Foreword and Introductory Remarks

Thus spake Ankhtify:[1]

> *"I gave life to Hefat and Hermer when the sky was clouded and the land in wind, when every man was dying of hunger under the sandbank of Apophis…*
>
> *"I rushed this grain southwards to arrive at Wawat. It travelled downstream, it arriving at Abydos while Upper Egypt in its entirety was dying of hunger, all men eating their children.*
>
> *"Never did I allow death from hunger to occur in this province…*
>
> *"Ankhtify says that this entire land had become like a grasshopper with emptiness as one goes north, the other going south…"*

According to Ankhtify, nomarch of the third Upper Egyptian nome and overlord of the second, a significant famine had struck Egypt during his time in power. The calamity of which he speaks is thought to have come about as a consequence of steadily declining Nile water levels, which had become a serious concern by the end of the Old Kingdom.[2] In an heroic effort, Ankhtify managed to sustain the lives of his own people and due to his remarkable ability, was even able to provide food for some of his neighbours.[3] Conversely, in the same autobiography, Ankhtify identifies the spread of the marshlands as a significant problem when he tried to enforce the authority of the king in the region and to impose his own leadership upon those local rulers who appeared somewhat reluctant to embrace it.[4]

[5] *gmi͗.n(=i͗) pr.w ḫww t̠tf(.w) mi͗ grg.t mkḥ3.n* [6] *i͗r.y=f*

"I found the house of Khui inundated like a marsh, abandoned by him who belonged to it"

Thus, there seemed to have been two competing influences affecting Ankhtify and his contemporaries. The land was in drought while the river had become like a swamp. Are we experiencing narrative hyperbole, or can there exist a situation where both events occur simultaneously?

F.1. Egypt <u>is</u> the Nile

Ancient Egypt has been described as a '*Hydraulic Society*',[5] its civilisation developing as a direct consequence of the large-scale manipulation of water.[6] It is difficult to envisage the development of the complex ancient Egyptian civilisation without the adoption of irrigation, something recognised by historians of old: Herodotus, in his *Histories*, recognised the land of Egypt as a "gift from the Nile", while Pliny the Elder claimed it was the river that did the farming.[7] The hydrology of Egypt is unique because almost all of the water that flows through the country comes from external sources, initially falling as snow and rainfall in locales much further south. Each year, the river peaked in an annual flood because of the monsoonal rains in the south, swelling the normally placid flow into a mighty surge. These waters carried masses of rich silt, which were deposited as they flowed over the banks and spread across much of the Nile valley.

The Egyptian calendar year had three seasons, and their names and timings derived from the river and the associated agricultural production. Before the floods arrived every season, the land needed to be repaired and prepared: natural dams were improved and extended, old water channels needed to be repaired and new channels dug.[8] The start of the calendar coincided with the arrival of the floodwater, known as the time of *akhet*, 'the inundation' (of water). When the flood occurred, it discharged nutrients carried by the river onto the surrounding countryside, these nutrients,[9] therefore being lost to the river (see Figure F.1).

Peret, 'the emergence' (of land), is the period when water started to recede, leaving rich and fertile alluvial soils ready for planting, while the season known as *shemu,* 'the deficiency' (of water), was the time when harvests began. This regular cycle underpinned the society that developed in the Nile valley. [10]

The Egyptians developed an agricultural system thought to be one of the most productive in the ancient world. Good quality, fertile land was a prerequisite for successful

[1] Author translation (apologies to Nietzsche) from Vandier, *Mo'alla,* Ins. 1–12, 161–174.
[2] Hassan, *Floods & Disasters*, 1–23; Said, *River Nile*, 141–143; Lloyd, *State & Society*, 176–177; Stanley etal, *Nile Flow Failure*, 395–402; Parcak, *Physical Context*, 8–10.
[3] Merer in Lichtheim, *Literature* I, 87, makes similar claims. On the veracity of Ankhtify's claims, see Vandier, *Mo'alla*, 34–44; Coulon, *Véracité et rhétorique*, 117, 129–132.
[4] Grimal, *A History of Ancient Egypt*, 142; Seidlmayer, *FIP*, 129; Manassa, *El-Mo'alla to El-Deir*. http://escholarship.org/uc/item/4pc0w4hg (13/03/2016).
[5] Butzer, *Hydraulic Egypt,* 7–10; Alleume, *Systemes Hydraulic*, 301–322.
[6] Wittfogel, *Oriental Despotism*, 19, 311. Also Wörster, *Rivers of Empire*; Butzer, *Hydraulic Egypt*.
[7] Herodotus, *Histories* 2.5; Pliny the Elder, *Natural History*, 18, 47 & 167.
[8] Butzer, *Hydraulic Egypt*, 41–47.
[9] Said, *River Nile*, 131–135.
[10] Hildebrand & Schilling, *Early Nile Agriculture*, 81–95, Alleume, *Systemes Hydraulic,* 301–322.

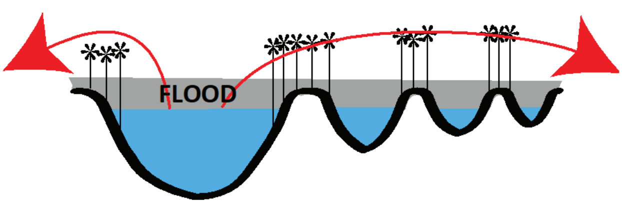

Figure F.1: An inundation deposits resources onto the land.

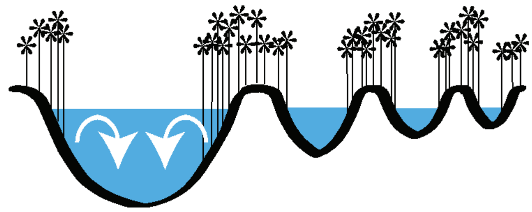

Figure F.2: No inundation means that the nutrients remain in the river.

economic development.[11] Field crops such as wheat, barley, flax, vegetables and fruits provided food, drink and fabric. To ensure a successful harvest, the height of the Nile floods was crucial, and it was measured each year. Nilometers, stone steps leading from the riverbank down into the water, registered the level and, during the Old Kingdom, the heights of 63 annual floods were recorded by 11 different kings. With increased control of water, agricultural surplus could develop.[12] Agricultural success was then followed by rapid population growth. As long as resources were available, overpopulation was not a significant problem.[13] However, though the annual flood was mostly reliable, it could sometimes appear lower than expected.[14] Regular lower-than-average floods led to an onset of lean times with numerous accounts of famine recorded in Egypt's past, with evidence from objects such as the Palermo Stone suggesting short-term fluctuations.[15]

It seems, however, that during the Old Kingdom, the power of the river and the inundation associated with its annual flood was gradually weakening.[16] During 'drought', the river would still have carried these nutrients downstream but did not have the necessary volume to overflow its banks, resulting in nutrient retention within the river channel. As the current slowed, it would have lost the necessary momentum to carry these nutrients, which would have been deposited on the riverbed and river's edges rather than beyond (see Figure F.2), providing excess biological energy to be utilised within the riverine habitat.

F.2. The Effect of 'Drought' upon the River

Since reliable agriculture has been linked to the prosperity and stability of the society[17] a continuous slow decline in water levels[18] and a corresponding increase in aridity should have been noticed at the end of the Old Kingdom.[19] It has been suggested that the drought had a major impact upon the culture of ancient Egypt – in some cases, the fall of kings.[20] Evidence suggesting a continuous drying out of the country from the Predynastic era onwards implies that famine and drought were at least a regular occurrence,[21] one that perhaps should not have had as significant an impact upon the civilisation as many claim.[22] The developing aridity of this time may have encouraged improved production methods.[23] If the current modelling is correct, however, and if ancient Egypt was experiencing climate change, then, in addition to regular lower than usual levels of inundation, the country may also have experienced regular above-average floods as well as unexpected significant rainfall events. Said, in describing the various fluctuations that the River Nile has experienced over its history, comments on the vagaries of its flow.[24]

F.3. The Effect of Excess Water upon the River

While the inundation was relatively predictable, whatever its level, rainfall events in Egypt occurred with irregular and unpredictable timing, thereby interfering with the progression of the 'normal' cultivation cycle. Just as too little flooding meant that irrigation efforts were ineffective, excessive flooding was also problematic.[25] Agricultural success further south, for example, is attributed to lack of large inundations, with excess water flowing downstream.[26] Just as the flood governed the annual outcomes of agriculture, the timing of rainfall events would also have impacted upon the success, or otherwise, of the cultivation cycle.[27]

However, high water levels do not automatically equate to a positive environment.[28] A problem almost as significant as lower than usual flood heights was the occurrence of higher-than-average flood levels. Potential cultural responses to the environmental impact of variable flood levels have been proposed by Butzer and Bárta.[29] Extreme

[11] Soroush & Mordechai, *Short-term Cataclysm*, 1, 8–10.
[12] Said, *River Nile,* 188–208.
[13] Hely, etal., *Climate Water Tradeoff*, 681–686.
[14] Said, *River Nile*, 131–133, 141–142, 149–152.
[15] Macklin etal., *River Dynamics*, fig. 7.
[16] Said, *River Nile*, 134–138; Hamdan etal., *Climate & Collapse*, 89-100.
[17] Bard, *Archaeology of Ancient Egypt*, 51–53; Lawler, *Collapse Revisited*, 907–908. Santoro etal., *1000 Years of Famine*, shows extremes of flood and drought following a semi-regular unpredictable pattern.
[18] Hoffman, *Before the Pharaohs,* 311; Butzer, *Discontinuity*, 106. Park, *Class Stratification*, fig. 3, 103, infers a gradual increase in aridity throughout the Old Kingdom.
[19] Bárta, *Long or Short Term*? disputes the role of climate. Said, *River Nile*, 131–133, identifies Pre- and Early Dynastic droughts.
[20] Schneider, *Existence Now Silenced,* 311.
[21] Brewer, *Predynastic Temperatures*, 299–300.
[22] Said, *River Nile*, 7–91; Phillips etal., *Mid-Holocene Egypt*, 64–74; Butzer, *Collapse, Environment & Society*, 3634; Bárta, *Collapse Hidden in Success*, 18–28; Stocker etal., *Climate Change* 2013, 33–115.
[23] Midant-Reynes, *Prehistory*, 253 – contra Weiskel, *Environmental Lessons*, 99.
[24] Said, *River Nile*, 129, 143–148, 176.
[25] Coulon, *Famine,* 1.
[26] Macklin etal., *Nile Floodwater Farming*, 698.
[27] Morris, *Art of Not Collapsing*, 79–81, Soroush & Mordechai, *Short-term Cataclysm*, 7–8; Nicholson & Shaw, *Materials & Technology*, 514.
[28] In fact, the flood levels during the First Intermediate Period appear to be above average; see Schneider, *Existence Now Silenced*, 314.
[29] Butzer, *Discontinuity*, 254–257; Bárta, *Collapse Hidden in Success*, 23–25.

water levels could wash away years of careful planning and preparations; canal and boundary markers were lost, field fences washed away and the organised sharing of excess water severely disrupted.[30] The loss of infrastructure would have had significant negative consequences to ineffective governments.[31] Thus, excessive floods and unusual rainfall events may have interfered with the development of agriculture and the maintenance of cultivation in the region.[32] Other scholars have even suggested that excess rainfall events and higher-than-average floods in the Nile valley may have hindered the adoption of agriculture in the region.[33]

At this time in history, high rainfall events causing large scale erosion in wadis was followed by instances of dry sand entering the Nile Valley. Excessive siltation can produce dense, compacted and poorly aerated soils; this saturated soil is less productive than well-worked land.[34] High volumes of water can result in severe weathering and rapid erosion as large amounts of fertile soil, laid down in preceding years, are washed away back into the river,[35] resulting in the riverine habitat receiving extra nutrient resources (see Figure F.3)[36]. Recent evidence points to the likelihood that, at a time when the flood had become less reliable, the Nile valley experienced significant rainfall events.[37] While unexpected, rainfall within the Nile valley has been shown to have always occurred, and mounting evidence suggests that severe rainfall events were becoming more commonplace during the timeframe under investigation.[38]

The physical force of the pluvial cascade impacted upon the integrity of some tombs built during this time, for example the tomb of Merefnebef,[39] while other tombs were structurally re-designed to resist the negative impact of a rain-fuelled deluge.[40] Interestingly, much of the land abandonment that occurred in Mesopotamia at this time has been linked to unreliable or irregular rainfall patterns,[41] suggesting a connection between unusual rain events in Egypt with those which occurred in other places around the region at this time.[42]

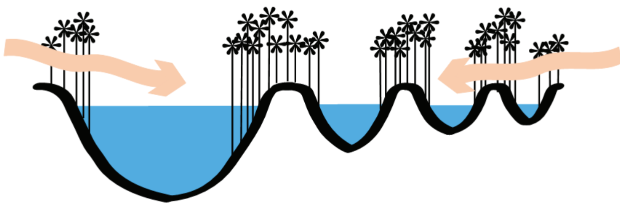

Figure F.3: Rainfall returns nutrients to the river.

F.4. Scientific Evidence of Irregular Water Supply

A large amount of corroborating scientific evidence identifies the timing and significance of the increasing aridity experienced at the end of the Old Kingdom and the consequent decline in agricultural success.[43] According to current scientific opinion, this phenomenon reached its nadir 4200 years ago.[44] Scientific evidence supporting this date includes analyses of ancient rainfall precipitation,[45] Nile delta sediment studies,[46] Mediterranean seabed silt deposit investigations,[47] Isotopic examination of fish bone remains,[48] chemical residue analyses of a variety of lakebed sediments;[49] as well as pollen deposit variances from various Nilotic plants[50] and radiocarbon examination of miscellaneous genetic material found in ancient remains.[51] The conformity of 'agreement' amongst the findings could make a cynical person suspicious, but there does seem to be a vast amount of evidence from many branches of science supporting the assertion of a significant environmental event taking place over the time in question: this time frame identified as approximately 4,200 years before the present. [4200 BP].

Recently, however, it has begun to appear that to some scholars that the idea of a long-term drought seems perhaps a little too simplified to explain all the observations and interpretations that have been made.[52] Very little distinction has been made between the various types of floods and their different impacts upon the society. These disruptive events may be indicators of a climate changing more gradually over the long term. Current climate change modelling suggests that extremes of weather will become

30 Said, *River Nile*, 7–91; Butzer etal., *Urban Geoarchaeology,* 3361–3364, fig. 19; Morris, *Art of Not Collapsing*, 80-81.
31 Butzer, *Pleistocene Nile*, 253–280; Nicholson & Shaw, *Materials & Technology,* 514.
32 Butzer & Hansen*, Desert & River*, 115, 129, 278; Butzer etal., *East African Lake Levels*, 1069–76.
33 Hassan, *Food Security,* 321–334; Butzer, *Hydraulic Egypt*, 9.
34 Butzer, *Hydraulic Egypt*, 17–18; Said, *River Nile,* 143–148.
35 Butzer, *Hydraulic Egypt,* 15–17, 51–53; Sampsell, *Traveller's Geology,* 12.
36 Hassan, *A River Runs Through*, 22–25; Bunbury etal., *Water Historical Perspective*, 52–71; Bunbury etal., *Memphite Floodplain Landscape*, 80–81; Butzer, *Quaternary Nile*, 161–162, 171.
37 Myśliwiec etal., *Saqqara Geoarchaeology & Paleoclimate*, 294–295; Hayes, *Most Ancient Land*, 96; Geriesh etal., *Groundwater*, 605, fig 21; Touzeau etal., *Nile Valley Aridity,* 92–100.
38 Welc & Marks, *OK Climate*, 124–133; Sowada, *Weather Evidence*, 69–74; Welc & Trzciñski, *Dry Moat Geology,* 323–343; Trzciñski etal., *West Saqqara Geoarchaeology*, 194; Embabi, *Landscapes & Landforms*, 32–35.
39 Myśliwiec etal., *Merefnebef*, 41, pl. 7b.
40 Kuraszkiewicz, *Architectural Innovations*, 32.
41 Myśliwiec etal., *Saqqara Geoarchaeology & Paleoclimate*, 295–298; Fiorentino, *Syrian Climate Change*, 56.
42 Kowalska & Kuraszkiewicz, *End of a World*, 173–176; Walker etal., *Holocene Subdivision*, 653–656.
43 Rzóska, *Nile,* 35–36.
44 See, for example, Krom etal., *Nile Sediment Fluctuations;* Stanley etal., *Nile Flow Failure*; Ducassou etal., *Nile Floods*.
45 Williams & Nottage, *Extreme Rainfall Impacts*; Butzer, *Discontinuity*; Bárta, *In Mud Forgotten*.
46 Arz etal., *Red Sea Dry Event*; Marriner etal., *Nile Delta's Sinking Past*; Shaltout & Azzazi, *Nile Delta Climate Change.*
47 Ducassou etal., *Nile Floods in Sediments;* Krom etal., *Nile Sediment Fluctuations*.
48 Brewer, *Predynastic Temperatures*.
49 El-Wakeel, *Lake Qarun Deposits;* Touzeau etal., *Nile Valley Aridity*.
50 Langutt etal., *Late Bronze Collapse*.
51 Butzer etal., *East African Lake Levels*; Buzon & Simonetti, *Strontium Isotope Variability*; Zanchetta, *Tephrostratigraphy*; Williams etal., *Late Quaternary Floods & Droughts*.
52 Bard, *Archaeology of Ancient Egypt*, 176–180, Müller-Wollermann, *End of the Old Kingdom*, 5.

more 'regular', longer droughts, wetter rainy seasons, cooler cold days and warmer hot days.

Rather than a predictable climate (climate being what you expect over a period of time), the world would seem to be entering a phase where the weather (weather being what you get day to day) experienced appears more unsettled.[53] The same phenomenon may have been experienced in Ancient Egypt with an 'oscillating' pattern of uneven weather displaying more irregular behaviours than previously experienced.[54] Developing geomorphological technologies have allowed scientists to improve the understanding of the nature of the historical Egyptian environment.[55] Kilimanjaro ice core analyses, for example, have identified stages in Egypt's recent past, with the most recent example dating from 5000–3500 BCE, when so much water would have been available for cultivation that irrigation should *not* have been necessary.[56] The annual regeneration of the soil and the subsequent abundant natural yield allowed for the retention of a herder-forager lifestyle to remain as effective cultural behaviours for many prehistoric Egyptians. This notion is at first glance counter-intuitive, but it is feasible to look on the river as a natural provider rather than the source of labour-intensive agriculture-based sustenance.[57] It was possible that the natural growth of pasture/vegetable greens/vines meant the Egyptians did not have to farm. Perhaps the continued practice of a herder-forager lifestyle in many parts of the country was as a consequence of unpredictable river behaviour, with the adoption of agriculture as an option adopted in response (i.e., choosing to) to a changing climate and not as a consequence of it (i.e., being forced to).[58]

F.5. Rationale, Hypotheses and Goals

When a river is expected to flood annually but an inundation does not occur, then the land bordering the river experiences a so-called 'drought'. In the cultural exemplar of many Western countries, a drought, usually defined as "*a prolonged period of abnormally low rainfall, leading to a shortage of water,*"[59] is what happens to the land, and its associated affects are usually applied to the impact that it has upon that land. In discussion of the Old Kingdom, a drought is usually seen as a dramatically low or absent Nile River inundation, and, similarly, most commentators considered the drought's effects on the land and the implications that a low flood had for the society.

It is important to not confuse our modern understanding of the term "drought;" with its use in the Egyptological discourse. In the modern vernacular, drought refers… "*as a period of unusually dry weather that persists long enough to cause problems such as crop damage and water supply shortages.*"[60] Traditionally, Egyptological terminology equates the term 'drought' to the lack of the regular/reliable annual flood,[61] which may be more precisely identified as an "agricultural drought"; one whereby "*the water needs for crops at various growing stages is not being met*".[62] Examples may include not enough moisture at planting time to germinate seeds or inadequate water while growing, leading to reduced yields. In the terms of this study, a 'drought' refers to a long period of less than normal river levels. This is more precisely identified as a "Hydrological drought" in the modern science literature, referring to "*persistently low water volumes in streams, rivers and reservoirs.*" The problems that will be discussed are based on the understanding that, during the time frame under investigation, the river was in a state of decline and the amount of annual relief that was normally delivered during the inundation was less than anticipated or expected.

"*A society is circumscribed by its environment.*"[63] To help us understand ancient Egyptians, we first need to develop an understanding of their environment.[64] Analysis of the long-term environment of a site or region allows for the investigation of a number of inferences that may arise based upon current scientific considerations,[65] improving the understanding of the cultural development of that site or region, as opposed to it being a centre for redistribution.[66] Hierakonpolis, as an example noted earlier, had developed into an important cultural centre by Predynastic times despite having no resources of note.[67]

Despite the apparent importance of the "drought" in the discourse of the end of the Old Kingdom, a critical aspect of investigations into this era appears to have been left out by the scholarship so far: scientific analyses of the ecological changes that would have taken place within the river itself during times of drought. From an ecological standpoint, when a river floods, it loses sediments and nutrients to the surrounding landscape. By contrast, a river that does NOT flood retains these nutrients. This organic bounty remains

[53] See Stocker & Qin, *Climate Change* 2013.
[54] Bunbury etal., *Memphite Floodplain Landscape*, 89–90; Steward etal, *River Runs Dry*, 202–203.
[55] see Butzer, *Archaeology & Geology*, 1617–1624; Welc & Marks, *OK Climate Change*, 1–10.
[56] Macklin etal*., Nile Floodwater Farming*, 696, fig. 3.
[57] A similar lifestyle to those 'fringe-dwelling' populations of the Mesopotamian marshlands, see http://www.clw.csiro.au/publications/consultancy/2004/ Mesopotamian-marshlands-soil.pdf (22/03/2018).
[58] Midant-Reynes, *Prehistory*, 137–138.
[59] https://en.oxforddictionaries.com/definition/drought (11/11/2016).
[60] https://www.livescience.com/21469-drought-definition.html (12/03/2016).
[61] Baines & Malek, *Encyclopaedia,* 18.
[62] https://www.livescience.com/21469-drought-definition.html (12/03/2016) (note: this site used for all drought based definitions).
[63] Butzer, *Discontinuity*, 102.
[64] Butzer, quoting Keimer, *Ecological Archaeology,* 106–111.
[65] Hassan & Stucki, *Climatic Change*, 37–46; Crumley, *Historic Ecotonal Shifts*, 377–384; Downing etal., *African Climate Change,* 19–44. See also Talling, *History of Nile Research*. Höflmayer, *Dating Catastrophes,* 133, points out that, including himself, many scholars still see no direct evidence.
[66] Butzer, *Hydraulic Egypt* and *Environment & Human Ecology*. Seidlmayer, *OK Elephantine*, 108–111, suggests that not all centres developed along the same lines or for the same reasons.
[67] Hoffman, *Before the Pharaohs*, 160–161; Butzer, *Archaeology & Geology*, 1620–21.

within the river and should significantly alter the normal biological networks of the river. Few investigations into how the Nile's ecology and its related ecosystems changed in response to a changing climate have been undertaken.[68] Changing ecological conditions would have changed the environmental circumstances of the river and, therefore, should have impacted upon the culture that developed along its banks have been undertaken. Just how the river may have been affected by drought and how this may have impacted upon the surrounding culture is the basis for this investigation.

In this examination, the consequences to the river itself of an insufficient or dramatically low inundation will be investigated. In a similar fashion, rainfall events ADD nutrients to the river, another source of nutrient concentration.

The rationale for the investigation is as follows:

1. *A weakened river (one with less ability to deliver the expected and desired flood levels necessary to sustain the annual Egyptian agricultural cycle) presumably carried a lower volume of water. The resultant inundation would have deposited fewer nutrients onto the land.*
2. *Unexpected rainfall events at this time would have resulted in extra nutrient flow into the rivers.*
3. *Consequently, the amount of nutrients remaining in the river should have increased, thereby impacting upon the Nile's ecology and its immediate environment. Because the river was so important to the society, any changes to it would have had an impact upon that society.*

F.6. The A.R.I.D. Hypothesis – an outline

From the above rationale, the following hypothesis was developed:

1. *If Egypt experienced an environmental change at the end of the Old Kingdom, then this must have impacted upon the river, and therefore the society that relied upon it.*
2. *This ought to have left an impression upon the visual culture produced by that society. It should be possible to identify changing influences in the artwork produced by observing the variances in the tomb decoration patterns over the time frame under investigation.*

The overall aim of this investigation, therefore, is to suggest what may have happened to the river Nile when the land was in 'drought'[69] and, the river increasingly nutrient-rich, to attempt to identify signs of a societal response. By attempting to identify the potential physical implications of the phenomenon of a declining river, this investigation will seek to identify how ancient Egyptian society responded to the phenomenon of A River In 'Drought'; hence the A.R.I.D. Hypothesis.

The project has been planned to follow two pathways of consideration, environmental and social: 1– In order to investigate any environmental change within the river, an examination of the ecological processes that could have been occurring is provided; 2– The changing compositions of tomb scenes is traced in order to identify any subsequent cultural change. The report is broken into four parts.

Part A will provide a palaeo-climatic overview, summarising and emphasising the importance that climate played in the developing riverine civilisation that came to be ancient Egypt. It will attempt to ascertain the ways that late Old Kingdom and early First Intermediate Period art may have indicated these environmental changes.

Part B will present a summary of basic ecological terms and will introduce the central principles of riverine ecology that have to be applied to the present investigation. From there, modern ecological examinations of current waterways experiencing similar irregular or unnaturally low water flows will then be applied to the situation that may have existed in ancient Egypt. From these, the potential habitat changes that may have occurred to the Nilotic system at the end of the Old Kingdom will be suggested.

Part C will attempt to identify if any perceived cultural response to this environmental change can be detected through changes to the decoration repertoire as depicted in tombs from the period in question. The progression of tomb scenes produced in the Old Kingdom and into the First Intermediate Period will be analysed for any apparent change in the patterns of representation.

Part D will discuss the results and summarise the findings. It will suggest potential directions for future examination. Finally, a conclusion will be presented.

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[68] Beyond three seminal texts: Butzer, Early Hydraulic Civilization in Egypt: A Study in Cultural Ecology (1976), Rzóska, The Nile, Biology of an Ancient River (1976) and Said, The River Nile: Geology, Hydrology and Utilization (1993).

[69] The term 'drought' is used advisedly; as will become apparent.