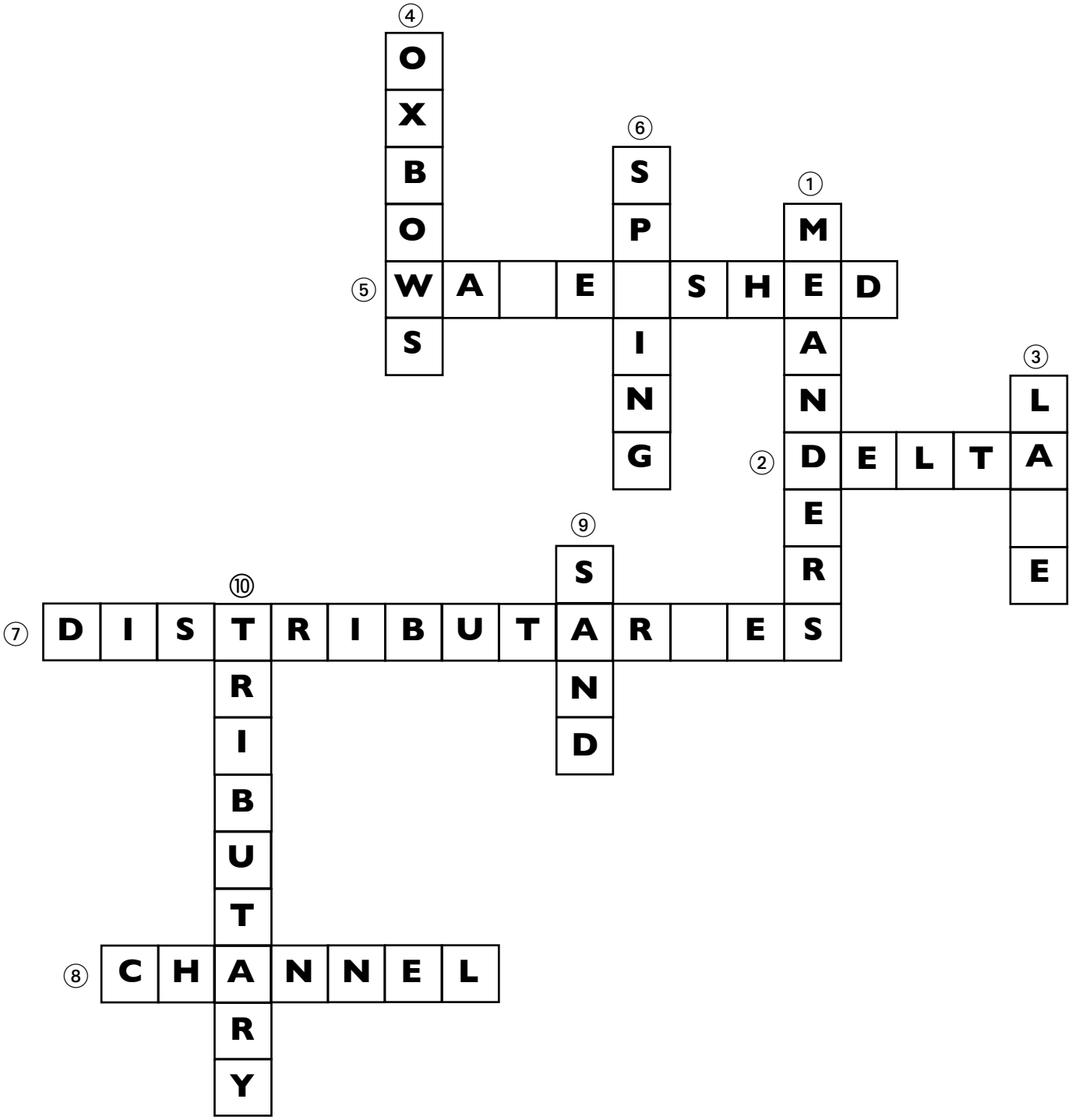
⑩ (down). Minor river (page 4)



Crossword Answers

Answers to crossword 2b

This crossword is more difficult than 2a but covers the same material.



Section 6: 'The River and Water CD' explained

Please note some of The River and Water CD material is also available under 'Geography/River/In-depth...for Projects' as part of the subscription to CurriculumVisions.com.

The specific purpose of *The River and Water CD* and 'Projects' area of the web site is to enhance the topics introduced in the student book and to allow students to undertake independent research using material presented for their age and ability.

It is possible to use the student book and the CD/web site independently. However, they are designed to reinforce one another.

The River and Water CD/web site give a kaleidoscope of photographs and data which simply couldn't be fitted into the book. At the start of their course students could begin by clicking on the 'World rivers' button from the home screen and then taking the 'Spoken tour', before working their way through *The River Book*, at appropriate moments referring to the CD/web either in class or in their own time. They can also use the CD/web as a basis for any research projects you might set them.

Using the CD version

The CD information is browser-based, which means that it can be opened in any browser used to surf the Internet (although it is optimised for Internet Explorer 5 and above).

The purpose of using a browser application is to make the CD content look and feel just the same as it would on the Internet. You can network the CD (provided you have bought a licence) so that many students can access the data at the same time.

Installing the CD

The CD can be used on both Macintosh and Windows-based machines.

Inserting the CD will usually cause it to start up automatically in Windows. However, this depends on the configuration of your machine and the place where the browser application is kept.

If the CD does not automatically start up your browser, then do this:

Windows

1. Eject the CD and try again. If it still doesn't start then:
2. Open Internet Explorer.
3. Type Control O and browse until you find your CD drive. In it look for the file 'index.html'. Select this and click OK.
4. Save the home screen as a Favorite for quick location in future.

Mac OS X (Instructions for first time loading)

1. Place the CD into your CD drive.
2. Open Internet Explorer by double-clicking on its icon in the dock.
3. Type (Command) O and browse until you find the CD.
4. Inside the CD scroll down to 'index.html'. Double click on 'index.html' to launch the CD.
   (Important: do not double click directly on index.html – open it from within your browser.)

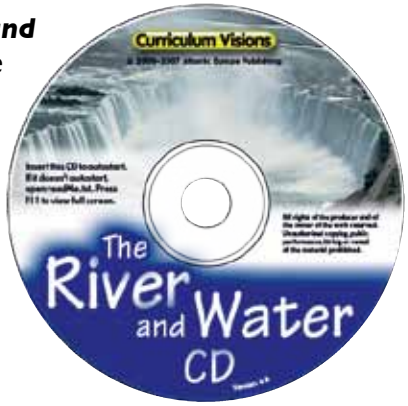
In all cases, once you have got the disk working, make the home screen of *The River and Water CD* one of your Favorites

and then when you load the disk next time you can find *The River and Water CD* directly from this list.

Copying text and images

All of the elements are unlocked and can therefore be copied for use in other documents. Simply scroll across text or (right) click on images to copy them in the method that suits you. Please note that copyright restrictions apply to the use of images.

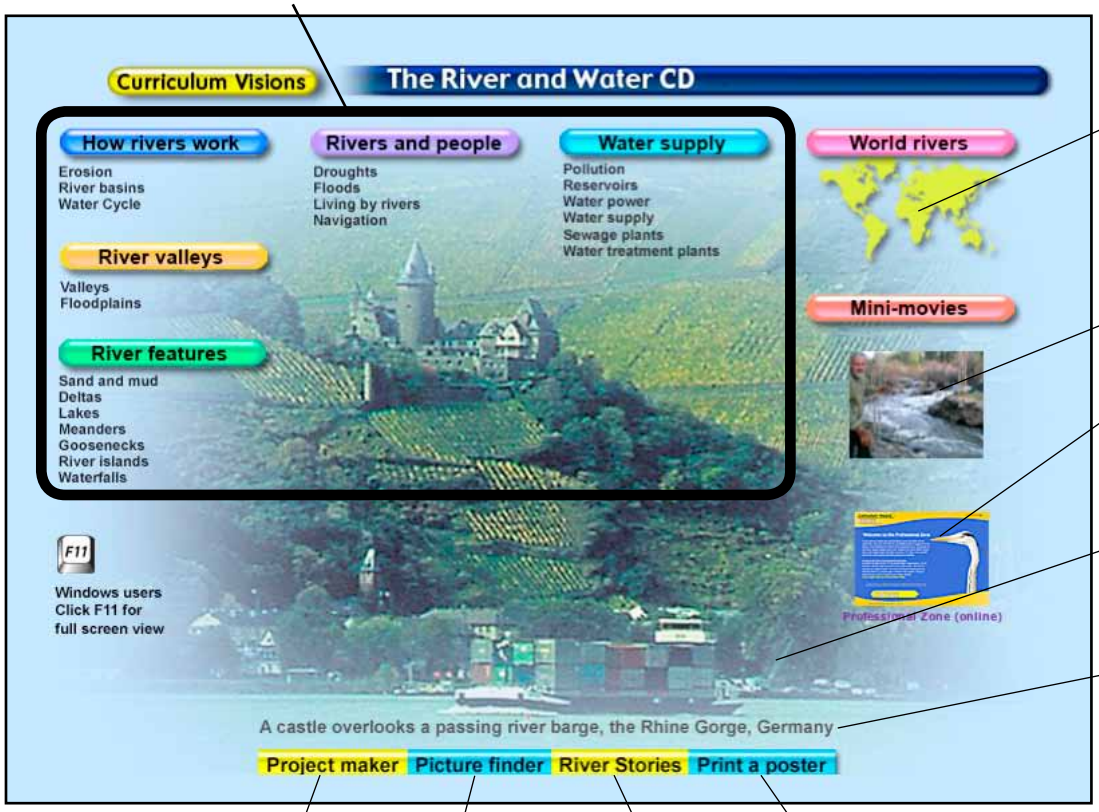
▶***The River and Water CD*** *(the appearance of the CD and its contents may vary from that shown on these pages)*



The home screen

The home screen should give students an immediate feel for the nature of rivers through its collage of pictures. The home screen also contains links to take students to the various parts of the data. The links include major sections on river features, water, valleys, and so on, UK and world rivers, river stories and other activities.

▼ A screen capture of the home screen (the background picture will change randomly every time the screen is refreshed).



There is also a major section of mini-movies.

Topics

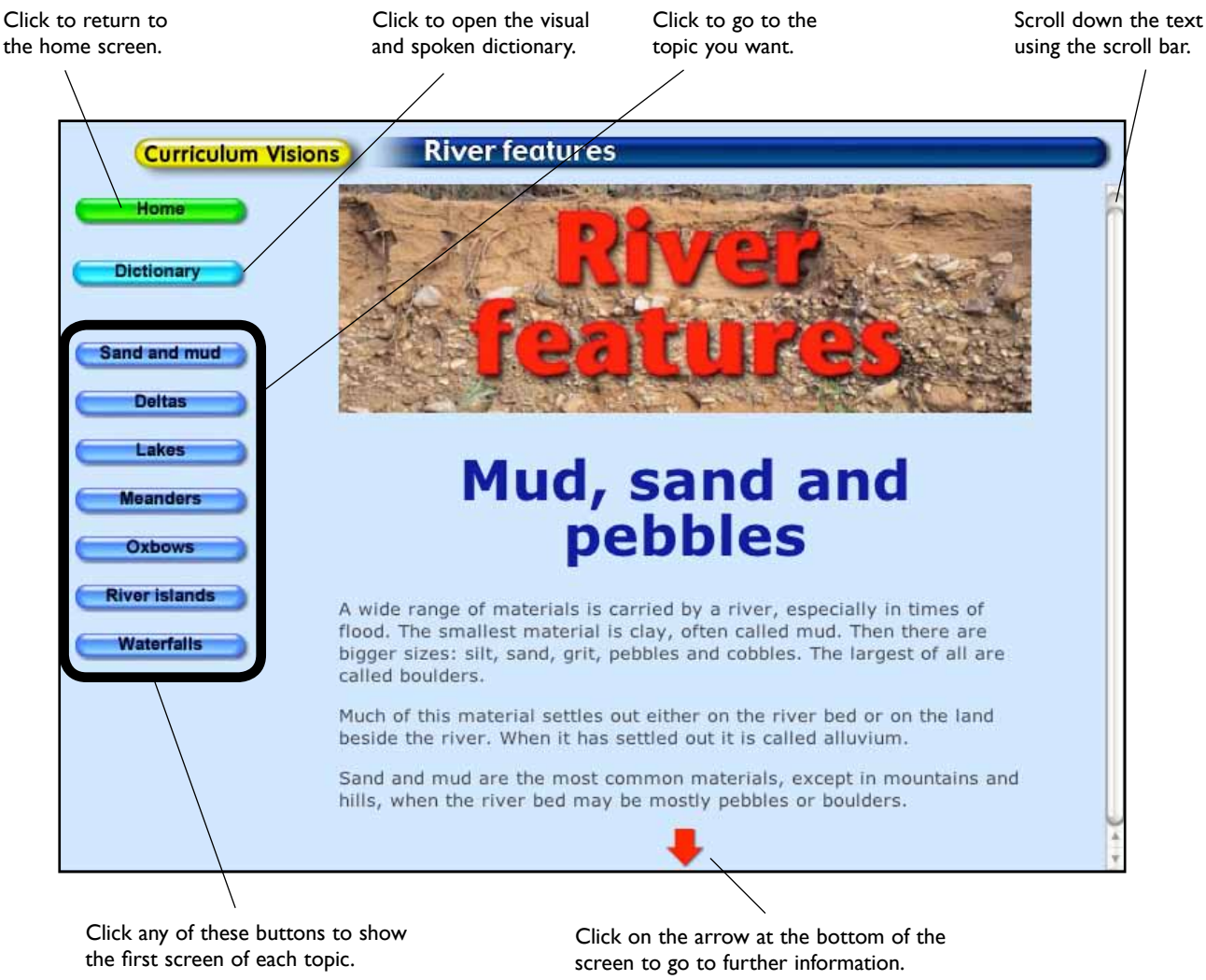
The river topics are accessed through the links at the top of the home screen. They each contain information that is organised by sub-topic.

There is more than enough material here to occupy students for many hours and therefore it is essential that you help them to understand what is involved. But the most important thing to realise is that all of this information is presented at the right curriculum level and will, therefore, save students having to go searching around the Internet to find suitable material. This is not to say they shouldn't go to the Internet, but we feel they should go to the Internet after they have benefited from the structure provided by our CD/web site.

The topics are a systematic way of going through an area of work. The topics are listed on the left-hand side of each screen.

Each topic consists of a summary page and a more detailed page or pages. This will allow **differentiated learning**. The pages are accessed by the arrows at the top and the bottom of the text panel.

▼ This screen capture shows the main features of each topic group.



World rivers guide: rivers at home and overseas

The section on world rivers allows students to find out about rivers in the United Kingdom and overseas.

From the world rivers button, they can go to a world map and choose their region of interest.

The first screen of the world rivers section allows students to choose a region or to listen to a commentary about rivers of the world.

By clicking on a region, it is possible to navigate to a chosen river by using an interactive map and a list of rivers. Only some rivers are put on the maps.

▼ This screen capture shows the world rivers section. From here you can select a region and find out about its rivers.

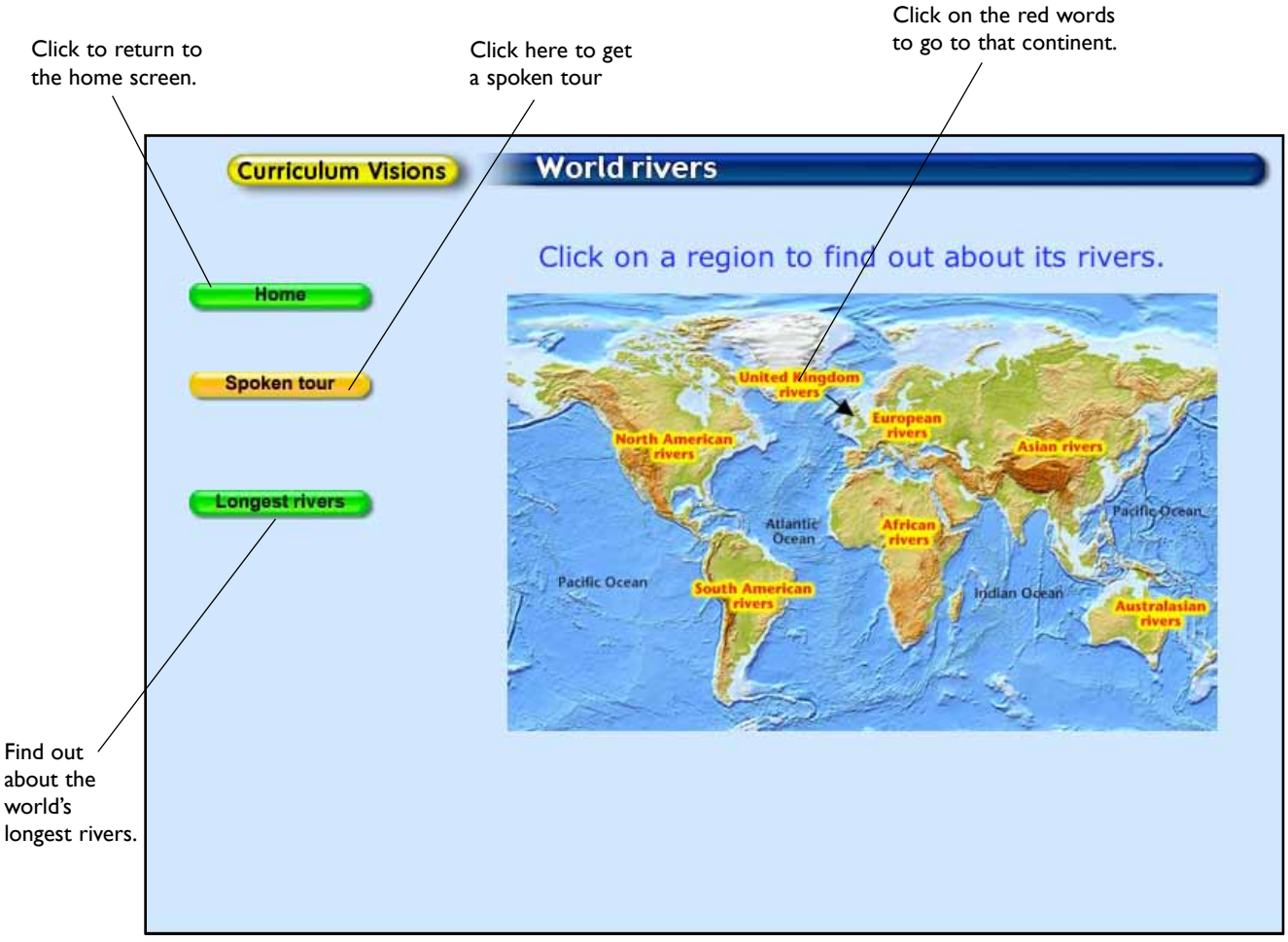
The number of rivers covered is far greater than the space available on a map! So use the map for large rivers and use the rivers list to find others.

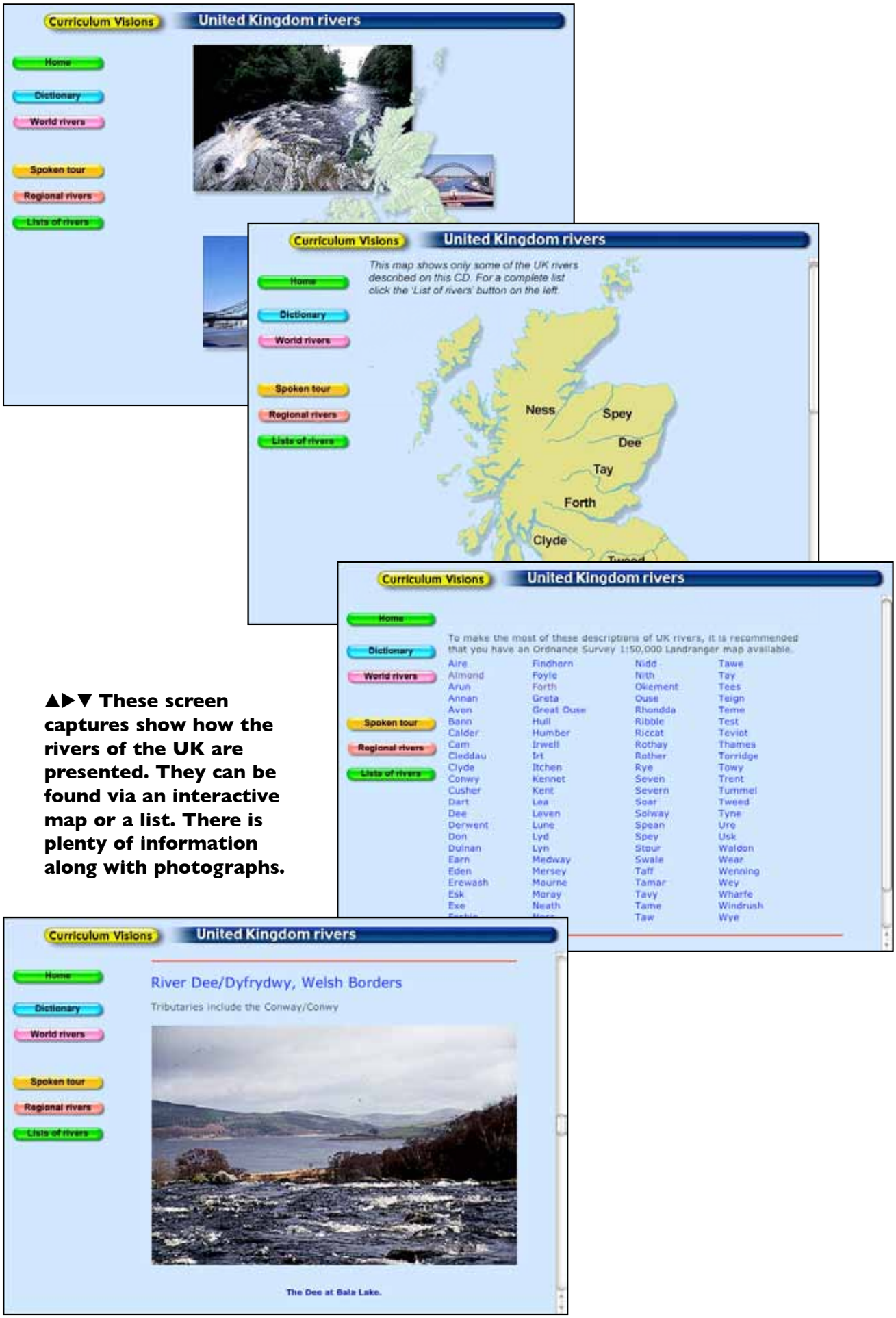
Home rivers

UK rivers command a substantial treatment in this CD/web site. The overview screen provides the opportunity to listen to a commentary which sets the scene or to click the interactive map or to click the list of rivers.

Overseas rivers

A very large number of rivers are given for overseas locations, with some emphasis on the rivers of Europe and North America. Students will easily be able to find the Zambesi, Victoria Falls, the Nile, the Amazon, the Rhine and so on. You may also encourage students to look at rivers they have not heard of.





▲▶▼ These screen captures show how the rivers of the UK are presented. They can be found via an interactive map or a list. There is plenty of information along with photographs.

Dictionary

You will find this facility on all navigation bars throughout. Whenever students want to know about a curriculum word they should click on this button. The dictionary contains only curriculum words. It is not a global dictionary, but focuses on those words that students will need.

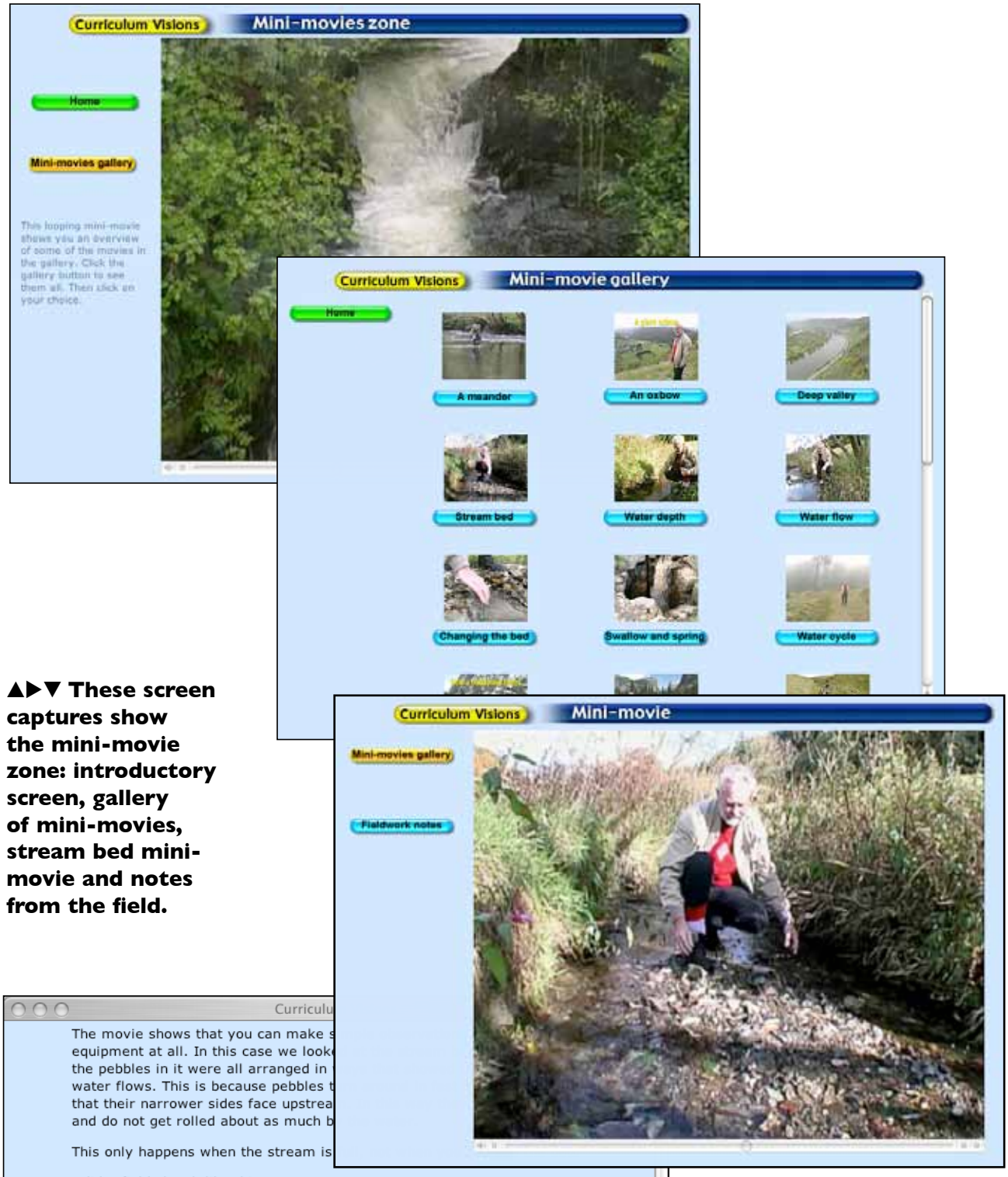
◀▼ These screen captures show the visual dictionary and the start of the entry for spring.

Project maker

Many students want to do a research project and this section provides a structured approach to this area of work.

An introduction about the nature of the project is followed by a sheet which encourages structured collection of information. This can be printed from the screen or printed out from an accompanying .pdf format to get better printing quality.

▼ The project maker screen.



▲▶▼ These screen captures show the mini-movie zone: introductory screen, gallery of mini-movies, stream bed mini-movie and notes from the field.

Picture finder

There are many occasions when students want to find an example of a feature. This is made easier by the Picture Finder. It is a list that gives the main features of each river covered.

The links take the student to the river they have selected, but after that they have to find the example from the photos available for that river. This will enhance their research skills at a suitable level.

Having found their choice they can then copy and paste into their own work.

Mini-movies zone

You can access the 24 mini-movies from the home screen by clicking above the small movie that plays on the right hand side of the home screen. (To save loading time the movie only plays on the introduction screen the first time it is accessed. After this it is represented by a still icon.)

The movie zone is a major feature and gives unrivalled access to specific topics. You can play these movies on a computer or you can play them on an electronic whiteboard for whole class teaching.

Each mini-movie is designed to show briefly, but clearly, a specific curriculum point about rivers.

Click through the overview movie to get to the gallery. Then select the gallery item you want.

Note you must have Quicktime 7 to play these movies. If you do not have it, then a dialogue box will appear explaining how to get Quicktime. Or you can download it first free at www.quicktime.com.

Once you have played the movie, you can use the controller below the movie to play the clip again or select parts to play and review.

Next to the movie is a button which, when clicked, will bring up a sketch of the kind students might be encouraged to make in the field. The sketch also focuses on part of the movie, showing students what the key point was. As with all parts of the CD except for the movies, you can copy and paste these field notebook sketches and you may want to put them on to A4 sheets so students can see them while the movies are playing.

Section 7: 'The River Picture Gallery' explained

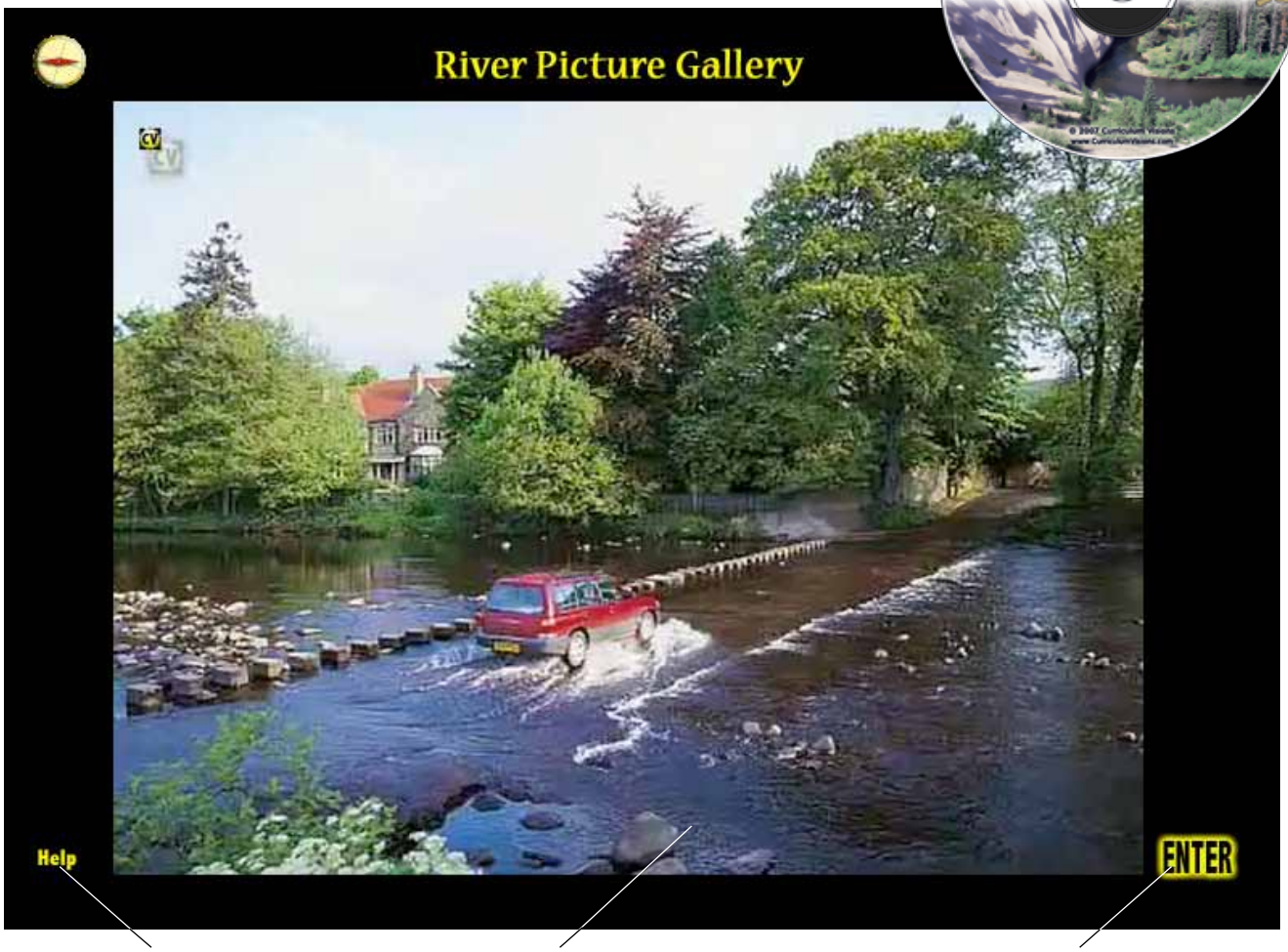
The River Picture Gallery is available for separate purchase on CD or online when you subscribe to www.curriculumvisions.com. It requires the plug-in divX (from www.divX.com) to run the introduction animation. The gallery contains 100 photographs and diagrams that can be used for any curriculum area, such as literacy, but the images have been specially selected for the river topic. Many of the pictures are in *The River Book* allowing you to integrate your teaching and reinforce key geography concepts.

Using the CD version

As with *The River and Water CD*, the information in *The River Picture Gallery* on CD is browser-based, which means that it can be opened in any browser used to surf the Internet (although it is optimised for Internet Explorer 5 and above).

A browser application makes the CD content look and feel just the same as it would on the Internet. You can network the CD (provided you have bought a licence) so that many students can access the data at the same time.

▼ This is the startup screen for The River Picture Gallery on CD *(the appearance of the gallery and its contents may vary from that shown)*.



Help section.

Introductory 'movie' displaying some of the pictures in the gallery.

Click here to go straight into the gallery with the thumbnail view of all 100 pictures.

Installing the CD

The CD can be used on both Macintosh and Windows-based machines.

Inserting the CD will usually cause it to start up automatically in Windows. However, this depends on the configuration of your machine and the place where the browser application is kept.

If the CD does not automatically start up your browser, then do this:

Windows

1. Eject the CD and try again. If it still doesn't start then:
2. Open Internet Explorer.
3. Type Control O and browse until you find your CD drive. In it look for the file 'index.html'. Select this and click OK.
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1. Place the CD into your CD drive.
2. Open Internet Explorer by double-clicking on its icon in the dock.
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4. Inside the CD scroll down to 'index.html'. Double click on 'index.html' to launch the CD.
   (Important: do not double click directly on index.html – open it from within your browser.)

In all cases, once you have got the disk working, make the home screen of *The River Picture Gallery* one of your Favorites and then when you load the disk next time you can find *The River Picture Gallery* directly from this list.

Using the Picture Gallery

The home screen

(*See overleaf, on page 126, for illustrations of the screens described below.*)

When you enter the gallery you see thumbnails of all 100 pictures.

If you click on any of the pictures in the gallery it will show as an enlarged 'pop-up' view. Clicking on this pop-up picture will take you back to the gallery with the thumbnail view.

Each picture has a simple caption underneath it. At the end of each caption you are given a number of options:

...More... brings up an extensive caption describing the picture and additional information including cross links to other topics. This description helps children with observation and interpretation skills. It is ideal for literacy tasks.

...Enlarge... places the picture in a larger frame.

...Postcard... arranges the selected image into a postcard format, complete with humorous 'stamp' and space for the children to write their own message. Just trim to the shape shown and fold the piece of paper over.

You can create a postcard with any one of the 100 pictures in the gallery. Once again an ideal literacy aid.

Copying text and images

All of the elements are unlocked and can therefore be copied for use in other documents. Simply scroll across text or (right) click on images to copy them in the method that suits you.

Index

This displays an alphabetical listing of key words on the left panel. If you click on any corresponding image numbers shown after the key word then the relevant picture will be displayed in the pop-up view on the right.

Teacher's notes

The Teacher's notes section provides a printable PDF file giving advice on using the Picture Gallery, and yet more information on each of the pictures contained within it.

Main screen
Click any thumbnail picture in the gallery to see a pop-up view.

Scroll down the text using the scroll bar.

Click on any image and it will be enlarged in the pop-up view.

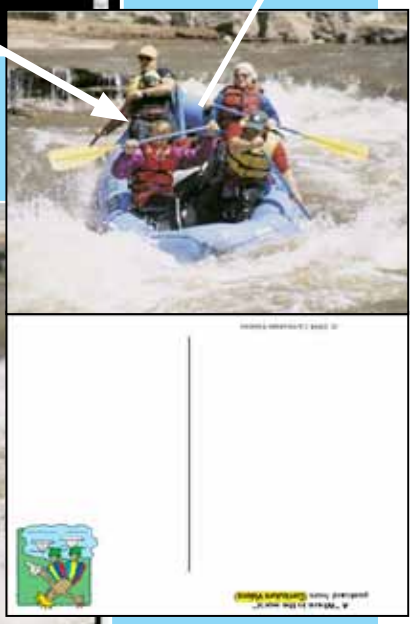
Picture captions are extended in the pop-up view.

View the index
Key words with links to related images in the gallery.

Click on the pop-up image to return to the home screen.

Teacher's notes
includes a PDF providing further information for teachers.

Postcard
Turn any one of the 100 pictures into a postcard and print it for use in literacy or geography tasks!



More provides a description of the image and additional background information.

Enlarge displays the image in a larger view.