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THE USE OF HISTORIC RECORDS FOR THE AUGMENTATION OF HYDROLOGICAL DATA

by

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ABSTRACT

Considerable hydrological information can be obtained from different kinds of historic records. This report describes a routine method for searching these records outlining the nature and value of the information that may be found, and some of the difficulties which may be encountered.

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1. INTRODUCTION

The past behaviour of a river is an important ingredient of almost all hydrological investigations. Traditionally, a hydrologist uses the conventional flow record from a gauging station at or near the study site. However, this is often only of short duration, so that the analysis might benefit greatly from supplementary information contained in historical records. The author has made a special study of historical sources for hydrological design and this report describes the type of information that can be obtained, mainly for sites in England and Wales, the availability of sources, and particular difficulties and pitfalls inherent in historical data. For the most part the report makes use of flood record searches to illustrate the technique although, as outlined in the following section, flood data by no means exhaust the possibilities.

There are five appendices which detail particular aspects of historical searches. Appendix A describes the methods of quoting dates used in old documents; Appendix B describes sources of topographic information to assist with identifying river features and village locations which might have altered over the course of time; Appendix C gives some references related to water supply and quality and Appendix D is a list of important events of four principal types. Selected references have been collected together in Appendix E.

2. TYPES OF HYDROLOGICAL INFORMATION

As might be expected, it is the extreme events that tend to be reported and hence found in many historical sources. Also, most material relates to the effect of the hydrological phenomenon, damage or death, rather than the event itself which has to be inferred from the information given. With these provisos the type of information that can be found is very wide ranging.

River flooding: It is possible to acquire information on the circumstances leading to the flood, the occurrence of surface runoff, the time of the flood arrival at a particular place, the peak height reached, the period of inundation and the rate of its recession; also details of the damage to crops and buildings, the effect of flood defence banks, and any breaches or overtopping that might have taken place, damage to weirs, sluices, roads and bridges, mills and occasionally changes in river channel.

Sea-floods: Surges are generated by high persistent winds which are superimposed on normal tides. As with river flooding, information might be found on the circumstances leading to the flood and also similar details on its duration and consequences. In addition, information might be available on resultant erosion to the coastline or

tidal river, damage to shipping and submergence of islands.

Droughts: Only occasionally will meteorological or river flow data be found. The more usual reports relate to the effect of low river flows on river traffic, fish life, milling operations and also the effect of heat and dryness on crops and water supplies.

Snow, ice and frosts: Reports of severe winter conditions may be found noting the duration of frozen watercourses, and occasionally the sea, and their effects on river and land transport.

Rainfall: Records can be found of prolonged rainfall, often a cause of severe floods, and also of tunderstorms with associated thunder and lightning activity. Occasionally quantative information is given but more often there is a verbal description of the severity of the storm and damage caused by heavy rain, hail or lightening. The most intense thunderstorms are often referred to as 'waterspouts' and their description may include a report of erosion caused.

Wind: The records here may indicate damage to crops and property or the uprooting of trees, sometimes leading to communication difficulties. The high wind periods can sometimes be related to subsequent tidal flood events.

3. BACKGROUND CONSIDERATIONS

Careful consideration needs to be given to the required objectives before embarking on a historic record search. Seldom will a numerical array of all flood levels with dates over a particular period be discovered. A list of some such is given in Volume IV of the Flood Studies Report (NERC, 1975) and recent work in the Severn and Thames areas (Griffiths, 1976) by their Water Authorities have brought more to light. However, it may be possible to set a recent known event in historical perspective such as to conclude than an event is not only the largest in 30 years of recent conventional record but is also, say, the third largest in 200 years. The objective may be even more informal, such as the need to know how frequently or whether a particular set of conditions has been experienced in the past e.g. the drying of an ephemeral stream.

These considerations have a bearing on how localised to make the search area and how far back into the past to search. As an example of the former, remember that the sequence of flood events in the lower tidal reaches of a river will be different from those found further upstream where freshwater flooding also has an influence. These again will form a different array from the flood events in the non-tidal reaches of the same river which in turn will have different flood sequences to those of the smaller tributaries subject to local severe storms. Historical reports, like current ones, tend to concentrate on the effects on people and so much historical data relate to settlements. The decision

on how far back in time to extend the search may be dictated by the effect of man-made changes, which of course even influence current records.

In choosing the events to be included in the final report there are three questions to be asked in respect of each one.

a. What is the nature of the event being recorded, and with what detail, and is it pertinent to the stated objectives?

b. Who is making the report, in particular what are his qualifications to know of the event, i.e. is it a personal observation based on his own experience; an editing of reports from other people, who themselves may have edited the information; a plausible rumour; or a complete invention, or falsification?

c. In the light of knowledge of this type of event, is the report credible, in whole, in part, or not at all?

Even a present day flood report contains edited information. Events discovered by historic search may on occasions seem to be just as objective, but generally they tend to be more subjective and usually contain much less detail. It should be remembered that most were originally recorded for purposes other than recording the hydrological aspects of the event and its circumstances. The following sections describe a methodical approach to a historical search.

4. THE FIRST STAGE - THE PRESENT DAY STATE OF KNOWLEDGE

It is assumed that flooding has occurred recently at a site of interest. The objective of the historical search is then to obtain a list of past peak flood levels. The starting point of any enquiry is the present-day state of knowledge of the event and its circumstances, supplemented of course by experience and acquired knowledge of the type of event under study.

Water Authorities usually produce a report on major flood events, a practice inherited from their predecessors. These reports are kept by the Authority as are any carried out by consulting engineers for remedial works following the event. The library of the Institution of Civil Engineers is the repository for some such reports. In general, however, the client's permission has to be sought before a consultant's reports can be made available. Such reports are invaluable primary sources as the contents extend to a description of the current state of the area, the generating mechanism leading to the flood event, an estimate of the discharge and level hydrograph and its attendant effects. This detailed picture of the development of an event in relation to its catchment and causative conditions is vital in

appreciating what probably occurred on other, earlier, and less well documented occasions.

If no report has been prepared it is valuable to carry out a similar survey of one's own. An obvious starting point is the Water Authority for any flow and level records that may be available. To this may be added the questioning and recollections of other eye-witnesses and participants, and it is advisable to have a carefully prepared list of questions dealing with the event in detail rather than in general. For example, questions should take the form 'did the flood rise to front door/first floor window cill/etc level?' rather than the open ended 'how high did the flood rise?'. Specimen questionnaires for this and other purposes are given in Penning Rowsell *et al*, (1977).

In addition, reference should be made to the newspaper files at the local library. Present-day news presentation militates against much detail being presented, and quite often the only real value in this exercise is the acquisition of useful flood photographs. Newspaper photographers take many more pictures than are ever actually printed and these can be applied for from the newspaper office.

The conclusion of this first stage of the historical search is a record of the latest flood event having reached a certain level at a certain time and date, plus necessary background information on the catchment and climatic factors giving rise to the flood.

5. THE SECOND STAGE - THE RECORDS OF THE RECENT PAST

In this stage, records covering the period when local and central government have had jurisdiction over river management are assembled. The most useful type of record is of course that from gauging stations although the difficulties of flow measurement under high flood conditions must be remembered when interpreting back data. The earliest flow records are those of water supply authorities often computing yearly and monthly total runoff by means of a reservoir or lake water balance. Beardmore (1872) gives examples from the last century. Daily flows are available for the Thames at Teddington from 1883 and the Lee at Fieldes Weir from 1851 although in the latter case the early record is spasmodic. These data are available from the Thames Water Authority and the Water Data Unit of the Department of the Environment.

None of the early authorities had a mandatory requirement to instal gauging stations until the River Boards Act, 1948, required the new authorities to do so, and the growth of the gauging station network dates from the River Boards' implementation of the requirements of that Act. By the year 1956-57, the Surface Water Year Book (Water Data Unit, 1935-1975) contained the records of 147 gauging stations, of which 23 were published for the first time, while the 1961-62

Year-Book included records of 271 stations, some 36 of which were published for the first time. By 1977 the number of gauging stations in the United Kingdom was probably in excess of 1200. From this, it is clear that most current gauging stations have records of less than 20 years duration.

In the absence of nearby flow records it is necessary to build up a level record from descriptions given in various sources. In this section we are concerned with the official sources. Table 1 shows the river management organisations with notes on their coverage and reporting policy.

TABLE 1 River management organisations

Organisation and operative dates	Regional coverage and area of responsibility	Reporting policy
Water Authorities 1974-	10 to cover England and Wales Water Supply, river management and river and effluent quality	Very little technical detail in annual report. Flood events are often subject of a separate report
River Authorities 1965-1974	29 to cover England and Wales. Water resource planning, river management and river quality	Floods and other hydrological and meteorological reports. Some separate reports for flood events. Internal committee dealing with land drainage and water resources
River Boards 1951-1965	32 to cover England and Wales. Primarily river management with some water resources responsibility	Reporting policy similar to River Authorities
Catchment Boards 1931-1951	46 to cover about 67% of England and Wales (see Fig. 1). River management and land drainage.	Annual or triennial reports produced spasmodically by some and include mainly flood and flood protection information.
Fishery Boards reconstituted 1923	Cover major fishing rivers in U.K.	Annual reports produced and include river level, rainfall and temperature and pollution information
Internal Drainage Boards (1861 - date)	Currently 314 to cover 12,500 km^2 of low lying areas adjacent to larger rivers and fen districts	Only the largest Authorities produced annual reports, and these concentrate on floods and flood protection measures. Engineer of Authority would report internally on notable flood events
River Conservancies (1877-1930)	A few catchments including Thames, Lea, Cumbrian Derwent and Dee. Maintenance of major river channels	Occasional reports on particular floods and annual reports
River Commissioners various acts Satisfactory to 1937	Responsible for specific river reaches, sponsoring improvement works and involved in cases of dispute.	

KEY

1. Hull
2. Ouse (Yorks)
3. Ancholme and Winterton Beck
4. Trent
5. Witnam and Steeping
6. Welland
7. Nene
8. Great Ouse
9. North Norfolk Rivers
10. East Norfolk Rivers
11. East Suffolk Rivers
12. Stour (Essex and Sussex)
13. Essex Rivers
14. Roding
15. Lee
16. Thames
17. Medway
18. Stour (Kent)
19. Romney and Denge Marsh drains
20. Rother and Jury's gut
21. Old Haven and Bulverhytne stream
22. Cuckmere

FIGURE 1 Map showing Catchment Boards

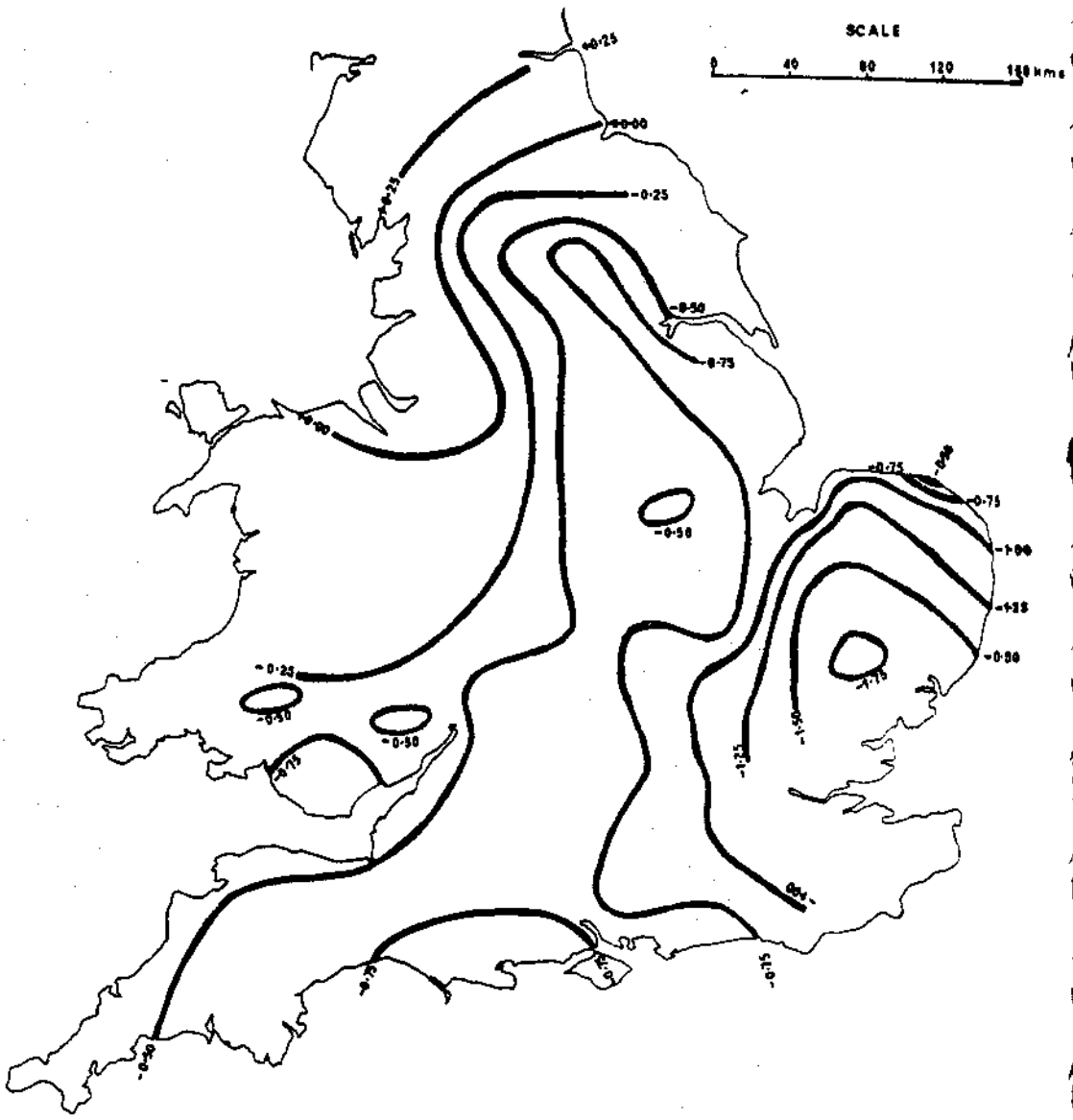
23.	Ouse (Sussex)	35.	Clwyd
24.	Adur	36.	Dee
25.	Arun	37.	Weaver
26.	Avon and Stour	38.	Mersey and Irwell
27.	Somerset Rivers	39.	Alt
28.	Avon (Bristol)	40.	Crossens
29.	Severn	41.	Douglas
30.	Wye	42.	Wyre
31.	Thaw	43.	Lune
32.	Dysynni	44.	Kent
33.	Anglesey Rivers	45.	Derwent
34.	Conway	46.	Waver and Wampool

The annual and internal reports of these organisations form part of the archives of the Water Authorities. Unfortunately there is no central holding library for the earlier annual reports, but a useful source is a serials holding list of the U.K. Marine and Freshwater Sciences Librarians Group (UK MFSL, 1976). Large public and university libraries will also probably hold copies of the reports of the local organisations.

Navigation authorities, particularly those operating navigable rivers, often recorded water levels above and below locks. While generally lock gauge-boards were read at specified times of the day, many of the lock keepers took extra readings during high water periods, and these records can often be found with the systematic records. Although the locks were largely built in the late 18th and early 19th centuries their systematic records date mainly from the late 19th century. In some cases, notably the Trent, Severn, and the Yorkshire Aire, Calder and Ouse (N E R C, 1975, Vol IV, Chapter 4) the lock levels can be used to extend a more recent water level record back into the 19th century. However care has to be taken that the bypass weir on the main channel parallel to the lock cut has remained unaltered. A problem of associating different gauge datums may be encountered. Generalised differences between Newlyn and Liverpool datum is to be found in Close (1921) from which Figure 2 has been copied. The British Waterways Board's (soon to be embedded within the National Water Authority) district offices at Nottingham, Gloucester and Leeds hold some data and others may be obtained from the British Transport Historical Records at Porchester Road in London and for northern rivers in York.

Sewer Commissioners have been mentioned in Table 1 because several remained in existence until the establishment of Catchment Boards in 1930. Most records of benefit to historical searches relate to an earlier era and so further details are given in Section 7.

Examination of the periodical literature should come next. Fruitful journals for accounts of floods and flood protection measures are the 'Proceedings of the Institution of Civil Engineers', published from 1837, the 'Transactions of the Institution of Water Engineers' (1896 to 1946 with accumulated index); succeeded in 1947 by the 'Journal' (also indexed), and since 1977 by the 'Journal of the



To convert to Ordnance Datum (Newlyn) add contoured value from map to Ordnance Datum (Liverpool).

FIGURE 2 ORDNANCE SURVEY DATUM CHANGE

Institution of Water Engineers and Scientists'. Examples of papers dealing with flood events (in the former) are (Symons 1875-76) dealing with the severe floods of October 1875, and (Wheeler, 1881-82) on the Conservancy of Rivers. The past volumes of the two engineering journals, the 'Engineer' (dating from 1856), and 'Engineering' (dating from 1867) also contain much valuable flood information. Professional and trade journals, 'Proceedings of the Institute of Transport', 'Surveyor', 'Municipal Engineer' and 'Water Services' are obtainable via university, public, and for members, the Institution of Civil Engineers libraries. Facilities for borrowing copies of publications not in their collections can also be acquired. This may entail loan of material from the national collections, which include the various Copyright Libraries. These are the British Library at London, the Bodleian Library at Oxford, the Cambridge University Library, the National Library of Wales at Aberystwyth, and of Scotland at Edinburgh, and Trinity College, Dublin.

The relative paucity of data on the generating circumstances of flood events experienced in some of the official documents may be offset by examining 'British Rainfall', 'Meteorological Magazine' and the 'Quarterly Journal of the Royal Meteorological Society'. The former began publication in 1860 as 'Symons's British Rainfall', became 'British Rainfall' in 1899 and has been issued yearly ever since. Some of the sections, particularly 'Heavy Rainfall on Rainfall Days' contain data on flood events with references to articles in other contemporary publications. As an example, 'British Rainfall 1932' includes the May rainfall and flood events in England, with reference made to flood data in another publication, (Roseveare, 1932), together with a comparison with the flood event of May 1886. Following up this lead in 'Symons's British Rainfall 1886' elicits information on that flood event and reference to a contemporary paper (Marriott & Gaster, 1886).

'The Meteorological Magazine' began in 1866 as 'Symon's Monthly Meteorological Journal', changed to 'Symons's Meteorological Magazine' in 1901 (Vol: 36) and to its present title in 1920 (Vol: 55), when its publication was taken over by the Meteorological Office. The 'Quarterly Journal of the Meteorological Society' began in 1872 and changed to its present title in 1884. The monthly journal 'Weather' began publication in 1953. Examination of the collections of these journals enables a sequence of reliable weather with somewhat generalised flood information to be built up back to the 1860s.

In addition to the extraction of event data from Water Authority archives and from the other sources enumerated in this section, continuous cross-referencing with newspaper reports should be maintained. A discontinuity in their coverage may be expected for the period of World War II (1939-45). For security reasons the degree of the severity of the winter of 1939-40, one of the most severe of the 20th century, and the effects of the 1940 flood events received scant attention.

This stage of the historical search closes with information back to the latter half of the 19th century, at least on the larger rivers,

obtained from relatively accurate and consistent sources. From this point back the coverage is much more spasmodic, and is similar to the recent level of coverage for extending data on tributaries.

6. THE THIRD STAGE - THE 18TH AND 19TH CENTURIES

Dealing now with more intermittent sources of information than those available when river management organisations were operating, it will be seen that the major sources are newspapers, the periodicals issued by local historical groups, and specialist reports by surveyors and government commissioners. It should be borne in mind that it was during this period that large scale urban development took place and this led to not only an increased awareness of the flood hazard but also to possible effects on the river regime.

Newspapers

The quality of newspaper coverage of flood events was very much more detailed prior to World War I than it was to become later. If flood data from this improved coverage coincides with records from long-term recorder or gaugeboard this permits a check to be made of the newspaper account, or else provides an estimate of the level of a locally employed datum. Detailed treatment of the flood generating circumstances and of the time sequence of the events during the flood can be followed through several newspaper issues. The major floods of the 19th century, such as those of October 1875 occupied newspapers almost entirely. Often the accounts contain references to previous similar events. As an example the following summarises an article appearing in the 'Nottingham Daily Guardian' for Wednesday, January 2nd, 1901

> A heavy and prolonged downpour on Sunday, 30th December 1900. It was recorded locally as 1.684 inches, and compared with the year's previous heavy fall of 1.286 inches on June 11th 1900. The water-level rose rapidly during the night of Monday 1st Jan/Tuesday 2nd Jan 1901, and by the morning of the 2nd flooding was taking place over both banks of the river. By Tuesday night the flood level had passed the 1869 flood mark and had almost reached the 1852 flood mark.

There was reference also to earlier floods in 1875 and 1877. The 1901 flood was described as the worst since 1877.

The process of determining relative flood height can be carried back through the 19th century and well into the 18th, depending on the numbers and longevity of newspapers themselves. Although newspapers developed from the middle of the 17th century many of the early

issues contain national rather than local news, and it was only after the 1740s that local information assumed any prominence. There are exceptions to this and for a few places flood level information can be obtained from the 1680s.

The newspapers also recorded many other items of hydrological interest, for example, the areal extent of storms and of flooding by tidal breaches and temperature extremes. In the second half of the 19th century many papers carried frequent summaries of local meteorological records. However, it should be remembered that the current standards of instrumentation and observational practice had not at that time been determined. The Meteorological Office and the University of East Anglia's Climatic Research Unit under Professor H H Lamb have collected much of this early data. There is always the possibility than an interesting event was omitted because of other more pressing demands on news space. To minimise the possibility of missing minor flood data it is necessary to examine the newspapers for the years between the major flood events. This part of the search can be assisted where the newspapers, either on the first or last issue of a year, published a summary of the outstanding events of the past year. This annual summary is likely to be the only form of index to the contents of the newspapers despite the efforts of some local libraries to index the issues serving their area. The only national newspaper index is that for the 'Times', for which quarterly summaries have been produced since the beginning of 1791. The 'Times' itself first appeared some six years earlier. This index covers events both around London and in the provinces but also overseas as the following list of natural events from the 'Times' index for the first half of the 1808 show,

6th January	Gale damage Hull
17th/18th January	Great storm damage at Margate
19th/20th January	Ship disasters in gales
1st February	High Tide at Flushing, Holland drowns 29 people
16th February	Accidents in London during the storm. Mails to Cambridge, Norwich, Holyhead and Yarmouth delayed by storm
25th February	Severe storm at Bangor
18th April	Floods at Bristol
19th July	Tremendous thunderstorms at Glastonbury
28th July	Extraordinary heat (Letter) Accident at Deptford during storm

Nevertheless, a great many events of local importance did not find their way into the 'Times', and the fact that the Index does not include anything for a particular locality is no guarantee that local newspapers need not be examined.

There are two major centralised collections of early newspapers. The British Library collection (formerly the British Museum Newspaper collection) includes all provincial newspapers and London newspapers post 1801. Earlier London newspapers are housed in the Burney Collection at Bloomsbury. The names and available editions likely to be of use can be traced with the help of Crane & Kaye, 1966 and there is also an eight volume catalogue to the British Library collection (British Library, 1975).

The'Gentleman's Magazine' dates from 1731 and information on flood events and other hydrological data can be found until the 1830s when the character of the Magazine changed. The earlier volumes are particularly useful because of the relative scarcity of newspaper reports. An example, taken from the year 1736 (Volume VI) provided the following information:

January.	Very little frost this winter - continuous rain leading to much foot-rot in sheep.
	Hard frosts in Europe - the Vistula frozen over for a month.
February.	Canvey Island and Foulness under water due to a high tide. Westminster Hall flooded to a depth of 2 feet.
	About the middle of February there were hard frosts and frequent snow - lasted about a fortnight. A great deal of snow in Scotland - several people frozen to death. Snow in North Wales deeper than for some years past.
May 31st	Recently completed river navigation works near Chester breached by high tide - river returned to original channel.
July 5th	Continual rain since beginning of month; considerable floods in Thames valley - large bank collapse near Tingwick, Oxfordshire - material with tree and hedges swept into a river jam.
July 15th	Fleet Ditch filled up.

It can be seen that many of the items are oriented towards events in the vicinity of the capital. Less attention is paid to the rest of the country and only the more exceptional events appear. Both University and Borough library collections often include copies of this monthly Magazine.

Local Histories

The earliest town and country histories date from the late 16th century, eg Lambarde (1576) and Stow (ed. Wheatley, 1956) but most begin either in the late 17th or early 18th centuries, eg Aubrey (1719

ed. Ponting, 1969). Flood events appear in histories for riverside towns such as York (Drake, 1736). Where lists of natural phenomena are included, some of the earlier entries may well be suspect. A great deal of spurious information seems to have originated in the 18th century, possibly the most notorious case being that of Thomas Chatterton (1752-1770), who 'invented' natural phenomena for a history of Bristol. Local librarians are usually well informed on the availability of such histories.

Local Natural History Field Clubs, or Archaeological and Historical Society Proceedings usually appear on a county basis, though some, such as the 'Surtees Society' cater for larger areas. Articles specifically on floods and weather phenomena appear occasionally, as for example in the 'Proceedings of the Woolhope Naturalist Field Club' of Hereford; this includes details of the flood levels reached by the river Wye at Ross, observations on the great drought of 1887 and on other weather phenomena (Southall, 1870, 1886 and 1887). There are accounts of the damage caused by the great flood of November 1771 in the Tyne and Wear river Valleys in 'Archaeologia Aeliana', the publication of the local antiquarian society for Newcastle-upon-Tyne. Other publications reproduce the contents of local diaries, which themselves include observations on floods and weather (Surtees Society, 1875, 1883, 1910 and 1914).

Local History collections may occasionally include books written specifically on rivers (e.g. Dunston, 1910, bridges, either on one particular structure, such as old London Bridge (Home, 1931), or those on different areas of the country, such as the Jervoise series (Jervoise, 1930, 1931, 1932); and frosts (Andrews, 1887). They may possess copies of local weather journals, such as that of Gilbert White, 1720-1793 (Johnson, 1970), and possibly printed diaries containing useful flood and meteorological information such as those of John Wesley, 1703-1791 (Curnock, 1909); John Woodforde, 1740-1803 (Beresford, 1924-31); and Dorothy Wordsworth, 1771-1855 (De Selincourt, 1952). Some counties have local 'Notes & Queries' publications, one of the oldest being the still surviving London series (1849 to date). Useful items appear occasionally but as the indexing of these publications is unsatisfactory, the searching is laborious.

Directories

Many counties are the subject of Directories with special sections on the larger settlements (White, 1844). Towns also had Directories of their own, as did some industrial areas, for example Leeds and the clothing districts of Yorkshire (White, 1853). Generally the Directory series started in the last quarter of the 18th century and appeared at irregular intervals up to comparatively recent times. The same information often appears without any updating in successive editions. Floods and weather phenomena appear in some, while a great flood disaster such as that caused in Sheffield by the Bradfield reservoir collapse in March 1864 led to the inclusion of articles in later editions of directories even for areas remote from Sheffield. For the counties bordering the North Sea coast, storm surge events

can be mentioned, and one Lincolnshire Directory contained a list of storm surge heights recorded at Boston between 1791 and 1877 (White, 1881). The availability of Directories covering a desired area or place can be ascertained by consulting Norton's Directory Guide (Norton, 1950).

Specialist reports

Detailed records, maps and plans, town expansions and their associated developments can usually be found in two places. The first, and probably the largest collections, are in the County Archivists Offices, while smaller collections are in the Borough Library local history sections.

The County Archivist's Offices often have collections dating back to the 1780s from when it was required that copies of all plans, sections, and books of reference associated with canal developments, aqueducts, navigation improvement schemes, town expansion after local enclosures, railway embankments and bridges, river works, drainage schemes, road bridge crossings, and potable supply reservoirs, all had to be deposited for public inspection with the local Clerks of the Peace for every County and Borough affected by such works. This requirement applied to any scheme requiring Parliamentary sanction.

Since 1930 this kind of material has had to be deposited with the Clerks of the County Councils. For many counties these vast collections now reside in the County Archivists Offices. This is an important source of detailed information on river and flood-plain conditions. Road bridge river crossing plans sometimes quote the local highest river levels then known, sometimes also with normal and low water levels. Accompanying the Deposited Plan collections are the Acts of Parliament for those schemes that were finally approved. Some railway company acts authorised river course alterations near railway bridge crossings and deposited plans reveal the change. The County Archivists collections usually include the Inclosure Acts and Awards and the maps associated with these may indicate changes in river and tributary stream courses.

The Borough Library collections often include a series of town maps, which usually begin some time in the 18th century. From these it is possible to map any changes in the rivers and flood-plains over the years. Borough records, and those of their administrative predecessors, often include flood information in the developed areas, as well as proposals for dealing with the hazards, and the removal and building of bridges. The early development of local administration is traced in Jackson (1949).

Flood marks were often made on Town Council orders and now provide a valuable source for flood levels. Their most obvious locations are on riverside structures, such as bridges, wharves, and locks. It is possible to find others some distance from the riverside and almost forgotten because subsequent flood defence schemes have kept the flood waters away for decades. Sometimes their whereabouts can be

traced from Council Records. Redevelopments of recent years have often led to the masking or destruction of some flood marks. Flood marks can also be found in riverside villages, even some distance from the river. These levels can be particularly valuable in determining the true relative severity of floods as they are away from the complicating influence of town expansion.

Government Sources

Evidence set before Parliament in support of large schemes such as for river improvement schemes, coastal works, and early canal proposals mention flood events, for example Smeaton's proposals before Parliament for the improvement of the use of the river Aire and Calder in the mid 18th century. These can be found in the Journals of the Houses of Commons and Lords both of which are annually and decennially indexed.

Parliament set up Royal Commissions to investigate particular problems and the following are among those which include hydrological information:

Name	Date	
Royal Commission on Water Supply	1828	Drought of July-August 1827 and Thames Flood of 1821
Metropolitan Water Supply Enquiry	1856	1852 drought
Water Supply Report following on Commission	1868 1866	 River Lea gaugings in 1850-1868 Cirencester well levels 1863-1868
Report of the Select Committee of the House of Lords on river conservancy	1877	
Duke of Richmond's Commission on Water Supply	1887	
Royal Commission on Coast Erosion	1906	
Royal Commission on Land Drainage	1927	(led to 1930 Land Drainage Act)

Such parliamentary papers are indexed and University and major municipal libraries may be expected to provide this type of material.

Other Sources

One of the most fruitful sources extending as far back as the late 17th century is the printed proceedings of the Royal Society. A selection from the Proceedings printed in 1808, includes articles

on high tides in the Thames estuary, reports on severe winters, such as that of 1708-09 (with comparisons made then with the earlier frost of 1683-84), and even on early attempts to estimate the flow of the River Thames.

To this point the historic search has worked back into the sources of the early 18th century. It will be clear that although actual dates of events are found, there is little flood-level data. The quest for data that can be used in a statistical determination of flood return period thus usually terminates at about this point. Searching earlier records is likely to produce only some vague idea of the occurrence of earlier floods.

7. THE FOURTH STAGE - THE 16TH AND 17TH CENTURIES

The number of available printed sources for these centuries is very much less than for more recent times and includes early newspapers as discussed in Section 6, State papers in the Public Record Office, and reprinted diaries and chronicles. There is a very great deal of useful material in manuscript form although investigation of village, town, official and ecclesiastical records can require specialist attention, if only to transcend the difficulties experienced with reading different writing styles. Emminson (1967) can be of great assistance in this task.

Public Record Office documents

These vast national collections began to be catalogued, calendared, and printed during the 19th century. The Calendars of State Papers, Foreign and Domestic, include occasional references to weather and flood events but indexing for identifying natural events is poor. Some studies have been made of a few of their contents of foreign papers (Salter, 1930) which relate to political and other conditions in this country as reported by the various ambassadors, Spanish (1485-1603), Papal (1198-1471), Venetian (1202-1675), Milanese (1385-1618), French (918-1206, etc), Roman (1342-1578) and other foreign (1547-1591). The Calendar of State Papers Domestic cover the period 1640-1704. Flood and weather events appear in them, as on the occasions mentioned for the delays in timber supplies for naval dockyards and the rebuilding of parts of London after the Great Fire of 1665. A similar coverage for an earlier period 1542-1631 appears in the printed 'Acts of the Privy Council', though much of the information is centred on London.

The nature and extent of the Public Records Office collections can be ascertained by consulting the 'Guide to the Contents of the Public Record Office', 3rd Edition, 1963-68, and Calendars, Handbooks, etc. listed in detail in H.M.S.O. Government Publications Sectional List 24

of the British National Archives (1976). The titles of additions to the collections can be found in the yearly volumes of 'Government Publications'. Many university libraries have copies of the printed collections.

Diaries and chronicles

Diaries and chronicles are a well known source of information and many have been reprinted. The table below lists the more important diarists with dates and references. Other minor diarists have been published by local history societies. A useful source for diarists' coverage is 'British Diaries' (1442-1942) (Matthews 1950).

Diarist	Region	Date	Comments	References
Samuel Pepys 1633-1703	London	1660-1669	Tidal surge and Thames breach of March 1660	Warrington, 1963 Sedgwick, 1911 (in Met. Mag.)
John Evelyn 1620-1706	London	Lifetime	1683-4 frost and floods after the thaw	De Beer, 1959 Sedgwick, 1911
Anthony à Wood	Oxford	Lifetime	Almost complete weather and flood calendar for much of 17th century	Clark, 1891-95
William Stukely 1687-1765	Leeds and England generally		Antiquarian Diary	Stukely, 1880-1885
Abraham de la Pryme	South Yorkshire	1671-1703	Corresponded with Royal Society and some publications in their Proceedings. Manuscript record in British Museum includes weather and flood reports	Jackson, 1869 Lansdowne Collection of British Museum (Mss. 899)
William Sampson	Clayworth 1681-1701 North Nottinghamshire	1681-1701	Weather account has been compared with Evelyn's diary	Sedgwick, 1914 (in Met. Mag.)

Diarist	Region	Date	Comments	References
Polydore Vergil c1470-1555	London area		All Tudor chronicles and give accounts of various flood, frost and weather events, eg. tidal surge of Sept. 1555, frost and floods of 1565	
Raphael Holinshed d 1580	General			Holinshed,1807
John Stow c1575-1605	General			Stow, 1615
William Camden 1551-1623	General			Camden, 1586
John Dee 1527-1608	London area		Diary of weather records kept for magical purposes	Halliwell,1842

Sewer Commissioners and Courts of Sewers

Although the original Statute of Sewers was enacted in 1427 (6. Hen 6, c.5) it was the Tudor re-issue of much of it in 1531-32 (23.Hen 8,c.5.) that led to accumulations of Courts of Sewers records relating to specified low-lying (usually tidal) lands. The Commissions of Sewers were not Drainage Boards, nor were their areas of jurisdiction regarded as drainage districts (Hobday, 1952), but they existed to promote land drainage works and the prevention of flood. They became involved with disputes between different upstream and downstream interests along specific lengths of rivers. Some of the problems encountered by early Courts of Sewers, have been studied by later researchers (Kirkus, 1952), and these records appear in printed form, (Owen, 1968). The bulk of the records however are in manuscript. The Land Drainage Act, 1930 (20 & 21. Geo. 5, c.44) terminated the jurisdiction of the Courts of Sewers, their powers becoming absorbed by the new Catchment Boards. The document collections passed to the Catchment Boards many of whom later deposited them either with County Archives or University collections.

The 17th century saw much new legislation dealing with the improvement of rivers for navigation purposes. The Courts of Sewers became involved with the many disputes between navigators' proposals and the interests of mill owners, whose weirs were a principal source of obstruction. These disputes include many references to floods, and document collections such as the Harleian, Kings, Lansdowne and Stowe MSS collections in the British Museum and in the Bodleian Library at Oxford are supplemented by partisan pamphlets (also containing flood events) at the two centres mentioned and the Goldsmiths Library of London University. A useful river history and source of information on

these disputes is River Navigation in England 1600-1750 (Willan, 1964).

Ecclesiastical and other sources

The bulk of these are in manuscript, but printed extracts have been published by the various Parish Register Societies. A considerable amount of weather and occasionally flood information has been found incorporated with the records of the births, deaths and marriages. Several parish registers preserve accounts of the great winter snow of 1614-15, as for example at Youlgrave, Derbyshire, and Beeston-next-Mileham, Norfolk, while the parish register for Ubley, Somerset records the great frost of 1683-84, noting such details as 'digging a grave in frozen ground took one man two days', and that snow was still to be seen on Mendip in midsummer (Cox, 1910).

Records of the larger town churches occasionally provide flood levels, as in the records for St. Werbugh's church in Derby, which was demolished during the 17th century by successive floods from the Markeaton Brook. Depths of water on the church floor were recorded in the late 17th century, the deepest, some 2 ft occurring on 19th July 1673 (Cox, 1875-1879).

Foreign records of English events were kept by the international banking houses of the day, particularly the Fuggers. Studies of their records have appeared for the late 16th century (Von Klarwill, 1926).

The Statute of Bridges, 1531, placed the responsibility for the upkeep of a bridge with the Borough in which it was situated.

The yearly accounts of the bridge wardens reveal the occurrence of floods, droughts, and severe winters. Most of these accounts exist in manuscript form but such few as have been printed in collections of Borough Records show that they can be used to construct an almost complete river event calendar. This source is referred to in greater detail in the next section.

8. THE FIFTH STAGE - THE MEDIEVAL PERIOD

Many records after the time of Henry VIII (1509-1547) were kept in English, but before this time Latin was used, and any investigation of manuscript sources or even later printed versions will require some knowledge of this language. The records of the Middle Ages are divided into governmental, ecclesiastical and lay.

Government sources

The Government sources are to be found in the Public Record Office

collections, and the publications of the Pipe Roll Society (1884 to present). The table below summarises the types of 'rolls' of parchment on which the information was stored, with notes on available 'calendaring' and publication. The calendaring process has been carried out since the mid 19th century and amounts to a summary of the contents of each roll together with the names of individuals concerned and the date and an index to the location of the original. The quoted date is the regnal year and Appendix 1 describes the dating systems used in historical sources. The calendars are themselves indexed but unfortunately concentrate on the names of individuals and less on the subject area. Most University Libraries have copies of the Calendars and indices but if more detail than they contain is required then the original at the Public Record Office has to be scrutinised.

Name of Roll and Dates	Purpose of Document	Calendaring and Printing
Patent Rolls	Royal Acts, grants, licences, etc of wide variety. Commissions for raising monies to repair bridges, and for repairing bank breaches.	Printed 1201-1232 Calendared 1201-1572
Close Rolls 1204-1903	Sealed instructions containing writs or orders to individuals for a wide variety of acts, payment of salaries, observation of treaties, etc.	Calendared 1204-1509
Inquisitions Post Mortem	Enquiries to determine heir to properties, with inventory of holdings including mills and fisheries, and terms under which land is held	Printed 1236-1377 Extracts published by local historical societies.
Liberate Rolls	Payment from royal funds - occasionally for repair of flood damage to royal mills, etc..	Printed 1200-1204 Calendared 1226-1272.

Possibly the most important Commission issued in the Patent roll series was the one of Oyer and Terminer for the 16th April 1257, issued by Henry III (1216-1272) to Henry de Bathonia, an itinerant Justice, authorising him to determine the cause and requirements for the repair of a breached sea-wall in Romney Marsh, Kent. Another Commission of 10th May 1257 led to the codification of the 'Customs of Romney Marsh' by Henry de Bathonia concerning such repairs and the defraying of the costs among benefitting landholders. These customs were used for later commissions throughout the country, and formed the basis of all land drainage law up to 1930. Flood events were covered by the issue of the series of Commissions 'de wallis et fossatus' (banks and ditches) and so can be extracted easily from

the Calendars. For example a Commission issued on 4th June 1275 states:

> 'Commission de wallis et fossatus to Thomas de Fraunketon, John Bek and Alexander de Monte Forti in Hoyland, where the lands of the King and of the Prior of Spaudyng (Spalding) and others are in danger of inundation. They are to enquire who are liable and distrain all those who hold lands in the Wapentake of Ellowe and elsewhere to do their contingents'.

Research on these records carried out by Sir William Dugdale (1605-1686), (Garter King-at-Arms) in the reign of Charles II led to his 'History of Imbanking and Draining of divers Fens and Marshes' in 1662, reissued in 1770 (Dugdale 1770) and likely to be available in university and large municipal libraries. Not every Commission 'de wallis et fossatus' appears in Dugdale, as in his day no Calendar existed to help his researches, and some refer to repairs needed by banks following long periods of neglect rather than to recent flooding.

Sometimes a particularly stormy period or the passage of a tidal surge produced effects in different parts of the country for which Commissions occur fairly close together in time, for example, 1373 produced commissions indicating more than one kind of flood event. One issued on May 30th was for the sea coast in the Wash and along the north coast of Norfolk. Two were issued on October 24th referring to damage in the Hull area by floods descending from the Wolds and for the lower tidal reaches of the River Trent. Two days later a Commission was issued for damage in the Romney Marsh area, with another on the same day for other parts of Kent, while on November 30th yet another was issued for parts of Kent.

Grants of 'pontage' by the crown, authorising the collections of monies for bridge repairs were sometimes associated with flood events that had caused such damage that the ordinary sources of income were inadequate to pay for the repairs (Flower, 1915 and Jusserand, 1889). An example, for 22nd October 1328, was to the 'Mayor, Bailiffs and good men of Oxford' granting pontage for six years for repairs to the bridges on the Rivers Thames and Cherwell. Grants of 'quayage' were sometimes made so that high tides could be prevented from flooding the towns. It is thus possible to build up a date list of flood events from the contents of the Patent Rolls supplemented by the Close Rolls.

Another source of flood information lies with the way land holding was passed at death. When a Lord of the Manor died, his estates reverted to the Crown until the King's Escheator held an enquiry, or 'Inquisition Post Mortem' to determine the extent and value of the holdings. Some of these records reveal damage to mills by floods, damaged weirs, destroyed flood-banks, ruined crops by rain and floods, and damaged sea-defences.

This by no means exhausts the Record Office collections. There are Pipe Rolls, Fine Rolls, Exchequer Rolls, Subsidiary Rolls, Receipt Rolls, Issue Rolls and Memorandum Rolls together with the Records of the Courts of Law, the Curia Regis Rolls (1193-1270), and the

Coram Rege Rolls (1272-1702) (the Rolls of the King's Bench) etc. Flood data are very rare here and difficult to trace.

Lay records

The three groups, the Barons, the King's officials and the Church all produced Manorial Rolls containing the administrative details of their estates' management, including the bailiff's yearly returns itemising costs. Some of these documents have been examined to extract weather information indicated by its effects on the sowing, growing and harvest periods of the agricultural year. Recent researches by economic historians on the rolls of some of the great estates near the south coast have gone far to establish an almost complete series of wet and dry seasons for the 13th to the 15the centuries (Titow, 1959-60, 1970; Brandon, 1971a, 1971b). The second author lists the climatic conditions then prevailing which caused the Romney Marsh breach and the near destruction of Winchelsea in 1287, the same period as events in the low countries where the Zuyder Zee was forming. This process was completed by the great St. Elizabeth's flood of 19th November 1421, at which time the Barnhorne floods in Sussex were also severe. Flood events in the Low Countries (Vanderlinden, 1924) for 1374, 1375, 1409, 1421 and 1423 were all years of flooding along the Sussex and Kent coasts.

Most studies based upon manorial and borough records of this age have dwelt on economic and social topics, eg. Hill (1956) and the Victoria County History series, and so information on weather or flooding is to be found mainly in the original manuscript form.

Bridge records were mentioned in Section 7 as a date source. Many older bridges were built under church influence and sometimes at church expense. Where repair and maintenance could not be met out of charitable or revenue sources, as has already been alluded to, the crown grant of 'pontage' was acquired for a set period, often three years. By the mid 14th century Bridge-Masters were appointed annually and their annual accounts can be used to construct a calendar of floods, droughts and severe winters. Excerpts from these accounts, which exist right up to the middle of the 19th century in places, appear in some Borough Record collections, but few studies of a total collection of records such as Becker (1930) have been made.

Ecclesiastical records

The special contribution to flood and weather records by the Church lies in the chronicles produced by the various religious foundations (though by the close of the medieval period lay chronicles for some towns were produced (Flenley, 1911)).

A monastic foundation embarking on a chronicle would base it at the outset on a pre-existing chronicle, adding the dates of their foundation, and the dates of the line of Abbots. An example of this is the Chronicle of the Benedictine Abbey of Burton-upon-Trent whose earlier pages are a reproduction of the Chronicle of Roger de Hoveden in Yorkshire, until local material takes over in the

mid 13th century (Luard 1864). Many chronicles such as that of Croyland Abbey extended the record over the lifetimes of at least two chroniclers (Riley, 1854). Some of the monastic houses produced outstanding historical documents among which may be noted those of William of Malmsbury (c1095-1143), (Giles, 1889), Roger of Wendover (d 1236) (Giles, 1849) Roger de Hoveden (d 1201) (Riley, 1853), Florence of Worcester (d 1118), (Forester, 1854), and Henry of Huntingdon (1084-1155) (Forester, 1843). The best known chronicler of the whole; period is Matthew Paris (c1200-1259) of St. Albans Abbey (Giles, 1852).

All these chroniclers, and many other lesser figures, include accounts, albeit sometimes in florid and fanciful terms, of floods, droughts, severe winters and catastrophic thunderstorms. An example is an account of a severe thunderstorm in August 1165 in the Scarborough area of Yorkshire, when a diabolical horse shape was seen stamping the cliffs, the hoofprints being visible for about a year afterwards. This fanciful description might be interpreted to refer to erosion caused by severe local run-off resulting from a funnel shaped 'waterspout' type storm (Britton, 1937). Such storms and erosion features have been noted more recently in Longtoft, Yorkshire (Lovel, 1893). Two 13th century examples of informative chronicles are those of John of Oxendes which is replete with East Coast flood disasters, and the Historia Major of Matthew Paris which contains a yearly summary of floods, droughts, and weather generally (Giles, 1852). Many collections have been made of the flood and weather events from Chronicles. The earliest extensive collection is that made by Dr Thomas Short (1749) which influenced many later selections. The best 20th century collection of medieval natural events is due to Britton (1937) in which all the entries have been translated from Latin.

Most surviving chronicles have been published but despite their ready availability, which has given rise to the belief that they represent the sole written record of their era, caution has to be exercised in interpreting the natural events purported to have occurred. Nevertheless they do provide insights into what must have been quite sophisticated data collection organisations. For example Symeon of Durham (Arnold, 1885) draws on prior records then extant; references are made to river level records (Babington, 1875) and relative tidal levels on the Humber. One survival, now unique, but probably not particularly exceptional in its day, is the earliest known English weather diary, compiled by the Rev. William Merle for the period 1337-1344 (Symons , 1891). Part of the record refers to the Oxford area and part to north Lincolnshire.

These sources take us back to Norman times which is the furthest that is possible with independent research. The earlier sources described in the next section are so few in number that they have been thoroughly scrutinised for relevant material and the results have been published.

9. THE SIXTH STAGE - EVENTS BEFORE THE NORMAN CONQUEST

Available sources for pre-Norman Britain are very sparse indeed and are restricted to a few chronicles and the Lives of the Saints. Entries relating to natural phenomena were coloured by the belief in divine displeasure entering into the affairs of man.

The Anglo-Saxon Chronicle (Garmonsway, 1953) is the major source and spans the period from the 6th to the early 12th century. It is a composite of seven chronicles from different parts of England. Notable entries are of tidal surges in 1014 and 1099 although the relative scarcity of this event seems implausible and it is quite likely from internal evidence that those entries are significant because of monkish opinions on the rulers of the day. Bede's 'History of the English Church and People' is an earlier source (Sherley-Price, 1955) and mentions St. Wilfred's Drought of 681 in south-east England.

Some of the different lives of the saints contain references to natural phenomena, usually those successfully affected by the intercession of the saint, but their chronologies are so vague that it is difficult to form any idea of which year the events occurred.

Accounts of Roman expeditions provide a few extra notable events, for example a tidal surge in the North Sea which almost destroyed two legions in 15 A.D. (Grant, 1956). The paucity of such records from reliable sources raises a question over the origin of the many flood events dating from this period that appear in the lists compiled by Lowe (1870), Symons (1888), and Brooks and Glasspoole (1928). Britton's (1937) list also mentions these earlier events but with frank disbelief. They can all be traced back to Short (1749) and it must be concluded that his Thames flood of 7 A.D., Severn flood of 115 A.D. and Dorset sea floods of 131 A.D. are spurious or are unwarranted shifts of floods known to have occurred elsewhere in the Roman world to Britain (Birley, 1976).

There is archaeological evidence of sea flooding along the east coast as excavations have unearthed two levels of occupation separated by two metres of marine silt at Welney. The absence of coastal fortifications along much of the east coast and in particular around the Humber is hardly credible on military grounds but is probably accounted for by coastal erosion.

10. THE WIDER SCENE

A historic search for flood and other hydrological events only as far back as the middle of the 18th century leads to the realisation that

many first ranking events affect very large areas of the country and even other parts of Europe. The worst flood for many areas in the north of England occurred in November 1771, when many bridges in the river Wear and Tyne catchments were destroyed. Parts of Hadrian's wall were damaged and the same heavy rainfall also generated several years irruption by Solway Moss. Further south the floods of February 1795 occupy the most severe flood position. This event occurred at the close of a winter which was severe in the whole of Europe.

This demonstration of similar events occurring both in England and in nearby parts of Europe has the value that events missing from the sparse English written record may be fairly confidently derived from some of the more numerous continental sources. In particular, the Chronicles of Merovingian (481-752) and Carolingian Gaul (752-987) can be used in this way, as for example in Gregory of Tour's 'History of the Franks' (Thorpe, 1974), which includes a report of the extremely harsh winter of 548 A.D.; very high tides, probably in November 578, and a prolongued drought in 584 A.D., all of which may have affected parts of Britain. There is a limit to this type of correlation, however, as the Sagas of the Norse Kings (Laing, 1930) provided very little meteorological information beyond the mention of a few severe winters, which may well have no English equivalent.

It is worthwhile to be able to form some idea of the relevance of a local historical search in possible wider schedules of events. Knowledge of the climatic variations in Britain in the historic past is valuable in this respect, and modern studies such as 'The Changing Climate' and 'Climate: Present, Past and Future' both by Professor E H Lamb, indicate the latest developments of thought on this topic (Lamb, 1968, 1977). Earlier studies that might be helpful are 'Climate and the British Scene' (Manley, 1953); 'British Floods and Droughts' (Brooks and Glasspoole, 1928); and 'Climate through the Ages' (Brooks, 1950).

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APPENDIX A: Methods of referencing dates

Medieval documents and sources do not in general reference dates by the current year number, month name, and day number system. This appendix describes the systems that are found.

Year references: The present Gregorian calendar started on September 13th 1752 (which followed 2nd September 1752 on the Julian Calendar). The change had been made in the 16th century by some European countries. The need for the change arose because the Julian calendar had three leap years too many each century. The opportunity was also taken to fix the start of the year as January 1st. Hitherto the year has begun on various days

1. Between the 6th century and 1066, the year began on Christmas day (December 25th).

2. Between 1067 and 1153, the year began, as it does now, on the 1st January.

3. Between 1153 and 1750-51, the year began on the Day of the Annunciation of St Mary, 25th March. Thus 24th March 1657, was followed next day by 25th March 1658.

4. During 1751, the year began on 25th March and ended on 31st December.

5. From 1st January 1752 the year begun as it has ever since, on 1st January.

There can be confusion dealing with documents recording events in January, February, and March, in determining exactly which year one is dealing with. Many dates carry the dual designation of say 1582/83 up to 25th March, and change to 1583 after that day. It might be found that some dates about the time of the change are given as O.S. (Old Style i.e. Julian Calendar) while others refer to N.S. (New Style - the Gregorian System).

The idea of different starting dates for a year still remains to this day with the fiscal year, starting on 4th April, and the Water Year, starting on 1st October. Some medieval documents use 'Exchequer Years' beginning other than on 25th March, while the Account Rolls run from Michaelmas (29th September).

Another system much used in official documents is the 'Regnal Year'; the year counted from the start of the reign of a particular monarch, and this is still used for Parliamentary Bills and Acts. The first Statute of Sewers in 1427 has as its legal reference 6.Hen.6.,c.5. as it appeared in the 6th regnal year of Henry VI. Where a Bill was

introduced in one regnal year and became an Act in the next, both appear in its legal definition. Thus the 1861 Land Drainage Act is designated 24 & 25 Vict.c.133, and the 1930 Land Drainage Act is legally catalogued as 20 & 21 Geo.5.,c.44.

Apart from legal documents some chronicles were written in terms of regnal years. John Warkworth's Chronicles of the First Thirteen Years of the Reign of Edward IV (Halliwell, 1839) includes references to a Bourne flow near St Albans, recorded as flowing strongly on 4th March 1473 'and ran still to the 13th June in the year following'. It so happened that Edward IV's regnal years began in April, while the ordinary year at that time changed on 25th March, so by either reckoning the bourne flow died away on 13th June 1474, three months after the record of its strong flow on 4th March 1473-74.

Months: When the month number is expressed relative to the start of the year care must be taken to account for the shifting starting date, or for a special purpose year.

Days: Apart from the current day numbering system two other systems are found, the Roman dating and Saint's days.

In the Roman system the first day of any month was the Kalends, a day originally denoting the first day of the new moon. In four of the seven 31 day months, March, May, July and October, the 15th day of the month was the Ides, a day originally intended to denote the full moon. The 8th or 9th day before the Ides, i.e. either the 5th or the 7th day of the month was called the Nones. All intermediate days were reckoned back from the Kalends, Nones, or Ides. For example, the 5th of the Kalends of May was 27th April. Table A1 shows the positions of these three days in relation to each month of the year. Table A2 shows a specimen section of a year with the special days added and the number sequence for denoting intermediate days.

Many references are made to a Saint's day or near to one. Probably the only well-known surviving examples are:-

St. Valentine's Day	-	13th February - Ides of February
St. George's Day	-	23rd April - 9th of the Kalends of May
St. Andrew's Day	-	30th November - 2nd of the Kalends of December
St. Stephen's Day	-	Boxing Day, 26th December - 7th of the Kalends of January
St. Patrick's Day	-	17th March - 16th of the Kalends of April
St. David's Day	-	1st March - Kalends of March
St. Swithin's Day	-	15th July - Ides of July

The Calendar of Saints days grew during the medieval period. One English addition was added in the 12th Century, when 29th December (the 4th of the Kalends of January) became St Thomas à Becket's Day, as a record of his murder on that day in 1170. Becket became St Thomas the Martyr, and should not be confused with St Thomas the Apostle whose day is not far away on 21st December. The whole day before a Saints Day was called the Eve of the Saint's Day; Christmas Eve is the only surviving relic.

One complication is that the same person can have more than one day. St John the Baptist had 29th September (day of the decolation (execution)), and 24th June (day of his nativity). St Mary had at least four days between February and September, with the further complication of possible confusion with St Mary Magdelen. Another difficulty is that caused by the varying position of Easter Day which itself determines the position of other days such as Low Sunday, Ascension Day, Whit Sunday, Trinity Sunday and Advent Sunday.

The complications of these different dating systems are dealt with very adequately in Cheney (1970). This handbook is to be found in most Borough and University Libraries. It can also be obtained from the Office of the Royal Historical Society, London.

TABLE A1 Dates corresponding to Roman day names

	Kalends	Nones	Ides
January	1	5	13
February	1	5	13
March	1	7	15
April	1	5	13
May	1	7	15
June	1	5	13
July	1	7	15
August	1	5	13
September	1	5	13
October	1	7	15
November	1	5	13
December	1	5	13

TABLE 2 Roman calendar for January

Jan	1	Kalends of January
	2	4th of the Nones of January
	3	3rd of the Nones of January
	4	2nd of the Nones of January
	5	Nones of January
	6	8th of the Ides of January
	7	7th of the Ides of January
	8	6th of the Ides of January
	9	5th of the Ides of January
	10	4th of the Ides of January
	11	3rd of the Ides of January
	12	2nd of the Ides of January
	13	Ides of January
	14	19th of the Kalends of February
	15	18th of the Kalends of February
	16	17th of the Kalends of February
	17	16th of the Kalends of February
	18	15th of the Kalends of February
	19	14th of the Kalends of February
	20	13th of the Kalends of February
	21	12th of the Kalends of February
	22	11th of the Kalends of February
	23	10th of the Kalends of February
	24	9th of the Kalends of February
	25	8th of the Kalends of February
	26	7th of the Kalends of February
	27	6th of the Kalends of February
	28	5th of the Kalends of February
	29	4th of the Kalends of February
	30	3rd of the Kalends of February
	31	2nd of the Kalends of February
Feb	1	Kalends of February

APPENDIX B - Topography

The historical searcher will naturally be familiar with the present day topography of the area that he is considering. However his historical researcher will need to be aware of any changes that have occurred in, for example, village locations in order to place the description of an event in the correct context. Similarly the presence of mills and other man-made alterations in the river can radically alter the regime, except perhaps for the very largest floods. He may also uncover a place name no longer current and need to locate it. The place name itself can be quite illuminating in indicating the nature of the river or country as perceived by the early inhabitants. This appendix gives examples of the major sources of topographic information.

Patterns of settlement: Comparisons of 50 year old maps with current ones show the radical changes to river courses and valley development since the passing of the Land Drainage Act, 1930. An even greater contrast would be found between the pre-1930 condition and that in prehistoric times before the waves of migrant settlers following the last Ice Age. Fox (1952) gives an insight into the choice of settlement sites although modern techniques such as Carbon-14 dating (Renfrew, 1973) and pollen analysis (Godwin, 1956) have caused ideas to be revised on culture diffusion and the delimitation of habitable areas respectively. Papers in 'Antiquity' (1927 to date), the 'Archaeological Journal' (1845 to date), the 'Proceedings of the Prehistoric Society' New Series (1935 to date), the 'Antiquaries Journal' (1921 to date) as well as in local archaeological journals give much local detail.

A good general picture of the evolution of the landscape through the historic period can be obtained from Hoskins (1957), which contains many useful references. The settlement patterns in the countryside developing after the Saxon invasions of the 5th century can be appreciated by studying the place-name survivals, particularly with reference to the names of rivers, woods, hills and settlements (Ekwall, 1936, and the English Place-Name Society volumes).

Mills: One of the principal changes since 1930 has been the removal of many old mills and their weirs to such a degree that their former prominence can hardly now be appreciated.

For locating early mill sites the earliest reference is Domesday Book, which recorded the value of all the country's resources both for the time of the survey, 1087, and for 1065 the last year of the reign of Edward the Confessor. The various volumes of the Victoria County Histories, begun in 1899, usually include translations of the relevant sections of the Domesday Book, with the site locations determined as far as possible. Regional summaries of the different classes of data contained in Domesday Book can be found in the various Domesday Geographies of H.C. Darby *et al.*, (1952, 1954, 1962a, 1962b, 1967). The

number of mills increased throughout the medieval period, so that not all the mills in an Inquisition Post Mortem (Section 8) appear in Domesday Book.

Bridges: There were few bridges in Saxon Britain, most being of wooden and therefore temporary construction and some built primarily for military purposes, for example on the River Lea in 896, Bedford in 919, Stamford in 921 and Nottingham in 923. There was an active bridge building period beginning in the second half of the 12th century, matching similar activity in Italy and France, and most medieval bridges date from the century following. The communication network they served seems to have been adequate not only for the medieval period but for some time afterwards (Stenton, 1936) (Willard, 1926). It was the mid 18th century before another bridge building period occurred and this again seems to have been stimulated by French example.

Canals and waterways: Priestley (1831) surveyed the principle canals just prior to the 'railway age' and De Salis (1904) surveyed the canal and navigable river network at the end of the 19th century. Since then there have been many detailed studies of individual waterways mostly dwelling on economic and social aspects. There are two notable studies of changes due to successive drainage to fen waterways and fen areas generally by Darby (1940a and b).

Topographical surveys and tours: Verbal descriptions of various parts of the country can be an important source of topographic information. Williams (1908) translated two early descriptions of Wales dating from the 12th and 13th centuries. The Tudor period produced a considerable number of topographical studies, many of them including a large amount of antiquarian material. For example Leland's (1506?-1552) 'Itinerary of England and Wales (Smith, 1906-10), and Camden's 'Britannia' at the end of the 16th century (Camden, 1610) contain a vast wealth of detail. The latter work also includes references to floods, tidal surges, and weather phenomena (Section 7). Late 17th century conditions are described in 'The Journeys of Celia Fiennes (1685-1703)' (Morris, 1947), while a 17th century piece of scholarship dealing with the ecclesiastical holdings of the medieval and early Tudor periods is Sir William Dugdale's 'Monasticon Anglicanum' (Caley *et al*, 1817-1830).

Probably the best topographical work in the early 18th century is Defoe's 'A Tour through England and Wales' (Cole, 1959). The growth in interest in new agricultural methods is reflected in Arthur Young's 'Tours' (Young, 1768, 1770). Wordsworth's 'Guide to the District of the Lakes' (Merchant, 1951) is an excellent topographic description of that particular locality. The topographic effects of the great industrial expansion of the 19th century were only just beginning to make themselves felt at the time of William Cobbett's 'Rural Rides' (Briggs, 1957). The county by county series of topographic studies in the early 20th century contain a wide variety of information of varying quality, and among these may be noted the 'Highways and Byeways' series.

Integrated studies of the relations between settlement and communication patterns and the physical circumstances through the ages can be found in Darby (1936), while in the European context East (1950) is valuable.

Maps: Although these are nowadays the primary source of topographical detail very little quantitative land surveying entered into the preparation of the maps of the 16th and 17th centuries (Carr, 1962). Such accurate surveys as exist refer only to some great estates. John Speed (1552?-1629) produced in 1611 an atlas of county maps 'The Theatre of the Empire of Great Britain', which can be used for identifying bridge sites, settlement sites, woods, but only generalised river information.

By the second half of the 18th century maps began to represent physical features accurately. The triangulation of France began about 1745 and the Ordnance Survey in England followed by 1791. Accurate surveying techniques were essential to the growth of the canal and railway systems. The first 1" to 1 mile map appeared in 1805 (Essex), starting a process which extended to cover the whole of England and Wales by 1873 (Carr, 1962) (Close, 1926). This 'Old Series' contain the first definitive representation of many river courses, islands, shoals and bridges. This 'Old Series' has been reissued recently by David and Charles. To help appreciate conditions in the earlier ages, the Ordnance Survey has issued a series of maps at various times since 1939, dealing with Ancient Britain (two sheets), Roman Britain, The Dark Ages (two sheets), and Monastic Britain (two sheets) (Ordnance Survey Maps).

APPENDIX C: Water supplies and quality

The main body of this report has been concerned with historical searches for flood information. This appendix has been included to trace the development of public water supplies and their influence on public health through some of the more important historical events. References are quoted where appropriate but they are fewer in number than those related to flooding.

It is well known that the availability of potable water has been and remains an important determinator of settlement sites. Typical examples of village sites following a water supply source may be found in Cambridgeshire along the outcrop of the Totternhoe Stone within the Chalk. However, the distribution of well drained land on which to build the villages (Topley, 1872) and to graze cattle and sheep are also important constraints. Up until 1817 London's development was limited by the availability of raised gravel patches and terraces with an easy water supply via shallow wells (Prestwich, 1872).

The general picture that is built up of medieval life is that poor health was the norm. Medieval records contain many reports of human 'pestilences' and 'agues', and 'murrains' - cow plagues, and 'distemper' in animals. Weather and water-controlled environmental factors were clearly important in this endemic unhealthy condition; poor crops caused general debility and low resistance to infection, uncontrolled grazing in wet land gave rise to foot rot in animals, insanitary living conditions and polluted water supplies giving rise to typhoid (Sabine, 1934) and dysentry, both water-borne diseases.

Malaria, also a water-borne disease, was endemic in Britain's swamps, lakes and marshes - in fact in any damp area away from running water. Many references can be found in chronicles and later records of 'sweats', 'agues' and 'fevers' for low lying areas such as the Somerset marshes, the Fens, the meres of Lancashire and Cheshire, and the great estuarial areas of the Humber and the River Thames (Smith, 1956).

In spite of these hazards the early middle ages was generally one of growing human populations leading to the increased areas of cultivated land. With correct farming procedures being largely unknown a gap developed between food requirements and food production, even though the amount of land in Central and Western Europe under cultivation was about the same in 1300 as it was to be 500 years later.

The increased storminess of the late 13th and early 14th centuries (Section 6) led to crop failures, which in turn led to famine and the spread of diseases. There were very bad grain harvests in 1315, 1316, and 1317, caused by excessive rainfall throughout Europe. Records indicate famine and even cannibalism, both on the continent and in Britain (Lucas, 1930). Similar events occurred in 1334 and also in 1345-1348. At the same time there was increased political instability

in England, France, Italy and Spain to add to economic decline, all of which occurred well in advance of the arrival in 1348 of the greatest human disaster of the medieval period, the Black Death.

An earlier occurrence of bubonic plague, or Black Death, in Roman times decimated the Eastern Roman Empire of Justinian, and spread westward through Gaul (Thorpe, 1974) and even reached Ireland. The Proceedings of local historical societies often contain accounts of the local effects of the outbreaks beginning in 1348-49, and a number of studies of abandoned villages have been carried out both for this period for later in the 14th century, and for early Inclosure of the 15th-16th centuries (Beresford, 1954). Up to one third of the already reduced population probably perished in this period (Zeigler, 1969). In agricultural terms there was a retreat from marginal land, and the abandonment of many rat infested villages. It can be seen that weather events contributed to the spread of the diseases. A severe river flood on the River Ouse at York in December 1348 may well have driven the infected rats from the riverside wharves into the city (Jeanselme, 1922) and the heavy rains of the autumn and winter of 1348 (Britton, 1937) may well have played a contributory part in spreading the plague locally, by confining people to their rat infested homes.

These events and their consequences reduced the population pressure and eased the land hunger. Many outbreaks of plague affected Britain from 1348 until 1665 (Leasor, 1962), some of which were complicated by weather events. Borough records document their consequences. The last outbreak of this pandemic was in 1720 in Marseilles.

The town supplies from wells, springs and rivers generally sufficied up to the middle of the 18th century. The well documented expansion of town populations first within and then beyond their historical boundaries gave rise to conditions which were ideal for the spread of another waterbourne disease, cholera. Formerly, the incubation period for cholera meant that infected boat crews perished on the way from its endemic centres in India, but the great pandemic of the 19th century travelled along the trade routes via Russia (1830) and Germany (October 1831). From there the short sea route to England led to its appearance in Sunderland in late October 1831 (Howe, 1972). It spread all over England, Scotland and Wales, many major towns suffering several hundred deaths before autumn 1832. Its spread and effects can be followed by reference to newspapers of the day. There were other cholera outbreaks in 1848-49, 1854, and 1866. It was during the 1848-49 outbreak that Dr John Snow at Soho identified its spread as due to drinking infected water (Stamp, 1964).

These outbreaks came at a time when increased pure water supplies were being sought. Local rivers were an obvious choice but due to increased pollution from untreated sewage these soon ceased to be of use locally. The River Thames through London was already grossly polluted in the 1840s. An early riverside reservoir, built at Aston near Birmingham in 1831 was completely abandoned as a potable supply by the late 1850s. Sources not too far away were first tried, but often the growing size of the industrialised towns polluted these too, leading to the search for

supplies much further afield. For towns in the lowland areas this often meant that supply lines had to run for considerable distances.

Another source tried from the 1820s was borehole supplies from suitable aquifers, such as the Bunter Sandstone and the Chalk. Deep boreholes to underground supplies were developed at Birkenhead, Liverpool, Wolverhampton (Bateman, 1859) and Nottingham after the 1830s. The problem of one borehole interfering with the supply from another was experienced by the middle of the century. Liverpool discovered mutual borehole interference at three and a half miles distance due to connecting fissures in the sandstone, while borehole supplies from the upper Dover Beck valley near Nottingham dried up the upper parts of its watercourse (Mansergh, 1897).

The British Association reports (from 1842) contain considerable information on the development and amounts of different potable supplies. In particular, a committee collected borehole records and yields for a period of 21 years, between 1875 and 1895 (Whitaker, 1975-79). Other groundwater phenomena such as subsidence caused by salt abstraction in the Cheshire Plain were also reported (Ward, 1888). In the early part of the 20th century, the Geological Survey produced a series of Water Supply Summaries, county by county, summarising the potable supplies and the borehole logs then in commission (Whitaker, 1910, 1921, 1925).

Another source of potable supplies, reservoirs, was an adaptation of the idea of reservoirs supplying the summit levels of canals. The first trans-valley earth embankment reservoir in the Midlands was the Thornton reservoir in the southern part of Charnwood Forest, completed in 1854 by Thomas Hawksley (1807-93), to supply water to Leicester. Bad design and construction led to collapse of some of the early embankments. One occurred in February 1852 when the Bilberry reservoir embankment, near Holmfirth, collapsed releasing a flood which drowned 90 people (White, 1853). The worst English disaster of this kind occurred in March 1864, when the Dale Dyke reservoir embankment collapsed, releasing a flood wave into Sheffield which drowned 250 people and caused immense damage (Smith, 1971).

The stone wall dam era began in 1878, the largest in its day being the Vrynwy Dam (1881-92) supplying a 70 mile pipeline to Liverpool. The proposed schemes, the squabbles between towns seeking to develop the same supplies for their own purposes, the internal squabbles during the construction (such as the Hawksley-Deacon dispute over Vrynwy), the building of the works, and their final inauguration can all be traced in fair detail by referring to the two engineering journals 'Engineering' and 'The Engineer'. In particular, the latter journal often ran a supplementary feature dealing with a specific major work when it finally came into commission. Articles on the engineering aspects of these schemes can be found in the Proceedings of the Institutions of the Civil and the Mechanical Engineers (1847 to date).

The insanitary conditions in the growing towns became increasingly recognised as the prime causes of the continued ill health of many of

the inhabitants and responsible for the continuous epidemics. Collected reports on the sanitary conditions in many towns were presented to a Select Committee of the House of Commons on the Health of Towns (Royal Commission on the Health of Towns, 1845), by Edwin Chadwick (1800-90) (Chadwick, 1842). Most Borough libraries have copies of the local reports made by Chadwick and his supporters, as well as the newspaper accounts of the disputes in Council meetings between advocates of sanitation, better housing, the introduction of sewerage schemes, and their opponents. Chadwick's work led to the final separation of sewage from water supplies, the provision of sewage farms, the adequate distribution of water supplies, and the closure of hundreds of polluted wells. As the century progressed different Borough Councils acquired control of the previously private water companies, and made provision for water supplies to be made available in areas previously unable to pay for them.

Chemical knowledge increased considerably during the 19th century and the variation in the quality of water supplies from different sources was recognised (Dalton, 1889). Chemical pollution was recognised first (Folkard, 1881-82), and it was only in the 1880s following the new science of bacteriology discovered by Louis Pasteur (1822-95), that Robert Koch (1843-1920) was able to identify micro-organisms responsible for some of the diseases, including *Mycrobacterium tuberculosis* in 1882 and *Vibrio cholerae* in 1883 (Howe, 1972).

Some of the recently commissioned upland sources of clean water presented new chemical problems, such as the presence of too much iodine in some moorland waters leading to cases of goitre and the effects of acid peat waters on lead. Chemical treatment works had to be built to render safe some of these supplies (Ackroyd, 1900). Abstraction from deep boreholes in the Chalk aquifer beneath London led to sea water intrusion before the end of the 19th century (Thresh, 1899). At the close of the century Ronald Ross identified the role of the mosquito in the transmission of diseases such as yellow fever and malaria (Howe, 1972).

The level of sewage pollution in rivers led to legislation in the second half of the 19th century. The natural self-purification process in rivers was recognised, as well as the need to measure the different industrial sewage effluents, organic and inorganic. The Royal Commission on Sewage Disposal 1912 proposed a form of the now standard B.O.D. test for sewage effluents, as well as desired levels of suspended solids concentration. Attempts to put these recommendations and later legislation into effect has been well documented and can be followed by reference to water engineering and public health journals.

This appendix is a very brief review of the historical benchmarks relating to public health and water supply. By its nature information on this subject area is more dispersed than flood reports but the references and information should aid the historical searcher in his own region.

APPENDIX D

Introduction

The following sections include a list of 'benchmark' events which should assist a historical search by focussing attention on particular dates which can often lead to other events. It is very difficult to achieve a uniform criterion for inclusion especially for the medieval period. Four headings have been used: tidal surges, severe winters, droughts and land floods. As far as possible only those events that affected a reasonable geographic area have been included and this has only been elaborated for the period from 1500 onwards.

The main usefulness of such a list is in directing attention to particular dates when referring to chronological material such as newspapers or journals but earlier events have been included for completeness. The list was originally put together in connection with historical searches for the Trent and midlands area which accounts for a preponderance of material relating to that region. There is little purpose in continuing this list beyond 1912 as more recent events are probably quite well documented and a benchmark date to aid the search is unnecessary.

2. THE FIFTH STAGE - The Medieval Period (1066-1500)

TIDAL SURGE: 1099(Nov); 1144; 1170; 1176; 1178; 1214; 1218(Nov); 1236(Mar); 1236(Nov); 1248(Nov); 1250(Oct); 1251(Mar); 1253(Oct); 1275(Sep); 1279(Feb); 1282(Nov); 1287 (Jan & Dec); 1288(Feb); 1292(Dec); 1294(Oct); 1307(Feb); 1331-1332; 1334(Nov); 1364; 1369; 1374, 1375; 1378, 1379; 1386; 1393, 1400; 1401; 1402; 1404; 1407; 1409; 1411(Oct); 1413(Mar), 1420, 1421; 1422; 1423; 1429; 1446, 1448(Mar); 1467.

SEVERE WINTERS: 1069; 1076-77; 1085; 1092-93; 1110-11; 1114-15; 1141; 1143; 1149-50; 1167; 1176; 1180; 1204-05; 1210; 1216; 1222; 1229-30; 1233-34; 1241; 1251; 1254; 1261; 1268-69; 1281-82; 1288-89; 1291-92; 1301; 1305-06; 1308-09; 1334; 1338-39; 1353-54; 1363-1364; 1377; 1381; 1407-08; 1429; 1431; 1433-34; 1447; 1452; 1465.

DROUGHTS: 1078; 1089(?); 1095; 1114; 1136; 1158; 1177; 1191(?); 1213; 1222; 1224; 1231; 1236; 1240; 1241; 1242; 1244; 1252; 1253; 1255; 1259; 1260; 1263; 1272; 1276; 1277; 1284; 1285; 1288; 1291; 1305; 1324; 1325; 1326; 1331; 1333; 1352; 1356; 1375; 1384; 1385; 1387; 1388; 1390; 1399; 1426; 1464; 1473; 1474, 1475.

LAND FLOODS: 1093(Nov)(Northern England); 1098; 1105(Jan)(Wales); 1115; 1125; 1141; 1151; 1156; 1181; 1193; 1199; 1201; 1203; 1209; 1223; 1227-9 (Dec-Feb); 1233; 1236; 1237(Feb); 1238(Dec); 1239(Jan-Mar); 1240(Severn); 1242(Nov); 1249(June); 1250(Nov)(Midlands); 1251; 1257; 1265(Nov); 1269(Feb); 1270(Mar); 1271(Sept) (Southern England); 1273(Mar); 1275; 1277(Mar); 1280(April); 1290(Jan) (East Anglia); 1294(Aug) (Northern England); 1296(Mar) (Northern England); 1309(Jan); 1314; 1315; 1316; 1327(Northern England); 1339(Northern England); 1348; 1358(Northern England); 1377(Northern England); 1381(Southern England); 1382; 1386(West Country); 1393(Southern England); 1408(Northern England); 1413; 1427 (Southern England); 1439(East Anglia); 1450; 1483 (Wales); 1485(Midlands); 1488(Midlands); 1499.

THE FOURTH STAGE - The 16th and 17th centuries

1502		Severe winter
1504		Severe winter
1514	November	Floods - Central England
1517		Severe winter
1517-18	September to May	Great drought
1527	April- June	Heavy rainfall - damaged crops
	October	Heavy rain
1528	September	Rainfall - ruined harvest
1530	5th November	Tidal surge - North Sea - damage to East Coast, Flanders, Zealand and Holland
1531		Tidal surge - North Sea
1536	December	Great frost - River Thames frozen
1537	December	Great frost - River Thames frozen
1539		Drought
1540	February-September	Drought - severe in England and in Europe
1541		Heavy rainfall in Spring followed by drought
1542		Wet summer - floods in Southern England
1543		Severe winter
1548		Drought
1552		Heavy rainfall - floods in Southern England
1555	September	Tidal surge - North Sea - floods in London
1564-65		Severe winter - River Thames frozen - severe in Europe - floods followed thaw - River Ouse bridge at York swept away
1566		Wet Spring followed by dry summer and autumn
1571	October	Tidal surge - floods in Wash, Yarmouth, Thames Estuary
1575	February	Floods in Central England
1579	February	Heavy snow - thaw with rain - floods in Southern England

1581		Drought up to December
1585		Rainfall produced a wet year
1587		Floods in Midlands - River Derwent bridge at Derby swept away
1588		Floods in Midlands - River Thames flooded twice in one year
1590		Severe winter
1591		Drought
1592		Drought
1594-95		Severe winter in England and in Europe. Thames, Rhine, Moselle, Po and Venetian Lagoons frozen - severe floods after thaw
1596		Floods in Midlands
1600		Floods in Midlands
1601		Floods in Midlands
1603		Floods in Midlands
1605		Floods in Midlands
1607	January	Tidal surges in Bristol Channel, North Sea and Channel
1607-08		Severe winter - Cumberland Lakes frozen; severe also in Europe (Zuider Zee frozen); great floods followed thaw
1610		Tidal surge - North Sea
1611		Floods in Midlands
1613	November	Tidal surge in North Sea
1614-15		Severe winter followed by floods and drought in summer 1615
1616	December	Floods in Midlands
1617		Severe winter
1619		Drought
1629		Floods in Midlands
1630		Drought
1632-33		Severe winter - River Thames frozen
1634		Severe winter - Rivers Thames and Trent frozen
1638		Severe winter - floods in Midlands and in North of England following thaw
1645		Tidal surge - East Coast floods
1648		Floods in Midlands

1652		Drought
1655		Severe winter - rivers frozen
1657-8		Severe winter in England and in Europe
		Seine and Rhine frozen - sea frozen in parts
		Cold spring in England
1660	March	Tidal surge in North Sea - heavy rainfall in Thames Basin produced combined surge and river floods in London
1661		Drought
1662		Floods in Midlands
1663	December	Tidal surge - floods in Thames Estuary and London
1664-65		Severe winter
1666-67		Severe winter in England and Europe - more severe in Europe where it was known as the Double Winter because many rivers froze twice
1669		Floods in Midlands
1670		Severe winter in England and Europe Floods in Midlands
1671		Tidal surge in North Sea
1673		Floods in Midlands and North of England Drought in summer
1674	May	Floods in Midlands
1676-77		Severe winter followed by floods
1680		Floods in Midlands
1681	Christmas-June	Drought
1682		Floods in Midlands and Southern England
1683-84		Severe winter - Rivers Thames and Trent frozen - floods followed thaw - part of Nottingham Bridge destroyed (February)
1686		Floods in Northern England
1687		Floods in Midlands
1689		Floods in Northern England
1690		Drought
1691		Floods in Midlands
1692		Floods in Northern England
1696		Floods in Midlands

1697		Floods in Midlands
1698		Floods in Midlands

THE THIRD STAGE - The 18th and 19th Centuries (to 1912)

1701		Floods in Northern England
1705		Drought
1708-09		Severe winter in England and in Europe
1710		Severe winter
1713		Severe winter
1714		Drought
1715-16		Severe winter - River Thames frozen - Tidal surge in North Sea (14th January 1716) during frost; severe winter in Europe; floods followed thaw
1716	Feb-Aug	Drought
1717		Floods in Midlands
1719		Drought - severe in England and in Europe
1722		Lowest River Seine level before August 1857
1723		Drought
1727		Tidal surge in North Sea - floods in London
1728		Floods in Midlands
1729-30		Severe winter
1730-31		Severe winter
1732	September	Tidal surge in North Sea
1733		Floods in Northern England followed by Drought
1734	October	Tidal surge in Dee Estuary
1735	January	Floods in Southern and Midland England
1736	February	Tidal surge in North Sea - London floods; a wet winter in England - severe in Europe followed by floods and summer drought

1736	December	Tidal surge in North Sea - floods in London
1738		Tidal surge in North Sea - floods in London
1739-40		Severe winter in England and in Europe River Thames frozen (Dec 1739 - 17.2.1740) River Ouse (York) frozen, Zuider Zee frozen
1740	December	Floods in Midlands and Southern England
1741		Drought
1742-43		Severe winter - River Thames frozen
1744	October	Floods in Midlands and Northern England
1747	October	Tidal surge in North Sea - London floods
1747-48		Severe winter in England and on Continent
1748	August	Floods in Midlands
1749	January	Tidal surge in North Sea - London floods
1750	January	Tidal surge at Cork
	July	Drought
1753	February	Floods in Northern England
	March	Tidal surge in North Sea - Floods in Thames
	October December	Floods in Midlands
1757	August	Floods in Midlands
1762-63		Severe winter in England and in Europe River Thames frozen; floods on Thames and in Midlands with thaw
1766	February	Floods in Midlands
1767-68		Severe winter - followed by floods
1770	November	Floods in Midlands
1771	November	Floods in Northern England; many bridges in Tyne Valley destroyed; Solway Moss moved
1772		Severe winter followed by floods
1773		Floods in Midlands
1775		Severe winter followed by floods
1776		Severe winter
1779		Tidal surge in North Sea
1780		Severe winter
1782		Severe winter

1784		Severe winter in England and in Europe Rivers frozen - flood after thaw
1785		Severe winter
1787	May	Floods in Midlands
1788	June	Midsummer floods in Norfolk Drought
1780-89		Severe winter in England and in Europe River Thames frozen - floods after thaw
1790	December	Floods in Midlands
1791	February	Tidal surges - floods in London
	October	Tidal surges in North Sea
1791	November	Floods in Midlands and Northern England
1791-92		Severe winter in England and in Europe Floods in Midlands and Southern England after thaw
1792	Summer	Drought
	September	Floods in North of England, Midlands and East Anglia
1793	January	Floods in Midlands and North of England
	Feb 27th	Tidal surge in North Sea
		Drought
	October	Tidal surge in North Sea
1793	December	Floods in Midlands and North of England
1794	January	Floods in South of England
	Summer	Drought
	October	Tidal surge at Cork
	December	Floods in South of England
1794-95	Dec-Feb	Severe winter in England and in Europe Thames, Trent, Zuider Zee frozen; severe floods followed thaw
	Summer	Drought
1796	29th January	Tidal surge in Bristol Channel
	February	Floods in South of England
	Summer	Drought
	December	Tidal surge in North Sea
1796-97	Dec-Jan	Severe winter
1797	September	Floods in South England
	October	Floods in Midlands and South of England

1798	September	Tidal surge in North Sea
	October	Tidal surge in Channel
1798-99	Dec-Feb	Severe winter followed by floods Tidal surge on East Coast at time of thaw-melt floods
	October	Floods in Midlands and South of England
1799-1800	Dec-Feb	Severe winter - Thames frozen - floods followed thaw
1801	October 19th	Tidal surges in North Sea
		Floods in Midlands
1804-5		Severe winter
1807	November 30th	Tidal surge in North Sea
1807-08		Severe winter
1808	April	Floods in Midlands and West Country
1808-9	Dec-Jan-Feb	Severe winter - floods followed thaw
	September	Floods in Midlands and North of England
1810	November 10th	Tidal surge in North Sea
1812		Floods in Midlands
	October 21st	Tidal surge in North Sea - flooding in London and on East Coast
1813-14	Dec-Feb	Severe winter - Thames, Trent, Tweed frozen; severe floods followed thaw (February)
1820	January	Floods in Midlands
	March 2nd	Tidal surge in North Sea - highest level between 1791 and 1877 - floods along East Coast
1821	December	Floods in Midlands
1822		Floods in Midlands
1824	October	Floods in Midlands and South of England
1826	Feb-Sept	Drought
1828	August	Floods in Midlands
1829		Floods in Midlands
1829-30		Severe winter in England and in Europe
1831	February	Floods in Midlands
1836	February	Tidal surge in North Sea
	November	Floods in Midlands
1836-37		Severe winter followed by floods
1837		Floods in Midlands

1837-38		Severe winter - Thames & Trent frozen (January); floods followed thaw
1842-43		Severe winter in England and in Europe
1843	January	Floods in Wales
		Drought
	November	Floods in Wales
1844	January	Drought
1844-45		Severe winter - floods followed thaw
1845	October	Floods in Northern England
1846	January	Floods in Midlands and South of England
	February	Floods in West Country
	August	Floods in Wales
1846-47		Severe winter
	Spring	Drought
	October	Floods in Northern England
1848	March	Floods in Southern England
	December	Floods in Northern England
1849	January	Floods in Northern England
1850	January	Tidal surge in North Sea
1852	January	Floods in Midlands
	November	Tidal surge in North Sea - floods coincided with land floods in Thames Estuary
		London flooded
		Floods in Midlands and Northern England
1853	February	Tidal surge in North Sea
1854	January	Floods in Midlands and North of England
	February	Tidal surge in North Sea
		Floods in West Country
		Drought
	November	Floods in Midlands
1854-55	Dec-Feb	Severe winter in England and in Europe
		Drought
	November	Floods in West Country
1855-56		Severe winter
1857		Drought
1858		Drought

1858-59		Severe winter
1859	February	Tidal surge in North Sea
1859-60		Severe winter
1862	March	Floods in Midlands
1864	March	Floods in Midlands
1867	January	Floods in Midlands
1868	February	Tidal surge in North Sea
	Summer	Drought
	December	Floods in Midlands and North of England
1869	December	Floods in Midlands
1870		Floods in North of England
1872	January	Floods in Midlands
1873	December	Drought
1874	March	Tidal surge in North Sea
	July	Floods in Midlands
	October	Tidal surge in North Sea
1875	March	Tidal surge in North Sea
	July	Floods in Midlands
	October	Floods in Midlands and North of England
1876	December	Floods in Midlands
1877	January	Tidal surge in North Sea
	October	Tidal surge in North Sea
1878	December	Floods in Midlands
1881	January	Severe winter
	March	Floods in Midlands and North of England
1882	October	Floods in Midlands
1883		Tidal surge in North Sea
1886	May	Floods in West Country and Midlands
1887	Feb-August	Drought
1889		Drought
1892	January	Floods in North of England
1894	November	Floods in South of England
1894-95		Severe winter followed by floods
1896		Tidal surge in North Sea
1897	November	Tidal surge in North Sea - floods along East Coast, East Anglia, Essex

1900-1901		Floods in Midlands
1908	June	Floods in Northern England
1909	December	Floods in Midlands
1910	December	Floods in Midlands
1911		Drought
1911-12		Wet winter
1912	August	East Anglia Flood

APPENDIX E - REFERENCES

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