The Hydraulic System of Uxul

Origins, functions, and social setting

Nicolaus Seefeld

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In memory of Sven Bayer (1978-2015)

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Foreword

In his book *Maya Civilization*, which was first published in 1993, Pat Culbert wrote that "this is an exciting time to be a Mayanist" (Culbert 1993: 160). There were several reasons for this excitement. Progress in deciphering the Mayan script had overturned the earlier romantic image of a peaceful and gentle people and transformed the Classic Maya from a prehistoric into a historic civilization. At the same time research into ancient Mayan settlement and wetland systems, in which Culbert himself had been actively involved since the 1970s (Adams et al. 1981), had disproved the notion of a slash-and-burn farming population inhabiting a largely empty landscape.

Twenty-five years later, one can confidently say that the study of ancient Maya civilization continues to be just as exciting. The origin of lowland Maya hieroglyphic writing has now been pushed back to at least the third century BC (Saturno et al. 2006) while LiDAR (Light Detection and Ranging) has revolutionized archaeological remote sensing in the Maya lowlands (Chase et al. 2011; Chase and Weishampel 2016) as well as in other forest regions of the world (Evans et al. 2013). The new data provide us with both a detailed picture of the scale of ancient landscape engineering and a much better idea of the size of the ancient populations.

For researchers who, like the author of this book and the author of this foreword, have invested a great deal of time and energy in tedious landscape surveys and excavations of water features within the tropical forests of the Maya lowlands, these new remote sensing technologies cause excitement. What once took archaeologists years can now be accomplished in comparatively little time if the necessary funds are available. However, while these new technologies may complement traditional fieldwork, they will never entirely replace it (Chase et al. 2011). This book provides good evidence for this.

The Hydraulic System of Uxul is based on Nicolaus Seefeld's dissertation, the result of many years' work. The core of the book consists of a detailed presentation of the results of his excavations of three hydraulic features at Uxul, Campeche, Mexico, which he conducted under the auspices of the University of Bonn between 2009 and 2014. The volume also includes a comprehensive discussion and summary of the history of research into water and land management in the Maya lowlands. The author discusses how the ancient Maya managed and mastered water in a landscape characterized by karst hydrology, seasonal and unpredictable levels of rainfall and an inaccessible water table. This critical resource initially supported and sustained an increase in population size but also created problems that may have contributed to the so-called collapse of Classic Maya civilization. Although the role of climate change and drought in the demise of Classic Maya society is a much debated issue, this book clearly shows the importance of water supply to survival in one of the most densely populated areas in human history.

Estella Weiss-Krejci
April 3, 2018
Austrian Academy of Sciences, Vienna, Austria

Preface

This present book is an updated and revised version of my doctoral dissertation that I completed and defended in 2017. It is the result of an extensive and intensive investigation project, which was determined to close an essential research gap – the understanding of the water management strategies of the Maya in pre-Hispanic times. Its central focus is the identification of the adaptation strategies that enabled a constant water supply of Classic Maya polities during the critical dry seasons. The starting point for this project consisted of the determination of the geological and climatic factors that cause recurring water scarcity in the Central Maya Lowlands. Building on these results, I focused on the reconstruction of the climatic conditions in the Central Maya Lowlands during the Late Classic Period, when this region was most densely populated. At the same time, the identification of adaptation strategies was constantly accompanied by the revision of hydraulic features that had been described by other scholars.

In 2009, I had the opportunity to participate in the Uxul Archaeological Project, which was launched the same year by the director, Nikolai Grube. At the onset of the project, only one water reservoir was known to exist, the western Aguada (later named *Aguada Occidental*), which had been discovered by Karl Ruppert and John Denison (1943: 17). During the first field season, I was responsible for the continuation of the topographic survey of the site. This process led to the discovery of another large water reservoir in the east of the site, which I subsequently named "Aguada Oriental" and archaeologically investigated in 2009. These initial results showed that Uxul not only featured an array of well-preserved hydraulic features, but a more complex hydraulic system than had been previously observed in a medium sized Maya polity. Based on these results, I received permission to pursue my own research project concentrating on the adaptation strategies of Uxul's pre-Hispanic inhabitants that had enabled a constant water supply for the settlement.

In the course of the investigation, several other hydraulic features of various scales were discovered and studied in Uxul and contributed to an increasingly precise understanding of the functionality and the development of the hydraulic system. Due to this intensive investigation, I soon defined the hydraulic system of Uxul as the central reference point of the broader study. While Uxul's hydraulic system was certainly highly adapted to the specific conditions of the local landscape, numerous other Maya polities had emerged and flourished in quite similar topographic conditions and, in effect, also overcame similar adversities. Accordingly, the functionality of the respective hydraulic features of Uxul could be transferred to hydraulic features of other sites in the Central Lowlands. In addition, the investigation of Uxul's hydraulic system allowed a comparative assessment of the overarching research question: The definition of the adaptation strategies of the pre-Hispanic population that enabled a constant water supply for settlements in the Central Maya Lowlands. Once it became clear that the site of investigation and the resulting data enabled a comprehensive evaluation of the research question, four questions were defined as the central goals of the present study:

(1) The determination of factors causing temporal water scarcity and the elaboration of the characteristic local and regional variations in water-availability within the landscape of the Maya Lowlands.

(2) The assessment of the different types, technical layout, functionality and geographic distribution of hydraulic features[1] that the pre-Hispanic Maya developed in order to allow a constant water supply for their settlements.

(3) The analysis of the function and development of Uxul's hydraulic system and its integration into the local landscape, the urban infrastructure and the different residential areas of the settlement.

(4) The elaboration of the inferences drawn from Uxul's hydraulic system on the form of society and governance in which it emerged and a general assessment of the relevance of water management in the politics of Late Classic Maya society.

[1] Definition: Landscape modifications or constructions for the storage, transport and/or redistribution of water which are either visible in the landscape or can be identified by means of archaeological methods. In the following course of the dissertation, these elements will always be referred to as hydraulic features.

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I would like to express my gratitude to all the friends and colleagues who enabled me to publish this book, which is based on my dissertation. I am grateful to my supervisor Prof Dr Karoline Noack (University of Bonn), for her help and courageous support throughout the preparation of this work. I am particularly thankful to Univ.-Doz. Dr Estella Weiss-Krejci (Austrian Academy of Sciences, Vienna), who gladly offered her support and expertise in the preperation of my dissertation and this book. Thanks to her valuable remarks, many critical aspects of this book underwent significant improvements. Moreover, I would like to thank Prof Dr Martin Bentz (University of Bonn) and Dr hab. Jarosław Źrałka (Jagiellonian University, Cracow) for their help and their participation in my dissertation committee. Furthermore, I am grateful to Prof Dr Nikolai Grube, director of the Uxul Archaeological Project, who was always deeply interested in the progress of my research project.

Over the course of many field seasons in Uxul, Dr Antonio Benavides-Castillo, Director of the Centro INAH Campeche, and his wife Sara Novelo Osorno were reliable friends and provided support in many logistic matters or medical emergencies. In this context, I would also like to thank Lirio Suárez Amendola, former director of the Centro INAH Campeche, and Marco Antonio Carvajal Correa, former museum director of the Centro INAH Campeche, for their kind cooperation in obtaining permissions for material-analyses as well as Dr Pedro Francisco Sánchez Nava, National coordinator of Archaeology of the INAH, Mexico, for his logistic support of our overall project. From the team of the Uxul Archaeological Project, I would also like to thank Julia Bach and Sara Dzul Góngora, who were responsible for the ceramic analysis and provided me with valuable information on the chronology of Uxul's hydraulic features.

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Thank you.

1 Introduction

Since the inception of Maya studies, the issue of water supply in Maya polities of the Central Lowlands during the Classic Period has been a matter of controversial debate. Due to the annually recurring dry seasons, the availability of water during this period is and has always been problematic. In the light of these conditions, the fact the pre-Hispanic Maya were able to establish, develop and maintain prosperous urban centers over long periods is difficult to explain. The longevity and resilience of the ancient Maya over a period of 1,500 years reveal significant cultural and environmental adaptations to a seasonally wet-dry tropical ecosystem inhabited by a sizable population (Scarborough *et al.* 2012: 12408). Population estimates for the southern Maya Lowlands in AD 700 suggest as many as five million people – a population-density much greater than the region supports today (Culbert and Rice 1990; Scarborough and Burnside 2010). These demographic figures indicate that the pre-Hispanic Maya had evidently developed effective adaptation strategies for survival in this landscape (Parry *et al.* 2007: 28; Scarborough *et al.* 1995: 98). However, even at the current state of Maya archaeology, these adaptation strategies are largely unknown and have barely experienced a systematic investigation.

1.1 Definition of the research question

Due to these circumstances, we are currently lacking an exact explanation of how the Classic Maya polities of the Central Lowlands secured a constant water supply. Even though the scientific community acknowledges the general existence of pre-Hispanic artificial water reservoirs, it is not aware of the historical development of hydraulic features and their sociopolitical relevance in Classic Maya society. Furthermore, many scholars still debate whether the pre-Hispanic climatic conditions of the Maya Lowlands had an effect on the formation of hydraulic features. A central cause for the continuing debate on the social relevance of water management and the influence of paleoclimatic conditions on the development of hydraulic systems is the imprecise understanding regarding the specific geological and climatic conditions in the different geographical regions of the Maya Lowlands (Fedick 1996).

1.2 Research goals

This book is focused on both the hydraulic system of Uxul and the hydraulic features of the Maya Lowlands in general. The main reason for the large number of open research questions is the fact that the scientific discussion on the historical development and sociopolitical relevance of water management in the Maya Lowlands is based on a very limited set of hydraulic features and thus fails to put particular findings into the broader geographical, historical, and social context. Therefore, the author tried to carry out a differentiated investigation and discussion of hydraulic features and the theories on their historical and sociopolitical relevance. In order to enable a systematic investigation of these open research questions, the author defined the four general research goals mentioned in the preface.

(1) Determination of factors causing temporal water scarcity and the elaboration of the characteristic local and regional variations in water-availability within the landscape of the Maya Lowlands. A precise determination of the different geological and climatic factors responsible for the temporal water scarcity in the Maya Lowlands is essential to understand the causes and effects of natural processes and to develop an understanding for the approaches of potential cultural adaptation strategies. In this regard, a differentiated knowledge of the regional variations in the geology, topography and climatic conditions are crucial in understanding the necessity and functionality of the different types of hydraulic features in the Maya Lowlands.

(2) Assessment of the different types, technical layout, functionality and geographic distribution of hydraulic features that the pre-Hispanic Maya developed in order to provide their settlements with a constant water supply. A precise overview on the geographic distribution of the different types of hydraulic features, their adaptation to the requirements of the specific landscape and their interaction

with other hydraulic features is fundamental for a well-founded understanding of how the pre-Hispanic Maya approached the construction of additional water sources. Furthermore, the differentiation of the various types of hydraulic features and their geographic distribution is important in order to investigate whether this geographic distribution was a reaction to the specific natural landscape or the result of purely cultural decisions.

(3) Analysis of the function and the development of Uxul's hydraulic system and its integration into the local landscape, the urban infrastructure and the different residential areas of the settlement. As pointed out, this book aims to resolve the open questions regarding the historical and social relevance of water management through the broad scope analysis of all published hydraulic features in the Maya Lowlands. Nevertheless, since the author was able to address and investigate many open research questions in the field, the hydraulic system of Uxul remains a central point of reference for the evaluation of the general social relevance of water management in the Maya Lowlands.

(4) Elaboration of the inferences drawn from Uxul's hydraulic system on the form of society and governance in which it emerged and a general assessment of the relevance of water management in the politics of Late Classic Maya society. Due to the lack of broadly based comparative investigations, it is first necessary to analyze and define the precise sociopolitical relevance of hydraulic features in different locations, epochs, and social strata of pre-Hispanic Maya society. Such a differentiated study is necessary to define the exact role of Uxul's hydraulic system for the local population and to define its relevance for the current state of research on water management in the Maya Lowlands.

1.3 Methods

In order to address the four main research goals, the author carried out an extensive literature review. This focused on defining the geological and climatic factors for water scarcity during the dry seasons and was complemented by the revision of the published data on the landscape and climate history of the Maya Lowlands. Simultaneously, the author analyzed all available publications on hydraulic features in the Maya Lowlands, many of which also included theories on their sociopolitical relevance in pre-Hispanic times to varying extents. Over the course of this project, the available publications on the landscape and climate history, the documented hydraulic systems and the theories on the historical and sociopolitical relevance of water management in the Maya Lowlands were gradually analyzed and incorporated into the general research objective. Furthermore, new publications were successively integrated in order to enable a differentiated presentation of the state of research. During this extensive study, the author was also able to observe many of the hydraulic features outside of Uxul in person. Apart from this broad scoped analysis of water management in the Maya Lowlands, the main method for answering the previously defined research goals was the archaeological investigation of Uxul's hydraulic system. In order to gain an understanding of the functionality of this hydraulic system and its adaptation to the local landscape, the author applied two basic research methods:

(1) A topographic survey of the settlement landscape to locate landscape modifications serving to divert and accumulate precipitation (see Figure 1.1a), and

(2) An archaeological investigation of these landscape modifications/hydraulic features to obtain data on the technology, chronology, and social implications of these modifications (see Figure 1.1b; Seefeld 2013a: 63).

For the purpose of enabling a thorough evaluation of the adaptation strategies of Uxul's pre-Hispanic inhabitants, the observations of the topographic surveys were continously consulted to better understand the characteristics of the local lsndscape and the cultural modifications. In the same way, the increased awareness of the drainage characteristics of the landscape, previous observations of the functionality ofUxul's hydraulic system all played a decisive role for defiining the location of specific excavation units.

Figure 1.1: The author during the topographic survey and excavations in Uxul.

The fieldwork was carried out as a component of the Uxul Archaeological Project, which began in March 2009. The project worked in collaboration with the Mexican Institute of Anthropology and History (INAH) and under the general direction of Prof Dr Nikolai Grube. Altogether, seven field seasons were conducted between 2009 and 2015. During the 2009 and 2010 field seasons, Dr Iken Paap held the position of field director. From 2011-2015, this position was held by Dr Kai Delvendahl. From 2009-2013, Dr Antonio Benavides Castillo of the Centro INAH Campeche was the Mexican co-director of the project. Throughout the entire duration of the project, funding was provided by the German Research Foundation (DFG). During the field seasons from 2009-2014, the author studied four different hydraulic features: The Aguada Occidental in 2010, the Aguada Oriental in 2009 and 2011, the influx canal to the Aguada Occidental in 2012 and an artificial cave in Group Q in 2013 and 2014.

1.4 Structure of this book

In order to enable the systematic processing and discussion of each defined research goal, the author structured this book in such a way that the causality of the different environmental factors causing water scarcity and the cultural adaptations to overcome them are clearly comprehensible.

Thus, the first main section of this dissertation, Chapter 2, addresses and defines the environmental factors that cause temporal water scarcity within the Central Maya Lowlands. At the onset, it provides a detailed description of the geologic history (Chapter 2.1.2), the different geological zones of the Central Maya Lowlands (Chapter 2.1.4) and the respective water sources of these different geological zones (Chapter 2.1.5). Building on this, the climate (Chapter 2.2), soils (Chapter 2.3) and landscape formations of the Yucatán Peninsula (Chapter 2.4) that are the results of geomorphological processes are outlined. After the presentation of the geomorphology of the Maya Lowlands, Chapter 3 focuses on the history of research regarding the issue of water supply in pre-Hispanic Maya settlements. The aim of this chapter is not to provide a complete review of the research, but to present the benchmark investigations and the general positions in the scientific discussion, which were extremely influential for the models of prehistoric climatic conditions that are presented in the upcoming chapter.

Due to its importance in the scientific discussion of water supply during the Late Classic Period, the climate history and landscape history of the Maya Lowlands (Chapter 4) are addressed in a specific section. In order to provide the reader with a better understanding of the existing models of the pre-Hispanic climatic conditions in the Maya Lowlands, Chapter 4 first covers: (1) the scientific methods applied for the reconstruction of past climates (Chapter 4.1), (2) the existing models of pre-Hispanic

climatic conditions (Chapter 4.2) and (3) the present state of knowledge of paleoclimatic studies (Chapter 4.3). Lastly, Chapter 4.4 provides a discussion of previous models of pre-Hispanic climatic conditions.
The second main section of this dissertation, Chapter 5, provides a review of hydraulic features in the Central Maya Lowlands. These hydraulic features can be identified as the immediate physical remains of pre-Hispanic adaptation strategies for the assurance of a constant water supply. Since this book is written from the perspective of an archaeologist, these features are of particular importance and have been the basis of all previously published theories on the historical and sociopolitical relevance of water management in pre-Hispanic Maya society. In order to enable a differentiated evaluation of these theories, the author defined three different perspectives from which hydraulic features can be analyzed and interpreted (see Figure 1.2):

(1) The technical design and functionality of a hydraulic feature or a hydraulic system,

(2) The historical development (formal and geographical distribution) of hydraulic features, and

(3) The social setting in which these hydraulic features emerged and/or their (potential) relevance for the pre-Hispanic Maya society.

In the author's opinion, it is highly important to separate the presentation and discussion of these three different perspectives. Whereas the first approach is merely descriptive and based on the thorough documentation of hydraulic features, the second and third represent superordinate levels of interpretation, which are presented and discussed in Chapter 8.

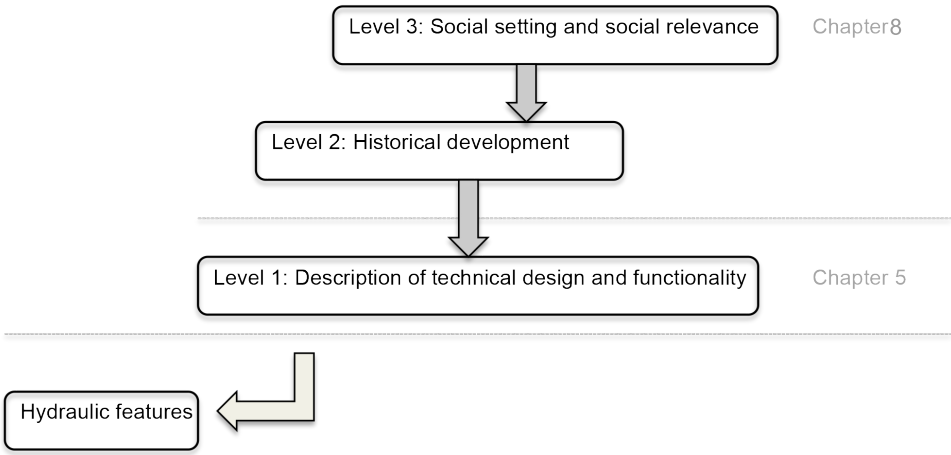

Figure 1.2: Schematic representation of the analysis of hydraulic features.

Chapter 5 however, will only illustrate and analyze the first perspective in the interpretation of hydraulic features – their technical design and functionality. Based on their structural composition and desired function, the wide range of hydraulic features can be subdivided into five main categories. The published examples of these features will be presented in specific subsections on canals (Chapter 5.2), terraces (Chapter 5.3), dam features (Chapter 5.4), drainage features (Chapter 5.5), reservoirs (Chapter 5.6) and complex hydraulic systems (Chapter 5.7). The main intention of this review is to provide the reader with an overview of the technological composition, functionality and geographic distribution of these different hydraulic features.

Based on the scientific understanding of the functionality of hydraulic features in the Maya Lowlands, Chapter 6 focuses on the third aspect of this book, the archaeological investigation of Uxul's hydraulic system. It begins with a brief introduction to the site of Uxul and the topographic location of its hydraulic features (Chapter 6.1) before presenting the results of the archaeological investigation (Chapter 6.2), the functionality of the respective features (Chapter 6.3) and the construction history of the hydraulic

system (Chapter 6.4). In order to provide a summary on the presented systems, Chapter 7 presents the functional and spatial patterns of hydraulic features in the Maya Lowlands.

Focusing on the fourth aspect of this dissertation, Chapter 8 once again draws the attention to the whole Maya Lowland area and presents the theories on the social and political relevance of water management in pre-Hispanic Maya society. The first section (Chapter 8.2) focuses on the general theories on agricultural production and water management. Chapter 8.3 presents the published models on the historical development of water management in the Maya Lowlands. In succession, Chapter 8.4 introduces the published models on the social relevance of water management.

Based on this theoretical background, Chapter 8.5 introduces a set of newly developed criteria for evaluating the sociopolitical relevance of hydraulic features. These evaluation criteria are used to analyze the sociopolitical relevance of the hydraulic features in both Uxul (Chapter 8.6) and the rest of the Maya Lowlands (Chapter 8.7). In succession, Chapter 8.8 discusses the validity of the published theories on the social and political relevance based on the analyzed hydraulic features, while Chapter 8.9 provides a concluding evaluation.

As the final chapter of this book, Chapter 9 provides a summary and conclusion of the research objectives, and the results of this study. Chapter 9.1 then highlights the main environmental factors for the issue of water supply, while Chapter 9.2 summarizes the observations on the geographical distribution and functionality of hydraulic features. Next, Chapter 9.3 provides an overview on the history of research and the development of theories, before Chapter 9.4 defines the relevance of Uxul's hydraulic systems for the general discussion of water management in the Maya Lowlands. Finally, Chapter 9 evaluates the current state of research (Chapter 9.5), defines the desiderata for future investigations (Chapter 9.6) and ends with a closing remark (Chapter 9.7).