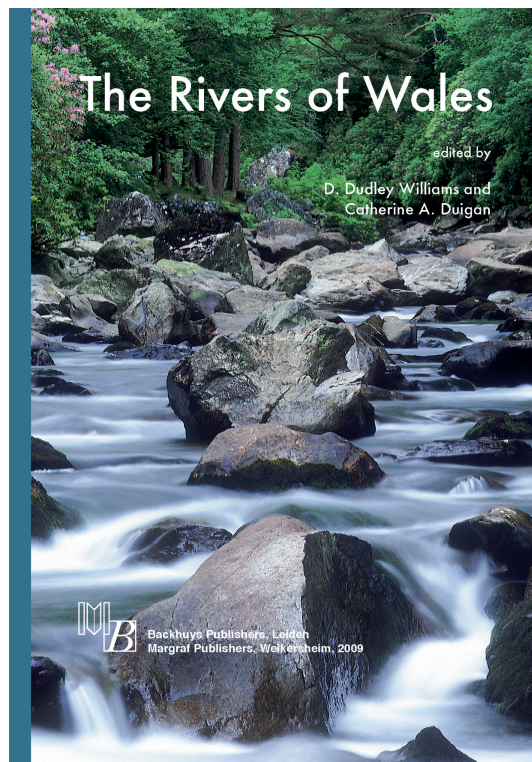


Chapter 2

Rivers in the Welsh physical and cultural landscape

Catherine Duigan

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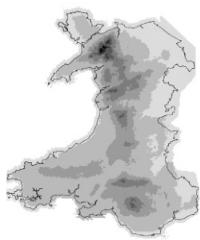


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Chapter 2

Rivers in the Welsh physical and cultural landscape

Catherine Duigan

Introduction

Rivers have carved the face of Wales producing a physical and cultural landscape. The rivers are a product of the Welsh weather, which is a variable feast of constantly changing conditions. The mean annual temperature at low altitudes in Wales varies from about 9.5°C to 10.5°C, with the higher values occurring around or near the coast (Meteorological Office data). This temperature value decreases by approximately 0.5°C for each 100 m increase in height; around one quarter of Wales is over 305 m. Location, wind and cloud influence the duration of sunshine and rainfall. Along the Ceredigion (Dyfed) coastline an annual average total of over 1,700 hours of sunshine is achieved, whereas the mountainous areas have totals less than 1,100 hours (Meteorological Office data).

We are blessed with an abundance of water. Snowdonia is the wettest part of Wales with an average total of 3,000 mm of rainfall per year, and it is delivered in a distinct seasonal pattern (Figure 1); the coastal regions and the east accrue less than 1,000 mm (Figure 2) (Meteorological Office and Environment Agency data). Most of the rain falls between October and January and a number of severe winter flood events have been experienced in the last decade (Figure 1; see Side Bar 1). The average number of days each year when snow or sleet falls varies from 10 or less in the southwest to greater than 40 in Snowdonia (Meteorological Office data). Approximately 45 percent of the rainfall is evaporated or used by plants.

This temperate climate has produced over 20 major river systems draining a total surface area of 20,770 km² within a region that is 256 km long by 96 km wide (Welsh Assembly Government data). An intricate surface drainage pattern has developed on the underlying geology (Frontispiece), often replacing the rivers of ice that dominated during the last Glacial Period. The water resource supplies a population of 2.95 million in Wales, with about two thirds concentrated in the southeast around Cardiff, the capital city. However, there are additional demands from the nearby large metropolitan areas

in the midlands of England. Due to extensive areas of hard bedrock, there is little underground storage; so the majority of the rainfall is quickly channelled to the river systems making them very responsive to periods of heavy rainfall or drought. Some of the rain is stored in wetlands and lakes which act as reservoirs slowly releasing the water during drier periods. This environment has helped to define the nature of Welsh rivers and has sculpted the landscape.

The mountain rivers of Snowdonia and mid-Wales are relatively short, steep and fast-flowing. Some of them are fed by tributaries arising on Snowdon, the highest peak in Wales (1,085 m), and reach the sea within 20 km. The larger rivers flowing to the east and south have a similar upland genesis but also have the space and time to make a slow meandering voyage to the sea through extensive areas of floodplain. For example, the River Wye has an estimated length of 250 km from source to mouth. In turn, the regions through which they pass influence these rivers. The soft, clear acid waters of the uplands run through acidic thin soils often supporting only sheep farming, forestry and tourism ventures. Travelling through the landscape also has a major effect on the chemical properties of river water, and pronounced regional differences have been described for Wales (British Geological Survey 1999). The degree of acidity of rainwater as measured by a pH value is around 5.6. As the rainwater percolates through the soil in poorly buffered upland areas this value changes under the influence of soil carbon dioxide and organic acids and produces acidic stream water (Plate 1). Higher pH values reflect more availability of base cations from the underlying geology, soil, and from human sources. They are generally associated with the coastal areas and lowlands (Plate 1). This distribution pattern is also discernible in water conductivity measures and other chemical parameters (British Geological Survey 1999). On a regional scale, this environmental variation and interaction supports a diversity of microclimates, habitats, wildlife and

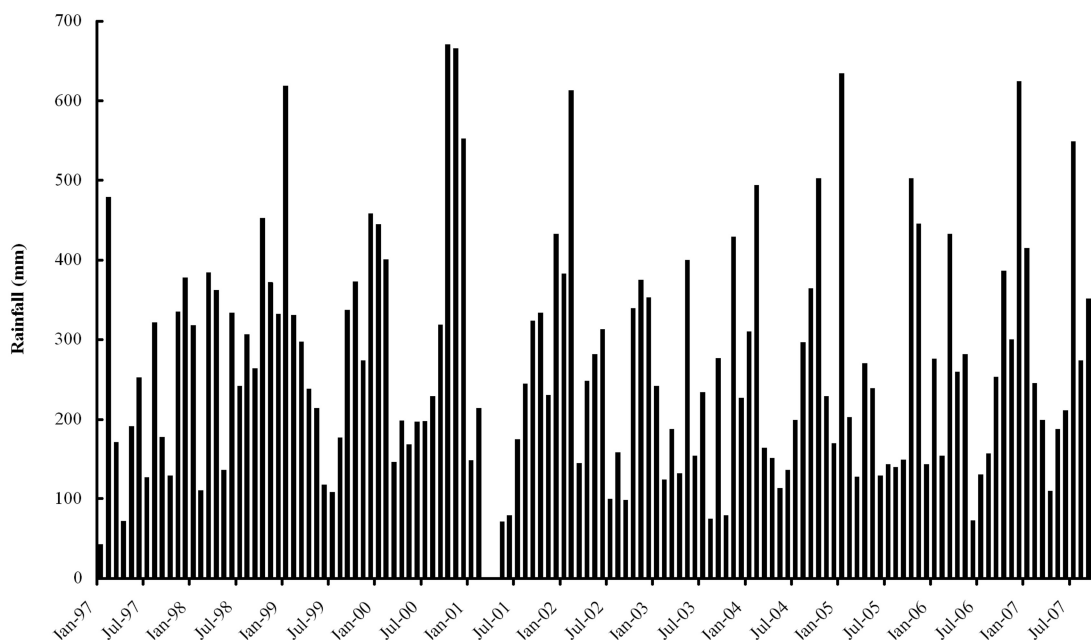


Figure 1: Annual and seasonal rainfall pattern for Snowdon during 1997-2007 (derived from data collected at Environmental Change Network Site). The October-November 2000 notable flood event is clearly discernible (Side Bar 1). The gap in the data in 2001 corresponds with an outbreak of Foot and Mouth disease.

regions with distinctive landscapes. Today some 79% of the land in Wales is used for agriculture. Woodland covers 12%, while urban areas, roads and railways make up 5% of the land. Existing areas of semi-natural habitat are often closely associated with river channels.

Historic rivers

The Welsh landscape has been described as a palimpsest. Like an old piece of vellum, each generation has erased and modified the work of earlier generations to produce their current surroundings. Rivers are also capable of carrying out this type of

Side Bar 1: October-November 2000 - a notable flood event in Wales

A series of major storms with high rainfall hit Wales in October-November 2000 (Figure 1). The autumn rainfall across England and Wales was the highest on record in over 200 years. The cumulative October rainfall across Wales was 255.9 mm, in comparison with the long-term monthly average of 137 mm. By the end of September, the soils were saturated and the major reservoirs were full and unavailable for floodwater storage. At the end of October into early November, a series of depressions with gale force winds and heavy rain passed across Wales. At Pendinas in the Afon Alyn catchment the cumulative rainfall was a record

224.9 mm between 28 October and 8 November (Environment Agency data). The highest daily record total of 80.5 mm of rain was recorded on 29 October at the Dolydd rain gauge on the Upper Severn. On the same day, 24-hour rainfall peaks of 60-90 mm were recorded in the Upper Usk catchment and 60-70 mm in the Upper Wye catchment.

Local drainage systems could not cope with the volume of water. The saturated soils started to slip, and a number of communication routes were blocked. Farming activities were severely curtailed. Water levels rose and rivers overflowed their channels. Some river levels, especially in North Wales, were the

highest on record. Flood defence systems were severely tested and overtopped in some areas. Over 1,900 separate incidents of flooded properties were recorded (Environment Agency data). The emergency services and other public agencies were involved in issuing flood warnings, managing flood defences and rescuing, evacuating and accommodating people displaced by the floods. Luckily nobody died as a direct result of this flood event.

(Environment Agency Wales 2001)

landscaping. The history and development of Welsh society is intimately linked with the water resource. River valleys facilitated the development of early communication routes for foot and horse travel, and provided refuge from coastal marauders. Early hunters and gatherers would have navigated the rivers in wooden boats and exploited the freshwater fish populations. In 1929, a 5 m long stern section of an oak log boat was retrieved from the River Ithon and conveyed to the Llandrindod Wells Museum (Figgis 1995). Several other log boats have been recovered from Welsh lakes and bogs.

The introduction to this book made reference to the Celtic worship of water. The spirits associated with rivers, lakes and wetlands were considered very powerful and capable of fostering or destroying life (Green 1992). Water was an especially mysterious substance, which fell from the heavens or bubbled from the ground, and moved with independence and strength in the form of rivers (Green 1992). Its properties included the supply of nutrients for the land and therapeutic minerals. It is not surprising therefore that water, and especially rivers in Celtic Wales, were worshipped and given offerings. In many cases the objects were broken to sever their links with this world and then cast into an inaccessible place, such as a river, which acted as the route to the afterlife (Green 1992). Also, in Celtic mythology salmon were thought to possess supernatural powers such as knowledge, and heroes or gods or holy men could turn into salmon. There may even have been an aquatic form of the Welsh dragon, which lived under a whirlpool in the River Taff near Cardiff, but its habitat is presumed lost following the construction of the Cardiff Bay barrage (Marren 2002)! Many river names are thought to have a Celtic origin and have been the subject of academic research (Thomas 1938, Jones 1989). The celtic or early Welsh ‘afon’ corresponds with ‘abhainn’ in Irish or ‘avon’ in Cornish, hence we have the tautology of the River Avon.

Documented human history and legend are also associated with Welsh rivers (Side Bar 2). In the Mabinogion, after a disastrous marriage with Matholwch, the King of Ireland, Branwen died of a broken heart and was laid to rest on the banks of the River Alaw, Anglesey. St. David, patron saint of Wales, was known as ‘David the Water-Drinker’. The River Alun flows through the cathedral grounds of the city bearing his name, now one of the most popular tourist attractions in Wales. The bard to the princes of Gwynedd, Einion ap Gwalchmai had to leap across the mouth of the River Nodwydd near Pentraeth on Anglesey to win the hand of his true love Angharad.

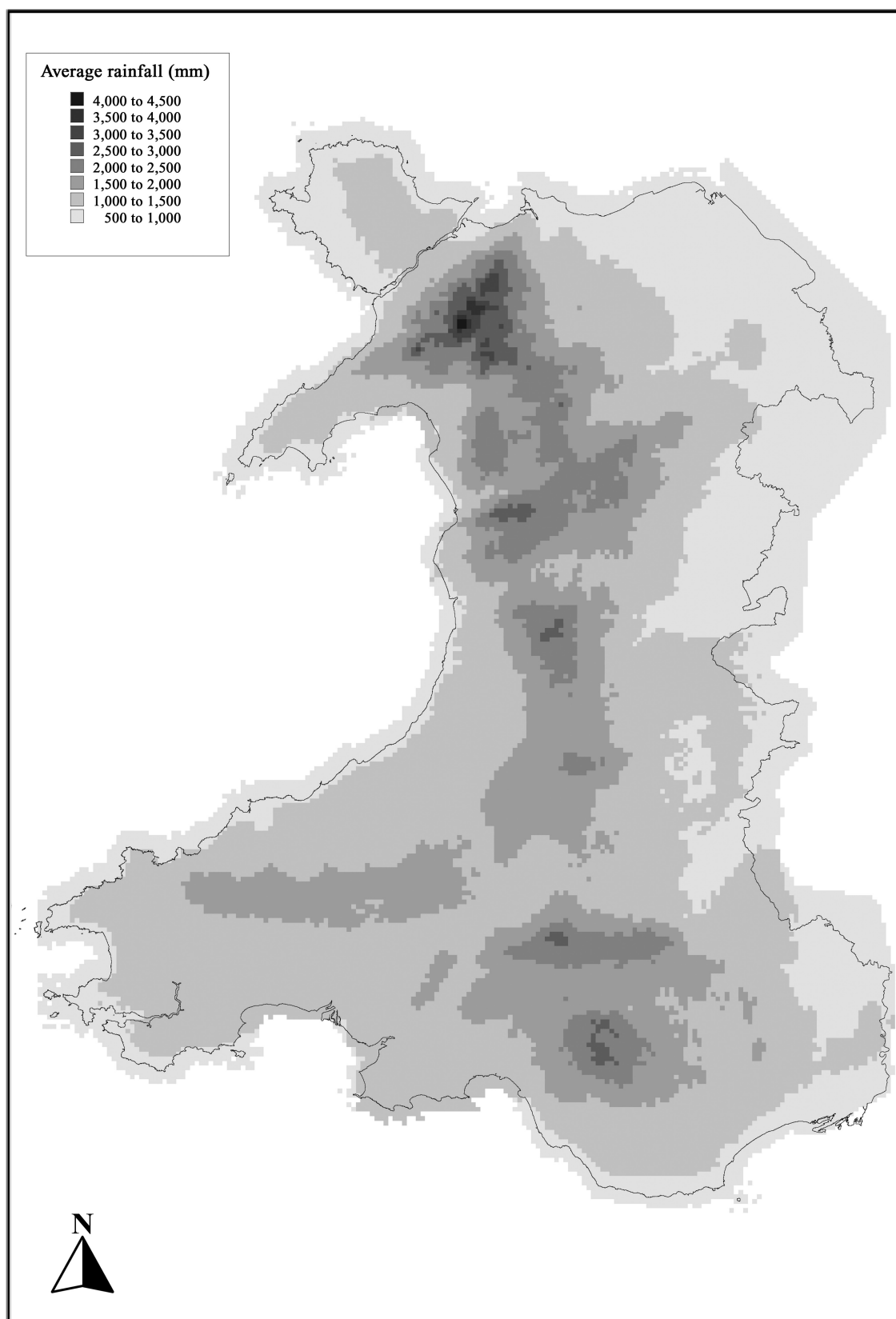
Side Bar 2: Welsh river legend

Mother Plynlimon (the mountain where the Wye rises) had three daughters, Rheidol, Severn and Wye, and she told them all to make the best way they could to the sea. Rheidol took the most direct route; Severn took the longer because she thought more of herself, and preened herself as she went. But Wye became so enamoured with the loveliness of the country through which she passed that she kept pausing and looking round and wandering about to fill her being with so much beauty. And so, though she set out from the same place and arrived at the same journey’s end, she travelled twice as far as Severn and took twice as long to get there.

(Massington 1952)

The boundaries of early tribal lands were often set along river courses and evolved with the development of human territorial organisation. For example, in medieval Anglesey the Alaw River was the border between the land units or ‘hundreds’ of Aberffraw and Cemais and there are numerous examples of rivers acting as parish boundaries (Jones 1989). A river was often the first line of defence during turbulent times. The border between England and Wales has varied with movements of river channels. Roman forts were situated on river confluences. For example, the fort at Pumsaint, Carmarthenshire, was located where the Twrch joins the Cothi and this location facilitated the control of movements in the valleys (Cadw:Welsh Historic Monuments 1998). Curves in the channel of the lower Wye are reflected in the adjacent section of Offa’s Dyke. Castles, such as those at Pembroke and Conwy, used large rivers as an important defensive element in their structure. Where possible, water-driven mills were incorporated into the fortifications as an essential castle facility. This strategy can be seen at Caerphilly Castle, South Wales, where the wheelpit and paved spillway are still visible (Watts 2000). The native law of Wales, or Cyfraith Hywel, which has been studied from manuscript sources dating from the 13th century, makes a number of specific references to income sources derived from mills, fishes and fur (Jenkins 1990). For example, the skin of an otter was valued at eight pence while the skin of a beaver was worth three score pence.

As society developed, rivers were considered obstacles to be crossed and road conditions were a particular challenge. The Welsh language even has a verb rhydu (or rhydio) describing the act of crossing a stream. Ford-related names are common on Welsh maps, and persist even where a bridge has replaced



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Figure 2: Regional rainfall distribution map on a 1 km square scale.

the original ford (Jones 1992). Fords, and associated settlements, sometimes became key loci in the road network, with roads deviating to the crossing point, or serving as intersection points for a number of roads (Jones 1992). The exact location of a ford was determined by a number of environmental factors such as channel depth, substrate and the nature of the adjacent flood plain. Fords were also of strategic military importance and often the setting for battles (Jones 1992). This factor was appreciated by the Princes of Gwynedd who reportedly excavated a number of fords to slow down the Norman invasion of North Wales. Equally, conflicts were sometimes resolved at key fords. For example, the treaty of Montgomery (1267) between Henry III and Llywelyn ap Gruffydd was made at Rhyd Chwima, the ford of Montgomery, which was a traditional place of negotiation on the Welsh border (Jones 1992).

The aesthetic value of water was appreciated in early descriptions of Wales. Rivers served as the inspiration of painters, poets, bards and writers. Early travellers and tourists from Giraldus Cambrensis (1188) to George Owen (1603), Thomas Pennant (1781) and George Borrow (1862) commented on the use and beauty of Welsh rivers and their wildlife. The end of the 18th century saw the emergence of true tourism in Wales as people started to appreciate the opportunity to escape the urban landscapes created

by the Industrial Revolution and wrote accounts of their travels (Newbery 1994). In the course of his observations on the River Wye, the Reverend William Gilpin (1782) became the main theorist of the aesthetic concept of the picturesque. Tourists were taught how to recognise and appreciate the natural beauty of the countryside. Political unrest on the continent following the French Revolution also made the wilder parts of Britain a safer option for a scaled-down Grand Tour. By the late 1700s an excursion on the Wye was thought to have ‘become an essential part of the education...of all who aspire to the reputation of elegance, taste and fashion’. An outstanding example of this type of study is the book on the rivers of Wales produced by John George Wood (1813). The two parts, illustrated by scenic sketches, gave ‘historical, topographical and picturesque’ descriptions of the major river systems. This work was dedicated to his grace Henry Charles, Duke of Beaufort and subscribers included the King, HRH the Prince Regent, The Queen, HRH Princess Elizabeth and HRH Princess Mary.

On a more practical level, in the 1700s each parish was responsible for the maintenance of its roads and annually two overseers were appointed by the Justices of the Peace (Ramage 1987). This was a thankless unpaid post, refused under payment of a five pound fine, and the holder was responsible for getting the whole parish to turn out and repair

Side Bar 3: Descriptions of Welsh rivers from Kilvert's Diary (1870-1879)

Robert Francis Kilvert was born near Chippenham, Wiltshire, on the 3rd December, 1840. Early in his career he served as a curate at Clyro, Radnorshire, and in 1877 he became vicar of Bredwardine on the Wye in Herefordshire. On the 20th of August, 1879 he married Elizabeth Anne Rowland whom he had met on a trip to Paris. They went on honeymoon to Scotland and on his return on the 23rd September he died of peritonitis.

The Wye, Saturday, 5 March 1870
‘Very cold last night, and sharp frost and the day brilliant and the air exquisitely clear though the wind was East. The view from the banks lovely, the river winding down from Glasbury like a silver serpent, flowing beneath at the foot of the poplars. Hay in the distance bright in brilliant sunshine.

Every watercourse clear upon the mountains in the searching light. As the sun went down a pink and then a deep purple glow bathed the mountains and Cusop Hill and a keen frost set in. The rich pink and deep purple light very unusually splendid.’

Cader Idris, Tuesday, 13 June 1871

‘Here we saw a mountain standing apparently close by waiting upon Cader Idris. It was Plynlimmon. Here we passed round over the back of the mountain and began ascending the summit from the S. We came to a little round pool or rather hole full of water. The old man pulled a little tumbler out of his pocket rinsed it and gave me a glass of the clear bright water. It was delicious. Then he drank himself. He said the pool was the

head water or spring of the Dysyni River. He has never known it dry in the driest summers. We saw from the spring the winding gleam of the Dysyni wandering down a desolate valley to join the Dyfi, its sister stream.’

The Dee at Llangollen, Friday 16, June 1871

‘Meantime we walked down to the gardens belonging to the Hotel on the other side of the road, and sat on the garden seat and river wall watching ‘the cataract flashing from the bridge’ and the quiet stream and pools below the fall dark under the trees opposite and dimpling with the rising of innumerable fish, in the warm damp evening. My father took a fancy to throw a fly, so I got a rod for him from the billard marker and he fished till supper time.’

Side Bar 4: The Tywi Valley

The Tywi rises in the Cambrian Mountains and makes a steep descent to the Llyn Brienne Reservoir. With declining gradient around Llandovery, it becomes an actively eroding river, meandering across a wide floodplain. It enters the sea at Carmarthen Bay. It is approximately 111 km in length, draining a catchment area of 1,376 km² (National Rivers Authority 1995).

The historic significance of the valley is largely derived from a group of planned parks and gardens, and a number of artistic associations supported by the local gentry, often claiming descent from the Welsh uchelwyr (noblemen). This area was fought over through time. As part of the Ystrad Tywi, it remained in Welsh control under Lord Rhys and his descendents until the late 13th century. It is evident that the locations of the military forts, the settlements and, of course, the roads and fords were dictated by a very dynamic river system, which moved back and forth across the valley floor. There is historic evidence of a medieval forest-based economy and it was probably always prime agricultural land. From the early 1700s onwards, country gentlemen created several

landscape parks in the Tywi valley (Whittle 1992)(Figure 5). The landscape has inspired medieval bards and poetry over several centuries. The Tywi valley was eulogised by James Dyer an 'Augustan' poet in his poem 'Grongar Hill' (1726).

In 1946, the Land Utilisation Survey of Britain described the valley as 'the best quality dairying land in the county'. Intensive dairy farming is still carried out in the lowlands, with more mixed cattle stocks in the middle reaches. Coniferous plantations and sheep farming predominate in the uplands. The remains of abandoned lead and zinc mines can be found in the upper catchment.

The River Tywi was designated as a riverine Site of Special Scientific Interest and Special Area of Conservation primarily for its populations of shad (*Alosa alosa* and *A. fallax*), and otter (*Lutra lutra*). It is also one of the most important fisheries for sea trout or sewin (*Salmo trutta*) in Wales. The geological conservation interest lies in its dynamic nature and the reworking of previously deposited river sediments, which are often expressed as distinct features such as small river cliffs and exposed gravel shoals. The physical

nature of the river influences its biodiversity. Water crowfoot (*Ranunculus penicillatus* ssp. *penicillatus*) and water starwort species (*Callitriche hamulata*, *C. stagnalis* and *C. platycarpa*) are present in moderately flowing sections. The shad and salmonids have well established spawning areas with suitable gravels. The plants on the exposed gravel shoals and banks consist of unstable communities that can tolerate periodic inundation and erosion. The Tywi is the most important river in the UK for little ringed plover (*Charadrius dubis*) as it supports 4-5% of the population (in 1997). The extensive areas of shingle provide ideal breeding habitat for this species. Kingfishers (*Alcedo atthis*), sandmartins (*Riparia riparia*) and the common sandpiper (*Actitis hypoleucos*) also make use of the river for nesting. A number of rare invertebrate species are associated with the shingle banks, including the 5-spot ladybird *Coccinella quinquepunctata*, the ground beetle *Lionychus quadrum*, and the predatory shingle flies *Tachydromia acklandi*, and *T. halidayi* (Fowles 1994).

the roads on specific days. Specific instructions were given with regard to finding the road repair material, including 'you may search for and dig out and take away Gravel, Sand, Chalk, Stones or other Materials for the said Purposes, in any Common land, or Ford, River or Brook, within your Parish, or other place.....without doing any damage to any Building, Highway or Ford, or dig within a hundred feet of any Bridge (above or below it) or to any Reservoir, or Weir.' By the early 1800s road conditions had improved throughout Britain and led Wood (1813) to remark that this improvement was 'no where more conspicuous than in the principality of Wales.' Detailed descriptions and appreciations of waterfalls feature in many of the early travel

journals and they were considered an intrinsic part of 'the cult of the picturesque' as an embodiment of natural beauty (Newbery 1994). These early travels also provided an opportunity to follow up other pastimes such as botanising and fishing. The well-known diarist Robert Francis Kilvert (1840-1879) lived much of his life in the Wye valley but also reported on excursions to other Welsh rivers (see Side Bar 3).

Today several river valleys feature in the Register of Landscapes of Historic Interest in Wales, for example, the Tywi (see Side Bar 4), Wye, Conwy and Ogwen (Cadw: Welsh Historic Monuments 1998, 2001). In the 1700s and 1800s, river valleys provided the dramatic backdrop for country seats



Figure 3: Coracle fishermen at Cenarth on the Afon Teifi (reproduced with permission from the National Library of Wales).

(Whittle 1992), for example, Llannerch on the River Clwyd, Erddig above the Clywedog near Wrexham and Piercefield on the River Wye. Pioneering engineers had the technology to allow ‘the triumph of art over nature’. In some cases, water was diverted to create various styles of water features. Sometimes watercourses were dammed to create fashionable ‘lakescapes’ and places of recreation or recuperation. Streams in a predominantly limestone valley in Lord Cawdor’s Stackpole Estate at Bosherton, Pembrokeshire, were successively dammed to produce a lake for boating and a coarse fishery. They are now recognised as a key landscape of special historic interest and wildlife conservation site (Whittle 1992, Haycock & Duigan 1994, Duigan & Haycock 1995, Cadw: Welsh Historic Monuments 2001). At Middleton Hall, William Paxton tried to create a spa, and streams were dammed to create a series of lakes connected by channels with cascades and bridges (Whittle 1992). Around 1727, Herbert Mackworth, industrialist and gardener, living at the Gnoll, near Neath, dammed a series of streams and used the head of water to drive machinery in his mines and copper smelting works, and to supply an elaborate artificial cascade in his garden (Whittle 1992).

Early fisheries

Athenaeus, the Greek writer circa 200 AD, reported

that the Celts who lived near rivers or the sea ate baked fish, sometimes with vinegar, cumin or salt (Green 1992). Unfortunately, archaeological remains are relatively scarce due to the delicate nature of fish remains. At first, fishing was a means to supplement the diet, but as society and technology developed it is likely that for generations of riverside communities the income from fishing was often equal to or better than that derived from agriculture. Giraldus Cambrensis refers to ‘the noble River Teivi that abounds more than any river of Wales with the finest salmon’ and the large numbers of salmon and trout in the Wye and Usk. A variety of fishing techniques and traps was developed, including the use of basket traps, seine and sling nets, stone weirs and coracles (Jenkins 1976). On a map from 1584, the location of an eel trap is clearly shown on the Afon Llynfi, a short distance downstream from Llangorse Lake (Parry 1986-87).

Giraldus Cambrensis also provided the first complete description of a coracle as an almost round boat made of willow and covered with raw hides which was used for fishing or crossing streams (Jenkins 1974). It was carried to and from the river on the backs of the fishermen (Figure 3), and later water-proofed flannel, calico or canvas replaced the hide and made it much lighter. Men made the wooden frame but women usually were responsible for fitting the cover and the water proofing process, which involved the use of pitch. As a coracle is very

manoeuvrable and draws only a couple of inches of water, it is ideal for shallow, rocky Welsh rivers where it was used mainly for fish netting. Often there was customisation of the design to individual rivers and the preferences of the fisherman (Jenkins 1974). The net consisted of a shallow bag dragged along the bottom of the river and the mouth was kept open by suspension between two coracles. The type, size, weighting and arrangement of the netting varied according to local tradition, size of prey and river conditions. The right-hand fisherman of the coracle pair usually carried the net; the senior partner on the left is responsible for hauling in the net when fishes were caught.

Sometimes a claw on the flattened top of the long thin paddle, often made of light larch, fitted into the coracle seat and below the rope on the right side when carried on the shoulders. This allowed the wearer to adjust the pressure of the carrying rope across his chest. A Teifi coracle is usually paddled with a figure of eight motion over the fore end. Fishing expeditions were not without risks. In 1781, H.P. Wyndham described 'The dexterity of the natives who fish in these coracles is amazing, though it frequently happens to the most expert, that a large fish will pull both boat and man under water.' Originally the fishes caught were salted or smoked and sold as far away as London and France, but the advent of the railway made this preservation no longer necessary.

Local communities developed customs and rules related to this type of fishing. On the Teifi, the river was divided into four sections called a 'bwrw' or cast, around the villages of Cilgerran, Cenarth, Aber-cuch, and Llechryd (Jenkins 1976). Each cast was further subdivided into three parts, each called a 'traill' or trawl. At an annual April meeting of the fishermen lots were drawn to allocate the fishing locations for the first night of the season and then rotated for the remainder of the season. Before the development of fisheries legislation, a closed season on the Teifi was enforced by the coracle fishermen and extended from August to February. The coracles in each village were locked up by a designated fisherman (Jenkins 1976). Jenkins (1974) noted that although many present day Carmarthen coracle men are not Welsh-speaking, their fishing terminology is always in the Welsh language and is probably derived from medieval Welsh indicating the antiquity of fishing tradition. At one time, coracle fishing was an extensive practice on a large number of Welsh rivers – Dee, Eastern Cleddau, Severn, Wye, Usk, Conwy, Dyfi, Nevers, Loughor – but more recently it has been confined to the Teifi, Tywi and Taf in west Wales.

Working waters

Welsh rivers have worked hard in providing an energy source, a processing and transport medium, and a waste disposal facility. The traditional industries associated with Wales, such as farming, mining and quarrying, have been dependent on an abundant supply of water during their historic development. The Romans must have created environmental devastation in the process of using the diverted waters of the River Annell to mine gold at Dolaucothi, Carmarthenshire (Cadw: Welsh Historic Monuments 1998). The water was stored in tanks fed by a system of leats, and released in torrents to scour the land surface. It is also considered likely that they used waterpower to drive the ore crushing machinery at this site (Watts 2000).

The boundaries of farms on Anglesey were often defined by streams whose water was used for a range of activities such as corn-grinding, wool-milling and fulling (Jones 1989). In fact water-driven mills for the grinding of corn were a vital component of medieval society (Carr 1982). These establishments either belonged to the local prince or a relative, ecclesiastical landowners, or private individuals. Non-mill owners and their bondsmen owed suit to the mill owner. This meant that the prince or bishop was entitled to a share of all the corn that was ground, so there are well-documented histories for several sites.

In the slate industry, rivers were used as a means of transporting the finished material, and as a power source. As slate mining developed around Blaenau Ffestiniog in the late 18th and early 19th centuries, the processed stone was hauled overland to quays constructed on the River Dwyryd (Cadw: Welsh Historic Monuments 1998). Later, reservoirs were built to provide power for the machinery and balance mechanisms.

If rivers did not provide the ideal route for goods, pioneering engineers did not hesitate to divert river water into canals, which represented a constructed and more convenient option. In 1793, an Act of Parliament permitted the Ellesmere Canal Company to build an extensive network of canals linking the River Dee to the Mersey and Severn (Pearce 1978). This was an early career break for the great engineer Thomas Telford who constructed the Horseshoe Falls on the Dee at Llantysilio and diverted the build-up water into the canal. He also constructed the impressive Pontcysyllte aqueduct carrying the canal over the River Dee (Cadw: Welsh Historic Monuments 2001). In the early 1800s, Thomas Telford rebuilt an older route between Shrewsbury and Holyhead to construct

the A5 roadway. This road followed several river valley sides but also required large bridges to be constructed over a number of rivers. Telford was also smart enough to use riverine topography to his advantage. For example, as the old A5 approaches Bryngwran on Anglesey from the east, the course shifts to make use of a gap eroded into a ridge by the River Caradog (Jones 1989).

Some Welsh rivers were severely impacted by the metal mining industry. The final report for an 1861 enquiry into the state of Salmon Fisheries in England and Wales cited the poisoning of rivers by mines as a major environmental impact on fisheries. The Commissioners said 'The most striking case of contamination of waters by the efflux from mines that we met with....was in two small rivers, the Ystwyth and Rheidol, which form a junction as they fall into the sea at the town of Aberystwyth in Cardiganshire. These two streams both contained salmon in some abundance, about thirty years ago. Since the working of the Goginan Lead mines, or rather since machinery has been employed there to make the crushing process more effectual, a total

extinction of animal life has taken place in the waters of the Rheidol, which receive about seven miles above the outfall the refuse water from these mines. The Ystwyth has been similarly affected by other lead works.....Furthermore it was proved beyond doubt, that not only the fishes in these rivers, but animals grazing along on their banks, cows, horses, pigs, and poultry, had been poisoned, not so much by drinking the water, as by eating the grass, which in time of floods has been covered by the infected waters.' Apparently these mines relied almost completely on waterpower, with an extensive series of leats connecting the storage reservoirs (Cadw: Welsh Historic Monuments 1998).

A similar scenario developed on Anglesey where water collected in the workings of Parys Mountain was used in a copper precipitation process in specially constructed pits on site (Cadw: Welsh Historic Monuments 1998). This mountain was once the greatest copper mine in Britain and the largest copper producer in Europe in the late 18th century. Mining is currently suspended; at least while world ore values make it an uneconomical



Figure 4a: Photograph of the Afon Tryweryn near Capel Celyn, now flooded by a reservoir (reproduced with permission from the National Library of Wales).

venture. However, the pollution legacy of this industrial past remains with the Afon Goch (welsh: 'red river'), which was recently described as one of the most metal and acid-contaminated streams in the UK (Boult et al. 1994).

The manipulation of the water table often required for coal mining must have had significant effects on the flows and water quality in Welsh rivers. Even after the development of steam power, water wheels remained in use in inaccessible areas where coal was not readily available (Watts 2000). In addition, the watercourses were used for the disposal of associated waste matter, such as cinders and ash. There are descriptions from the late 1800s of black water being discharged from the collieries into the Afan, South Wales (Anon. 1861). Cinders were visible on the bed of the River Taff at Cardiff following floods at this time.

In some areas, industries needing large amounts of water came to dominate their supporting river valleys. Around 1900, 52 woollen mills, factories and associated business operated in the Drefach-Felindre area and the villages of the middle Teifi Valley

were the main centres of woollen manufacturing in Wales (Cadw: Welsh Historic Monuments 2001). Paper milling grew in importance in the late 1700s when wallpaper was in high demand for interior decoration. The remains of four paper mills in the lower Wye Valley are considered an important example of early industrial settlement (Cadw: Welsh Historic Monuments 1998).

The politics of Welsh rivers

The 20th century saw the development of several large-scale reservoir, water transfer, and hydro-electric schemes on Welsh rivers. In the 1950s the Welsh speaking population of Capel Celyn in Cwm Tryweryn, in the upper Dee catchment, objected to their farms and homes being flooded for the creation of a reservoir to supply water to Liverpool in England (Figure 4a). A defence committee was formed and 125 local authorities, trade union branches, religious and cultural organisations, and the majority of the Welsh Members of Parliament provided support (Clews 1980). Although founded



Figure 4b: Protestors from Capel Celyn on the streets of Liverpool, 1956 (reproduced with permission from the National Library of Wales).

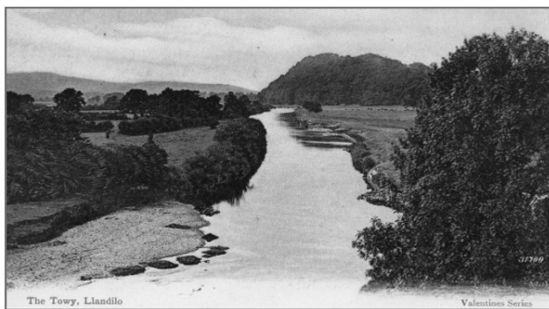


Figure 5: Scenic view of Tywi Valley, circa 1900 (reproduced with permission from the National Library of Wales).

in 1925, it was only during this period that Plaid Cymru became an established political party, with Gwynfor Evans, its leader, attempting to address a session of Liverpool Corporation. The villagers protested on the streets of Liverpool (Figure 4b) and attempts were made to sabotage the construction of the dam on the Afon Tryweryn. A bomb blew up a transformer at the dam site on 10th February, 1963 and one of the perpetrators was given a one year prison sentence. Chaotic scenes took place at the opening ceremony for the dam on the 21st October, 1965 – protestors tried to stop the convoy of cars carrying the officials, stones were thrown, fireworks exploded, the Union Jack was burned, the microphone cable was cut, the refreshment marquee collapsed, the toilets were set alight and the climax consisted of a charge down the slope of the dam led by the Free Wales Army making its first public appearance (Clews 1980).

At more or less the same time, a consortium of 13 English authorities was trying to develop a reservoir in the Clywedog valley, Montgomeryshire. Only six farms occupied this valley and Plaid

Cymru tried to block the land takeover but was unsuccessful. After construction began, a bomb destroyed a cable car tower that was being used to carry rubble and concrete (Clews 1980). Work was delayed for months and damages in the range of £30-45,000 were estimated. The violent campaign continued for the next few years and several more bombs were placed on water pipelines (see map, page 185 in Clews 1980). With the approach of the investiture of the Prince of Wales in 1969, efforts were made to seek a political solution. Denis Coslett of the Free Wales Army invited the Prime Minister Harold Wilson to meet him for coracle-based discussions in the middle of the River Tywi but this invitation was declined. Eventually, in a co-ordinated exercise, all of the leaders of the militant organisations were arrested and imprisoned and this marked the end of the bombing campaign (Clews 1980). Some political analysts have no doubts that the political and militant reactions to the largely water-development schemes of this period helped to form the modern political identity of the Welsh nation.

To conclude, the rivers of Wales remain intrinsic to the fabric of Welsh society and are a vitally important natural resource. They have a long history of use for navigation, energy generation, recreation, waste disposal and industrial processes. Despite these pressures, Welsh rivers also support a substantial proportion of the biodiversity of the region and this is reflected in their designation as a series of nationally and internationally important conservation sites. Other chapters in this book will focus more on the habitats and species involved, and on their historic interrelationship with humans and the wider environment.

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