INTRODUCTION AND THE EXAMPLE OF THE NILE

What makes riverine or ‘alluvial’ environments different, both from other environments and from each other, and how does this affect the archaeological record? How can we study environmental change in alluvial environments and what impact has it had on human populations? This book aims to answer these questions. It also aims to provide an introduction to the physical and biological aspects of alluvial environments which are central to an understanding of archaeology on, under and near floodplains. Questions of preservation, transportation, burial, environment and subsistence are all intimately related to the characteristics of the landscape and are also essential components in any archaeological interpretation. Another aim of the book is to introduce archaeological aspects of alluvial history to environmental scientists and geographers because the vast majority of, if not all, contemporary floodplains have to a greater or lesser degree been altered by human activity during the last 10,000 years. Indeed some have been so altered as to make them in part artifacts and as such indicators of the impact of humans on the environment. This book is therefore about both the impact of humans on their environment, and the impact of the environment on humans. In order to illustrate this and lead the reader through the complete cycle of the inference of cultural implications from the environmental data a classic example is used: the Nile. It is all too easy for specialists, be they archaeologists or geomorphologists, to work as part of a project team on a particular area or problem and never get to see the ‘big picture’. This introductory chapter and the rest of the book, whilst promoting specialist analysis of environmental data, also tries to stress the importance of a wider awareness of the potential uses and abuses of such data. It is abuse of the data which has in the past led to the twin evils of environmental relativism (i.e. the view that the environment does not have any particular role to play) and environmental determinism (i.e. the view that environment determines human behaviour).

In the last few years there has been an explosion of interest in the archaeology of wetland and alluvial environments at the research level (Coles, 1992a; Needham and Macklin, 1992). This raises the question of whether there is any such thing as the archaeology of a physical environment such as coast, floodplains or mountains. The archaeology of a particular physical environment may be distinctive for two reasons. First, because much cultural history and all prehistoric culture can only be viewed through the physical and biological

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Table Intro.1 *The components of geoarchaeology, adapted from Hassan (1979) and Goudie (1987).*

Components	Typical methods/data
1 site location	topographic maps, thematic maps, remote sensing, geographical information systems
2 geomorphological analysis of site environs	field mapping, stratigraphy, dating
3 regional stratigraphic studies	collation of geomorphological studies, remote sensing
4 sedimentary analysis of deposit	facies identification, studies of process and provenance, e.g. mineralogy, texture, mineral magnetics
5 palaeoenvironmental analysis	facies interpretation,palaeoecology, e.g. snails, pollen, wood, phytoliths, diatoms, insects
6 modelling relationships between human activities and landscape	correlation of environmental and cultural change, resource analysis, catchment area analysis, carrying capacity and Malthusian models
7 studies of natural hazards	most of the above
8 dating	radio-isotopes, luminescence dating, acid-racemisation, palaeomagnetic dating

remains of material culture. Therefore, irrespective of more elaborate theorising, the first step is the reconstruction of the material base of societies. The conditions of burial, which control the degree and bias of preservation, are therefore of fundamental importance for all archaeologists (Clarke, 1973). Like other natural environments, alluvial systems have particular preservation (or *taphonomic*) characteristics. Indeed, floodplains, along with some other environments such as salt marshes and sand dunes, can have an excellent archaeological ‘memory’. The information preserved, while providing exciting possibilities for the reconstruction of past living conditions, is controlled by a variety of physical factors; some are independent of human action, e.g. astronomically forced climatic change, and some are caused by human impact. If archaeologists are to use absence of evidence as data (which it is difficult to avoid), then all possible causes of a lack of preservation must be understood. This realisation was one factor in the rise of the research area of *geoarchaeology* (use of geological methods in archaeology) from the late 1970s onwards. Originally the result of collaboration and contact between archaeologists and geologists or geomorphologists (Davidson and Shackley, 1976; Rapp and Gifford, 1985), it has now become a recognised sub-discipline within scientific archaeology. This has occurred side by side with increased interest in other aspects of environmental and landscape archaeology and there is a large overlap between geoarchaeology and both environmental and landscape archaeology as illustrated by Hassan’s (1979) ‘components of geoarchaeology’ (Table Intro.1).

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A major objective of both geoarchaeology and broader environmental archaeology is palaeoenvironmental reconstruction, because data on changes in natural environments are of archaeological significance. It is for this reason that the first half of the book concentrates on physical and biological processes of alluvial environments which affect the formation, survival and bias of archaeological evidence from alluvial sites. While based on scientific methods, both the questions asked and the interpretation of data are as open to alternative paradigms as is the rest of archaeology (Clarke, 1972).

Alluvial environments can also be said to have their own archaeology because throughout prehistory they have, despite great variability, been distinguishable from other environments in their resources and hazards. This has led in the past to somewhat grandiose claims being made for the sociocultural effects of alluvial settlement, including the development of hierarchical social systems (Wittfogel, 1957) and the rise, and in some cases fall, of urban societies such as Mohenjo-Daro (Jacobsen and Adams, 1958; Lambrick, 1967). Later work on the settlement patterns of the Tigris–Diyala floodplain based upon field survey (Adams, 1965; 1981) has enabled a more sophisticated level of analysis balancing environmental factors. Johnson's (1972) use of central place theory showed how important water transport networks were, relative to the optimum utilisation of usable land, for the location and pattern of settlements. However, the earlier over-simplistic and deterministic ideas illustrate a potential problem faced by most, if not all, geoarchaeological or environmental work. Namely, a neo-environmental determinism derived from correlations between environmental and artifactual evidence, as is caricatured by Burgess's suggestion that the cause of the apparent increase in the deposition of bronze artifacts in rivers, lakes and springs after 1500 BC was the development of a 'water-cult' related to increased precipitation and waterlogging (Burgess, 1980 cited in Shanks and Tilley, 1987). At the other extreme, some post-processual archaeologists relegate environmental evidence to an unimportant backdrop to the myths, traditions and experiences that condition human existence. This is environmental relativism as it implies that the particular nature of the environment will have had no significant impacts on that society or culture. This book lies, along with middle range theory, somewhere in between, taking as its starting point the specification of relations between environment, subsistence, technology and social ranking. The physical and biological resources of alluvial environments are seen as offering changing, complex and integrated sets of possibilities to human groups at costs which may or may not be acceptable *when judged in their own terms*. In this sense, the book follows a possibilistic view of the relationships between human behaviour and the environment. The environment not only filters and biases our initial data but must have affected the behaviour of our subjects in varied and subtle ways, including their perception of that environment. Alluvial environments are sensitive to changing climatic conditions and the Holocene has not been climatically constant

(Kutzbach and Street-Perrott, 1985; Goudie, 1992). So the interaction between the climatic signal in alluvial stratigraphies and the cultural signal forms an underlying theme of this book. Since both the reaction of fluvial systems to external forces and human environmental modifications are spatially variable, this theme must be considered at the appropriate scales and we should be wary of making long-distance correlations or generalised statements.

Part I of the book covers the principles underlying the physical and biological processes that operate in alluvial environments and the methods used in the study of these processes. Chapter 1 introduces floodplain evolution as this is essential for studies of environmental change and its relationship to human activity. Our knowledge of how floodplains have evolved is also dependent upon dating, which is covered in chapter 2. The interpretation of floodplain sediments and soils, covered in chapter 3, is a necessary part of all alluvial archaeology. This includes a basic understanding of the processes of river flow, sediment transport, erosion and deposition. An understanding of these fundamental factors is needed for the accurate interpretation of the fluvial 'jumbling' of artifacts. Most early prehistoric artifacts, and indeed sites, are reworked and disturbed. Hand-axes are little different from the normal pebbles carried by rivers, and sites may be little more than natural zones of accumulation of these 'pebbles'. However, because archaeologists attempt to interpret both axe form and artifact or site arrangement, the role of natural processes must be understood. In describing and interpreting an early prehistoric terrace site it is impossible for the archaeologist to ignore the palaeoenvironment and this normally means integrating the archaeology with some geomorphological interpretation of the site stratigraphy. In later prehistoric contexts, the floodplain may itself be seen, in part, as an artifact of human settlement within the catchment. In order to determine the real impact of cultures on fluvial systems the natural controls on those systems must be understood, otherwise there is a very real danger that the relationships between culture and environment are obscured. Floodplain excavations can provide a wealth of environmental data and chapter 4 deals with the methods of obtaining, analysing and interpreting archaeobotanical and archaeozoological data from floodplain sites.

Part II focuses on applications of these principles and techniques to the interpretation of artifacts, sites and the relationships between human activity and the alluvial environment. Chapter 5 concentrates on those studies where the archaeology is confined to artifacts within the floodplain stratigraphy. This is most typical of Old World Palaeolithic archaeology and much of North American archaeology. One of the geoarchaeological advantages of the alluvial environment is the preservation of many sites through burial, and the study of buried sites and the history of alluviation is discussed in chapter 6. This history is related, in part, to land use, and floodplains can provide excellent information on land use history, as described in chapter 7. Indeed the floodplain is an important component of nearly all archaeological landscape

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studies. The last chapter explores the peculiarities of floodplains and low terraces for human occupation, and relationships between occupation and environmental change. This includes what T. Evans (1990) has called the asymmetry of human activities in the valley as compared with the valley sides. Can we assume that floodplain sites are rarely, if ever, simply sites that happen to be near rivers, i.e. how are function and environment related? Both positive and negative factors should be evaluated in any interpretation of floodplain settlement history, even if some of these factors are archaeologically invisible, such as perceived risk. While this book focuses on valley bottoms as blocks of landscape, they must be related to the record from the rest of the landscape. As Evans (1990) has stated: 'What wet sites share are preservation factors and similar environments. To divorce them from their [dry] regional cultural/chronological context necessarily pushes their interpretation towards functional universals and environmental determinism.'

This book is segmented so that those readers requiring the scientific/environmental background to alluvial environments can commence with Part I but those only requiring floodplain archaeology *per se* can commence with Part II. The appendices are provided as elaboration of some of the more technical material covered in Part I, but material which is essential to practical or experimental work. An exhaustive global coverage is clearly impossible, so the aim throughout Part II is to take some of the more important or better-documented sites, largely from North America and Europe, and present them in the light of the theoretical discussion in Part I. The sites are united by the fact that, in every case, site interpretation has involved an element, sometimes large, sometimes small, of the reconstruction of a fluvial palaeoenvironment from stratigraphic evidence.

In order to illustrate the overall theme of the book, i.e. how geological, geomorphological and hydrological methods can be used in alluvial archaeology, I propose to start with a classic example: the fluvial history of the Nile. The history of the Nile in recent times as well as in the more distant past is a complex mix of environmental, economic and legal issues (Howell and Allen, 1994), and because of its supreme importance to the Pharaonic civilisations it has been, and continues to be, the focus of much geoarchaeological study. This work has included a wide variety of methodologies and data sources drawn from subjects as diverse as Egyptology, geomorphology and climatology.

An introductory example: the Nile

The high Egyptian civilisation that emerged in the late fourth millennium BC was not only located on the Nile floodplain but was entirely dependent upon the Nile for its survival in an environment with virtually no rain and no fresh groundwater supplies. The classic work of Wallis Budge (1926) gives us some insight into the importance of the Nile in Egyptian life through its mythology and culture. Egyptians called the Nile Hapi which was also the name of the

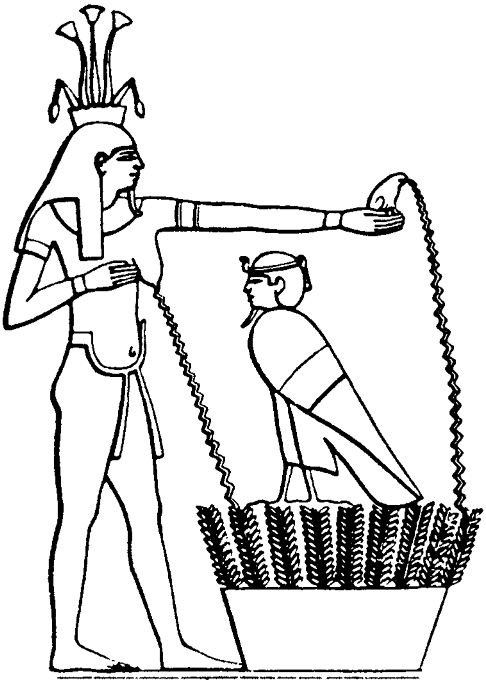

Fig. Intro.1 Hapi the Nile God. The frog (a symbol of new birth) and the lotus plants on his head reflect the crucial role of the Nile in Egyptian agriculture as both appeared as a result of the flood. Adapted from Wallis Budge (1926).

God of the Nile. The God Hapi was depicted as a man with woman's breasts (Figure Intro.1), indicating strength, and powers of fertility and nourishment. They celebrated the God at the festivals of inundation, and because of the central role of the river in the Egyptian economy the collection of accurate hydrological records began in the First Dynasty (*c.* 3000 BC) with the engraving of maximum annual flood height on a large stone stele. The first Nilometer (fixed recording device or structure) was cut into the rocks at Samnah in the Twelfth Dynasty (*c.* 2200–2000 BC). The Nile's behaviour formed the basis of the oldest Egyptian calendar, which divided the year up into three parts, one of which (Akhet) was the main flood season. The height of the flood controlled the amount of land watered and therefore the supply and cost of bread. If the Nile reached a height of 16 cubits food supplies would normally be sufficient to supply the population for a year and this was celebrated in the 'Wafa' festival. If the flood reached 18 cubits and the middle lands were flooded the 'Neirouz' festival inaugurated the new year's day of the agricultural year, and if 20 cubits was reached the 'Saleeb' festival was held, celebrating the flooding of the high lands (Evans, 1990). Successions of 'low Niles' always produced famines such as the seven-years famine which occurred in the Third Dynasty

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(*c.* 3190–3100 BC). The Nile was probably just as important in pre-Dynastic and post-Dynastic times, and so its Holocene history is an essential part of the archaeology of Egypt.

The geomorphological history of the Nile has been reconstructed from studies of repeating sequences (cyclothems) of deposits in its delta (Stanley and Maldonaldo, 1979), sediments in the lower and middle valley (Butzer and Hanson, 1968; Adamson *et al.*, 1980) and deposits in the swamps of Sudan (Williams, 1966). The archaeological importance of the alluvial environment has favoured interdisciplinary approaches as typified by the surveys of Caton-Thompson and Gardner (1932) and Sandford and Arkell (1939) and later by the work of Butzer. Butzer's (1976) 'cultural ecology' approach is quintessentially geoarchaeological, including studies of valley sediments, geomorphology and ecology. The valley which Butzer describes is bounded by limestone hills to the west and cliffs to the east (Figure Intro. 2). It is floored by Pleistocene sand and gravel and there has been a long-term tendency for the river to migrate towards the eastern side of the valley. During the glacial maximum (*c.* 20,000–12,500 bp) the Nile was a highly seasonal braided river system with massive floods over four times larger than historical floods and periods of the year with no flow at all. This regime was caused by cold dry conditions in the East African Highlands and it produced a wide floodplain some 40 m above the present level between the first and second cataracts, where it corresponds with the area of the Sebilian culture. The Pleistocene period, which ended with overflow from Lake Victoria and increased rainfall in Ethiopia, was followed in the Holocene by permanent river flow and a period of extreme floods which caused incision of the river into its floodplain (Adamson *et al.*, 1980).

Up until about 5000 years ago higher rainfall than present in Ethiopia and a lack of flood storage in the slowly developing Sudd swamp resulted in centuries of high floods. These floods caused cycles of deposition and incision until Egypt and Nubia became more arid and less extreme when floods began to deposit the Arminna/Kibdi silts annually on the narrow Egyptian floodplain. Silt and sand deposition has produced natural levees and a domed cross-profile (Figure Intro. 3). Both sediments and surface features also indicate the presence of more channels in the past, some of which, such as the Bahr Yusef, still exist today. The existence of these former channels helps to explain the location of some Ptolemaic and older settlements such as Aphroditopolis and Heracleopolis. There is also documentary evidence of their existence (Strabo 17:1.4). In between these channels were large floodbasins which were flooded to a depth of about 1.5 m in a normal flood (Butzer, 1976). In its natural state the floodplain vegetation would have been evergreen forest of fig and acacia fringing the channels, and grassland or acacia-scrub savannah on the seasonally inundated flats. Palaeolithic settlements, such as those mapped by Butzer and Hanson (1968) in the Kom Ombo Plain, cluster on levees and riverbanks. This allowed easy utilisation of a variety of resources, including wildfowling in

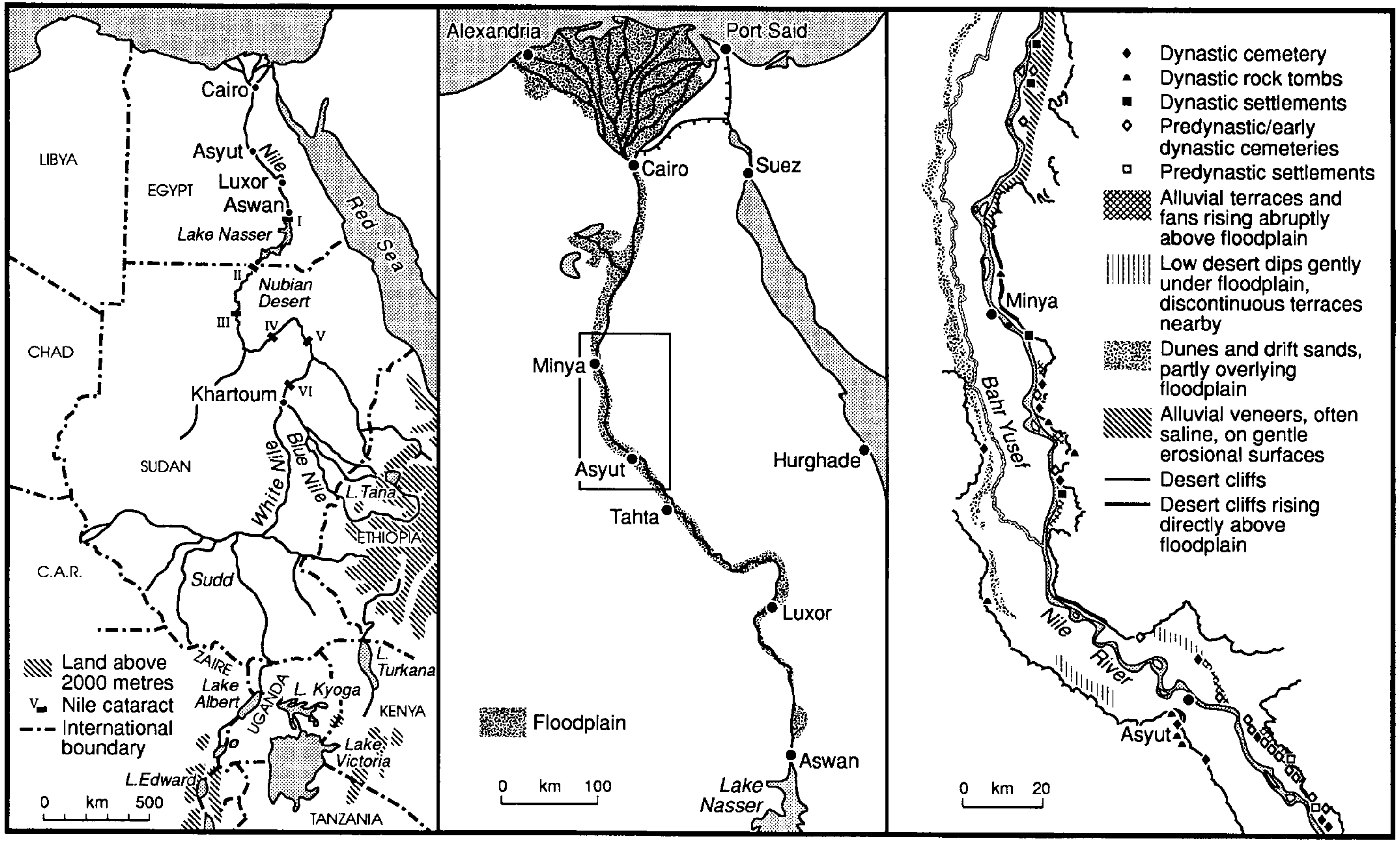

Fig. Intro.2 Map of the Nile catchment and Egyptian Nile valley showing major geomorphological features and localities mentioned in the text. Based in part on the pre-dynastic site survey by Butzer (1982) and Adamson *et al.* (1980).

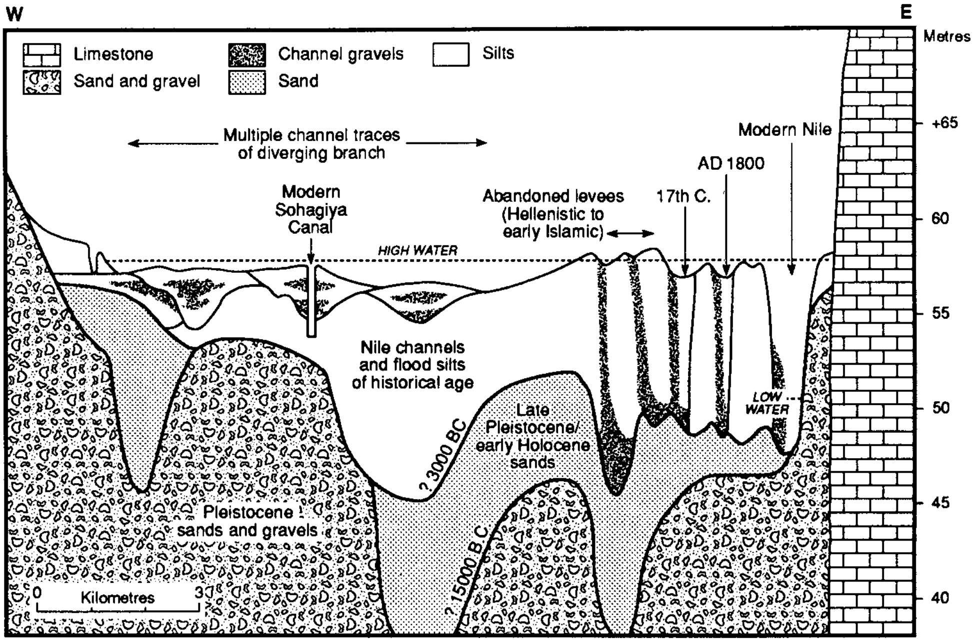

Fig. Intro.3 Simplified Nile valley cross-section near Tahta. Aapted from Butzer (1976).

the Nile and papyrus-filled cutoff meanders and backswamps and hunting big game on the open flats. Early farming communities occupied similar locations, planting crops in the wet soils after the floods and grazing animals on the alluvial flats. Artificial irrigation (which can involve as little as a few channels cut across levees) began in the late pre-Dynastic period and greatly increased the area of annual cropland and decreased the threat from poor floods. From then on, the Nile flood was managed; this included the construction of canals, dykes to confine floodwaters and facilitate transport, embankments and in upper Egypt the construction of large floodbasins. Every town and village was expected to contribute labour for this work which was supervised by the king's officials through the governors of each of the forty-two nomes or districts.

A key element in the river and flood management was recording flood heights. Undoubtedly the best-known and oldest flood records are from the Nile, and they extend back almost continuously to AD 622 with fragmentary records extending back to 3100 BC. In nearly all the dynasties some records were made of high and low floods. The Nile flood is supplied by summer monsoon rains over Ethiopia (Riehl *et al.*, 1979), while the winter flow of the river depends upon the rains near the equator. The river is therefore a barometer of two components of the climatic system and a good indicator of climatic change.

There are, however, many problems in trying to reconstruct climate from a flood series derived from this data. The completion of a full series is prevented by inconsistency between the records of different periods, with different datums being used, and even different measuring scales (Bell, 1970). The longest early fragment lasts from early in the First Dynasty (about 3050 BC) to the Fifth Dynasty (around 2500 BC). It was carved onto what is now known as the Palermo stone. Even this data set is not without problems, as Helck (1966) thinks that the largest flood value in the array may be fictitious and was invented for religious purposes. Bell (1970) has attempted a partial hydrological analysis of this data by converting it to metres. This involves assuming that two spans equals 0.524 m. Since the datum is unknown an arbitrary relation is used to compare the series with a modern series from the Nilometer at El-Roda, Cairo. The problem of the datum height is complicated by the aggradation of the river and floodplain and Bell (1970) has used a value of 1 mm yr^{-1} (derived from Butzer, 1959), to correct for this effect. Whether this is appropriate or not depends upon the measuring device that was used. The data come from the Memphis Nilometer, which if it was of the portable kind would have had a zero which moved up with the floodplain; if, however, it was of the fixed kind with a scale carved on a wharf or special well, then it would have had a fixed zero and the correction would be inappropriate. The surviving Nilometers such as that at El-Roda are Graeco-Roman and are large stilling wells often with galleries which allow water to pour in as the river level rises. Using either of the assumptions it is clear that the average flood heights decreased (from what may have been a high period) from the First to the Second Dynasty (about 3100 BC to 2800 BC), reflecting a decrease in the amount of rain from the summer monsoon over East Africa (see Figure Intro. 2). The Dynastic records show great famines caused by droughts and failure of the yearly floods in the periods 2180–2130 BC, 2000–1950 BC and around 1750 BC. Bell (1971) and Evans (1990) have argued that the First Dark Age of Egypt was brought on by a prolonged and intense drought; however, the death of Pepi II and political fragmentation were also important in the decline to anarchy that occurred at the end of the Sixth Dynasty. From the records of twenty-eight floods found in Nubia, Bell (1975) argues that during the period 1840–1770 BC there were a number of phenomenally high floods. Calculations using the stable cross-section of the second cataract with a stage 10 m higher than the average flood of the twentieth century give a discharge of $32 \times 108\ m^3\ day^{-1}$ ($22.2 \times 105\ m^3\ s^{-1}$). This flood was three times the magnitude of the largest floods of the last hundred years and would have been catastrophic, with a water depth on the floodplain of between 4 and 2 m above the modern flood level. Records are unavailable for the New Kingdom and the Late Dynastic period (1570–332 BC) but there are records of exceptionally high floods in the ninth to seventh centuries BC, the fifth century BC, and the first centuries AD. Flood heights increased again in the period AD 600–1000.

These records have been supplemented by excavations of Dynastic sites. The