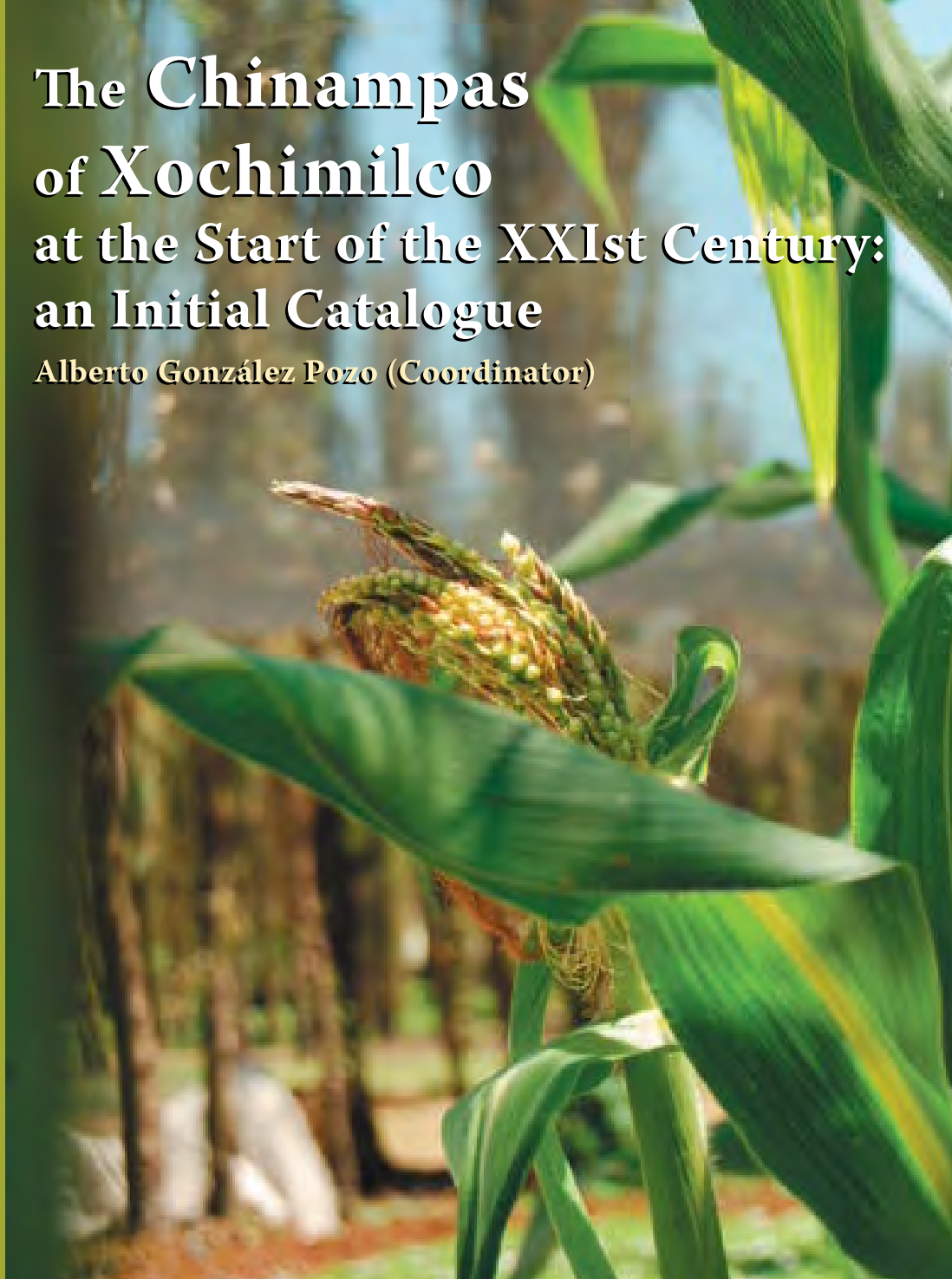
The Chinampas of Xochimilco at the Start of the XXIst Century: an Initial Catalogue

Alberto González Pozo (Coordinator)



Casa abierta al tiempo
UNIVERSIDAD AUTÓNOMA METROPOLITANA

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Preface

From its beginnings, more than 36 years ago, the Universidad Autónoma Metropolitana set out, as part of its essential activities, to connect its teaching and research programs with specific problems of Mexican society. In keeping with this aim, the Xochimilco campus has adopted the Modular System as a method of teaching and learning, by means of which a specific problem is highlighted and becomes the object of transformation of a particular area of study. In this way both teachers and students involve themselves in studying a problem of social reality in order to find solutions in an interdisciplinary manner, since a problem never manifests itself in the form of isolated aspects, but is, rather, the reflection of a complex relation of variables.

On the southern edge of Mexico City lies a region of ancient historical and cultural tradition that has aroused the interest of both academics and authorities for many years: namely, the extensive areas of chinampas in the vicinity of Xochimilco. These have been studied from a diversity of perspectives: biological, anthropological, productive, social and even political; however, until now nobody had set out to catalogue these horticultural islets.

Since 2005, a group of researchers from the Division of Sciences and Arts for Design and other invited specialists, coordinated by Dr. Alberto González Pozo and supported by a collaboration agreement between the local Borough of Xochimilco and our University, has been engaged in this task. The research team regarded this work of cataloguing as a necessary step in the process of safeguarding and rehabilitating the chinampas of Xochimilco, which at present are regarded as a site of exceptional and universal value both from a historical or esthetic, and an ethnological or anthropological, perspective.

In view of the considerable extension of the area of study, San Gregorio was selected as the point where the work of cataloguing was to begin, since this particular area still conserves many

of the attributes that characterize this traditional form of cultivation and production. During the process of research, attention was given to aspects related to the national and international normative framework to which the preservation of the chinampa area is subject, as well as to the characteristics of production, the present state of its territory, their products and irrigated areas. Of considerable importance is the prevalence of traditional methods of cultivation on the chinampas and the way in which the soil and newly sown crops are protected from intense sunlight, hailstorms, birds or parasites. Many chinampas remain active but those that have been abandoned or are in disuse amount to a considerable number of hectares; this —together with the uncontrolled expansion of irregular settlements, infrastructure and buildings— is a factor which puts at risk the conservation of this rural area.

Hence the importance of the present work of cataloguing, which will enable the state of conservation of chinampas and canals to be determined— fundamental information as far as the formulation of proposals for future conservation actions is concerned.

This commemorative book was first published in Spanish in the framework of celebrations of the first thirty-five years of the Division of Sciences and Arts for Design as a presentation of the initial advances of the research. Given the complexity of the subject of study, investigation into the chinampas will, of course, continue, remaining open for the drawing of further conclusions. It is hoped that as more information is gathered and the analysis of the problems involved continues, we will be better able to respond to the needs involved in protecting this cultural heritage that is of concern both to Mexico and to the international community. In other words, to contribute to the raising of awareness as regards the cultural value of the chinampas among as wide a range as possible of authorities, academics, *chinamperos* and visitors in support of their conservation. After all, what would Xochimilco be without its chinampas?

Mtro. Juan Manuel Everardo Carballo Cruz
Director de la División de Ciencias y Artes para el Diseño
Universidad Autónoma Metropolitana - Xochimilco

Foreword

Xochimilco Today: The Challenge of Conserving the Cultural Values of an Ancestral Mode of Production in the Contemporary World

When Xochimilco was included —together with the Historic Center of Mexico City— in the World Heritage List in 1987, the category applied was that of Exceptional Universal Value. Nowadays a more precise category exists —that of Cultural Landscape— and had the inscription taken place at a more recent date it might have found a better accommodation under that heading. For it is that "cultural landscape" resulting from a peculiar ancestral way of cultivating flowers and fruits on artificially constructed gardens that constitutes its singularity. As the pages of this publication —which takes in the whole evolutionary itinerary of this productive culture— will demonstrate, the relation between chinampa technology and local culture goes back many centuries into the past, tailoring a sustained cultural effort to the daily needs of a voracious metropolis that today congregates more than twenty-two million inhabitants. Xochimilco is an inherited miracle that still resists absorption in one of the largest conurbations of the planet.

All the meanings of social life have flowed along the canals of Xochimilco. Those canals are something more than seams that intercommunicate and separate chinampas; they are avenues along which both the products and the symbolic practices of multiple and overlapping socio-cultural practices circulate. And, of course, they continue to play an essential part in the organization of the various spheres of daily life — a way of life that, while continuing to be highly productive, faces the pressures of unrelenting urban growth that has long since begun to make inroads into its territory, its topography and its way of giving renewed continuity to its history.

The World Heritage List now has 911 sites registered, of which more than 300 confront the complexities of conservation in urban contexts. It can be stated, without fear of exaggeration, that the phenomenon of rapidly developing cities is the major challenge for international conservation, since the World Heritage Committee evaluates, year in, year out, more than a hundred sites where preservation and urban development prove to be incompatible practices. The state of conservation of Xochimilco is as much a matter of concern as that of so many urban sites, almost forty in Latin America, included in the category of historic centers.

A World Heritage site is always a utopia in concrete form. The conservation vs. development dichotomy constitutes a permanent challenge. The academic perspective has shown little interest in the emotions, the perceptions that form part of the pleasure derived from the site, or that constitute an impediment to the experience. The World Heritage has to weigh up the challenge of the social conviviality of citizens, but one must wonder whether World Heritage sites are well situated for studying the complexities of the present-day social world. The work carried out in Xochimilco is sufficiently explicit to make us aware of all the social architecture that needs to be created when considering the preservation of values, without attempting to turn them into museum pieces, nor masking the socio-cultural realities that accompany them. I would like to underline on this occasion the appropriateness of the methodology used to arrive at a figuring out of efforts of preservation in what is a very particular case, and at the familiar scale.

Today, the Convention requires the development of a certain approach to doing anthropology; or, rather, it facilitates the advance of an anthropology of the modern worlds, necessary to analyze the social significance of a site. Having analyzed the development of the process embarked upon in Xochimilco, we can no doubt gather the fruit of a lesson authorized by the anthropological experience. I believe the social dynamics set in process by the participative Management Plan for Xochimilco developed by my fellow officers at the UNESCO's Office in Mexico helped generate the space for dialogue necessary for the personal testimony of a *chinampero* to enjoy conditions of equality with those of specialized experts, complementing visions for safeguarding a landscape of traditional productive cultural life.

Xochimilco is a test case. The methodology for reading the difficult task of converting it into an opportunity for preservation requires an approach to the social dimension of cultural processes when conceptualizing and discerning about units of conservation. The technical component, although necessary, had proved insufficient in Xochimilco at the moment of reading social complexity and providing a deeper, more critical, and more comprehensive analysis of a worrying situation, resulting from uncontrolled urban expansion, poverty and the loss of ecological contextual quality, and expressed in images of a world in cultural and social decline, in a traditional context that resists surrendering its rural character, in the midst of a city that resists ceasing to grow as a city.

The intention of UNESCO has always been to read the complexity in the life of sites, generating specific languages of collaboration between disciplines. The results obtained make it quite clear that a process of preservation of the site neither begins nor ends with the mere restoration of buildings and canals to resemble scenes of yesteryear, but rather in the search for possible contexts in which to reformulate the tradition. And that tradition has called for an approach to symbolic worlds, collective representations, profound beliefs, cognitive styles, the communication of symbols, the analysis of "language games" and, with that, a better understanding of the sedimentation of traditions expressed in cultural forms significant for the inhabitants of such sites. The work presented here complements the data achieved so far by research, and takes us a step further in the understanding of the cultural, family and personal efforts of a community that must cope with the acute changes of the modern world and its urban dynamics that outstrip the capacity for response of an organized productive society. The task of accompanying the *chinamperos* in their efforts and delivering the present reading of the situation has been entrusted to the Universidad Autónoma Metropolitana, under agreement with the Borough of Xochimilco, and these stupendous results give a clear demonstration of the need for concerted action.

In Xochimilco the heritage space of anthropology and the anthropological time of the heritage have come together in order to define new objects of reflection. The process has demonstrated that, in order to analyze the components of cultural landscapes, it was not only necessary to be concerned about

the marketing of flowers, or the ecological conditions affecting the water in the canals, but to analyze that scenario from a perspective of the forms of community and organizational development and that of local government.

What these pages distill is a new beginning, not a going back, and even less a holding in suspense, but certainly a clear wager on overcoming forms of myopia in the techniques of traditional conservation. It opens a window for a vigilant awareness of so many other aspects of social life in World Heritage sites that had often passed unnoticed.

This work reveals a renewed possibility for taking up threads linking historical and contemporary readings, and shows that dialogue between knowledge and significance, between symbolism and knowing, is not on the point of disappearing; rather, it confirms that real society is more complex than the models that attempt to draw an account of it, especially in the case of contemporary cultural landscapes.

José Lezama Lima remarked that "the joy of the centipede is the crossroads". I firmly believe that the results obtained through this work open up new paths —that can no longer be neglected— for defining the universal value of the productive cultural landscapes that are part of the World Heritage. I also believe that the different ways of living in and experiencing a site (unequally, but ineluctably) are contemporaneous, and that, thanks to the study presented here, the history of this contemporaneity, rich in hopes and loaded with contradictions, can today be better understood in Xochimilco. It deserves our heartfelt congratulations.

Nuria Sanz
Director for Latin America and the Caribbean
Latin-American and Caribbean Unit
World Heritage Center of the UNESCO

Introduction

The *chinampas* situated in the south of the Valley of Mexico have been the subject of many publications: some describing their undisputed esthetic, touristic or recreational attractions; others alluding to a past stretching back to ancient Mesoamerican cultures; yet others emphasizing their abundant biodiversity or stressing their economic and agronomic importance. Finally there are those that describe their relation —not always harmonious, and increasingly unsustainable— with the urban development of the capital city (today with over 20 million inhabitants) which surrounds them and threatens to devour them.

This publication by the Universidad Autónoma Metropolitana presents the initial results of an undertaking that has been delayed far too long: the survey and cataloguing of the close on 20,000 chinampas that still survive in varying conditions of conservation in Xochimilco and Tláhuac: two local administrative districts that lie on the south-eastern edge of what was until recently known as *México: Distrito Federal*.[1] A survey

[1] Translator's note: In January, 2016, what was previously known as the "Distrito Federal" changed its name officially to *Ciudad de México*. This administrative entity, which will be referred to henceforth simply as "Mexico City", remains politically separate from the urbanized municipalities that surround it to the north, west and east and belong to the Estado de México. The conurbation as a whole is referred to as the "Metropolitan Area". The subdivisions of Mexico City, which include Xochimilco and Tláhuac, are known as *delegaciones* in Spanish and will here be referred to as "Boroughs".

of the physical condition of the *chinampas* is a task that should have been undertaken some time ago, since one of the basic premises of conservation is the need to identify and cataloguing each component, taking into account its present state of conservation; this will in turn mark the direction towards which the efforts of conservation of the whole should be directed. Hence cataloguing the chinampas required a clear definition of the situation affecting *each one* of those artificial agricultural islets at the moment of carrying out the survey.

The long, narrow islands called chinampas were created by their indigenous inhabitants as a sustainable way of anthropizing [2] the peculiar natural environment that awaited them on their arrival in the Valley of Mexico. This was an expanse of shallow lakes and wetlands that covered the lowest lying areas of this basin, particularly in the Xochimilco-Chalco sub-basin. These chinampa zones were as important for sustaining civilization as the town and cities with which they have shared the basin. But diverse changes that have taken place since the Spanish conquest, and particularly during the last century, have precipitated the gradual collapse of the once vast chinampa areas. In spite of this diminution enough remains to justify the restoration and maintenance of the chinampa areas as cultural landscapes of prime importance. It should be noted that in 1987 the World Heritage Committee of the UNESCO voted to include them in the prestigious list of cultural and natural sites that humanity as a whole, and in particular Mexico, cannot afford to lose without despoiling itself of the testimonies of its own identity. This confers on the task, here undertaken, of cataloguing these thousands of chinampas and disseminating the first advances an ever increasing urgency.

[2] We use this term to define the action of human beings on the environment, capable of converting it into an ally without losing its essential qualities.

It is worth bearing in mind that this work only became possible in 2005, when the local Borough of Xochimilco took the initiative of concerting a collaboration agreement with the Xochimilco Campus of the Universidad Autónoma Metropolitana; this led to the formulation of various studies in the chinampa zones, one of which was precisely the initial stage of the task of cataloguing the chinampas.

As has already been mentioned, there was already much literature regarding the chinampas. Their presence at the southern end of the Valley of Mexico has, after all, aroused the curiosity of laymen and experts for centuries. No sooner had the Spanish invaders consummated their conquest than Cortés and his contemporaries took note of the chinampas, describing them with admiration. The chronicler Agustín de Betancourt did likewise in 1697, describing Xochimilco and its chinampas in his *Teatro Mexicano*. The chinampas also attracted men of science such as José Antonio Alzate y Ramírez, who described in detail the agricultural methods practiced in them. In the convulsive situation of Mexico in 1912, the agronomist Miguel Santamaría made a voluminous description of the current state of the chinampas in San Gregorio Atlapulco, a record that even now, more than a century later, provides a comparative reference of prime importance.

Anthropologists and archeologists have also taken up the subject, not only as concerns the sparse archeological remains of pre-Hispanic chinampas, but also to trace their development through the succeeding centuries. This affords a comparative view and testifies to the considerable degree to which the ancient chinampa culture has persisted down to the present day. Contributions like those of Elizabeth Schilling, Pedro Armillas, George West, William Sanders, Angel Palerm, Jeffrey Parsons, Teresa Rojas Rabiela, Carlos Javier González and Mari Carmen Serra Puche have allowed the gradual dissemination of much of the knowledge that is now available regarding this cultural heritage. But all these studies deal with the chinampa zones as a whole, not with their

individual peculiarities, which is what is needed in order to identify them and ensure the continued existence of each chinampa.

What is presented here is not the literal content of the studies that were carried out during the successive periods of 2005 and 2006, nor of their cartographical annexes. Nor do we offer the complete contents of the 544 record forms completed and catalogued during both phases of the study. The first stage covered 17.5 hectares, with a total of 106 chinampas, while the second registered a considerably larger area: 75 hectares with a total of 438 chinampas. Each stage generated its own technical report, a set of catalogue forms, a set of plans, a photographic record and a database: materials that can be consulted on request at the municipal offices in Xochimilco or at the UAM-Xochimilco (via its Academic Planning and Development Committee (*Comisión de Planeación y Desarrollo Académico*: COPLADA), where complete sets are kept comprising the entire documentation of both investigations. The present intention is, however, to offer a summary, for the purpose of dissemination, of the main results and most important findings from both stages, with the addition of some further data, as an example of what public universities can do to enrich the fields of science, the arts, and culture in general.

With this aim in mind, the present publication has been structured in three parts, each part consisting of several chapters. The first part provides the reader with some basic historical and normative information to help understand the background and the parameters within which the study was developed. In Chapter 1, the author of the present lines and overall coordinator of the study sets forth the aims and scope of the research and characterizes the universe analyzed. In Chapter 2, Ignacio Armillas Gil, Alberto González Pozo and Cecilia Rodríguez provide a summary of what is known about the historical past of the chinampas, from their origins more than a thousand

years ago down to the present day, citing authors and works in which interested readers can find greater detail regarding the subject. In Chapter 3, Ignacio Armillas Gil presents a synthesis of the technological aspects of construction, production and maintenance of the chinampas that correspond to what we have called a process of *sustainable anthropization* of the original environment, an operation that made possible the success and survival of not only the chinampa zones themselves but also the successive capitals of Tenochtitlan and Mexico City. The knowledge of these processes, rudimentary as it may be, will help the non-specialized reader to a better understanding of the way the rest of the work is organized. Then, in Chapter 4, Salvador Díaz Berrio, Alberto González Pozo and José Gabriel Castro Garza present the international, national and local normative framework relevant to the preservation of the chinampas. This is indispensable for understanding the maze of regulations and authorities responsible for attending to the threats that hover over this kind of property.

The second part deals with the task of survey and research work undertaken by this team in 2005 and 2006. In Chapter 5, Ignacio Armillas Gil and Roberto Fernando Chiapa Pérez approach matters concerning the methodological instrument devised for satisfying the desired aims of safeguarding. This part elaborates on the limitations of using existing forms, particularly those used for cataloguing historical buildings in Mexico and other parts of the world. Then, in Chapter 6, Fernando Roberto Chiapa Sánchez, Benigno Ángeles Escamilla and Manuel Montaño Pedraza describe what was involved in the fieldwork including the filling out of the catalogue forms, and the difficulties for carrying out this task. They also mention the decisive participation and the valuable assistance of the chinampa farmers themselves — a truly indispensable element for the completion of the study. Fragments of their opinions are also included in the same chapter. The second part closes with Chapter 7, in which Carlos Eduardo

Arriaga Téllez, José Gabriel Castro Garza and Meregüildo Toledo Esteban describe the analysis of data gathered in the field and the process of transforming it into information with the help of a database and statistical methods of weighting in order to condense the results and present them in maps and graphics.

The third part presents our conclusions and consists of three chapters. In Chapter 8, Alberto González Pozo, Ignacio Armillas Gil and Carlos Eduardo Arriaga Téllez set out, in summary, the principal results emerging from the study. Then, in Chapter 9, Alberto González Pozo and Carlos Eduardo Arriaga Téllez show how these can be used for the practical purposes of conservation, which is the principal aim of this entire effort. And by way of final reflection, in Chapter 10, the three main researchers of this project, Alberto González Pozo, Ignacio Armillas Gil and Salvador Díaz Berrio make some suggestions that aim at the further organization of this kind of project, with possible improvements, so as to complete the cataloguing of all the Chinampas some time in the future; for as long as this goal is not reached it will be difficult to protect the integrity of a cultural property so exposed to a multitude of threats that put its survival in jeopardy.

The present work is the fruit of an effort of teamwork and this is now the place to list those who contributed to the two field seasons:

The nucleus of researchers was formed, both in 2005 and in 2006 by Alberto González Pozo, the author of these lines and project coordinator, accompanied by Salvador Díaz-Berrio Fernández, who concentrated on the legal aspects and their background, and Ignacio Armillas Gil, who contributed to designing the form for cataloguing the chinampas. He also provided valuable information and reflections on the pre-Hispanic past of the chinampas, as well as a priceless collection of drawings and aero-photos that his father, Pedro Armillas, used during the 1950s and '60s for his studies of the chinampa zones. It should be stated that, of the three principal researchers,

González Pozo and Díaz Berrio formed part of the academic staff of the UAM-Xochimilco while Ignacio Armillas Gil was a Visiting Scholar at Cornell University, and took the time to accompany us during several periods, giving us effective and generous support both in fieldwork and in tasks of analysis and interpretation.

As regards the rest of the team, its composition changed somewhat between 2005 and 2006, but several members were present throughout both seasons. This was the case of Fernando Roberto Chiapa Sánchez and Carlos Eduardo Arriaga Téllez, who acted decisively as associate researchers in both seasons in field and analytic work. The same can be said of Ricardo Ortiz Salas, although his participation was for shorter periods. Benigno Ángeles Escamilla and Meregüildo Toledo Esteban also participated in both stages, but were promoted from Auxiliary to Associate Researchers between one stage and the other.

Luz Cecilia Rodríguez Sánchez, José Gabriel Castro Garza and Manuel Montaño Pedraza participated in the second stage as Associates; Julio César Lira and Marco Antonio Martínez collaborated as Auxiliaries in the first, while Rogelio Canto Santillana and Luis Gerardo Feijoo did so in the second. Already in 2006, the decision was taken to pass all the forms filled out by hand into a digital version, this work being performed with great efficiency by Raquel Jiménez Huerta and Imelda Martínez.

My thanks are due to all of them for the time, interest and abilities with which each contributed generously to concluding the work undertaken in the two seasons. Most of them also figure as co-authors of this publication which I now have great satisfaction and pride in presenting.

Assuming the entire personal responsibility as regards any institution or individual whose direct or indirect support in the carrying out of this work may have been involuntarily omitted, I close this introduction with the following acknowledgments:

First of all, to the Universidad Autónoma Metropolitana —and its Xochimilco Campus in particular— where most of the contributors to the study and this first formal publication have labored academically. The UAM-X has been, literally, a fertile *campus*, metaphorically a rich *chinampa* which has nourished with time, resources and all kinds of support the research that has germinated there and has yielded useful fruit in the form of knowledge indispensable for future development. I include here the General Rectorship, which was under the leadership, consecutively, of Luis Mier y Terán and José Lema Labadie, as well as the Rectorship of the Xochimilco Campus under Norberto Manjarrez Álvarez and Cuauhtémoc V. Pérez Llanas, successively. From its Academic Planning and Development Committee (COPLADA) under Miguel Ángel Zavala Sánchez, we received administrative support and were in frequent contact with the highly efficient Olga Lina Franco. In the Centro Universitario de Estudios Metropolitanos (CUEM), we were able to extend in 2008 our studies of the chinampa zones in Tláhuac and Mixquic thanks to the invitation extended to us by its Coordinator, the architect Eduardo Preciat Lambarri. In the Division of Sciences and Arts for Design we were given constant and unlimited support by two Directors: first Rodolfo Santamaría and later Everardo Carballo. The same must be said as regards the academic space we occupy in the Department of Theory and Analysis within the Division, where the successive heads, Jorge González Aragón, Alejandro Tapia Mendoza, and at present José Luis Martínez Durán, have supported us without reserves. Finally, but by no means of less importance, has been the valuable contribution of Catalina Durán MacInster, in charge of the Division's Editorial Program, in whose experienced hands and those of her team the original Spanish edition was brought into being.

Equally important has been the support given by the authorities of the Borough of Xochimilco, headed successively by public accountant Faustino Soto Ramos and biologist Uriel González Monzón.

It would be a serious omission if I failed to mention that it was precisely Sergio Alejandro Méndez Cárdenas, in his capacity as advisor to the Local Authority, who came to me initially with the proposal to undertake this project. With him we frequently agreed on the course to be taken by the study and it was to him that we delivered the results of both stages. In the local government offices we also received the support and guidance of the successive heads of the General Directorate for Environment and Rural Development, Avelino Méndez Rangel and Rosa María Salazar Mata, as well as the directors of the Rural Development Sections: successively, José Luis Reyes Rodríguez and Oscar Naim Páez. The company of the biologist Cuauhtémoc Peralta was also invaluable in the first tours of inspection in the field in both zones, when we were just beginning to become aware of the extension and variety of the chinampa zones, since he introduced us to the first groups of *chinamperos* who came to meet us on being informed of the beginning of our work.

It would likewise be unfair not to mention all those who have had familiarity with the two phases of the study both before and after its conclusion, and whose comments and observations have enriched its results. I begin by mentioning Francisco Romero, of the Department of Mankind and Environment in the Biological and Health Sciences Division of the UAM-X, who made valuable comments during the design of the cataloguing form in the two versions that were used successively. The same must be said of Francisco Medina Jaén, of the Directorate of Archeological Records, and the architects Claudia de la Garza, Raúl Delgado Lamas, Agustín Salgado, Saúl Alcántara, Jorge González Briseño and Pablo Trujillo, of the National Coordination of Historical Monuments of the INAH.

During the course of the study, and after its conclusion, we received many stimulating comments that have helped us to clarify or enrich some points. Such is the

case of many of the participants in the three Workshop-Seminars on Safeguarding and Conservation of the Chinampa Zones of Mexico City, principally Teresa Rojas Rabiela of CIESAS, Jorge Legorreta of the UAM Azcapotzalco, Armando Equihua and Hermilio Navarro, of the Postgraduate College, Beatriz Canabal and Verónica Nava of the Biological and Health Sciences Division of the UAM Xochimilco, Maria Eugenia Terrones of the Instituto Mora, and Ana Julia Arroyo, of the Directorate of Continuing Education of CyAD, who helped organize those events.

Jeffrey Parsons, of the University of Michigan at Ann Arbor, was closely acquainted with the study in its different stages of progress; he accompanied us on a memorable visit to the zone and, along with his valuable comments, he provided us with several publications of his own concerning the same subject. These were previously unknown to us, and have been of considerable help. We also benefited from the opinions and suggestions of Ciro Caraballo of the UNESCO-Xochimilco Project, Eliseo Moyao, of the Directorate of Natural Resourses (CORENA) of the Mexico City Administration, Adrián Guillermo Aguilar, Director of the Instituto de Geografía of the UNAM, Nuria Sanz, of the World Heritage Committee of the UNESCO, José Luis Llovera, General Director of Urban and Territorial Development of the SEDESOL, and Javier Villalobos, Chairman of the Mexican Committee of ICOMOS.

I have reserved the final mention, because I wish to give it special emphasis, for the *chinamperos* of San Gregorio Atlapulco and San Luis Tlaxialtemalco, in the Xochimilco Delegación. Our thanks are due especially to Don Genovevo Pérez Espinoza and Don Félix Venancio González. They have proudly taken over the leadership of the resistance offered by several scores of previous generations of *chinamperos*, united in defense of that environmental and cultural treasure which still exists to be appreciated and enjoyed by the inhabitants of the Mexican metropolis, the country and the

world. This work is dedicated to them and to all the local people we have met, and who helped us examine, inch by inch, their beautiful territory; likewise to all those we have not met but who continue diligently to work their chinampas. We owe them all our sincerest admiration and gratitude.

Alberto González Pozo

Part One

I. Purposes and Scope of the Study

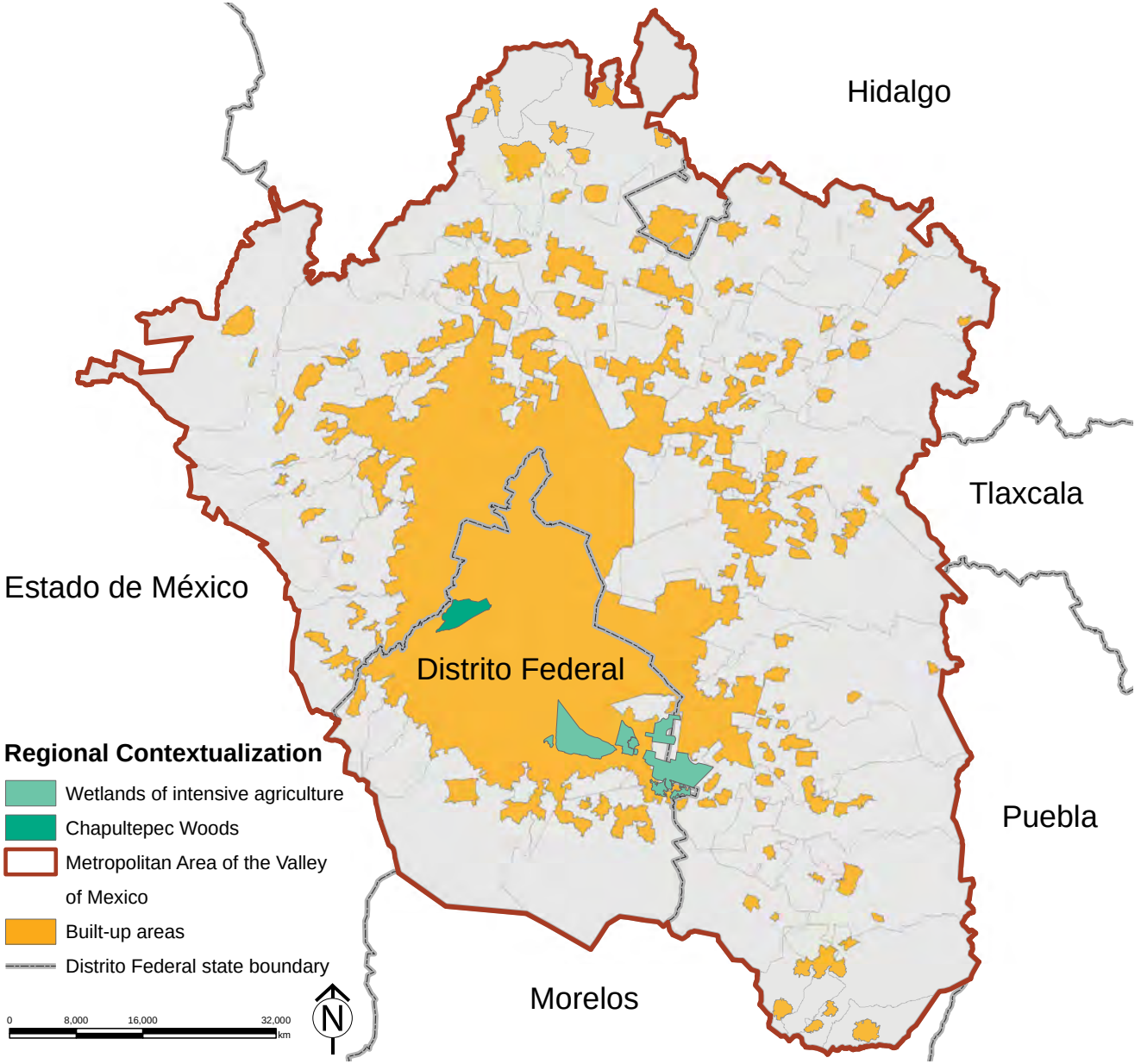
Alberto González Pozo

The present publication describes the initial stages of a project undertaken to catalogue those agricultural islets that still exist in the wetlands included in the Mexico City boroughs of Xochimilco and Tláhuac. The catalogue is intended to record their attributes as cultural assets recognized by the governments of the Mexican Republic and its capital city, as well as by the international community through the UNESCO.[1] The cataloguing of the chinampas is indispensable for their safeguarding and restoration and yet, as late as 2005, there was no detailed record of what remains of this Heritage site.

Hence the specific aims of this project were:

- To provide a description of the historical evolution of the chinampa zones, from their origins to the present situation using existing sources.

[1] It is important not to lose sight of this primordial objective, since the chinampa zones have been the subject of many other studies in the fields of hydrology, topography, pedology, life sciences, agronomy, geotechnics, hydrology, economics, sociology and town-planning. They are serious and important works and we will be referring to many of them in the pages that follow; they do not, however, set out to characterize the chinampas —whether individually or as a whole— as goods making up a cultural landscape.



Map A. Metropolitan Area of Mexico City, showing built-up areas and, contained within them, the two extensive green areas of a historical character: the woods of Chapultepec and the intensively farmed wetlands of Xochimilco-Tláhuac.

- To establish as exactly as possible the location and dimensional characteristics of each islet.
- To identify the main physical attributes of each chinampa, such as their extension, the presence of buildings or other features, the characteristics of the surrounding bodies of water, the state of their margins and the presence, condition and frequency of the *ahuejotes* (*Salix bonplandiana*), the characteristic trees which are important to the structural integrity of the chinampas.
- To register the use to which each chinampa is devoted, in particular as regards the production of vegetables, flowers, etc., characterizing whenever possible the presence of traditional eco-techniques employed in construction, maintenance and cultivation; or alternatively, the presence of modern practices. The detection of other uses (livestock raising, different varieties of urban use, or disuse) is also indispensable, since these represent important departures from their original agricultural use.
- To collect and record observations or testimonies of the *chinamperos* present at the moment of cataloguing *in situ*.
- To make note of any visible damage or threat to the existence of each chinampa, particularly where these are temporarily or permanently under water or threatened by urbanization.
- Taking the above elements into account, to evaluate the state of conservation of each chinampa and to determine priorities for its restoration; and finally,
- To find practical applications for the conservation of this type of cultural landscape, and to make recommendations for continuing and concluding the task of cataloguing as soon as possible.

Once these aims were established, the scope of the study was only limited by the time and the resources assigned to the two first annual phases that have so far been completed, as described in the following paragraphs:

The process began in the chinampas within the jurisdiction of the Borough of Xochimilco, since this local authority was the first to become interested in undertaking this task with the support of researchers from our University. Hence, an agreement was drawn up between the Advisor to the Local Administration of Xochimilco, Sergio Alejandro Méndez Cárdenas, and Alberto González Pozo, Research Professor in the Department of Theory and Analysis of the Division of Sciences and Arts for Design of the Universidad Autónoma Metropolitana-Xochimilco, to draw up a first exploratory study for cataloguing the chinampa zones that still exist in the borough. The work thus began while testing, simultaneously, the efficacy of the method employed to carry it out, since no trustworthy experiences existed as regarded that kind of task.

The study in question was subject to the framework of two Collaboration Agreements: one *general* agreement between the Head of the Local Authority and the President (Rector General) of the Universidad Autónoma Metropolitana, and a *specific* agreement between the same local government authority and the Director of the Xochimilco Campus of the UAM. The management and administration of the Specific Collaboration Agreement was entrusted to the Academic Planning and Development Committee (COPLADA) of the Xochimilco campus.

Once both agreements had been signed, Alberto González Pozo, as the person in charge of the study, proposed that a preliminary inspection be made of the chinampa zones in Xochimilco, including the best known, those closest to the district offices, and also those of Santa María Nativitas, San Gregorio Atlapulco and San Luis Tlaxialtemalco. Once the visits had been completed, a preliminary proposal was made to begin work at three different locations, one in the chinampas of the central zone, another in San Gregorio Atlapulco and the third in San Luis Tlaxialtemalco, so as to characterize the range of different problems facing conservation. But this initial purpose was

modified when work began on deciding the guidelines for the field data capture form that was to be used, since this process brought to light the difficulty of the task and the restrictions imposed by the limited time and resources available for carrying it out. Finally it was decided to begin in 2005 with a test run involving a small territory in San Gregorio Atlapulco. The selected area was of little more than fourteen hectares, comprising 106 chinampas.

There were two main reasons for choosing San Gregorio for beginning the study as the initial area to be surveyed. The first was that, in that zone in particular, many of the attributes of chinampa culture are conserved that have made it famous throughout the world. It is still a productive horticultural zone, it has not been disturbed overmuch by touristic activities, and it maintains alive many of the traditional forms of cultivation and production. When compared with other chinampa zones, its network of canals is still mostly navigable and the percentage of *ahuejotes* existing on the banks of the islets is still significant. Moreover, many of the studies that have been carried out during the twentieth century to understand the nature of the chinampas have also taken San Gregorio as a representative reference. We shall be referring to many of these studies in the following pages.

When the 2005 phase of the study had been successfully completed, we became convinced that it was indeed possible to carry out the process of cataloguing. Nevertheless, the first results also made us aware that in the Xochimilco Administrative District alone there are more than ten thousand chinampas, which means that the task of cataloguing them all is considerable, although

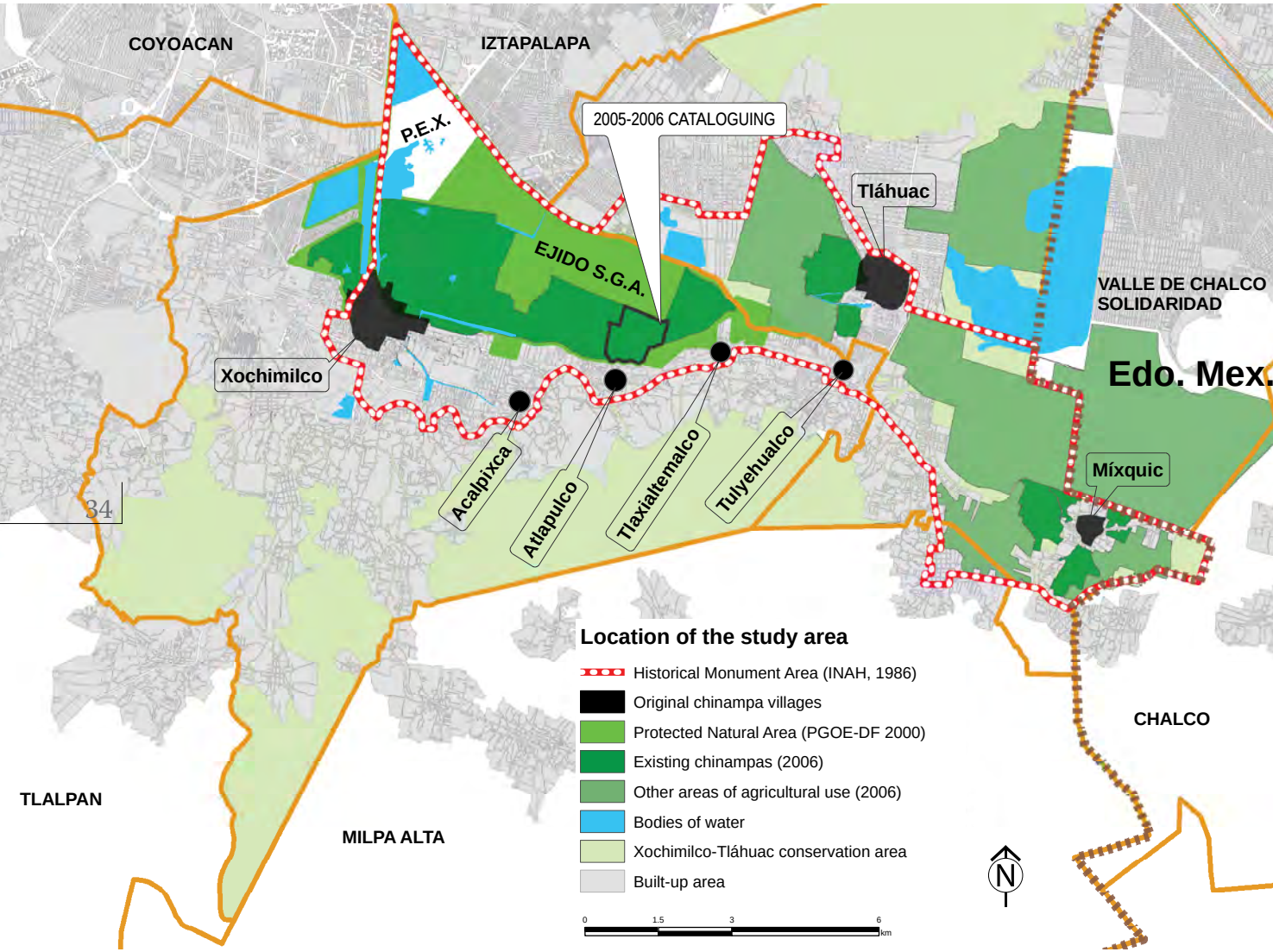
[2] In 2007 fresh visits were made to San Gregorio on our own account, and in 2008 we participated in another interdisciplinary study carried out under an agreement between the Universidad Autónoma Metropolitana (through its Center for Metropolitan Studies, coordinated by the architect Eduardo Preciat Lambarri) and the Secretariat for Housing and Urban Development (SEDUVI) of the Mexico City Administration. During that study, still unpublished, field tours and cartographic surveys were made of all the chinampa zones that still exist in the Xochimilco and Tláhuac districts of Mexico City.

the experience acquired during the first phase would now make it possible to perform the task with greater speed and efficacy.

This indeed proved to be the case, since in the second phase, corresponding to 2006, a total of 75 hectares was covered in which 438 chinampas were found to exist. Hence, between the two stages, it was possible to catalogue a total of 544 chinampas over an area of 90 hectares.

Other independent studies effected between 2007 and 2008 by some of the members of the study[2] team, allow us to state that those 90 hectares and just over half a thousand chinampas catalogued represent less than 3 percent of the total existing in varying degrees of conservation in the Boroughs of Xochimilco and Tláhuac.

Consequently, this work is not a simple edition of the results of the two stages effected in 2005 and 2006 as they were handed over to the Xochimilco Delegación, but rather a third, independent product aimed at academic dissemination. It is a reworking in which we have availed ourselves of a large part of the accumulated information in order to make known to a wider —and not necessarily specialized— public the results of that effort. For example, we do not present here the reports, the sets of maps, the complete catalogue of filing cards nor the database corresponding to each of the two stages. Those are materials that can only be consulted in the Xochimilco Borough's offices or in the Academic Planning and Development Committee (COPLADA) of the UAM-Xochimilco. What we show here is a single text that sets out to describe that first process of cataloguing, along with one set of maps and a representative selection of the catalogued record forms and the most relevant results of specific consultations of the database.



Map B. The Historic Monument Area, its chinampa zones, and the area in San Gregorio Atlapulco catalogued between 2005 and 2006.

II. Origins and Evolution of the Chinampa Landscape

Ignacio Armillas Gil, Alberto González Pozo and Luz Cecilia Rodríguez Sánchez

The complex evolution of the Xochimilco-Chalco subsidiary basin at the southern extreme of the Valley of Mexico spans an extensive period of time going back to its original geophysical formation and taking in subsequent transformations throughout the historical stages in which the cultural landscape of the chinampas arose, was consolidated and —with considerable difficulty— still subsists.

The Natural Setting

The Valley of Mexico, also known by its indigenous name of Anáhuac, is in reality an *endorheic* basin, since it has no natural drainage to the sea. This basin is situated in the central stage of the Trans-Mexican Neo-Volcanic Axis, which crosses the national territory along the 19th parallel north, between the Pacific Ocean and the Gulf of Mexico.

Like other basins of similar formation, that of the Valley of Mexico is characterized by having a generally level bottom, formed by a alluvial and lacustrine deposits. The broad plain, which is interrupted occasionally by small rocky outcrops and a few volcanic cones, occupies approximately 40% of the total area of the basin, its floor being at an elevation of

between 2,235 and 2,243 m above sea level.[1] The perimeter of the valley delimits an area of approximately 8,000 square kilometers, measuring around 110 km on the north-south axis and 80 in the east-west direction.[2] The fringes of the basin, formed by rugged mountain slopes, are tree-clad up to an elevation of 4,000 m above sea level. The highest summits —which until recently had perennial snow-caps— exceed 5,000 m above sea level.

The climate of the basin is characterized by dry winters with low nocturnal temperatures and wet summers with mild temperatures. About 80% of annual rainfall occurs in the summer months from June to October, however there are notable variations in annual volumes of precipitation from one year to another. Precipitation also varies considerably between the plains at the northern end of the basin, which receive an annual average of barely 450mm, and the more elevated southwestern slopes, which receive an average of 1500mm of rainfall per year.[3] Due to its considerable extension, the rugged topography of the periphery, elevation, angles of slopes, different kinds of soil, and the disparities in the pluvial regime, the Valley of Mexico embraces a wide range of environmental zones comprising a great variety of ecosystems making up the complex natural mosaic that characterizes this basin.

In the pre-Hispanic period the floor of the basin was almost entirely covered by bodies of water forming a system of five shallow interconnected lakes. The lowest of these lakes was

[1] Ignacio Armillas Gil, "Introducción", *Estudios sobre sismicidad en el Valle de México*, Departamento del Distrito Federal, Secretaría General de Obras, Mexico City, 1988, pp. V-XVII.

[2] Jeffrey R. Parsons, *The Last Pescadores of Chimalhuacan, Mexico: An Archaelogical Ethnography*, Anthropological Papers, University of Michigan Museum of Anthropology, no. 96, Ann Arbor, 2006, p. 11.

[3] William T. Sanders, Jeffrey R. Parsons and Robert S. Stanley, *The Basin of Mexico. Ecological Processes in the Evolution of a Civilization*, Academic Press, New York, 1979, pp. 81-82.

Lake Texcoco, the most saline of all,[4] while the lakes to the north and south were at higher levels: the surface of Lake Zumpango being some 6m above that of Lake Texcoco and Lake Chalco standing at about +3m. Since the bottom of the valley was almost flat, the depth of the lakes showed little variation. These two characteristics —shallow waters and flat, regular bottoms— favored the eventual construction of artificial islets in the lakes. Depending on the quality of the water, the islets could be used for agriculture or simply for habitation.

At the southern extreme of the valley is the sub-basin of Xochimilco-Chalco, with an extension covering 1500 square kilometers. It is enclosed to the north by the Santa Catarina range; to the east, the Sierra Nevada (which includes the Iztaccíhuatl and Popocatépetl volcanoes); at the southwest corner, the mountain pass to the valley of Cuautla; to the south, the sierra of Chichinautzin; and to the west, the lava fields, or pedregales, of Coyoacán. The two lakes together[5] occupied a surface of 148 km^2, and were connected with that of Texcoco via a narrow channel at the north-west corner, between the settlements of Churubusco and Culhuacán.[6]

[4] Enrique Beltrán, *El hombre y su ambiente: ensayo sobre el Valle de México*, FCE, Mexico City, 1958. pp. 14-15.

[5] Translator's note: Before the arrival of the Spaniards what was originally a single large body of water had been divided into two by a causeway joining the island town of Cuitláhuac (the modern Tláhuac) with the northern and southern shores. The westernmost part was known as Lake Xochimilco, after the town on its southern shores, while the eastern expanse was Lake Chalco, named after a confederation of tribes that had settled around it. By the time of the Spanish conquest the greater part of both lakes had been colonized by chinampas.

[6] Jeffrey R. Parsons, K. Kintigh and S. Gregg, *Archaeological Settlement Pattern Data for the Chalco, Xochimilco, Iztapalapa, Texcoco and Zumpango Regions, Mexico*, Technical Papers, University of Michigan Museum of Anthropology, no.14, Ann Arbor, 1983, pp. 14-19.

The dominant climate in the Sub-basin, at least for the last millennium, has been the most benign of the whole Valley of Mexico, with greater rainfall, general humidity and less marked thermal oscillations around an annual mean of 19° C.

Geotectonic Origin of the Valley of Mexico Basin

The peculiarities of this geophysical scenario are due, in their origins, to a process of geotectonic and hydrological phenomena that began at least 230 million years ago and led, first, to the gradual configuration of the central Mexican highlands and then, some 600,000 years ago, the closure of a series of valleys so as to form the endorheic Valley of Mexico. We refer to the description given by Mooser of both processes in the outline of the process that follows.[7]

The earliest stages of that process of transformations is best explained by the dynamics of drift and interaction between continental masses and contiguous plates of the terrestrial crust during the Triassic. Throughout the period analyzed and until the present day, the North American Plate has moved southward at the rate of 3 cm. per annum while, on the Pacific side, the Cocos plate follows the opposite direction but at the greater velocity of 5 cm. a year. These movements create deep fractures in the crust. As a result of one of these fractures a seam of volcanic activity was formed along the nineteenth parallel which, as has been mentioned, crosses

[7] Enrique Santoyo Villa, Efraín Ovando-Shelley, Federico Mooser H. and Elvira León Plata, *Síntesis geotécnica de la Cuenca del Valle de México*, TGC Geotecnia, Mexico City, 2005, pp. 5-25.

the national territory from Nayarit on the Pacific coast to Veracruz on the Gulf of Mexico, with the valley of Anáhuac along the middle section. This activity was intense during the Jurassic.

During the lower Miocene the mountain ranges and valleys of central Mexico were in the process of formation, these included the present valleys of Cuernavaca, Cuautla, Puebla-Tlaxcala and Tehuacán. According to Mooser, these primeval formations included the valleys that have come to conform the basin of the Valley of Mexico. Below today's basin there are buried fossil valleys at depths of up to some 400 meters where watercourses once flowed towards Cuernavaca and Cuautla. Some 600,000 years ago they were obstructed by the appearance of another more recent volcanic arc, the Sierra de Chichinautzin. This mountain chain stretches from the Nevado de Toluca to La Malinche, passing by the Cerro San Miguel forming the barrier that created the basin.

What followed was the formation of a deep natural depression, enclosed within the orographic limits of the new endorheic basin, where water swept alluvial deposits and frequent layers of ash and lava, products of the intense volcanic activity in the Quaternary, which gradually raised the bed of the new valley and its lakes in formation. In this extremely long process, the shallow lagoons of Chalco and Xochimilco made their appearance at the southern end of Anáhuac, followed by the lakes of Xaltocan and Zumpango to the north, and the great body of Lake Texcoco in between.

Today, when we refer to hard layers in the subsoil of the valley situated at a depth of 30 to 50 m., in reality we are alluding to consolidated intermediate strata, beneath which lie other strata of tuffs and clays and aquifers of fossil waters.

According to David Huddart and his collaborators, during the late Pleistocene and early Holocene, besides the above mentioned volcanic activity (and perhaps as its consequence), significant climatic variations took place in the climate of the forming basin. The alternating periods of drier or wetter, warmer or colder climate brought about changes in

the levels of the lakes as well as changes in the flora and fauna in the basin; including the extinction of some species of megafauna.[8] During this period, which spans from 40,000 to 8,000 years before the Present, the natural landscape of the wetlands in the southern portion of the basin was formed. The human presence was to be responsible for transforming this environment into a cultural landscape.

Human Presence in the Valley of Mexico and the Xochimilco-Chalco Sub-Basin

The most widely accepted theory holds that human beings migrated from Asia into the American continent using the so-called Bering Land Bridge, which was formed during periods of glaciation when the sea level fell more than 46 meters as compared to its present level. Migrations across this land bridge would have been feasible from 35,000 to 19,000 and from 14,000 to 12,000 years before the Present.[9] Hence many different theories are possible regarding the periods in which these migrations occurred and the way in which the new

[8] David Huddart and Silvia González, "A Review of Environmental Change in the Basin of Mexico (40 000-10 000 BP). Implications for Early Humans", in José Concepción Jiménez López et al. (eds.), *El hombre temprano en América y sus implicaciones en el poblamiento de la Cuenca de México*, Colección Científica, INAH, Mexico City, 2006, pp. 77-105.

[9] David Meltzer, "Why Don't We Know When the First People Came to North America?", en *American Antiquity* no. 54, 1989, pp. 471-490.

settlers moved across the continent. Until recently the most generally accepted idea was that migrations proceeded towards the south following a corridor along the Rocky Mountains.[10] Other authors state that the first settlers probably followed coastal routes since no evidence has been found of migrations along the Rocky Mountain corridor.[11] Besides, it is worth pointing out that the coastal routes offered a greater variety of ecosystems, in close proximity of each other, which would have favored the subsistence of nomadic groups. What seems most likely is that repeated migrations took place from Asia to America in different periods going back perhaps as far as 35,000 years and then, intermittently, until 10,000 years before the Present.[12] Likewise, the most probable course of events is that repeated migrations from Asia used different routes during different periods, dispersing throughout the Americas.

Although there is evidence of human presence that may go back further in time, the most ancient human remains found in the Valley of Mexico are those of the so-called *Mujer del Peñón III*, which have been dated by means of Carbon 14 to 10,775 ±75 years before the Present.[13] According to the same authors, at Tlapacoya, a site on the shores of

[10] David G. Anderson and J. Christopher Gillam, "Paleoindian Colonization of the Americas: Implications from an Examination of Physiography, Demography, and Artifact Distribution", in *American Antiquity*, no. 65, 2000, pp. 43-66.

[11] Knut R. Fladmark, "Routes: Alternative Migration Corridors for Early Man in North America", in *American Antiquity*, no. 44, 1979, pp. 55-69.

[12] Meltzer, op. cit., p. 474.

[13] Silvia González, José Concepción Jiménez López, Robert Hedges, José Antonio Pompa y Padilla and David Huddart, "Early Humans in Mexico, New Chronological Data", in José Concepción Jiménez López et al. (eds.), op. cit., pp. 67-76.

the ancient lake of Chalco, a skull was found that gave a slightly lesser degree of antiquity: 10,200 years before the Present. From these findings it would appear that there already was human presence in the basin during the Paleolithic. This human presence was in the form of small nomadic bands that possessed rudimentary stone-age technology and survived by exploiting the rich variety of flora and fauna, including aquatic resources present in the wetlands and lakes.

As we have already suggested, the great diversity of environmental niches in the basin provided a mosaic of opportunities for the inhabitants. The proximity of diverse ecosystems reduced the need for roaming large distances in order to obtain food during the annual cycle. This is so much so that the archeologist Christine Niederberger postulates the possibility of small permanent or semi-permanent settlements existing on the lake shores of the sub-basin of Xochimilco-Chalco some 8,000 years ago, that is to say, before the introduction of cultigens in the basin.[14] Niederberger bases this assertion on remains of diverse foods found at the same location that would have been available during different seasons of the year.

According to Richard MacNeish,[15] the cultigens that were to become the basis of the Mesoamerican diet were developed through a gradual process that began possibly some

[14] Christine Niederberger, "Early Sedentary Economy in the Basin of Mexico", in *Science*, vol. 203, no. 4376, 1979, pp. 131-142.

[15] Richard S. Macneish, "The Food Gathering and Incipient Agriculture Stage of Prehistoric Middle America", in R. C. West (ed.), *Handbook of Middle American Indians*, vol. 1, University of Texas, Austin, 1964, pp. 413-426.

9,000 years ago, in various regions of Mesoamerica. The domestication of cultigens and their adoption for human subsistence was no doubt a gradual and erratic process, but it involved the irrevocable transition from a nomadic to a settled agricultural life and the eventual development of civilizations in Mesoamerica.[16]

Apparently, however, the introduction of agriculture in the basin itself took place later than its adoption in other regions of Mesoamerica. According to the archeologist William Sanders, this could have happened as recently as some 3,200 years before the Present. It was probably introduced from the Valley of Morelos, since the first villages arose near to the mountain pass that connects the basin with that valley.[17] However, given the existence of agriculture in other regions, it is of course possible that some cultigens could have made their appearance at an earlier date. A factor that delayed the more widespread use of agriculture in the basin was the need to develop varieties better adapted to the altitude of the Valley of Mexico.

Gradual Formation of the Chinampa Landscape in the Pre-Hispanic Era

The introduction of agriculture in the basin entailed the gradual transformation of its inhabitants' way of life, a transformation that would facilitate the development of settlement systems and would culminate in the flourishing of cities. This view is supported by the work

[16] Ignacio Armillas Gil, *The Origins of Urbanism in Ancient Mexico*, doctoral dissertation, University of Columbia, UMI Dissertation Services, 1983, pp. 56-112.

[17] Personal communication cited in I. Armillas 1983:45.

of archaeologists such as Grennes-Ravitz who has documented the existence of settlements in the basin during the period 1450-1200 BC.[18] Niederberger, on the other hand, has detected the existence of settlements, such as Tlapacoya, with economies based on agriculture, that were already functioning as religious and political centers in the period between 1250 and 1000 BC.[19] Jeffrey R. Parsons has pointed out that, between 900 and 500 BC, the basin witnessed a notable increase in population, possibly due to improvements in agriculture, although the demographic volume was still scarce. He also stressed the fact that the largest settlements were concentrated on the shores of the lakes or the alluvial plains at the more humid southern end of the basin.[20]

By 500 BC the biggest and most complex of the settlements in the Valley was Cuicuilco, possibly the earliest city in the Valley of Mexico. According to Ángel Palerm,[21] there is evidence of hydraulic works and the possible practice of agriculture in raised fields in the proximity of that settlement dating to several centuries before the Christian era. This seems feasible since the location of this settlement on the shores of the lake facilitated the ex-

[18] Ronald A. Grennes-Ravitz, "The Extrapolation of Preclassic Reality from Postclassic Models: The Concept of an Olmec Empire in Mesoamerica", in *Actas del XLI Congreso Internacional de Americanistas*, Mexico City, vol. 1, 2-7 September 1974, Mexico City, 1975, pp. 378-383.

[19] Christine Niederberger, "Excavaciones en Tlapacoya-Zohapilco", *Ibid.*, pp. 403-411.

[20] Jeffrey R. Parsons, "Settlement and Population History of the Basin of Mexico", en Eric R. Wolf (ed.), *The Valley of Mexico*, University of New Mexico Press, Albuquerque, 1976, pp. 69-100.

[21] Ángel Palerm, "Sistemas de regadío prehispánico en Teotihuacán y en el Pedregal de San Ángel", in *Revista Interamericana de Ciencias Sociales*, series 2, vol. 1 (2), 1955, pp. 297-302.

ploitation of lacustrine resources, suggesting that its economy was based, at least in part, on those resources. Consequently, the practice of some kind of horticulture on platforms in the marshy areas of the lake created either by means of the draining of the terrain by excavation of canals or by construction of islets in the shallow waters is a possibility.

At the opposite extreme of the Anáhuac, on land adjacent to springs bordering the urban zone of Teotihuacan, William T. Sanders has identified what appear to be irrigation canals and raised fields for agricultural use.[22] According to Sanders, this practice dates to the beginning of our Era and reached its maximum extension in the Valley of Teotihuacan two or three centuries later. Another indication of the existence of agriculture on raised platforms during the apogee of Teotihuacan can be seen in the lower frieze of a mural in the Palace of Tepantitla, one of those that have been excavated in that ancient city. This frieze shows rectangular fields bordered by canals, represented in a geometrical design along with other scenes related with water and fertility.[23]

Furthermore, the people of Teotihuacan demonstrated their knowledge and skill in carrying out hydraulic works (the canalization of the San Juan river, for example, adapting it to the orthogonal layout around the center of the city) which makes it feasible that they might have transformed marshes into a system of canals and raised fields during that period.

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[21] William T. Sanders, "The Agricultural History of the Basin of Mexico", en Eric R. Wolf (ed.), T*he Valley of Mexico, Studies in Pre-hispanic Ecology and Society*, School of American Research, Santa Fe, New Mexico, 1976, pp. 101-160.

[22] Esther Pasztory, *The Murals of Tepantitla*, Garland, New York, 1976.

Some researchers have noted that the orientation of the network of canals in several chinampa localities in the Xochimilco-Chalco sub-basin is the same as that of the urban layout of Teotihuacan and does not correspond to that favored by the Aztecs.[24] This observation should be interpreted with caution since —according to Jeffrey R. Parsons and others— although there is evidence of some occupation with villages and small agricultural villas on the edges of lakes Xochimilco and Chalco or around the courses of the Tlalmanalco and Amecameca rivers before the Common Era, there is no evidence of chinampas in any of the two lacustrine zones until a horizon between 750 and 1350 AD.[25] This points therefore to a period after the decline of Teotihuacan and would have occurred between the advent of Toltec domination, its decline after the confrontation with Cholula, and the first Aztec occupations. This suggests that if there was influence of Teotihuacán in the orientation of the layout of chinampas in the sub-basin, this does not seem to have been direct but, rather, a consequence of traditions that outlasted the fall of Teotihuacan.

[24] Michael D. Coe, "The Chinampas of Mexico", in *Scientific American*, vol. 211, no. 1, July 1974, pp. 90-98.

[25] Jeffrey R. Parsons, Elizabeth Brumfield, Mary H. Parsons and David J. Wilson, *Prehispanic Settlement Patterns in the Southern Valley of Mexico. The Chalco-Xochimilco Region*, Memoirs, no.14. University of Michigan Museum of Anthropology, Ann Arbor, 1982, pp. 206-244.

There is little archeological evidence of agriculture in wetlands within the basin in the post-Classic period following the fall of Teotihuacan; nonetheless, William T. Sanders and his colleagues have pointed out that it would be difficult to understand how some of the largest settlements in the basin of that period could have maintained the population levels they apparently had without the support of an intensive agriculture.[26] These authors cite as an example the population that developed on the island of Xico within Lake Chalco between 750 and 950 of the Christian Era. However, although agriculture on platforms raised on marshes apparently already existed, it was not extensively used in the Valley of Mexico; at least there is no evidence of the existence of large areas of chinampas in the basin during that period. The information available so far allows us to think that agriculture on raised platforms was limited to a few communities in lakeside marshes.

Sanders and his colleagues speculate that this could be explained by the presence of a greater depth of water in the lakes of the basin during the first millennium of our Era, which would have made the construction of raised platforms difficult. But around the beginning of the second millennium new climatic changes could have resulted in lower water levels, creating better conditions for the construction of chinampas. According to these researchers, another factor could have been that the population density in the basin —or alternatively the proportion of population involved in activities other than agricultural production— was not high enough to require intensive methods of food production. Whatever the reason, agriculture upon artificial platforms, although known and practiced during the first millennium AD, was apparently not used extensively until the second millennium.

[26] William T. Sanders, Jeffrey P. Parsons and Roberts S. Stanley, *op. cit.*, 1979, p. 281.

The period around the late fourteenth and early fifteenth century witnessed a rapid and widespread propagation of areas under chinampa cultivation in the southern part of the basin. This expansion of chinampa agriculture coincides with the flourishing of the Aztec Empire and is particularly notable in the fresh-water lakes of Xochimilco and Chalco.[27] According to these researchers, the settlement of the sub-basin during the Aztec I and Aztec II periods showed a pattern of occupation along the margins of the lakes and the islands within them. This settlement pattern changed radically at the beginning of the Aztec III period, when a decisive expansion of chinampas onto the lake bed itself is detected. This conclusion coincides with the observations of Edward Calnek, who proposes, based on ethno-historical observations, that the principal works of massive formation of chinampas took place between 1426 and 1467 of our Era.[28]

Parsons adds that, during this period, areas of chinampas also existed around the town of Xaltocan in the lake of the same name, as well as in Lake Texcoco, at the foot of the hill of Chimalhuacán on the central eastern slopes of the basin.29 These were sites where fresh-water springs flowed, offsetting the salinity of the lakes and thus making chinampa horticulture possible. According to Ávila López, there were also chinampa areas in Iztapalapa and, to a limited extent, around the Aztec capital of Tenochtitlan.[30] Agricultural

[27] Pedro Armillas, "Gardens on Swamps", *Science*, vol. 174, Nov. 1971, pp. 653-661; Sanders *et al.*, *op. cit.*, 1979, p. 281; Parsons, "El papel de la agricultura chinampera", in Carlos Javier González (ed.), *Chinampas prehispánicas*, INAH, Mexico City, 1992, pp. 206-244.

[28] Edward Calnek, "Settlement Pattern and Chinampa Agriculture at Tenochtitlan", in *American Antiquity*, vol. 37, no. 1, 1972, pp. 104-115.

[29] Parsons, *op. cit.*, 1992, pp. 206-244.

[30] Raúl Ávila López (ed.), "Arqueología de Chinampas en Iztapalapa", in *Chinampas prehispánicas*, INAH, Mexico City, 1992, pp. 81-154.

activity in those areas was facilitated by the hydraulic works undertaken by the Aztecs in order to reduce the salinity of the western part of the lake, such as the construction of the dike known as the Albarrada of Nezahualcóyotl which controlled the flow of water between the eastern and western parts of Lake Texcoco, as well as other works that conducted fresh water from the slopes of the basin into the western sector of the Lake. But the greatest concentration of chinampa agriculture was without doubt in the lakes of Xochimilco-Chalco.

As will be recounted in greater detail below, the chinampa zone of Xochimilco was inscribed in the UNESCO's World Cultural and Natural Heritage List, together with the Historic Center of Mexico City (the ancient Tenochtitlan). This unusual joint inscription was an implicit acknowledgment of the close link between the two areas since pre-Hispanic times. This has, in fact, been a symbiotic relation.[31] On the one hand, the Aztec capital required a great quantity and variety of foodstuffs for the support of its population and its armies: on the other hand, the agricultural zone enjoyed a wide and constant source of demand for its products, thus ensuring its own prosperity.

[31] A relation is said to be symbiotic when those associated (the "symbionts") benefit mutually from the nexus that unites them—when the relation is more than one of dependency, even where such dependency is mutual and positive. In a symbiotic relation the existence and prosperity of the parties is itself a function of a common well-being. This was the nature of the relation between Mexico-Tenochtitlan and the sub-basin of Xochimilco-Chalco that persisted throughout more than six centuries.

Tenochtitlan required the sustenance that Xochimilco provided, for it was an atypical preindustrial city. The Aztec capital was situated on some small islets within Lake Texcoco, and thus lacked a surrounding agricultural zone of its own to supply it with foods, as was characteristic of pre-industrial cities.[32] If at the beginning its isolated lacustrine location granted it a certain degree of protection from a military point of view, on the other hand this limited its agricultural potential, depriving its population of food security. But by chance, at the relatively short distance of 30 kilometers and accessible by water were the lakes of Chalco and Xochimilco, zones highly favorable for agriculture.

Given that the greater part of the land was covered by lakes and marshes, expanses of flat lands suitable for cultivation were very limited in the sub-basin. This physical situation stimulated the practice —and favored the expansion— of a complex and ingenious agricultural system apt for the exploitation of marshlands: the chinampa. This adaptation turned out to be so successful that, by the beginning of the sixteenth century most of the surface of both lakes had been converted by human action into a prodigious complex consisting of scores of thousands of islets devoted to horticulture.[33] Production per surface unit surpassed by a long way any other agricultural system in use in the pre-Hispanic era. By employing this system of agriculture in wetlands, the shallow freshwater lakes and marshes that covered the lower reaches of the sub-basin were converted into a horn of plenty that provided most of the sustenance of the Aztec capital.

[32] Gideon Sjoberg, *The Preindustrial City: Past and Present*, The Free Press, 1960, p. 36.

[33] P. Armillas, *op. cit.*, 1971, pp. 653-661.

The fact that most of the grains, fruit and vegetables consumed by the inhabitants of Mexico City came from the region of Xochimilco and Chalco had already been observed by researchers like Santamaría,[34] Schilling,[35] and West and Armillas.[36] However, it was not until the latter half of the twentieth century that systematic studies set about determining the potential levels of agricultural production of the sub-basin in pre-Hispanic times.

The first of these investigations was published by the archeologist William T. Sanders who judged that the agricultural production of the region could have been sufficient to feed a population of as many as 170,000 people at the beginning of the sixteenth century.[37] A few years later the archeologist Pedro Armillas carried out research into the extension of chinampa areas in pre-Hispanic times in the Xochimilco-Chalco sub-basin. On the basis of historical data and information, analysis of aerial photographs and field reconnaissance of the surface, Armillas concluded that, in that period, the area dedicated to chinampas in the lacustrine bed of the sub-basin extended over some twelve thousand hectares. Discounting approximately

[34] Miguel Santamaría, *Las chinampas del Distrito Federal. Informe rendido al señor director general de Agricultura por el agrónomo Miguel Santamaría*, Secretaría de Fomento, Mexico City, 1912.

[35] Elizabeth Schilling, "Los jardines flotantes de Xochimilco (1938). Una selección", in Teresa Rojas Rabiela, *La agricultura chinampera, compilación histórica*, Universidad Autónoma Chapingo, Mexico City, 1983.

[36] Robert C. West and Pedro Armillas, "Las chinampas de México: poesía y realidad de los jardines flotantes", en *Cuadernos americanos*, no. 50, Mexico City, 1950.

[37] William T. Sanders, *Cultural Ecology of the Teotihuacan Valley: A Preliminary Report of the Results of the Teotihuacan Valley Project*, Pennsylvania State University, University Park, 1965.

25 percent in consideration of the surface occupied by canals and open lakes, more than nine thousand hectares would have remained apt for agricultural production. Drawing on empirical estimations of production and subsistence, Armillas found that the agricultural production of the zone could have fed at least 100,000 personas.[38]

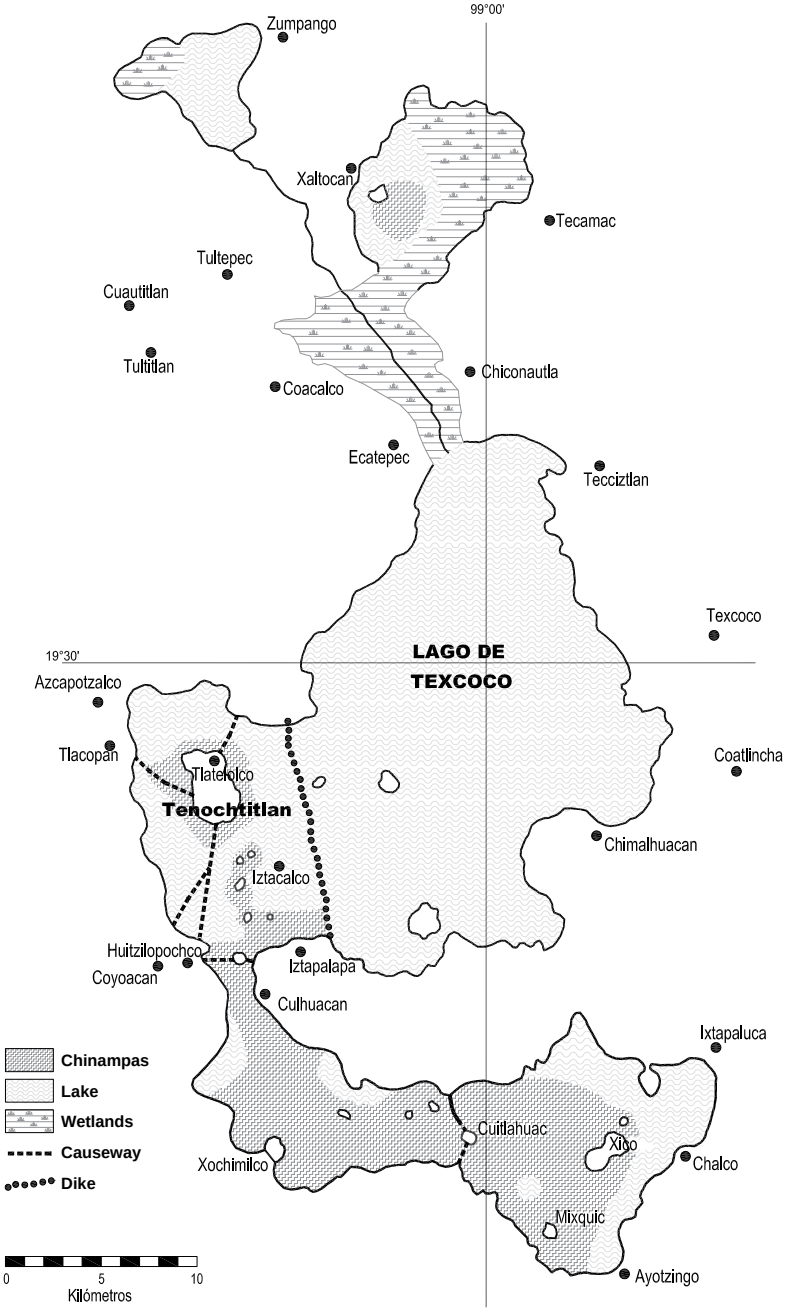
In part supported by the work of Pedro Armillas, Parsons estimated that the Xochimilco-Chalco sub-basin itself would have had a population of only 37,000 inhabitants around the end of the fifteenth century. These figures would indicate that it could have produced a food surplus equivalent to nearly twenty thousand metric tons of maize per annum in that period.[39] In the same work, based on calculations of the annual subsistence requirements and a population of Tenochtitlan estimated at between 150,000 and 200,000 inhabitants, this researcher assessed the alimentary requirements of the Aztec metropolis at between 30 and 40 thousand metric tons of maize.

Edward Calnek, on the other hand, has pointed out that, in and around Tenochtitlan itself, chinampa horticulture was very limited, at least at the beginning of the sixteenth century.[40] This researcher estimates that the population density of this city at the time would

[38] Pedro Armillas, *op. cit.*, 1971, pp. 653-661.

[39] Jeffrey R. Parsons, *op. cit.*, 1992, pp. 210-244.

[40] Edward Calnek, *op. cit.*, 1972, pp. 104-115; and E. Calnek, "Patrón de asentamiento y agricultura de chinampas en Tenochtitlán", in Carlos Javier González (ed.), *Chinampas prehispánicas*, INAH, Mexico City, 1992.



Map C. Lakes of the Valley of Mexico at the fall of the Mexica Empire, showing the chinampa areas in Xaltocan, Tenochtitlán and adjacent islets, Iztapalapa and the lakes of Xochimilco and Chalco. (Adapted from the original drawing by Pedro Armillas, made available by Ignacio Armillas Gil).

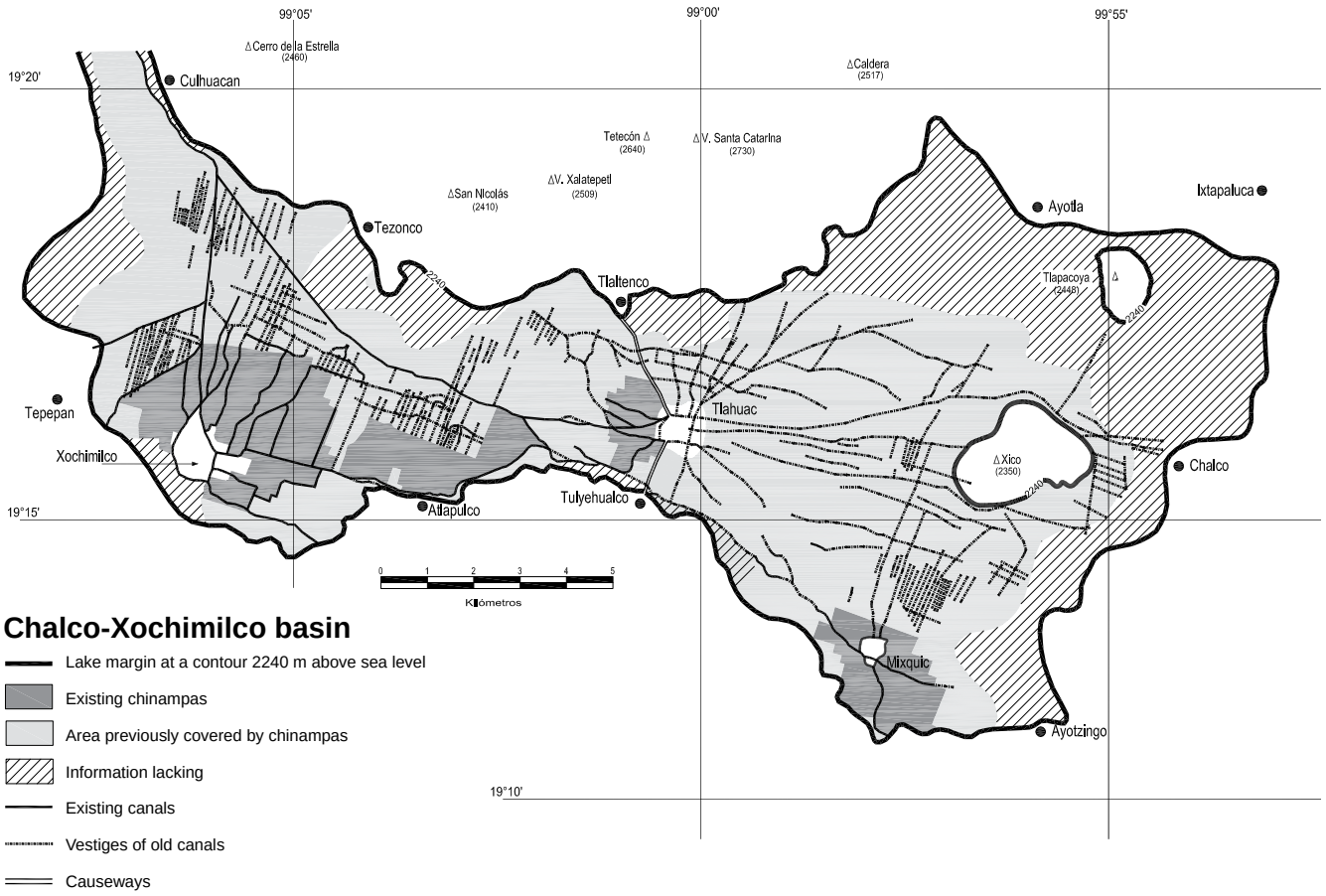
have been in the range of 12,000 to 16,000 inhabitants per square kilometer, which would have left little space for agricultural uses. According to Calnek, horticultural activities in the urban area were limited to a few small chinampas that provided at the most 15% of the nutritional needs of the families that worked them and, in most cases, only a fraction of that amount. It is evident that by necessity almost all the food consumed by the population of Tenochtitlan-Tlaltelolco at the time came from external sources.

Based on the study of codices and other sources, the historians Narcis Molins Fàbrega,[41] and Robert H. Barlow[42] concluded independently that the alimentary tribute received by Tenochtitlan could have satisfied the nutritional needs of approximately 40 to 50 thousands of its inhabitants,[43] in other words approximately a quarter of the urban population. This nutritional deficit called for the complement of other sources within the basin. Although the Anáhuac was particularly fertile and contained a variety of productive areas including agricultural terraces, lakes and other resources, the area of Xochimilco-Chalco was the one with greatest capacity for producing the food surplus required by Tenochtitlan.

[41] Narcis Molins i Fábrega, *El códice mendocino y la economía de Tenochtitlán*, Biblioteca Mínima Mexicana, vol. 30, Mexico City, 1954.

[42] Robert H. Barlow, "The Extent of the Empire of the Colhua Mexica", in *Iberoamericana 28*, University of California Press, Berkeley, 1949.

[43] Cited in Sanders *et al.*, *op. cit.*, 1979, p. 176.



Map D. Detail of the previous map showing how the lacustrine zone between Culhuacán, Xochimilco and Chalco was almost entirely covered by chinampas. (Adapted from the original drawing by Pedro Armillas, made available by Ignacio Armillas Gil).

What seems most likely is that at an early period, let us say in the mid fourteenth century, Tenochtitlan would have been more or less self-sufficient in terms of staple foods. But as the empire began to expand, so did the population of its capital, with, of course, a greater concentration of non-agrarian population. This would have included not only the members of the theocracy, the army and the administrators, but also traders, artisans and other specialists who tended to concentrate in the capitals of empires. And not only would population density have increased, but the functions performed by the increasing number of specialists in non-agrarian sectors would have required physical space, in direct competition with agriculture for the available land. Thus any food self-sufficiency that might have existed in the early stages of Tenochtitlan would have disappeared as the Empire grew and the population of the islets grew denser. Hence the city came to depend on the surplus produced in the chinampa area of Xochimilco-Chalco in order to satisfy its nutritional needs.[44]

Apparently, the zone fulfilled that function splendidly, producing large food surpluses that could satisfy a significant part of the nutritional needs of the capital of the ascendant empire. Reflecting on this aspect, Pedro Armillas concluded: "The material bases of Aztec imperialism were established by the peasant farmers who conquered the marshes".[45]

Clearly, then, the development and power of Tenochtitlan depended to a considerable extent on the agricultural surplus generated in the chinampa area of Xochimilco-Chalco; equally clearly, the development and expansion of this agricultural system was fostered by

[44] Ignacio Armillas Gil, "Wetland Agriculture and the Growth and Development of Mexico-Tenochtitlan", ponencia presentada en la LXXII Reunión Anual de la Sociedad para Arqueología Americana, Austin, Texas, April 2007.

[45] Pedro Armillas, *op. cit.*, 1971, pp. 660.

the Aztec capital's demand for foodstuffs. This is, in brief, the essence of the symbiotic relation between Tenochtitlan and Xochimilco in the pre-Hispanic period, a relation that was to continue through the subsequent centuries until the modern era.

The Colonial Epoch and the Drying out of the Anáhuac

Despite the importance of the chinampa zones during the Aztec period, in particular the Aztec III and IV periods, its coverage of the lakes of Chalco and Xochimilco diminished gradually after the conquest, during the Viceroyalty. They did not disappear, of course; rather, they persisted, like the communities that continued to cultivate them; but their extension became gradually reduced for various reasons that we shall now summarize.

The chinampa landscape attracted the attention of the Spanish conquistadors at the moment of their arrival in the Valley of Mexico in 1519, and the reports they sent to the Crown show their admiration for its hydraulic infrastructure. Cortés, in his *Cartas de relación*, records his first impression on approaching Xochimilco:

> We came upon the view of a pleasant city that is called Suchimilco, which is built upon the freshwater lake, and as its natives were apprised of our coming, they had made many stone walls and ditches and raised the bridges to all the entrances into the city.[46]

[46] In Ángel Palerm, *Obras hidráulicas prehispánicas en el sistema lacustre del Valle de México*, Sep-Setentas 32, sep, Mexico City, 1973, p. 55.

As a result of the conquest, Xochimilco suffered the same fate as Tenochtitlan, being razed to the ground by Cortés's armies. Once the zone was pacified, Pedro de Alvarado received the *encomienda* over the Xochimilca people, which was reassigned shortly afterwards to Luis Delgados, since Alvarado had gone off in search of new conquests. In 1541, as in other similar cases, the encomienda passed finally into the dominion of the Crown.[47]

The *encomienda* was a system introduced by the Spaniards in early times subjecting the indigenous peoples to a regime by which their communities —in exchange for the benefit of being converted to Christianity and enjoying the protection of the *encomendero*— had to pay a tribute to their overlord and the Crown in money or in kind, including days of unpaid labor. It was that same system of compulsory labor —in fact little short of slavery— that had been in use for the exploitation of the population of the Antilles, with disastrous results from the demographic point of view. But with the passing of the first two decades after conquest —and once evangelization was beginning to achieve its effects— the opinions of the enlightened clergy and important personalities finally convinced the emperor Charles V and the Council of the Indies of the need to outlaw all forms of slavery throughout the territories under Spanish dominion. Hence the monarch issued, in Barcelona in 1542, the so-called New Laws, which ordained that all Indians who had been placed under the *encomienda* of individuals must revert to the care of the Crown on the death of the *encomendero*, while restrictions were placed on *encomiendas* that had been given to civil or religious

[47] Peter Gerhard, *Geografía Histórica de la Nueva España 1519-1821*, UNAM, Mexico City, 1986.

authorities. The Laws also disposed that excessive *encomiendas* should be cut down to size and *encomenderos* who had mistreated the Indians under their charge should be deprived of their *encomiendas*; likewise, the granting of new *encomiendas* in the Indies was prohibited.[48] All this was in line with what had already taken place in Xochimilco the year before the promulgation of the New Laws.

But the new labor systems, in theory voluntary and generating wages, remained tainted with many of the vices of the compulsory system of the *encomienda*. Hence the history of the indigenous communities of New Spain is full of episodes that constitute a chain of situations unfavorable for their members, with frequent reverses that also affected the cultural landscape that they had raised in the pre-Hispanic era. Many of the works and services they were obliged to render, as well as a sequel of epidemics (such as those of 1545 and 1562) left the communities severely decimated. Nevertheless, the chinampas, their farmers and customs did not disappear, although their extension and importance declined as the Viceroyalty advanced. In these changes, evangelization played a decisive role. The chinampa area was at first under the supervision of the Franciscans, who, in 1535 founded the convent of San Bernardino at Xochimilco (although Gerhard considers that this could have taken place a decade before) and later that of Santiago Chalco, leaving to the Dominicans the attention of San Pedro Cuitláhuac (Tláhuac) and San Andrés Mixquic to the Augustinians.[49]

[48] Silvio Zavala, *El servicio personal de los indios en la Nueva España, Vol. I, 1521-1550*, El Colegio de México / El Colegio Nacional, Mexico City, 1984, pp. 19-34.

[49] Gerhard, *op. cit.*: pp. 106, 252.

Another gradual change in the colonization process involved the haciendas, which began to multiply in the Valley and in all of New Spain, as well as the acquisition of lands by the colonizers for their own field crops and orchards or vegetable gardens. As part of this process, between 1524 and 1534 many lands were granted to Spaniards as *huertas* for such purposes. It is interesting to observe that the modular dimensions suggest a previous layout as indigenous chinampas. These concessions were followed by confiscations of wells and other water resources.[50]

However, most of the chinampa zones of Xochimilco-Chalco escaped being transformed into haciendas for a variety of reasons, among which being the fact that the indigenous people resisted such changes by using any legal means available to them. In one instance, according to a foundational document concerning San Gregorio Atlapulco to which we shall refer in greater detail below, in 1532, Cortés had granted to a group of five "elders" headed by Francisco Xochimatzin of Atlapulco the assignments of plots comprised within their territory, including both flat and hillside lands and waters.[51]

In spite of this, in 1541, a Corregidor was assigned for Xochimilco (which was subordinated for administrative purposes to Texcoco, and did not attain the status of an independent jurisdiction until three decades later); and in the same period the town lost control of San Agustín de las Cuevas (the present-day Tlalpan), which passed into the jurisdiction of Coyoacán, while the latter, in turn, formed part of the Marquesado of Hernán Cortés.[52] Other villages or towns of the sub-basin, such as Culhuacán, Cholopósco (Churubusco),

[50] Palerm, *op. cit.*, 1973, pp. 156-160.

[51] Juan Manuel Pérez Cevallos and Luis Reyes García, *La fundación de San Luis Tlaxialtemalco según los títulos primordiales de San Gregorio Atlapulco, 1519-1606*, Gobierno del Distrito Federal, Del. Xochimilco and Instituto de Investigaciones Históricas Dr. José María Luis Mora, Mexico City, 2003, pp. 11.

Iztapalapa and Tezonco, were subject to Mexicalcingo, while Mixquic and Tláhuac were subject to Chalco.

With the evangelization process under way, the Crown began to think up different ways of extracting indigenous labor from the conquered territories for its own purposes and those of the Church. Thus, in 1544 Charles V instructed his Viceroy, Antonio de Mendoza, to oversee that the Cathedral Church of Mexico-Tenochtitlan be rendered "of good size and sumptuous", since the existing one had been was very small and "had been poorly made". He also gave instructions that the work be carried out under the tripartite system (i.e., with contributions of the crown, the Spaniards and the Indians). The viceroy, on following these instructions the following year, recommended that for this purpose the towns of Chalco and Xochimilco and all those subject to them be called on—this by virtue of their being local people and having materials suitable for the building of the church. The system was adopted despite the fact that the service of Indians in the construction of churches, hospitals and other religious works had been expressly forbidden by the New Laws of 1542-43.[53]

With the passing years, other ordinances accumulated to the detriment of the inhabitants of the Xochimilco-Chalco area. Among these the changes introduced in the settlement system are worth mentioning, such as the *congregación*, or forced concentration, of inhabitants in more compact villages in order to facilitate both missionary efforts and the assignment of compulsory labor. Such was the case in 1555 with the re-foundation of San Gregorio Atlapulco. In the founding charter for the settlement, which is still extant, it is established that the purpose of the *congregación* was to concentrate in one single compact settlement the

[52] Gerhard, *op. cit.*: p. 252.

[53] Zavala 1987: III, 587-588.

existing hamlets which were dispersed in *barrancas* (which, incidentally, explains the place-name Atlapulco, which means "place of large ravines"). The following year, once the work on the church and convent was complete and the consecration was performed, a covenant was signed with the king, represented by viceroy Velasco, in which the monarchy recognized the status that Cortés had conceded to the elders 24 years before. The town, in turn, acknowledged its subjection to the king and the tribute it was bound to pay him.[54]

Some years later, in 1559, Philip II raised the status of the town of Xochimilco, which henceforth bore the title of *Noble Ciudad*:

> "…we hereby make known our favor and will, and command that from this day forth the aforesaid town of Xochimilco shall be called and entitled… the *Noble City* of Xochimilco, and that it shall enjoy the pre-eminences, prerogatives and immunities that are enjoyed and must be enjoyed by the other cities of our above-mentioned Indies".[55]

But the Indian governors of Xochimilco were more concerned by the exactions to which they were subject than the honors recently acquired, and so, in 1563, they sent a letter to Philip II requesting the restitution of the possessions and rights of which they had been despoiled. They argued that Xochimilco was a Crown possession, that they had not offered resistance to Cortés during the conquest and that, on the contrary, they assisted with 2,000 canoes with supplies and 12,000 during the final assault on Tenochtitlan. As for Pedro de Alvarado, their *encomendero*, they had given him the support of 500 men in his conquest of

[54] Pérez Zevallos and Reyes García, 2003: 17.

[55] Juan Manuel Pérez Zevallos, *Xochimilco ayer*, vol. I, Gobierno del Distrito Federal, Del. Xochimilco and Instituto de Investigaciones Históricas Dr. José María Luis Mora, 2003a, Mexico City, p. 55.

Honduras and Guatemala. They had then served in the conquest of Xalisco under Nuño de Guzmán with 600 men and many supplies. Furthermore, of all the Indians who took part in those expeditions, not one had returned; yet, in spite of all that, they had been despoiled of their lands. The governors added that, between the Crown and the Marqués del Valle (i.e. Cortés), not only had they been despoiled of their own lands but also their authority over other towns such as San Agustín (de las Cuevas, i.e. Tlalpan) and that their own local caciques and *macehuales* of Tecpan, Tepetenchi and Olac no longer obeyed them. They added, finally, that at the moment of writing their complaint they were assisting the Spaniards in Mexico City with 3,000 men for buildings, services and agricultural work, in which they were being consumed and suffered ill-treatment; as a result of all this, now only 6,000 or 7,000 men remained of the 30,000 they had been when the Spaniards arrived.[56] These complaints and petitions were futile since the demands for contingents of Indian labor did not cease. For example, in 1584 there were weeks in which over a hundred Indian laborers from Xochimilco were at work on the building of Mexico City's cathedral with the meager wages of to 4 *tomines* per week.[57]

Meanwhile, the village of San Gregorio Atlapulco was beginning to develop. Between 1584 and 1586 a hermitage was built in the *tlaxillacalpan* (neighborhood) of San Luis Tlaxialtemalco. During the following decade this provided a base for twenty-three friars on their way to evangelize the inhabitants of the zone.[58]

In 1603 what had taken place in the neighboring vicinity of San Gregorio half a century earlier repeated itself here in the process of "congregating" its dispersed population. In

[56] Zavala 1987: II, 565.

[57] Zavala 1987: III, 701.

[58] Pérez and Reyes, *op. cit.*, p. 14.

this case, the inhabitants of various nearby settlements were "transported" to the new center in San Luis Tlaxialtemalco and "with sadness went weeping" to set up home in their new abode.[59] The episode is regarded today as the official foundation of San Luis and the start of its relative independence from Atlapulco, to which it had been closely linked and from which it has never managed to separate itself completely.

Silvio Zavala mentions many other cases of the work the indigenous people had to perform for building and other public works in Mexico City during the second half of the sixteenth century and the first half of the following, among them the cathedral, churches, colleges, convents, pavings, bridges and other civil works, including the extraction and cartage of stone and wood.[60] However, all these contributions of almost unpaid labor pale before the demands exacted by the work involved in constructing the main drainage system of the Valley of Mexico between the early seventeenth century and the late eighteenth.

So far we have stressed historical facts relating mainly to Xochimilco and its subject settlements of Atlapulco and Tlaxialtemalco during the first century after the Conquest that had repercussions on the inhabitants of the chinampa territory, which is itself the subject of the present study. It is, however, necessary to broaden the horizon and visualize the whole basin of the Valley of Mexico so as to appreciate the transformations that were to affect the ancient chinampa villages during the seventeenth and eighteenth centuries. The first of these transformations was due to the projects for draining the lakes of the Anáhuac. These works were projected mainly in order to control the risks of flooding of the capital and other settlements in the valley, a situation that presented itself in seasons of particularly abundant

[59] *Ibid.*, p. 11.

[60] Zavala 1987: II, 715-16; III, 290, 424 and 693; 1990: V, Part 1, 122-23; V, Part 2, 826, 838-840 and 884.

rainfall, without considering the effects that changes in the hydrological system might have in the sub-basin as a whole.

The problem of flooding had already affected the Aztecs in 1449 and 1498, and reappeared sporadically in the capital of the Viceroyalty in 1555 and 1579. However, in 1604, an inundation of an even greater magnitude called for serious measures to be taken. These took the form of a project designed by the German Heinrich Martin (Enrico Martínez). A precursory project by Francisco Gudiel of half a century before had identified the problem as lying in the abnormally intense freshets of the Cuautitlán river on the northern lakes of the valley, Xaltocan and Zumpango. These, being at a higher elevation than those of Mexico and Texcoco, were thus more prone to overflow, affecting the more densely populated areas. The solution, glimpsed at by Gudiel and more precisely worked out by Martínez, appeared relatively simple, although not without problems: it would be necessary to cut a pass through the mountains via Nochistongo, in order to drain the northern lakes beyond the valley into the basin of the Tula River. The massive Nochistongo canal succeeded in mitigating the threat without eliminating it completely, since the other part of the problem, the contribution of the lakes of Chalco and Xochimilco, was equally critical.

When excavations were completed in 1611 there were problems because the canal was not lined and was thus prone to landslides, undoing the effect of the works. At the same time, the project had only aimed at draining the excess water from the Cuautitlán river in the northern extreme of the lacustrine zone, and the problems were of a greater scope. Consequently, in 1614, King Fernando III sent out a Dutch expert in canals to study the problem and propose solutions to the Viceroy Diego Fernández. This expert, Adrian Boot, presented a project in 1620, including dikes, canals and pumping systems. He identified the primary source of the problem as being the lakes of the south, but accepted the need to conclude effectively the drainage canal at Huehuetoca towards the north of what is now the Estado de México.

The succeeding Viceroy, Diego Carrillo the Marqués de Gelves consulted both Martínez and Boot, but made the unsouind decision to close the entrance to the canal in 1623 and to rebuild some of the dikes surrounding the capital. The year before, in 1622, the officials of the Viceroyalty had decided to close the sluices at Mexicalcingo in order to prevent the southern lakes from draining into lake Texcoco and the latter in turn flooding the city. The consequence of this was that the Xochimilco-Chalco sub-basin filled to overflowing, flooding the villages and ruining the crops. This unleashed the protest of the chinampa farmers.[61] A short time later, in 1626, the city council or cabildo of Mexico City called on Enrico Martínez and Adrian Boot to analyze the situation of the threatening levels of water in the lakes, particularly that of San Lázaro; and they asked their opinion on whether or not to open the Mexicalcingo sluice to the waters that originated in Xochimilco.[62]

This chain of unfortunate decisions prepared the terrain for the great flood of 1629, for which the blame was laid on Martínez despite the fact that a year earlier he had already proposed that the canal should be lowered and that all the lakes should be drained by gravity. This time the floods lasted for five years forcing its inhabitants to abandon Mexico City until the waters finally receded in 1634. As soon as was feasible, in 1635, the Viceroy, Marqués de Cerralbo, undertook the first measures for recovery, among which were the rehabilitation of the royal aqueduct, which supplied the city with water and had become obstructed. For these works the labor of Indians from the towns and villages of the chinampa zone was once again commandeered. The communities affected were Tulyehualco, Mixquic, San Gregorio Atlapulco, Tecomitl and Tláhuac.[63] After this, in 1637, the rehabilitation of the Nochistongo drainage system was taken in hand, which took six decades to complete.[64]

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[61] Zavala 1990: V, Part 2, 1057-58.

[62] *Ibid.*

As a consequence of the disaster it was necessary to rebuild Mexico City almost in its entirety. Of course, indigenous labor was requisitioned once more for these tasks and much of this was drawn from the chinampa areas, which had also been devastated. To these calamities were added the epidemics and consequent high mortality. These resulted in the reduction of the population of San Gregorio, by 1689, to 400 Indian inhabitants and not a single Spaniard.[65]

Gradually, the city and its chinampa zones recovered, with the eighteenth century marking a new period of prosperity of the Anáhuac, along with that of New Spain as a whole. With prosperity came the influence of the Enlightenment: topographic, hydrological and agronomic knowledge regarding the basin became more precise and thus facilitated the drawing up of more ambitious and better founded projects. In this context, in 1753 Joseph de Páez drew up the Huehuetoca Royal Drainage Plan (*Plan del Real Desagüe*). Later, in 1774, Joaquín Velázquez de León carried out more precise topographic measurements and recommended a canal with a 0.5 percent gradient in order to drain the water from Lake Texcoco out of the basin. The outflow was to be at an elevation of 167 m. (200 *varas*) below that of the lake. Francisco de Garay, the new head officer in charge of drainage, excavated another canal with the name of Guadalupe and a further tunnel in order to disburden the lake of Zumpango, but its effectiveness was somewhat limited. Finally, in 1779, the canal at Nochistongo was opened in its entirety fulfilling the initial purpose of Martínez that the Cuautitlán river should not discharge into Lake Texcoco and its waters be diverted out of the basin.

As we have already indicated, the recurrent efforts to drain the lakes were concentrated in the north of the basin and in Lake Texcoco, while the southern lakes were not directly affected by these projects. At the same time as other parts of the basin were being drained, an extensive system

[63] *Ibid.*: V, Part 1, 192.

[64] Santoyo *et al.*, *op. cit.*, p. 40.

[65] Pérez and Reyes, *op. cit.*, p.14.

of canals was maintained connecting the chinampa zones with the capital and other settlements of the Anáhuac. Although settlements of the sub-basin such as the town of Xochimilco had suffered during the century following the conquest, by this time they had recovered something of their vitality. Agustín de Betancourt sums up the situation of Xochimilco in 1697 in the following description, that could have been written some decades ago:

> The town of Xochimilco is at a distance of four leagues from Mexico City […] on the banks of the fresh-water lagoon, where there are beds of flowers throughout the year in furrows formed of turfs upon the water, that the local people call chinampas, and this was what gave the town its name, Xochimilco being the "seedbed of flowers" […]. It is founded upon the water and has canals on which the canoes pass that serve for the transport of goods required by Mexico City.[66]

This horticultural system in the wetlands of Xochimilco and Chalco had already captured the attention of some scholars during the Viceroyalty, one example being José Antonio Alzate y Ramírez, one of the first to analyze in depth the peculiarities of chinampa cultivation (which will be described in detail in the following chapter). He also underlined the importance of the endemic species of aquatic fauna such as the *axolote* (*Abmystoma mexicanum*).[67] By emphasizing the importance of indigenous knowledge and technology, generally ignored

[66] Juan Manuel Pérez Cevallos, *Xochimilco ayer*, vol. II, Gobierno del Distrito Federal, Del. Xochimilco and Instituto de Investigaciones Históricas Dr. José María Luis Mora, Mexico City, 2003, p.15.

[67] Since 1994, various institutions, headed by the Universidad Autónoma Metropolitana, Unidad Xochimilco, through its Center for Biological and Aquatic Research at Cuemanco (CIBAC) has been working to prevent the disappearance of this native amphibian (Abmystoma mexicanum).

by the formidable scientific development of the Age of Reason, Alzate was also directing criticism against the Euro-centrism that prevailed over the culture of the period.[68]

Hence, after suffering many setbacks, the system of horticulture in the chinampa zone was maintained throughout the colonial period, although in a reduced area. And not only did it survive, but the varieties of crops were enriched. The wealth of autochthonous food crops remained under cultivation: maize, pumpkin, squash, green and red tomatoes, black beans, chilies, *chilacayote* (*Cucurbita ficifolia*), *chayote*, *quelites* (*Amaranthus hybridus* or *Chenopodium album*), *huauzontles* (*Chenopodium nuttalliae*), amaranth and *chia* (*Salvia hispanica*), along with various flowers, such as *cempoaxóchitl* (Mexican marigold). But now those were joined by new species from the old world such as turnip, onion, carrot, lettuce, cabbage, radish, cauliflower, spinach, alfalfa, coriander, celery, cucumber, beetroot, broccoli, peas and mint, and many more species of flowers and garden plants.[69]

Thus, despite the hardships suffered by the chinampa communities in the centuries following the conquest, their production continued to supply Mexico City with food — not only grain, fruit and vegetables but also fish. Hence the symbiotic relation that had been vital to the development of Tenochtitlan continued to be so for the subsistence of the capital

[68] "The customs established by the Indian inhabitants of the lakes of Mexico, and which they have instituted for attaining abundance of food in marshy places, and of which even the most educated nations are in ignorance, are of such utility that it would be a guilty omission in me not to publish the useful knowledge that I have acquired therefrom…", In Gortari, 1988b:26. See also Patricia Aceves Pastrana (ed.), *Periodismo científico en el siglo XVIII: José Antonio Alzate y Ramírez*, Universidad Autónoma Metropolitana Xochimilco, Mexico, City 2001. Cf. Particularly the articles written by Adolfo Olea Franco, "Archivo de Sabiduría Indígena: La aproximación de Alzate a la agricultura", pp. 541-555, and by Porfirio García de León, "El Axolotl: personaje vivo de la historia de la ciencia. De Alzate a la UAM-Xochimilco", pp. 451-469.

[69] Cristiani Beatríz Canabal, Rescate de Xochimilco, Universidad Autónoma Metropolitana, Mexico City, 1991, p. 33.

of the Viceroyalty. In parallel, its inhabitants adopted new crafts that made an important contribution to the economic development of New Spain; among these one might mention carpentry, metalwork, masonry, candle-making, stone carving and the building of canoes; trades that were mainly combined with horticulture.

Throughout the eighteenth century, the diversification of activities in the thriving Xochimilca economy was reflected not only in the supply of foodstuffs, but also of fodder, firewood, building timber and stone. At the same time stability in the levels of lake water enabled an animated flow of commercial traffic to be sustained throughout the year in the canals that communicated Xochimilco with the city. This was noted by Alexander Humboldt in his description of the Valley of Mexico; unlike conditions in Lake Texcoco, where canoes were unable to navigate to the capital during January and February, navigation between Xochimilco and the city was not affected during the dry months.[70]

Thus chinampa agriculture remained central in the history of the Xochimilca and Chalca peoples throughout the colonial period. The reason why chinampa production was able to resist the introduction of European agricultural systems during the Viceroyalty is that these systems were not suited to the topography and conditions of the sub-basin. On the one hand, the zone to the south of Lakes Xochimilco and Chalco is mountainous with few flat surfaces, which made it difficult to find large acreages suitable for plow-based agriculture. On the other hand, the plow was not only unnecessary for cultivating the soft earth of the chinampas, but it was simply not practicable to introduce draft animals onto the narrow, muddy islets, accessible only by punt. As Elisabeth Schilling explains:

[70] See Hira Gortari Rabiela and Regina Hernández Franyuti, *Memorias y encuentros: la Ciudad de México y el Distrito Federal (1824-1928)*, vol. 1, Departamento del Distrito Federal and Instituto de Investigaciones Históricas Dr. José María Luis Mora, Mexico City, 1988, pp. 26-27.

It is for this reason that in the Xochimilco area large haciendas were not developed, but only some small farms, establishments with limited livestock alongside the cultivation of agricultural crops, where the indigenous people remained the principal influence in the formation of the landscape.[71]

Figure 1. Historical Photo of area of chinampas viewed from the heights of Sta. Maria Acalpixca n/d. In the foreground is a transitional zone of milpas. The chinampas can be seen in the middle-ground with some traditional domestic buildings on the left. In the background, low-lying expanse of lands between Sta. Catarina and the Cerro de la Estrella.
Source: Conaculta-INAH, *Memoria de la Ciudad de México, Cien años, 1850-1950*, Conaculta-INAH / Lunwerg Editores, Barcelona, 2004

[71] Schilling, 1938 in Rojas, pp 82-82.

As one might expect, national independence had repercussions on the Xochimilca-Chalca territory, a fact that was reflected principally in modifications to the administrative system. Nonetheless, the structural changes set off by the transition did not occur immediately; some years had to pass for such developments to materialize. Meanwhile, the main problems for the Xochimilcas were the conflicts between the authorities of the *ancien régime* and the liberals, as well as the administration of justice.[72]

Beyond the new political and administrative realities, the Xochimilcas were confronted with a new problem: "the encroachment on natural resources and undermining of the corporative forms of ownership",[73] for both lands and waters began to arouse great interest on the part of the liberal bourgeoisie, as well as the authorities of the city government (since independence in 1826 known as the "Federal District") since, once the limits of the new entity were established, Xochimilco fell under its administrative jurisdiction.

Another factor that rose to importance during that period, and that needs to be stressed, concerns the growth of the population dwelling in the vicinity of the lakes, since it began gradually to upset the hydrological and ecological equilibrium of the wetlands, to the degree that these expanses started to be transformed into drained lands devoted either to human settlement or to rain-fed agriculture and livestock raising. One important consequence of these changes was the formation of the so-called *ciénegas* (swamps) to the north

[72] Héctor C. Hernández Silva, *Xochimilco ayer*, vol. III, Gobierno del Distrito Federal, Del. Xochimilco and Instituto de Investigaciones Históricas Dr. José María Luis Mora, Mexico City, 2003, p. 19.

[73] *Ibid.*, p. 41.

of the chinampa zones: the *ciénega grande* of Xochimilco and that of San Gregorio. The *ciénegas*, being produced by the partial desiccation of the lakes, were regarded as common resources; hence their exploitation ought to be for the benefit of the community. However, as tends to happen, third-party interests appeared: large landowners and businessmen started to bid for control of these expanses of new land.

In spite of century-old efforts to drain the basin, its canals continued to be vital as the principal paths of communication for the transportation of goods and people. In this context it is worth mentioning the inauguration in 1850 of a steamboat line communicating Xochimilco with Mexico City, which made water traffic between both areas even more intense.

Nevertheless, in the final decades of the nineteenth century and the first decade of the twentieth, what was to be the greatest challenge to the survival of the chinampa zone of Xochimilco-Chalco took shape: the appropriation by the growing city of the sources of water that fed the wetlands. By then the metropolitan area of Mexico City was exhausting its own immediate sources of water as a consequence of its territorial expansion and increasing population. For this reason, in 1883, Dr. Antonio Peñafiel carried out a study of the availability of water resources in the Valley of Mexico basin, with the aim of identifying new sources for supplying the city. Peñafiel's conclusion was that:

> No other recourse remains than to introduce water from the large spring of the southern region of the lake of Xochimilco, whose flow is sufficient to provide a populous city such as our capital is to be… Since the springs of that region are the well-founded hope for the conservation of Mexico City, science and government must fix their regard on the general replanting of the woodlands, but especially those

> of the places where the springs are to be found, and on the canals in which excess waters flow [...], since it is a well established scientific principle that woodlands foster regular rainfall, help avoid flooding and maintain the sources of drinking water.[74]

To substantiate this conclusion, Peñafiel maintained that what was at stake was a *surplus* of waters that ended up to no useful purpose in the marshes of Xochimilco and in the canal known as La Viga, so that its use by the city was more than justified. He did not, however, mention that these waters were already being used on a day-to-day basis by the Xochimilcas for the irrigation of their chinampas and other field crops, besides being essential for replenishing the canals and lakes in which various species of fish and wild fowl proliferated; hence the word *surplus* did not reflect the real situation.

Nevertheless, the idea of exploiting the water sources of the Xochimilco-Chalco sub-basin to improve the supply for Mexico City was gaining acceptance. On April 20, 1904, Porfirio Díaz's government published the decree of expropriation of lands of public utility in order to undertake one of the first great infrastructure works of the twentieth century: the Great Aqueduct that was to bring water from the springs of Xochimilco to the nascent metropolis. Construction took place between 1909 and 1914. The work was planned to collect water from the various springs and so transfer some 2,000 liters of water per second through closed ducts with the assistance of four electric pumping stations at La Noria, Nativitas, Santa Cruz Acalpixca and San Luis Tlaxialtemalco. The newly laid out neighborhoods or *colonias* on the fringes of the capital, such as the Condesa and Hipódromo, were the first beneficiaries of these efforts.[75]

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[74] *Ibid.*, pp. 59-60.

[75] Jeannette Porras, *Condesa Hipódromo*, Clío, Mexico City, 2001, p. 77.

At around the same time, the agronomist Miguel Santamaría prepared a very detailed study on the agriculture of the chinampas titled *Las Chinampas del Distrito Federal*.[76] In this work, Santamaría not only described the chinampas and their process of construction, but also the plants grown, the systems de cultivation, and even the tools used by the farmers. He also mentions the fact that chinampa products were transported to Mexico City by means of the punts known as *trajineras* to the quayside at a place known as Jamaica on the southeastern outskirts of the city, where they were bought by traders from the market of La Merced for resale to the public. The study emphasized the uninterrupted productivity of the chinampas and the vigor of the chinampa communities, as well as the solidity of the connections between these communities and the capital.

In 1938, Elizabeth Schilling published an even more extensive and detailed work on Xochimilco including illustrations of chinampas and their mode of use, the pattern of land tenure and even examples of dwellings.[77] Like Santamaría, Schilling mentions the transportation of chinampa produce along the La Viga canal to what was still the edge of the capital at Santa Anita. She also stresses the recreational function of the chinampas for the capital's inhabitants, describing how the main canals offered a different aspect on Sundays and holidays when they filled with little boats decorated with flowers and full of visitors from the capital enjoying the attractive lacustrine environment. Thus one more nexus was added to the symbiotic relation between the metropolis and its chinampas: the chinampa area not only nourished the city, provided opportunities for recreation as well.

[76] Santamaría, *op. cit.*, pp. 41-70.

[77] Schilling, *op. cit.*, pp. 71-98.

Figure 2. Historical photo n/d. Showing what is probably a stretch of the Canal Nacional between Xochimilco and Culhuacán, early twentieth century, with much activity of goods and passenger transport.
Source: Conaculta-INAH, *Memoria de la Ciudad de México, Cien años, 1850-1950*, Conaculta-INAH / Lunwerg Editores, Barcelona, 2004

Figure 3. Historical photo n/d. Showing what is probably the Canal de Caltongo during the first half of the twentieth century with *trajineras* for touristic use. Source: Conaculta-INAH, *Memoria de la Ciudad de México, Cien años, 1850-1950*, Conaculta-INAH / Lunwerg Editores, Barcelona, 2004

Figure 4. Historical photo n/d. Showing the Canal de la Viga in the vicinity of Iztacalco, early twentieth century. Source: Conaculta-INAH, *Memoria de la Ciudad de México, Cien años, 1850-1950*, Conaculta-INAH / Lunwerg Editores, Barcelona, 2004

Twelve years later, in 1950, Robert C. West and Pedro Armillas published an article, "Las Chinampas de México", in which they state that the chinampas: "produce the greater part of the fresh vegetables consumed by the population of the capital of the Republic".[78]

This was in spite of the fact that the now much reduced chinampa zone was in marked decline. Furthermore, by then there were no longer waterways connecting both zones, for the La Viga canal had been transformed into an avenue during the 1930s and 1940s. From then on, produce from Xochimilco was transported to the city by road on trucks or by rail on open trams known as *góndolas*, which were wheeled platforms. The former were the same means of transport which were employed on the country's growing network of highways, facilitating the transport of foodstuffs from more remote areas. Hence, products from farther afield began to compete in the city's markets with those offered by the chinampas.

With the passing years, the diversion of waters from the springs that fed the lakes transformed large extensions of what had been lakes and wetlands into fields suitable only for rain-fed cultivation. In turn, the incessant expansion of the urban area required new lands and eyes began to be set on these desiccated fields as prime land for urban development. Finally, in the last quarter of the twentieth century and the first years of the new millennium the situation became critical. The urban sprawl has continued its expansion towards the chinampa zone, causing a constant rise in land values, thus further stimulating conversion to urban use.

The first attempts to organize the urbanizing tendency began in the early 1980s, when discussions began in the Chamber of Deputies on the possibility of expropriating the whole lacustrine zone and converting it into an "Irrigation District" under government control,

[78] West and Armillas, *op. cit.*, pp. 165-182.

while leading town-planning firms were also busy drawing up luxury touristic projects for the zone. None of these plans came to fruition, but the ground was being prepared for other proposals from the Government side.[79]

The intense seismic activity of September, 1985, that caused such devastation in the central area of Mexico City also had repercussions in the Xochimilco-Chalco sub-basin. In particular there was notable differential subsidence within the sub-basin, causing some areas to flood and draining others. But the greatest impact was perhaps the exodus of families from the damaged central areas to the urban periphery. This accelerated the rate of urbanization in the boroughs of Xochimilco and Tláhuac.[80]

Concerned about the impact of the disaster on the chinampa area, the Federal Government sought the cooperation of the UN Food and Agriculture Organization (FAO) in the implementation of two projects: one was titled "Emergency support for the lacustrine zone inXochimilco-Tláhuac", and the other "Strengthening of the associations of irrigators in Xochimilco-Tláhuac".[81] Both projects were concluded in 1987 and recommended adopting the following essential measures: tripling the capacity of the residual water treatment

[79] Alfonso González Martínez, "Los más recientes planes gubernamentales y el plan alternativo para el rescate ecológico de Xochimilco", in Beatriz Canabal Cristiani, *Rescate de Xochimilco*, Universidad Autónoma Metropolitana Xochimilco, Mexico City, 1991, pp. 37-49.

[80] Patricia Romero Lankao, Eike Duffing and Miriam Rodríguez Armenta, "Tres procesos contradictorios: desarrollo urbano, medio ambiente y políticas públicas durante el siglo XX", in María Eugenia Terrones López, *A la orilla del agua. Política, urbanización y medio ambiente. Historia de Xochimilco en el siglo XX*, Gobierno del Distrito Federal, Delegación Xochimilco and Instituto de Investigaciones Históricas Dr. José María Luis Mora, Mexico City, 2004, pp. 211-250.

[81] *Apoyo de emergencia a la zona lacustre en Xochimilco-Tláhuac and Fortalecimiento a las asociaciones de regadores en Xochimilco-Tláhuac.*

plant at Cerro de la Estrella, from 1.3 to 4 m3/s. in order to supply the chinampa areas; installation of water pipeline and distribution systems, directed at recuperation of the original agricultural system; rehabilitation of 430 hectares of chinampa areas; works of irrigation and drainage in the marshes and lakes under the ejido regime, restoring them from their flooded situation; works of artificial replenishment of the aquifers of the lacustrine zone; and organization of producers and support services.[82]

By then, the government's plans had begun to be formulated under a normative framework that became increasingly complex, as described in Chapter IV below. Thus in 1989 the federal government began procedures for expropriating *ejido* lands in Xochimilco and San Gregorio, and prepared a Ecological Rehabilitation Plan (*Plan de Rescate Ecológico de Xochimilco*) that adopted some of the measures proposed by the FAO. The emphasis was mainly on the construction of regulating reservoirs in the marshes of Xochimilco and Tláhuac, salvaging some of the archeological vestiges and opening new green spaces for recreation for the Mexico City metropolitan area.[83] But this plan was met with skepticism and outright resistance from many *ejido* and chinampa farmers of both administrative districts, who drew up a counter-proposal giving greater importance to the works of hydrological recovery of the chinampa zones and proposing the formation of a Regional Water Council to ensure participation in decision making regarding the rehabilitation plans.

[82] Isabel Cisneros Quiroga, "Programa para la recuperación de la zona lacustre de Xochimilco-Tláhuac", in Beatriz Canabal Cristiani, *op. cit.*, 1991: pp. 25-35.

[83] Canabal, *Ibid.*, pp. 11-23.

Their proposal also underlined that for these rescue works there was no need to expropriate lands but, rather, to seek the consensus of the *ejidatarios* regarding the indispensable works.[84]

As a result of these conflicts, the Ecological Rescue Plan for Xochimico that was finally carried out left pending some of the most controversial measures regarding the scope of the works and changes in land use. Its actions were concentrated in the northwest corner of the old chinampa zone, with the Xochimilco Ecological Park as one of its most visible outcomes.

Irrespective of these limited actions, demographic pressure and the resultant urbanization pressures continue to demand action from the political establishment. And meanwhile, the problems affecting the chinampa zones that still subsist in Xochimilco, San Gregorio Atlapulco, San Luis Tlaxialtemalco, Tláhuac and Mixquic continue to worsen. After several centuries of existence the vigorous symbiotic relation between Mexico City and Xochimilco is gradually being extinguished and the memory of the agricultural system prevalent in the chinampas is at risk of disappearing.

[84] *Ibid.*, pp. 103-105.

III. Chinampa Agriculture: Sustainable Anthropization of a Natural Environment

Ignacio Armillas Gil

Agriculture in Wetlands

Agriculture in wetlands, the cultivation of gardens upon platforms or artificial islands in lakes and marshes, has existed and persists in several parts of the world. In Asia there are still examples of gardens on islets or platforms at various sites, such as Lake Dal in Kashmir, in northern India, or Lake Inle in the southern part of Shan State in Myanmar (Burma). There is also evidence of cultivation of rice and vegetables on rafts floating on rivers in the south of China and the island of Borneo, as well as the use of floating nurseries in Malaysia.[1]

Although these practices in the cases of Lake Dal and Lake Inle, are also described by historical sources, their antiquity is not well attested. One of the few comparative works on the subject alludes to the difficulty of dating their origins with security, but it is evident that in both cases they go back several centuries, and in the case of Kashmir,

[1] Robert C. West and Pedro Armillas, "Las chinampas de México: poesía y realidad de los jardines flotantes", *Cuadernos americanos*, no. 50, Mexico City, 1950, p. 106.

perhaps millennia.[2] Nor do we known with certainty the extension and levels of production of that type of garden produce. Grove, however, also mentions that the city of Srinagar in Kashmir was supplied from the production of the gardens of Lake Dal, and this kind of agriculture is still practiced today.

In Europe a similar practice exists in the lower basin of the river Somme, in the vicinity of the medieval city of Amiens in northern France, where an area of cultivation on long islets known as *hortillonnages* still exists.[3] Apparently the *hortillonnages* go back to Roman times, and it is estimated that their maximum extension may have reached as much as 300 hectares. Nowadays, the area is reduced to some 25 hectares, but the remaining market gardens have continued to function successfully well into the twenty-first century.

In the Andean region, in areas around the shores of Lake Titicaca, the archeologist Alan L. Kolata has documented marshy areas with remains of what seem to be raised fields extending over some 120,000 hectares and which would have supplied the ancient civilizations of the region. Their origins appear to go back three millennia, and that form of agriculture, to whose productive wealth Kolata attributes the emergence and power of the Tiwanaku state, continued to be practiced until the Spanish conquest.[4]

Examples of intensive agricultural production achieved through the topographical modification of wetlands existed in other parts of Mesoamerica too. One of these areas is Lake

[2] David C. Grove, "Floating Garden Agriculture", *The Masterkey*, vol. 39, no. 1, Southwest Museum, Los Angeles, 1965, pp. 23-29.

[3] Paule Roy, *Les Hortillonnages*, Le Courrier Picard / Le Crédit Agricole de la Somme, Amiens, 1981; *Les Hortillonnages: une tradition maraichère*, Axio Communication Amiens, 1991.

[4] Alan P. Kolata, "The Agricultural Foundations of the Tiawanaku State: A View from the Heartland", *American Antiquity*, vol. 51, no. 4, 1986, pp. 748-762.

Pátzcuaro where evidence of canals and raised fields in marshes has been found dating back to the Early Classic period; these were certainly exploited during the Tarasco Empire.[5] There are also indications suggesting the existence of agriculture in raised fields in the central part of the state of Veracruz.[6] But there is no room for doubt that the most extensive area in Mesoamerica where this type of agriculture was practiced was that concentrated in the basin of the Valley of Mexico which is known as agriculture on chinampas or chinampa agriculture.

The presence of agriculture in wetlands in such far-flung regions of the globe should not be interpreted as the result of a process of diffusion from a single point of origin, since it occurs in locations temporally and geographically very far apart. It ought, rather, to be seen as a testimony to the evident advantages offered by this practice in terms of increasing agricultural output and the convergence that occurs in technological solutions under similar levels of development. This point of view is shared by a number of researchers, among them the anthropologist William C. Sturtevant, who visited the chinampa area of Xochimilco in 1960. In 1964, he extended his attention to the practice of horticulture on artificial islands in Lake Inle, Burma and, in 1968, to Lake Dal, Kashmir. Subsequently, he presented a paper on this subject at the Eighth International Congress on Anthropology and Ethnological Sciences in Japan.[7] On the basis of his studies in three localities, Sturtevant concluded that,

[5] Christopher T. Fisher, Helen P. Pollard and Charles Frederick, "Intensive Agriculture and Socio-Political Development in the Lake Patzcuaro Basin, Michoacan, Mexico", *Antiquity*, Sept. 1999.

[6] Alfred H. Siemens, "Oriented Raised Fields in Central Veracruz", *American Antiquity*, vol. 48, no. 1, 1983, pp. 85-102.

[7] William C. Sturtevant, "Agriculture on Artificial Islands in Burma and Elsewhere", in *Proceedings of the Eighth International Congress of Anthropological and Ethnological Sciences*, Science Council of Japan, Tokyo, 3 1968, pp. 11-13.

Figure 5. The *milpas* or maize crops once very numerous in the chinampas, have since become very rare, but can still be found occasionally.

Figure 6. Another native species which is still cultivated: the *chicuarote* chili, much used in traditional dishes of the chinampa districts.

although they were similar practices, agriculture on artificial islands in wetlands arose independently in different places.

Agriculture in wetlands provides excellent yields, since it exploits the characteristic conditions of these ecosystems that combine fertile soils with the constant availability of moisture, hence they are not directly dependent on the pluviometric regime. Nonetheless, their effective exploitation does depend on the development of a agro-hydrological regime that is both adequate and sustainable. The system requires profound knowledge of the local environment and the adoption of a series of specialized agricultural techniques and attentions. But the techniques vary, in turn, depending on geographical time and space. This chapter therefore sets out to describe briefly the particular set of knowledges, techniques and skills that have been, and are, employed in the lakes of the Xochimilco-Chalco subbasin and which make up what is known as chinampa agriculture.

Chinampa agriculture is an excellent example of integral sustainability, since it takes advantage of the physical medium in its entirety, including the flora and fauna present in the wetlands.[8] Until recently, the *chinamperos* exploited the abundant aquatic life —fish, frogs, tortoises and small crustaceans— for their own consumption and when possible to complement their incomes. The domestic fowl, pigs and cattle they raised in their villages could be fed on the grasses and waste products of the chinampas; and their manure and other remains could in turn be used as fertilizer.

The system that has evolved for working the chinampas of the Valley of Mexico is of a traditional and labor-intensive nature. Nevertheless, although ancient, its procedures have evolved over time. The description that follows identifies the main components and

[8] Juan Jiménez-Osornio and Arturo Gómez-Pompa, "Las chinampas mexicanas", *Pensamiento iberoamericano*, no. 12, July-Dec. 1987, Instituto de Cooperación Iberoamericana, Madrid.

techniques that are still employed, or have been employed during the last century. Given the scarcity of knowledge regarding the practices of the pre-Hispanic *chinamperos* it is impossible to establish with certainty the degree to which current traditional practices resemble those in use during the Aztec Empire. Nevertheless, it is worth mentioning that not only is the term *chinampa* derived from Náhuatl, but that the tools used and many of the techniques of cultivation are designated by words of indigenous origin, so that one may infer that chinampa technology also goes back mainly to a period before the conquest.

Construction of the islets

The islets or chinampas are the stage upon which cultivation takes place, and as such are the basic element of this system of agriculture. What is aimed at when constructing a chinampa is to achieve a level surface suitable for cultivation at a sufficient elevation above the surface of the lake so as not to drown the crops, and at the same time close enough for the roots to benefit from the moisture of the soil without having to depend on rainfall or irrigation. The wetlands are ideal for constructing islets of that nature since both of the required elements (fertile earth and abundant water) are already present; hence less effort is required to achieve the desired objective. Under these conditions, creating islets is principally a task of reordering the existing elements of nature. In other words, it is an *anthropization* or humanization of the natural environment.

[9] Teresa Rojas R., Rafael A. Strauss, K. and José Lameiras, *Nuevas noticias sobre las obras hidráulicas prehispánicas y coloniales en el Valle de México*, INAH, Mexico City, 1974.

Figure 7. The dominant orientation of the islets does not prevent some channels from taking exceptional changes of direction, giving rises to triangular remnants.

The anthropologists Ángel Palerm and Eric R. Wolf have classified chinampas in accordance with the technology of their construction as either "inland chinampas" or "in-lake chinampas".[10] The former are those that are constructed on lakeside terrain where the water table more or less reaches the surface. In these cases canals are excavated so that the water penetrates the islets whose surface is maintained above the water surface level. On the other

[10] Ángel Palerm and Erick R. Wolf, *Agricultura y civilización en Mesoamérica*, SEP-Setentas 32, SEP, Mexico City, 1972.

hand, the "in-lake chinampas" are constructed in shallow waters, as seems to have been the case over most of the extension of Lakes Xochimilco and Chalco. In these cases it is necessary to deposit solid material where it is required so as to raise the land above the water level. According to Palerm and Wolf, it is possible that both techniques have been used at one time or another in the lakes and marshes of the Valley of Mexico. Nevertheless, archeological research carried out over the last fifty years,[11] and descriptions of the process of construction provided by observers and researchers during the last century,[12] indicate that the predominant technique in what is now the region of Xochimilco and Chalco was the in-lake method. It is, therefore, this technique that will be described in the following pages.

In his work on the chinampas of the Mexico City, Miguel Santamaría offers a description of the process of construction by elderly *chinamperos* who had raised their own islets.[13] According to that source, the first step was to delimit the area intended to be raised by sinking stakes or planting reeds around the perimeter. This submerged fence is called a *chinamil*.[14] Once the *chinamil* is completed, the material for constructing the chinampa is carted to the site and layers of soil are deposited alternating with strips of what is called *césped* (and

[11] Pedro Armillas, "Gardens on Swamps", *Science*, vol. 174, 12 Nov. 1971, pp. 653-661; William T. Sanders, "The Agricultural History of the Basin of Mexico", Eric R. Wolf (ed.), *The Valley of Mexico. Studies in Pre-Hispanica Ecology and Society*, School of American Research, Santa Fe, New Mexico, 1976, pp. 101-160.

[12] Miguel Santamaría, *Las chinampas del Distrito Federal. Informe rendido al señor director general de Agricultura por el agrónomo Miguel Santamaría*, Secretaría de Fomento, Mexico City, 1912.

[13] *Idem*.

[14] Nahum Hamed García Villanueva (ed.), *Manual de construcción de chinampas*, Manuales de desarrollo sustentable, Instituto Mexicano de Tecnología del Agua, Mexico City, 2004.

other infill materials) until a surface is attained at some 20 to 30 centimeters above the water level.[15] Since the layers of *césped* consist of floating vegetable material, once this has been deposited it has to be made to submerge by accumulating upon it layers of earth and stones. Then once the islet is formed it is covered with a layer of soft fertile soil, and around the perimeter cuttings are planted of the local species of willow, known as *ahuejote* (*Salix Bonplandiana*), at every 4 or 5 meters along the edges. In just a few weeks, the trees will have taken root and the chinampa will have settled sufficiently for it to be worked.

There seem to be variants in the process of filling and in the materials used. In an interesting article on chinampas in the Valley of Mexico, Charles D. Frederick, illustrates profiles of several "fossil" chinampas (that is to say plots long ago abandoned in the dry beds of what were once lakes) excavated by Jeffrey R. Parsons. The stratigraphy varies from one case to another indicating different methods in the infill processes for building up the chinampas; some show a more marked or complex stratigraphy and others less so, which probably indicates that the filling material is not in itself so important and that the material used was simply whatever came most to hand. What was of prime importance was to form a stable and permeable platform, of which the topmost level, which was to sustain the crops, should be of good soil.

[15] The *césped* (literally, "turf") —or, in Náhuatl, *atlapalacatl*— is a floating layer of mixed aquatic vegetation that covers the less transited sections of the canals. R. West and P. Armillas reported different thicknesses of this *césped*, varying from 20 cm to a meter, that could support the weight of persons walking upon it when crossing from one islet to another (see West and Armillas, 1950, p. 107).

[16] Charles D. Frederick, "Chinampa Cultivation in the Basin of Mexico", in Tina L. Thurston and Christopher T. Fischer (eds.), *Seeking a Richer Harvest*, Springer, New York, 2007.

Figure 8. Complete chinampa measuring 12 meters across, bordered by channels and *ahuejotes*.

The long, narrow rectangular form, characteristic of the chinampas, was derived entirely from functional considerations; above all, the elongate form permitted the constant filtration of water, maintaining a uniform natural humidity. An additional advantage, as will be explained below, is that it facilitates irrigation, should this become necessary, and the loading of products for their transport to the markets. The dimensions, especially as regards length, vary, but the form is always long and narrow. The modern chinampa may measure between 6 and 12 meters in breadth, and from 100 to 200 meters in length,[17] but it seems that pre-Columbian islets were narrower and also shorter.

The perimeter trees and the maintenance of the islet

As has been mentioned, the islets are fringed by trees of the willow family (*salicaceae*), known locally as *ahuejotes*, which have been planted in order to consolidate the edges of the chinampa. The variety of willow used is *Salix bonplandiana*. This is a tree native to central Mexico, although its presence has been documented from the southern United States as far south as Guatemala. It is a species common on the banks of moving or standing bodies of water, and is an integral member of the flora of the lacustrine systems of the Valley of Mexico. Consequently, the svelte profiles of these trees dominate the landscape of the chinampas.

The selection of the *ahuejote* is ideal for the purposes of cultivation in the chinampas. Besides being a tree adapted to the environmental conditions characteristic of wetlands, its roots tend to

[17] William T. Sanders, *Tierra y Agua (Soil and Water), A Study of the Ecological Factors in the Development of Meso-American Civilizations*, A Thesis Submitted to the Faculty of Harvard University (digitalized version of the unpublished typescript), 1957, p. 76.

Figure 9. Example of healthy *ahuejotes* with satisfactory spacing.

Figure 10. The roots of the *ahuejotes* interlock preventing the banks, tall and nearly vertical, as in this case, from disintegration. Their tops are almost always covered with grass, which is normally of spontaneous growth.

grow down into the lake bed seeking a firm anchorage there, but they also form wefts that reinforce the structures of the banks of the islets, thus avoiding their collapse. The branches, unlike the roots, do not form interlocking masses, but rather grow tight against the trunks of the trees, so that while not forming broad, bushy crowns that would block out the sun and the rain, they do refresh the heat of the day, projecting a certain amount of shade, absorbing carbon dioxide and producing oxygen. In addition the rows of *ahuejotes* form barriers that reduce the force of the winds. Besides these structural characteristics and environmental benefits, these trees provide firewood for cooking, timber for constructing sheds and other uses. The small branches are used for covering seedbeds, as will be described below.

The process of cultivation

The agricultural process in the chinampas can be divided into several stages: sowing, cultivation, harvest and transport of products to the market. The following section describes each stage in greater detail.

Sowing

Most of the crops planted in the chinampas are germinated first in seedbeds known as *almácigos*. Habitually, the *almácigos* are of long and narrow form, some two meters across, thus facilitating access from the sides to all parts of the surface. A bed of dry vegetable matter is formed as a base and this is covered with a layer of slurry (*agua-lodo*) several centimeters thick. Once the slurry is sufficiently dry, cuts are made laterally and longitudinally to form a continual grid of cubic blocks

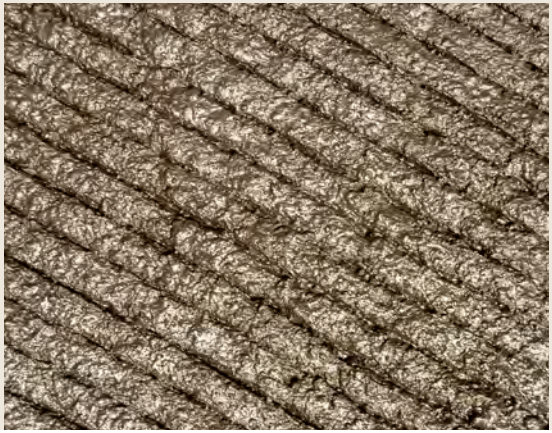
[18] Santamaría, *op. cit.*

called *chapines*, typically from 4 to 6 centimeters across. The dimensions vary in accordance with the type of plant to be cultivated.

In each *chapín* a small hole is made in the center, more or less a centimeter deep, in which several seeds are placed (the number depending on the type of crop) and then covered with fertilizer. Once this operation is complete the *almácigo* is watered again and covered with straw (*zacate*), large leaves and other protecting material, with branches or stones on top in order to avoid the seeds being dispersed by the wind. Covering the seedbed helps to promote germination; it also afford the new plants protection from the birds, the rain and sun, as well as the frosts and hailstorms that are common in the zone during the winter months. Germination is also propitiated by the heat generated by the decomposition of organic material in the slurry and the fertilizing medium (manure or compost). Another function of the covering is to conserve the humidity that evaporates from the *chapines* with the heat of the day, favoring condensation after the setting of the sun. By returning to the *almácigo* a part of the moisture evaporated in the course of the day, the covering reduces the need for watering to maintain humidity.

Once the seedlings have germinated and are sufficiently strong, the protective covering is removed and they are allowed to mature several weeks until their size requires more space. Particular care is given to ensuring that the roots of the plants do not extend beyond the *chapines*, become interpenetrated or anchored in the soil of the chinampa. Meanwhile they are kept moist. When the *chapines* are ready for them to be transplanted, the weakest seedlings are removed from each one, leaving only the best, which explains the purpose of placing initially several seeds in each *chapín*. The *chapines* are then easily separated by hand (since the blocks had been formed from the beginning), and are passed to the definitive plot, spacing them at distances appropriate to each crop.

As the soil of the chinampa is soft and moist, it does not need to be harrowed or plowed before transplanting the *chapines*. The only preparation required is to spread a slurry from the canals in order to renew the fertility and to level the surface. For this process two traditional tools are used: one



is the *cuero* or *zoquimaitl* (a pole approximately five meters in length with a leather bag open at one end in order to lift the slurry from the bottom of the canal) and the other is the rake (this being essentially a wooden board some 20 centimeters wide fixed to a long pole, for leveling the surface). In the past, the *coa* (*huitzoctli*) or wooden planting stick was used for making the holes in which the *chapines* are to be placed. In the modern period the *coa* has been replaced by the grub hoe or mattock.

The use of the *almácigo* offers several advantages: in particular, it permits the intensive use of the surface of the chinampa, a valuable space due to the labor required to construct and maintain it. If the plants were sown directly on the ground where they are to mature, they would have to be situated at appropriate distances to accommodate the size they will finally reach, which means that during the process of germination and the first weeks of growth, when the plant does not need so much space, an excessive surface area would be occupied. But if the seeds are germinated apart in compact seed beds, other crops can meanwhile grow and ripen in the rest of the chinampa. Thus, as crops ripen and space is liberated in the chinampa, their place is taken by the partially developed plants from the *almácigos*.

Figure 11. Process of formation of an *almácigo*: first, mud extracted from the canal bed is spread over a narrow area of earth.

Figure 12. Once the 5 cm layer of mud is dry, it is cut into 5 cm longitudinal strips. The same procedure is then repeated transversally to form a grid of *chapines*.

Figure 13. Once the grid is formed, sowing is started by hand, depositing one or two seeds in each *chapin*.

Figure 14. Seedlings germinating in the *almácigo*.

Figure 15. *Chapín* with a lettuce seedling, ready for planting out in the *chinampa* where it will mature.

Figure 16. Transplanting to the area of growth and harvesting in the chinampa requires manual labor, for which the *chinamperos* are highly qualified.

Another advantage of this method of germination is that it reduces the work of protecting the seedlings during the period of germination and while they are small, which is when they require most care. It is obvious, too, that attending a small area during this period is less laborious than having to protect each plant if these were spread out over the chinampa from the beginning. In recent years the covering of leaves and branches has been replaced by the construction of little greenhouses or micro tunnels with hoops made of branches or metal rods, stuck into the ground and covered with transparent plastic sheets.

At present the use of the *almácigo* also contributes to improving the quality and quantity of the crops. As has already been mentioned, at the moment of transplanting, the *chinampero* weeds out the weakest seedlings from each *chapín* leaving only the most vigorous. And on transplanting the seedlings along with their *chapines* so that they can ripen in the chinampa, the best conditions are obtained for their adaptation to their new

environments, thus ensuring that the whole crop is formed of strong plants, and saving the space that would have been occupied by feeble plants that would fail to yield fruit. In short, a better crop is guaranteed.

The crop

Another common practice in the chinampas, although not exclusive to this type of agriculture, has been polyculture, that is to say the raising of multiple crops in the same space. Traditionally, every

Figure 17. *Chilacayote* ready for harvesting.

chinampa contained various crops that grew together simultaneously. It was habitual, for example, to intercalate maize, beans and pumpkins or squash. Likewise, plants that were germinated in *almácigo*, such as the *tomate* (*tomatillo*, or Mexican green husk tomato) were intercalated with others that were sown directly in the chinampa such as turnip and carrot. Such practices reflect once again the intense use made of the surface of the chinampa. Besides, the special arrangement of different vegetables in polyculture is organized so that each crop receives sunlight in accordance with its needs, which leads to a greater accumulation of biomass.[19]

In recent decades a tendency has been observed to abandon polyculture in favor of monoculture. This is due in part to changes in the system of marketing that has evolved away from daily sales in the market to indirect marketing via intermediaries or wholesalers.

Irrigation

Although the chinampas are designed and constructed to take advantage of the moisture of the canals and reduce the need for irrigation, periods of drought occur in which the water level falls and it is necessary to water the crops. As has already been mentioned the morphology of the islets facilitates this labor. Their narrowness implies that water has to be transported only a minimal distance from the canal to the plant. Traditionally, irrigation was carried out in two ways. The simplest is by splashing the water with oars from a punt. The other is the use of the above-mentioned utensil, the *cuero*. This technique requires the *chinampero* to hold the pole more or less by the center and, standing on the edge of the canal, to submerge the bag in the water and, using the other end of the pole as a lever, to lift the bag, turn and pour the water over the plants. If the islet were too broad neither of these two systems would be practical and the water would have to be carried or carted to the point of irrigation.

[19] S. R. Gliessmann, *Multiple Cropping Systems: a Basis for Developing an Alternative Agriculture*, Mecanuscrito, USCS, 1983.

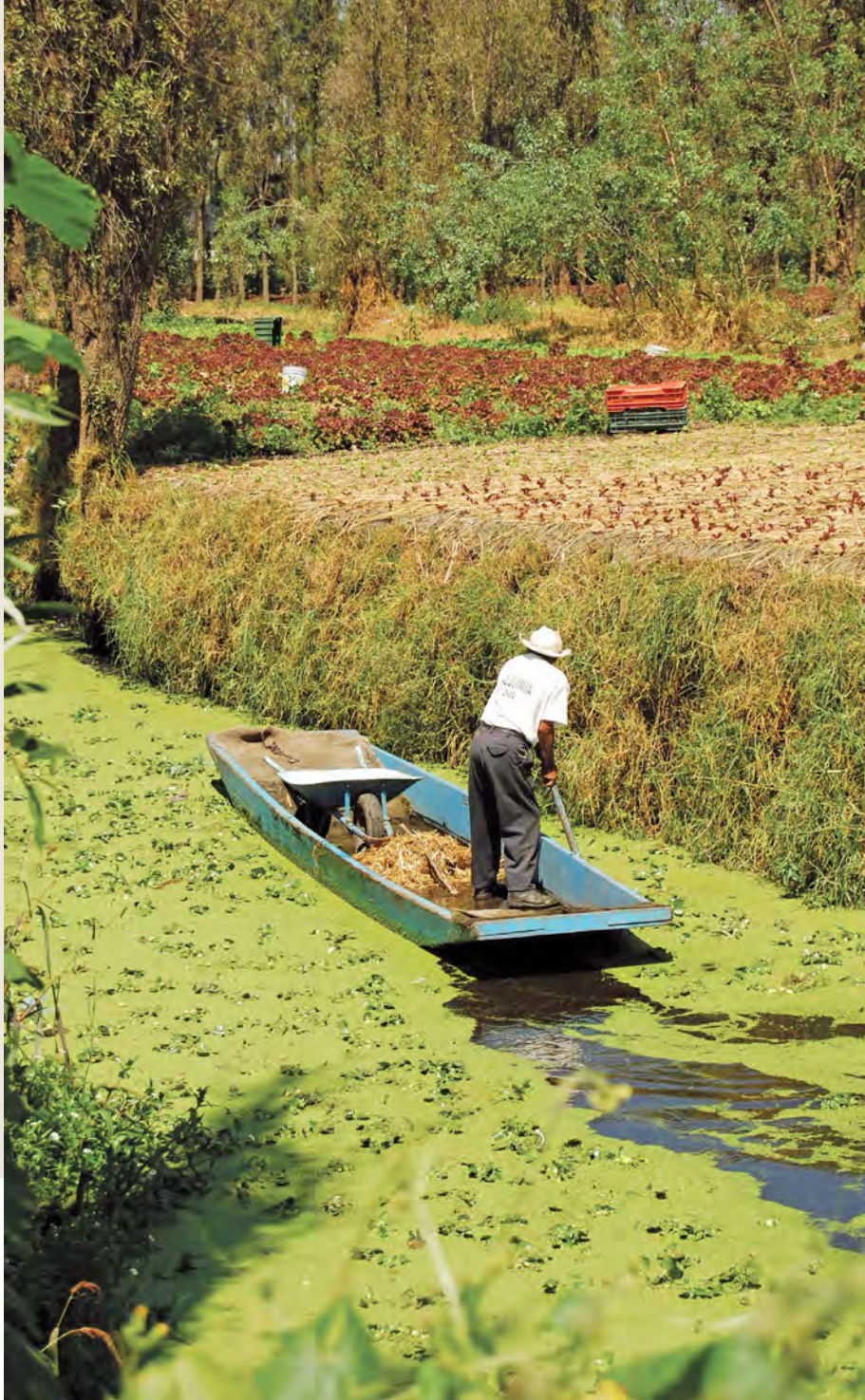


Figure 18. Narrow but still navigable stretch of the Canal Nacional, in the vicinity of San Gregorio Atlapulco. In past times it carried water from the springs of the south of the lacustrine zone and the Amecameca river, which carried the water from the thawing snows of the volcanoes.

This traditional form of irrigation has been almost entirely replaced in recent times by placing a gasoline-operated pump on board a punt which is moved along the side of the canal while the *chinampero* directs the water from the edge of the islet. When two or chinampas are fused given broader areas to be irrigated, tubes and hoses are placed to deliver the water to the parts furthest away from the canals.

The conservation of the environment

Intensive cultivation of any plot, however, fertile, soon leads to the exhaustion of the soil unless measures are taken to regenerate the nutrients. In awareness of this, the *chinamperos* practice crop rotation, on occasions leaving plots fallow, and the organic fertilization of the soil. The main method of fertilization consists in spreading the chinampa with compost, manure and slurry which is dredged from the bottom of the surrounding canals, using for the purpose the same *cuero* used for irrigation.

In addition, when the *chapín* is transplanted, a little fertilizer is placed in the hole in which it is implanted. The amount and type of fertilizer may vary depending on the plant to be cultivated. In pre-Hispanic times the excreta of bats were used for plants that required a strong fertilizer; human excrement, canal slurry and vegetable matter for others. Nowadays animal manure and compost is used, the latter being made up partly of *ahuejote* leaves and aquatic vegetation as a natural fertilizer, for which purpose it is usual to find a compost heap in every chinampa.

Salinization is another problem that sometimes affects the productivity of chinampas if it is not duly attended to. Ironically, the salinity of the soil in chinampas is the result of factors that also favor the high levels of productivity. The most important of these factors is the water that rises to the surface by capillary action thus providing the moisture needed by the crop; this process also draws up salts. The heat of the sun then evaporates the water and

leaves the salts deposited on the surface of the chinampa. The close proximity of the water table to the surface results in poor drainage; thus the salts cannot be washed off naturally. However, the *chinamperos* have learned to deal with this problem. In cases of high salinity the contaminated soil is simply removed and deposited in the *apantles*, as the narrow intermediate canals separating chinampas are known, so that the salts are dissolved in the water. Once the soil has been "washed" it can be salvaged in the form of slurry.

There is another factor that requires a more extensive, community-based effort. This is the control of water levels in the canals. As has already been mentioned, the water level in relation to the surface of the chinampa is a critical factor for sustaining the humidity required by the plants. If the level of the water surface falls beyond a certain level, abundant irrigation becomes necessary; in extreme cases the *apantles* may dry out; on the other hand, when the level rises too much the chinampa may become inundated. However, the level in the lakes fluctuates due to the annual climatological cycles and other factors, such as the fall in the level of the old lake beds relative to their banks (caused by extraction of water from

Figure 19. Navigable *acalote*, without obstructions. In the background improvised greenhouses can be seen that alter the original landscape of the chinampas.

the subsoil). For this reason, the chinampa area requires a certain degree of overall control of water levels. Dikes, sluices and other hydraulic works are necessary to control these levels. The *chinamperos* themselves improvise small dams in the *apantles* with *costaleras*, which are made up of sacks filled with sand in order to retain the water to some extent before it flows to a lower level (in some cases the result of the above-mentioned lake-bed subsidence). The construction, maintenance and control of these works require a more extensive collaboration of the population and, in some cases, the intervention of the state.

The harvest and transportation of products to market

Harvesting, known here simply as *corte* (cutting), is also an entirely manual labor, using nothing more than a knife. For each harvest various cuttings take place, selecting in each case the products that are ready for the market. The narrowness of the islets facilitates harvesting and loading of the product, since the *trajineras* can be placed in the canals, alongside the workers doing the harvesting. Thus the products do not have to be carried long distances before embarkation.

Before the appearance of motorized vehicles, the advantages of aquatic transport were considerable. A *trajinera* driven by one or two oarsmen could transport a considerable load, completing the trajectory between Xochimilco and Tenochtitlan (later on, Mexico City) in four or five hours. The ability to load the merchandise straight from the chinampa onto the *trajinera* and transport it directly to market without the need for reloading or storage in intermediate points represented a considerable saving. To transport the same quantity of foodstuffs by land would have required a greater number of operations with carts and possibly would not have been any quicker.

Even after the introduction of beasts of burden, carts, and the partial drying out of the lakes, aquatic transport between Xochimilco and Mexico City retained advan-

tages over land transport. That is evident from the preservation of canals between the two zones until the third decade of the twentieth century, when the last canal (La Viga) connecting Xochimilco with the terminal of Jamaica in the capital was converted into an avenue. Writing on the transport of merchandise from Xochimilco to Mexico City in 1912, Miguel Santamaría relates how:

> …Transporting was done at night, so as to arrive at the market at the earliest hour of the morning possible. From Xochimilco they leave at ten o'clock in the evening to arrive at Jamaica between two and three in the morning…[20]

Chinampa culture

We can not speak of the productive system without mentioning the essential element that agglutinates the community and maintains the traditions and knowledge, passing them on from generation to generation, the chinampa culture. Its long history is, without doubt, the result of a social organization rooted in the family. According to the historian Sarah L. Cline the family has been the basic unit of social organization in the cultures of the Valley of Mexico since pre-Hispanic times.[21]

[20] Santamaría, *op. cit.*

[21] Susan L. Cline, *Colonial Culhuacan 1580-1600*, University of New Mexico Press, Albuquerque, 1986, p. 257.

Figure 20. The intergenerational transmission of chinampa culture is the best way of guaranteeing its continuing existence.

Although the exploitation of the chinampa is essentially a family business, since all the tasks related to the production and distribution of the product can be carried out by the peasant farmer and his family, the construction of islets required collaboration by the community. William T. Sanders relates being informed in Tláhuac that previously this labor was performed by community groups of mutual assistance. According to the same source, these groups, made up of between four and six men, could raise a chinampa of up to 200 meters long in eight days.[22]

Hence when speaking of safeguarding the chinampas we have to consider the whole complex of factors, both the natural environment and that created by men, including the chinampas themselves, the system of agriculture practiced in them and the peculiar culture that gives it its life and has enabled it to be perpetuated as a sustainable practice through the centuries and down to our own days.

[22] Sanders, *op. cit.*, 1957, p. 257.

IV. International, National and Local Normative Frameworks

Salvador Díaz-Berrio Fernández, Alberto González Pozo and José Gabriel Castro Garza

Figure 21. The chinampa area of San Gregorio Atlapulco seen from the slopes of the hill of the same name. In the foreground, the built-up area of the village, behind, the Ciénega Grande of San Gregorio and urban areas of Iztapalapa and Tláhuac. In the background the Santa Catarina Sierra rises: the watershed that separates the Texcoco and Xochimilco-Chalco sub-basins.

For almost a century the chinampas of Xochimilco have been the subject of declarations and the creation of protected areas, which now enjoy the participation of local, federal and even international agents. It is paradoxical, therefore, that —despite the high esteem in which this territory is held on account of the natural and cultural patrimony that it still represents— it now runs the risk of disappearing unless serious measures are taken to conserve it. This chapter is thus devoted to describing the variety of laws, regulations, guidelines, rulings and plans with legal effects that concern the chinampas. These numerous provisions apply simultaneously, in superimposition, and at in times mutual contradiction, thus causing confusion among the different authorities responsible for administering them. Without intending to provide an exhaustive review, we shall limit ourselves to those elements of the normative framework that refer specifically to the definition of chinampa areas or their closest equivalents as cultural and environmental properties, as well as the importance of cataloguing them as part of the effort to conserve them adequately.

The Convention Concerning the World Cultural and Natural Heritage

The provisions of the 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage[1] which need to be taken into account for their relevance to a catalogue of the chinampas include the following distinction made in Art. 1 between *monuments*, *groups of buildings* and *sites*: together these constitute what the Convention understands as "Cultural Heritage".

[1] UNESCO, Convention concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972.

- *Monuments* refers to works of architectural or monumental art, archeological elements that have an exceptional historic, archeological or scientific value;
- *Groups of buildings* refers to architectural complexes whose integration in the landscape lends them a similar kind of value; and
- *Sites* refers to

> …works of man or the combined works of man and nature, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.

Consequently, for the effects of the Convention, the chinampa zones of Xochimilco and Tláhuac bring together most of the attributes comprised in the concept of *site*, since these constitute an enormous work of collaboration between man and nature and contain within them abundant archeological sites and remains. Likewise, they possess an exceptional universal value from the historical point of view, since they have accompanied, through many centuries (as we have described in Chapter 2), the urban development of the successive metropolises in the Valley of Mexico. They also have undoubted esthetic value, much appreciated by the constant affluence of tourists who visit them. Nor should their ethnological and anthropological value be underestimated, in view of the human ingenuity displayed in the geo-hydrological infrastructure of the chinampa zones and in the systems of high agricultural productivity employed. These are marked by the intensive use of labor, the traditional bonds of the *chinamperos* to these peculiar fields of cultivation, the handing down of methods and systems of production from generation to generation, along with many other ancestral traditions connected to the very existence of the "site". As will be remarked on below, it was the very definition of the "site" that facilitated —nearly twenty years after

the agreement of the Convention in 1972— the formal inclusion of the category of "cultural landscape" among the properties suitable for inscription in the Heritage List.

- Article 4 states that "Each State party to this Convention recognizes that the duty of ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage referred to in Articles 1 and 2 and situated on its territory, belongs primarily to that State". The drawing up of a catalogue of chinampas, therefore, constitutes the first step in that direction since its purpose is to identify them individually.
- Likewise, Article 5 (and its subsection c) states that in order "to ensure that effective and active measures are taken for the protection, conservation and presentation of the cultural and natural heritage situated on its territory, each State Party to this Convention shall endeavor, in so far as possible… to develop scientific and technical studies and research and to work out such operating methods as will make the State capable of counteracting the dangers that threaten its cultural or natural heritage". It is precisely to this endeavor that the present study sets out to contribute.

The Chinampas in the World Heritage List

Mexico participated actively in 1972 to establish within the UNESCO the Convention Concerning the World Cultural and Natural Heritage, but it was not until December, 1983, that the Senate gave its approval to the text of the Convention, and the corresponding Decree was published in January, 1984. Shortly afterwards, the National Anthropology and History Institute (INAH), together with several of its dependent agencies, formulated an initial list of

17 properties that Mexico was to present within a period of five to ten years, in accordance with the procedure determined by the World Heritage Committee. Already by August of the same year, in agreement with the Steering Committee of the Mexican branch of the International Council on Monuments and Sites (ICOMOS) the tentative initial list had grown from 17 to 22 sites and was finally to comprise 27 cultural and natural properties. The result was delivered to the Mexican National Committee for Cooperation with UNESCO (CONALMEX).

Besides the criteria set forth by the Convention for drawing up the Tentative List, the following *desiderata* were set forth:

1) To maintain an equilibrium between elements of natural and cultural heritage.
2) To seek to achieve geographical equity between the various properties so as to take in the greatest possible number of states and to avoid an excessive number of proposals in any one of them.
3) To reflect the diversity of the nation's cultural and natural heritage, taking into account the whole range from paleontological and prehistoric elements to outstanding expressions of the last hundred years (such as the so-called Mexican muralism) and including natural sites, from the deserts of the north to the tropical jungles of the southeast, as well as rare elements of fauna and flora.
4) To favor archeological, architectural and urban complexes —that is to say, "monument zones", as defined in the Federal Law of 1972— rather than isolated buildings or other elements.
5) To give preference to sites that already enjoy legal means of protection, support infrastructure, and management plans already in operation or in the process of formulation.

Figure 22. Here the distance between the water surface and the soil of the chinampa is excessive. The *ahuejotes* are in poor condition and some exogenous species can be seen.

It is important to point out that —following proposals and policies adopted by the INAH since 1984— rather than seeking a selection of *great monuments*, a broader vision was opted for: one contemplating territorial spaces or spheres, in harmony with the concept of *Zones* as defined in the Federal Law on Monuments of 1972, or that of *Natural Reserves* implicit in the environmental legislation then in force. This would reflect the cultural-environmental duality present in many sites of "exceptional" interest (since the concept of "cultural landscapes" had not yet been adopted). This motivated the presentation of dual sites such as Oaxaca-Monte Albán, Mexico-Xochimilco and Puebla-Cholula (the case for Cholula could not be upheld since this had not yet been declared a *monumental zone* from either the archeological or the historical point of view). With these criteria, the Indicative List —that is, the initial list with 27 properties— was received favorably by the UNESCO in late 1985.

In order to determine which sites were deemed suitable for initial presentation with the aim of preparing the corresponding files and forms, an intense effort took place in a Technical Committee appointed by the Mexican National Committee for Cooperation with the UNESCO (CONALMEX), then chaired by the Undersecretary for Culture of the Public Education Ministry (SEP).

Because of the national character of the Commission, a Technical Committee was set up to enjoy the broadest participation possible, involving not only those Institutes of the SEP competent in matters of the cultural heritage (INAH and INBA) and the directorates of the Urban Development and Ecology Ministry (SEDUE) with responsibility over the Natural Heritage and Urban Development, but also bodies devoted to the study of natural properties (such as CONACYT and the National Ecological Institute) and cultural assets (such as ICOMOS), and including the authorities responsible for these matters in the various States of the Republic and Mexico City (formerly "Distrito Federal"), regarding each specific case. The most intense work of this group took place during eleven sessions, from October to November, 1986.

The consequences of the 1985 earthquake had led to considering the inscription of the country's capital on the "World Heritage in Danger" list for rather than on the General List. However, the scale of damage suffered by the cultural and natural properties of Xochimilco and the capital's historic center was not overwhelming, nor did the rehabilitation policies as defined pose a threat to them; hence the decision was taken to present both sites jointly in accordance with the normal procedure.

The World Heritage Committee requests participating states to ensure that the sites they propose for definitive inscription in the World Heritage List have the highest degree of legal protection that each country affords. In the Mexican case, the law applying was that of 1972 and, by the nature of the site, in Xochimilco what was involved was a *Zone* and —in view of its dominant chronological characteristics— it should be considered a *Historic Monuments Zone*, although it also contained important prehistoric elements and some items of interest of recent date.

At the moment when the joint inscription of the Historic Center of Mexico City and the Historic Monuments Zone of Xochimilco was being contemplated, the capital's Historic Center had already received the corresponding official declaration as a Zone of Monuments issued by the Congreso de la Unión (the Federal Parliament) in 1980,[2] but Xochimilco still lacked an equivalent legal status, although the granting of such seemed imminent.

[2] "Zona de Monumentos Históricos de las Delegaciones de Xochimilco, Tláhuac y Milpa Alta", H. Congreso de la Unión, *Diario Oficial de la Federación*, Mexico City, April 11, 1986.

Fortunately this occurred with the eventual declaration of the Historic Monuments Area of the boroughs of Xochimilco, Tláhuac and Milpa Alta.[3]

Another fortunate decision was that taken when initially setting up the study for defining the area of cultural value to be comprised by a site with such special characteristics as that of Xochimilco and its chinampas. This was the inclusion in the Historic Monuments Zone of a large expanse of territory originally occupied by chinampas, as well as the whole group of twelve traditional lakeside towns and villages, including Xochimilco itself. As a result, protection was afforded to a zone close on ninety sq. kilometers, when the urban historical zones of greatest extension declared between 1974 and the writing of this chapter comprise no more than five (Oaxaca) seven (Puebla) eight (Mérida) or —in the case of the Mexico City Historic Center— nine sq. km., this being the most extensive zone in the country after that of Xochimilco, Tláhuac and Milpa Alta, which has a surface area ten times as large.

With this background in mind, it is easier to understand the form adopted by the official proposal for joint inscription of the Historic Center of Mexico City and the Chinampa Zone of Xochimilco, which the Mexican government presented to the World Heritage Committee in December, 1986.

This text of inscription is not transcribed here (since it can be consulted in the website http://whc.unesco.org/en/decisions/3738 of the World Heritage); it is, however, worthwhile to mention the arguments that were employed in order to convince the Committee that at least two of the criteria for validating inscription were satisfied regarding the chinampa areas to the south of the capital and their ancient lakeside settlements. To quote the file relating to *Justification for Inscription in the World Heritage List* as a cultural property:

[3] H. Congreso de la Unión, *Diario Oficial de la Federación*, Mexico City, December 4, 1986.

- The settlements of Mexico City and Xochimilco, built on land won from islets and from the shores of a great lake, enclosed in a broad valley at 2,200 meters above sea level, are an eloquent witness to the creative spirit and the efforts of men and women to form a habitat in a scarcely favorable environment. (criteria i and v)
- The urban layout materialized the fusion of the colonial settlement with the structure of causeways and canals of the pre-Hispanic city that are now only conserved in certain sectors, in particular in Xochimilco. Some ancient *barrios* and towns or villages, in many cases now incorporated in the city of Mexico in its expansion, present traditional establishments, environments and landscapes of exceptional characteristics, as is the case of Xochimilco, still separate from the urban agglomeration. (criterion ii)

Later developments regarding the Convention

As is nowadays recognized, when the Convention was formulated in 1972, its association of cultural and natural properties placed it in a vanguard position; it is also important to remember that in 1986 neither the term nor the concept of *cultural landscape* existed as a criterion for the inscription of sites by the World Heritage Committee; this category was only introduced in 1992; had it existed in 1987 when the inscription of Xochimilco took place it would no doubt have been applied. In the ensuing decades, opinions and doubts have sometimes been expressed regarding the convenience of considering cultural and natural properties together. In keeping, however, with current approaches in the study and practice of urban and spatial planning and a general appreciation of the relations between culture and nature, the decision to maintain the broadest vision has prevailed.

Within the World Heritage Committee itself, difficulties were often experienced for the consideration of sites presented as mixed, or that could be understood as such. This is evidenced by the small proportion of mixed sites that managed to attain recognition during the first twenty years of existence of the List. Out of a total of 552 sites registered from 1978 to 1998, only twenty were of mixed type, representing less than 4% of the total. Ten years later, the List had grown to embrace 660 cultural sites, 160 natural and 25 mixed, which still represented less than 4% (3.78%) of the total of sites inscribed.

The problem arose, in part, from the absence of a definition of this kind of mixed property or site in the text of the Convention, although Article 1 —regarding Cultural Heritage— refers simply to "sites", defined as "works of man or the combined works of nature and man". Mixed sites were generally inscribed under that heading rather than that of "natural sites" (Article 2) given the predominance of the actions of man in generating their "outstanding universal value" over that of nature which figures, rather, as a mere background or frame for human creativity.

From our point of view, most of the sites that Mexico had considered proposing for inscription ought to be regarded as mixed, as seemed obvious in the case of Palenque, and also of Teotihuacan, Oaxaca-Monte Albán and especially, because of the strong presence of the chinampas, Xochimilco.

On the other hand, the concept of "exceptional universal value from the point of view of… natural beauty", that can be attributed to natural sites (Art. 2 of the Convention) was applied only with great difficulty, when the parameters for evaluation of natural sites was based, in accordance with the criteria of the specialists, on scientific aspects related to the flora, the fauna and, on occasions, the geology.

These difficulties led, as a way out of the problem, to the establishment of a new category for the sphere of cultural sites, corresponding to the conception of *cultural landscapes*.

The result was seen rapidly in the configuration of the List, since in only ten years, from 1995 to 2005, the number of sites formally recognized under this heading increased by forty, from thirteen to 53; at the time of writing, they amounted to 65 sites. The fact that such an important kind of site —often under threat of extinction as a result of urban development— could now be inscribed in the List turned out to be positive. At the same time, however, the inclusion of these sites contributed to widening the gap between the numbers of cultural sites and natural sites inscribed in the World Heritage List.

With this increase, the proportion of sites inscribed as Cultural Landscapes came to represent more than 7% of the total of 878 inscriptions accepted so far, and this is without considering those sites that could have been inscribed under that category before 1992, as is the case of Xochimilco. In our opinion it would be convenient if the sites that could have been inscribed as *cultural landscapes* prior to 1992, were to opt now for classification as such, in order both to strengthen the value of their inscription and to afford them an recognition from an additional point of view and a new motive for appreciation. This set of factors would give useful support to the tasks of protection and conservation.

Federal regulations

The stipulation of the Federal Law on Monuments and Archeological, Artistic and Historic Zones[4] that were to have most impact on the methodology adopted for drawing up the catalogue of the chinampas of Xochimilco are the following:

[4] *Ley Federal sobre Monumentos y Zonas Arqueológicos, Artísticos e Históricos*, H. Congreso de la Unión, Diario Oficial de la Federación, May 6, 1972.

- Article 41, which determines that a Historic Monument Zone

> …is an area containing several historic monuments related to a national event or linked to past events of significance for the country,

which could be interpreted as applying to the chinampas since their construction, cultivation and conservation have, in effect, been linked to past events of importance for the country in respect of their indispensable role in the subsistence of its capital; and the *Regulations to the Federal Law on Monuments and Archeological, Artistic and Historic Zones*[5] which also include several articles relevant to the subject of the present study:

- Article 9 of these regulations states that

> …declarations of archeological, artistic and historic zones shall specify the characteristics of the said zones and, where applicable, the conditions to which buildings erected within them must conform.

In this regard, it is worth pointing out that none of the declarations of Historic Monument Zones that have been issued so far, including the one referring to the chinampa zone of Xochimilco and Tláhuac comply with this provision, thus seriously limiting the purposes contemplated by the Law.

[5] Poder Ejecutivo Federal, *Diario Oficial de la Federación*, December 6, 1975.

- Article 19 stipulates the information that must be registered for the purpose of declaring a zone:

> I. The location and boundaries of the zone; II. Its area; III. A list of the monuments comprised in the zone, and —where applicable— the names by which they are known.

However, in the Federal Ruling on the chinampas of Xochimilco-Tláhuac-Milpa Alta no detailed list of such properties appears, but only a general reference to the areas as such.

- Article 28 is also relevant to our purposes. It states:

> In the Public Registry of each of the competent Institutes a catalogue shall be drawn up of the monuments and zones, comprising any documentation that has been required for the purpose of carrying out the corresponding registration, and it shall be continually updated.

For present purposes, the "competent Institute" is that of Anthropology and History (INAH), and the Registry of both monuments and Historic Monument Areas is kept by the National Coordination of Historic Monuments.

It is important now to examine the "Decree declaring a zone of historic monuments in the Boroughs of Xochimilco, Tláhuac and Milpa Alta, Mexico City",[6] since this is the legislative

[6] Poder Ejecutivo Federal; published in the *Diario Oficial de la Federación*, Mexico City, December 4, 1986.

Figure 23. Canoes submerged in the Canal Nacional. Many are left in this way temporally in order to maintain the timber saturated with water and so prevent the joints from opening. When required, they can easily be rehabilitated.

instrument that has had the greatest repercussion on the area of chinampas in the south of the Valley of Mexico. As has already been stated, this is an extensive zone taking in three of Mexico City's local boroughs. Areas of Archeological Monuments that extend across more than one municipality are not uncommon, but it is unusual when the case in hand is a Historical Monument Area. It is worth bearing this in mind since the present research, which began in the Delegation of Xochimilco, was intended to conclude in the other two administrative districts of Tláhuac and Milpa Alta.

Of the thirteen recitals detailing the background of the decree in question it is worth highlighting six that are relevant to the purpose of the present study:

- That the area was the site of the lakes of Xochimilco and Chalco, that have since disappeared. This statement is important, since apparently the zone was defined following, in part, some of the ancient lacustrine shores.

  - That the area, functioning as a system, was the subject of important technical advances, such as the hydrological control of the basin of the Valley of Mexico, by means of dykes, causeways, canals, reservoirs, dams, etc.
  - That the area, functioning as a system, was the subject of important technical, social and economic advances, such as the Chinampa, essential for the subsistence of the historical development of Mexico City, capital of the Republic.

  Of course, this recital is of the utmost importance for the present study.

  - That the area with its abundant aquiferous resources… has provided Mexico City with drinking water.

Passing on now to the articles forming the body of the decree, the following are worth emphasizing:

- Article 2 describes in detail an area with 59 vertices and an extension calculated at 89.65 square kilometers. To begin with, this is the largest area of monuments in the whole country.
- Article 3 is a detailed description of the *specific characteristics of the Historic Monuments Zone* which is the subject of the Declaration. Section a) enumerates nearly 1,400 street blocks in 12 settlements including the administrative centers of Xochimilco and Tláhuac; section b) states that the area includes buildings of historic interest… *plus the corresponding chinampa zone*; and d) enumerates the elements of architectural value in the buildings, but makes no reference to those that give value to the chinampa zone itself.
- Article 4 provides a list of 84 buildings (including religious, civil, domestic constructions, plazas, a landing stage, vestiges of what was once a hacienda and the local stretch of the Porfirian aqueduct with its ventilation chimneys and pump stations, all of this being in the perimeter of the zone; but not one chinampa is identified.

In the same Federal sphere, but with different purposes to those pursued by the legislation on cultural heritage, we should mention the General Law on Ecological Equilibrium and Protection of the environment.[7] This law regulates the provisions of the Mexican Constitution relating to the preservation and restoration of ecological equilibrium, as well as the protec-

[7] Ley General del Equilibrio Ecológico y la Protección al Ambiente, H. Congreso de la Unión, Diario Oficial de la Federación, Mexico City, January 28, 1988.

tion of the environment, in the national territory as a whole and in sea zones over which the nation exercises its sovereignty and jurisdiction. Its provisions aim at fostering sustainable development. The Ministry for the Environment and Natural Resources (SEMARNAT) is the Federal agency responsible for putting into effect the capacities bestowed on it by law in this field; one such capacity originated the creation of a decentralized agency known as the Commission for Protected Natural Areas (CONAMP).

The Protected Natural Areas (PNAS) of Mexico constitute a heterogeneous mixture of ecosystems that each contain part of the country's biological diversity. They are situated in privately or communally owned lands, or in the government-controlled rural areas known as *ejidos*.[8] The decrees identifying and establishing the PNAS arose as a measure for restricting and regulating human activities in such areas in view of the strong pressures to exploit their natural resources, or the spread of human settlements and resulting changes in land use. The legal provisions involved in setting them up include the drawing up of a Management Program for each one as a complementary legal tool of great importance.

This frame of reference forms the basis for the Decree that established the "Protected Natural Area of the Ejidos of Xochimilco and San Gregorio Atlapulco",[9] with an area of 2,657 hectares subject to protection, conservation, improvement, preservation and restoration of its environmental conditions. It is a sui-generis declaration, given that the decreed zone is, more properly, a place that has been anthropized for at least a millennium. Nonetheless, because of the general character of the Law, in which attributions are contemplated for homologous bodies at state levels (in this case that of the Mexico City authorities), the effective action

[8] Translator's note: the term *ejido* refers to lands farmed by peasant farmers who have a family right to succession but where the state is the formal owner. Officially these plots cannot be sold or converted to other uses.

[9] Poder Ejecutivo Federal, *Diario Oficial de la Federación*, Mexico City, May 7 & 11, 1992.

of the SEMARNAT in the zone remains in the second place, subordinate to actions taken by the local authority in the matter, as we shall see further on.

Local legislation

Passing to the local level, it is necessary to mention some provisions of the "Law on Safeguarding the Urban Architectural Heritage of the Distrito Federal"[10] that are also relevant to this study. This is a legislative instrument that has had little practical effect, in the first place because the Cultural Secretariat of the Mexico City Administration that was assigned the responsibility for enforcing it lacks the means and specialized staff for the purpose. The text of the Law makes hardly any reference to Federal competences in the matter, despite including some provisions that apply to the case of the chinampas, as well as initiatives that the City Government might undertake for the purpose of safeguarding them:

- On defining its terms in Article 3, section 1, the Law states that the term Cultural Heritage is to be understood as

  > …the set of tangible and intangible expressions and features that reflect the way in which a human group lives, thinks, feels and relates to its natural environment…

  which is plausible but too general for practical purposes. Section 2 adds that a Cultural Monument is that

[10] Asamblea Legislativa del Distrito Federal, *Gaceta Oficial del Distrito Federal*, Mexico City, April 15, 2000.

> …work of mankind, whether tangible or intangible, or work of nature, in function of the meaning given it by human beings […] in which various singular values are recognized from the point of view of history, esthetics, science or technology, that have made or make it deserving to be the inheritance of future generations…

which corresponds clearly to the nature of the chinampas although without mentioning them expressly.

- Article 7 defines what is to be understood in Mexico City by a Zone of Urban Architectural Heritage, namely:

> …a defined and delimited area representative of the culture and evolution of a human group conformed by architecture and open spaces in a continuous or dispersed unit, whether in an urban or rural environment, whose cohesion and values are recognized from the historical, esthetic, scientific or socio-cultural point of view, that make it deserving of being the inheritance of future generations…

all of which in effect applies to the chinampa zone of Xochimilco-Tláhuac-Milpa Alta. Nevertheless, this approximation is still not sufficient and, indeed, further on, the same Law offers another definition that applies better to the case that concerns us here.

- Article 10 states, in fact, that

> …a monumental open space is a physical environment defined upon urban land, but free of any material covering, delimited, projected and produced by human beings for some specific end, in which one or several values are recognized from the historical,

> esthetic, technological, scientific or socio-cultural point of view so as to make it deserving of being the inheritance of future generations.

This also could apply to the chinampas, except that these are not "defined upon urban land" but, rather, have always been formed upon rural land that has only recently begun to be urbanized.

- Article 11 does, however, indicate that in effect the chinampas and their aquatic environment fall into this category, since it mentions that

> …open monumental spaces, according to their characteristics and uses of origin, can include:… (i). *Acequias*: i.e. ditches by means of which waters are conducted for irrigation or other purposes;… (iv) *Canals*: i.e. artificial channels by means of which water is conducted to an outlet or for diverse uses including vehicular circulation between chinampas;… (v) *Chinampas*: i.e. systems of artificial plots of land of Mesoamerican origin and tradition in the Mexico Valley Basin, separated by canals, in a lacustrine environment of shallow lakes, intended for the cultivation of vegetable species for productive purposes…

As can be seen, despite the ambiguities of the initial definitions, the local Law finally succeeds in defining the chinampas specifically as "monumental open spaces".

- However, in Articles 14 and 15 the Mexico City Legislative Assembly introduced yet another category in this Law. Indeed Article 14 (section 1) mentions the existence of "urban monuments" (*monumentos urbanísticos*), which may include, according to their characteristics:… exemplars of vegetable species, whether trees, shrubs, herbaceous or ground-covering plants…, whereas article 15 (section 1)

considers expressly among Mexico City's "urban monuments": "The species of… *Ahuejote* (*Salix bonplandiana*)…, that is to say the species of tree characteristic of the chinampas which thus also attain the status of an "urban monument".

- The fourth major division (Title IV) of the above mentioned Law contains a number of different articles that refer, using various terms, to declarations, public records, catalogues and centers for information on the urban architectural heritage of what was then called the Distrito Federal. Although they do not mention all the protected cultural properties in detail, they make it clear at least that the intention was to register, catalogue and concentrate information on the characteristics of each one as a first step towards other subsequent actions of protection. For example, Article 48 indicates that

> …The initiative for a property to be declared an architectural or urban monument, a monumental open space or a zone of Architectural Urban Heritage must include the following requisite information: (i) the name by which it is known; (ii) the location; (iii) in the case of an area of Architectural Urban Heritage, the proposal for its delimitation, in both textual description and plans; (iv) the delimitation of its zone of protection, textually and in plans; (v) its classification according to its period of origin; (vi) its typologies according to those established in Title II of this Law; (vii) its description in text, including data regarding its state of deterioration, and photographs; (viii) the justification and legal basis of the proposal; (ix) the definition and listing of its relevant component parts, appurtenances and accessories…

As can be seen, many more requisites than are called for in the cases of a monument or monumental zone under federal law.

- Article 62 includes a curious provision:

> …Such properties or zones that have been declared, whether totally or partially, and have been in existence for one hundred years or more, shall not fail to be liable for inclusion in the Architectural Urban Heritage, except in the case of their ceasing to exist…

  which applies automatically to the case of the chinampas, which have been in existence for many centuries.
- Articles 71-79 form part of Title V, and refer to safeguarding programs and their associated regulations. It is important to mention them since Article 71, which defines the organized set of activities and tasks that constitute a program of safeguarding includes cataloguing among such activities.
- Articles 72-75 sets forth the hierarchy of responsibility for programs between the different levels of local government (the "Distrito Federal", with an overarching responsibility, and its component boroughs or *delegaciones*), and the entities described as "partial", i.e. each particular Architectural-Urbanistic Heritage Zone.
- Article 79, on the other hand, stipulates that the partial programs must include:

> …(iv) the inventory and location of all the buildings and open spaces contained therein by individual lot or property, each being defined by name and official numeration, detailing land use and purpose, date or period of original construction, state of conservation, levels of protection, priority and type of intervention needed, importance, standards of construction, land-use and land-occupation coefficients…

> Not all these characteristics, to be detailed normally in a zone of monuments of urban or semi-rural nature, are relevant to a cataloguing instrument applicable to the case of the chinampas, but most of them are.

If we go on now to examine the legal stipulations applicable at local level regarding environmental aspects, it is necessary to mention the Mexico City Environmental Law,[11] which confers on the city's Environmental Secretariat powers for implementing the provisions established by the Law, among which are the following:

> …(iv) To establish and regulate those protected natural areas under the jurisdiction of the Distrito Federal, as well as managing and keeping watch over those whose administration is assumed under agreement with the Federation, other States or municipalities.

For practical effects, the body in charge of the administration of the PNAs in Mexico City is the General Directorate of the Commission for Natural Resources and Rural Development (*Dirección General de la Comisión de Recursos Naturales y Desarrollo Rural:* DGCORENA), under the jurisdiction of the city's Environmental Secretariat (SMA), which has, among other attributions, that of promoting the establishment and administration of protected natural areas as well as the geographical information system which supports it.

Mexico City's conservation lands still include a series of zones of important environmental value. As has already been mentioned, the disorderly growth of the built up area over conservation zones obliged the city government's authorities to design a set of regulations

[11] "Ley Ambiental del Distrito Federal": Asamblea Legislativa del Distrito Federal, *Gaceta Oficial del Distrito Federal*, January 13, 2000.

that would establish in detail an ecological and environmental zoning that would enable it to regulate rural land use. Thus the General Ecological Regulation Program (*Programa General de Ordenamiento Ecológico del Distrito Federal*: PGOEDF) was established, which contemplates an area of 87,310.80 hectares, 11.72% of which correspond to Xochimilco, and 7.50% to Tláhuac.

In this program different zoning categories were established corresponding to the situations affecting natural resources and zones of primary production. The results thus showed the conservation lands divided into a series of circumscribed areas defined according to the problems detected in each one. These zones were declared as:

a) Special Forestry Protection Zones;
b) Special Forestry Conservation Zones;
c) Agro-ecological Zones;
d) Special Agro-ecological Zones.

The latter category comprises 3.5 percent of conservation land and refers precisely to the surface occupied by the wetlands of Xochimilco and Tláhuac, where agro-productive conditions have degraded along with the landscape. This zone is regarded as priority since it brings together a series of elements of environmental, cultural and historical importance that require a comprehensive strategy for the setting in motion of projects of evaluation and reclamation of the cultural and environmental heritage. This category is oriented towards rehabilitation of soils and finding a solution to the hydraulic problem that exacerbates the process of degradation of the chinampas, canals and *apantles* that characterize this zone.

The next step in this evolution of the regulatory framework was taken in 2004 with the publication of the Protected Natural Area Management Plan for the Ejidos of

Xochimilco and San Gregorio Atlapulco to which we have already referred. Additionally, in order to further the impetus of a policy for environmental conservation and the efficient use of natural resources, and likewise to stimulate agro-ecological activities, the complementary Program of Funding for the Conservation of the Environment and Rural Development (FOCOMDES) and the Integral Program for Employment (PIEPS) were created. That same year the Environmental Law (Norma Ambiental) was published, establishing the conditions for ecological agriculture (NADF-002-RNAT-2002). And the following year, 2005, the Program for Agricultural Production free of Agro-Chemicals was published.

More recently, in January 2008, the Mexico City Law on Sustainable Rural Development was published in the city's Official Gazette; application of this is the responsibility of the Secretariat for Rural Development and Equitableness in the Communities of the Distrito Federal (*Secretaría de Desarrollo Rural y Equidad para las Comunidades del Distrito Federal*: SEDEREC). Among the faculties of this authority is that of implementing a policy of government support for the promotion of agricultural activities, cottage industries and ecotourism.

In accordance with the above, it may be noted that, from the legal and institutional point of view, the chinampa zones of Xochimilco and Tláhuac come under the aegis of a variety of different laws, regulations, programs and institutions. Nonetheless, the need persists to find some inter-institutional mechanism that would facilitate clearer and simpler procedures concerning conservation and restoration as the main axis for decision making where the fostering of productive activities in these zones is concerned.

The recent emphasis in management plans

From what has been stated so far, the various normative and institutional frameworks that seek to protect the chinampa zones of Xochimilco and Tláhuac are not free of limitations, disparities and contradictions regarding their application and respective competencies.

With the intention of overcoming this situation, and as a result of conversations held in 2002 with the Xochimilco local authorities, UNESCO's Delegation in Mexico decided to set up a program aimed at providing technical assistance entitled the "UNESCO-Xochimilco Project",[12] which seeks to lay the bases for an integrating Management Plan, since this was something the World Heritage Committee had been demanding since the beginning of the first decade of the century in order to coordinate all conservation activities in each of the sites inscribed in the World Heritage List.

With the first version of the Management Plan, published in 2006, it became clear that inter-institutional coordination is the key element for overcoming the contradictions referred to above. In the words of the Coordinator:[13]

> …Xochimilco is like a wagon that everyone wants to get moving. They all set about attaching ropes and tugging with all their might and main. The problem is that so far the ropes have been tied to any part whatever of the cart, and this uncoordinated tugging threatens to pull the thing apart, without managing in practice to move it an inch…

[12] Ciro Caraballo Perichi (ed.), *Xochimilco. Un proceso de gestión participativa*, Proyecto UNESCO-Xochimilco, Mexico City, 2006.

[13] *Ibid.*, p. 21.

The first result of this initiative has been the so-called Inter-Institutional Commission; this holds periodic sessions with the participation of the Federal Government, the Mexico City Administration and of the Xochimilco local authorities. The Commission provides a common space for those whose mission is to conserve the cultural heritage or the environment and those involved in promoting economic, social and urban development; hence it is able to foster the advancing of convergent strategies, policies and programs involving the numerous superimposed competences and jurisdictions that exist in the Xochimilco-Tláhuac region. The Commission enjoys, likewise, the active participation of non-governmental organizations interested in conservation, as well as organized and representative groups of civil society that wish to be kept informed of the progress of the Management Plan and to offer their opinions on matters that affect their vital interests.

Part Two

V. Methodological Aspects of the Catalogue Form

Ignacio Armillas Gil and Fernando Roberto Chiapa Sánchez

As the preceding chapters will have made clear, this work sets out to describe the process of cataloguing the chinampas still surviving in a selected zone of the Xochimilco-Chalco sub-basin. These gardens raised on marshland —of ancient origins and still subsisting with a life of their own— were individually identified, located and classified as regards their physical condition and use and their state of conservation. As has also been mentioned —in a context of existing national and international legislation— the cataloguing of cultural properties is an essential prerequisite to the tasks of safeguarding and conservation of these assets. The chinampa itself has been defined as an area of land delimited by bodies of water, normally canals or *apantles* or —in those cases where one or more of the surrounding waterways has dried up or been filled in— by other evidence of their recent existence.

Initially the team considered adopting one of the existing forms for cataloguing cultural properties in use by government authorities. This would have permitted an immediate start of the cataloguing process. So, as an initial procedure, the team set about examining existing model forms in order to evaluate their possible utility for the proposed task.

For example, the Directorate for Cataloguing of the National Coordination of Historic Monuments (CNMH) of the National Anthropology and History Institute (Instituto Nacional

de Antropología e Historia: INAH) kindly made available its National Catalogue Index Form for Historical Monuments with Reference to Gardens, Parks and Plazas. At first sight this form seemed relevant since, in accordance with the Federal Law on Monuments mentioned in the previous chapter, the chinampa zones were officially denominated "Areas of Historic Monuments". The use of this same form offered certain advantages, since it would have facilitated correlation of the results of our work with other studies carried out by that institution; and this would have rendered the corresponding databases compatible. Nevertheless, that possibility was soon ruled out for a number of reasons, the most important being that most of the fields on that form —while undoubtedly relevant to public gardens or squares, even for conventional orchards or market gardens— were scarcely relevant to the peculiarities of the chinampas. Likewise its four page extension made its use, when gathering the various data during *in situ* work in hundreds or thousands of chinampas, unwieldy.

Having rejected that form, and taking into account that the chinampa zones are of pre-Hispanic origin, the compatibility of the form used by the National Archeological Coordination (CNA) of the INAH for cataloguing sites of an archeological nature was assessed, with the idea of adding the catalogue of chinampas to the broader universe of cultural assets already catalogued. Nonetheless it was concluded that, while the genesis of the chinampas took place undeniably in the pre-Hispanic cultures, it is a cultural property of a very particular kind that has been reconfigured several times at different periods, enabling it to conserve its living character and agricultural use until the present day.

Given the peculiarities of the chinampas, none of the available forms turned out to be adequate to permit an immediate start of the cataloguing process. Therefore, once attempts had been exhausted to make use of, or at least to find inspiration in, an existing form, it was decided to opt for a completely new one, conceived specifically for the chinampa landscape.

To this end, two factors of fundamental importance for the design of a form of this nature were borne in mind: rigor in the selection of the aspects to be registered and simplicity as regards their recording in the field. Likewise it was considered desirable to use the same document to include both information gathered in the field and that processed digitally, so as to avoid errors of reference or omission of data during digital input, and so as to make application simpler. For the same reason, it was agreed to integrate the whole of the data on a single form, limiting it to a single sheet of normal US letter size, with fields for completion on both sides.

From the outset, the criterion was maintained that on the front of the form only numerical data would be entered or applicable options ticked. The reverse side would provide room for qualitative observations, insertion of the numerical codes of the photographs included and also space for the drawing of a sketch plan of the chinampa. These criteria were maintained throughout the various modifications made to the data capture form.

As a first step for deciding the contents of the front side of the form, the team prepared a list of essential characteristics or features for referencing and assessment, including location, description and qualification of the state of conservation of each chinampa. These features were to include geographical and dimensional coordinates of the islet and its morphology; presence of canals at its perimeter, including their hierarchy and navigability, dimensions, height of the cultivated land surface over the water level in the canal and the depth of water. Other characteristics to be recorded were land use and methods of production; factors of environmental impact and deterioration; indications of conversion of the plot from purely agricultural to other uses; presence of urban service networks; and finally, conditions of tenure or ownership.

During the two stages of fieldwork, the capture form evolved. A total of eleven versions were tested, evaluated and modified in field and back in the office. The process was

one of gradual evolution; the initial concepts were maintained and the changes centered on details of content rather than the general characteristics of the form.

The most notable modifications introduced during the first stage of the study responded to the fact that the earliest versions included cultural heritage factors, such as the presence of structures or vestiges of a historical, archeological or religious character. These were eliminated as specific fields since it was obvious that we would find few chinampas with these characteristics. Hence it was considered that it would be sufficient to make an annotation in the section of notes along with their identification on the sketch plan, in those cases where such elements were found.

As regards the reverse side of the form, it was decided to include certain additional data fields for completion *in situ*, which once computed would provide information on the state of conservation of each chinampa. Three such boxes were included: two for the factors relating to physical and productive conditions and the third for the sum of both, this being the conservation factor for each islet.

In 2005, once the first phase of the study was completed, it was decided to analyze the efficacy of the form on the basis of the results obtained. The modifications were mainly the product of two review processes: on the one hand, the results of experience in the field obtained during the previous stage; and, on the other, observations gathered during the first *Seminar-Workshop on Safeguarding and Conservation of the Chinampa Areas of Mexico City*, organized by the divisions of Sciences and Arts for Design and Biological and Health Sciences of the UAM-Xochimilco. This took place in June, 2006, and included a field session where over fifty participants were provided with an empty form and invited to fill it out in order to assess their comprehension of the methodology involved in cataloguing, and requesting their comments on it.

Thanks to this experience, the cataloguing form benefited from the observations of individuals from many different disciplinary and institutional spheres. The Seminar was also attended by a number of *chinamperos* whose active participation facilitated the inclusion for consideration of some aspects that could only have been identified from the point of view of people actively involved in the day-to-day practice of the methods and techniques of chinampa agriculture.

From the very beginning it was believed that involving the *chinamperos* in all stages of the work would itself lead to an inestimable strengthening of the results and hence the conservation measures to be implemented for the safeguarding of this particular heritage category. It was for this reason that it was decided to include, among the weekly sessions of the research team following the Seminar-Workshop, several on-site meetings with *chinamperos* who had showed interest in collaborating with the study.

During these meetings the most important contributions by the *chinamperos* to the cataloguing form were those concerning the changing modalities and techniques of cultivation through time. Thus, while cataloguing in the 2005 season was guided by a concern to identify traditional modes of production, when revising the form in 2006, a new focus was adopted with the aim of revealing in greater detail the variety of processes employed by present-day producers in the ongoing cultivation of their chinampas.

In this respect, although the farmers assumed the importance of conserving those ancestral techniques passed down from generation to generation, they were also aware that present conditions affecting the hydrological context of the Xochimilco Basin have made it practically impossible to continue developing farming practice without making certain modifications.

In the light of this situation, it was decided to modify the cataloguing form to reflect an outlook that while valuing the conservation of those ancestral aspects so far conserved

also recognizes others that are surely valid contributions to the ongoing maintenance and re-signification of the chinampa heritage.

Thus, several modifications were included in the form used in the second phase. While space had been allotted during the initial stage for a maximum of eight pairs of coordinates for describing the configuration of each islet, it was soon discovered that, owing to the partial fusion of chinampas or the drying out of the *apantles*, the geometry of some of the islets was more complicated than had been foreseen. Finally boxes were included that enabled as many as eleven pairs of coordinates to be recorded in describing a chinampa.

In addition, in view of the unstable situation regarding the channels, with a tendency to dry out with the consequent fusion of islets —a phenomenon that has recently become more widespread— it was decided that the depth of water in the channels was an important datum that needed to be included in the form.

Consequently, the need was recognized to specify in greater detail the peculiarities of the perimeters of the islets including the type of trees growing and their state of conservation. Hence a specific field was introduced into which all the information regarding the perimeter of the chinampa was introduced, including the situation of the adjacent waterways and the conditions of the banks.

Lastly —and this was perhaps the most important modification on the reverse side of the form— a section was included for inserting a maximum of four photographs denoting relevant aspects of each chinampa. A set of symbols was introduced for including information on the sketch-plans and a field was assigned for the signature of the borough's chief officer authorizing the operation of cataloguing.

Clearly, the criticisms received during the design process of the catalogue form which we have been describing not only contributed to its enrichment in terms of content, but also helped guarantee the opportune and efficient drawing up of plans and of heritage conservation measures.

This process resulted in a significant increase in the number of fields for completion in the form: from the 179 used in the 2005 season to a total of 672 in 2006. This increase of over 200% in the fields for completion in the second version of the form was not necessarily reflected in the volume of data obtained, since many fields relative to coordinates of location, dimensional aspects, characteristics of the canals and the *ahuejotes* were only completed for those polygonal chinampas that had as many as 10 vertices, which were exceptional cases, since normally the chinampas had from 4 to 6 vertices. Nonetheless, there was a moderate increase in certain categories, particularly regarding the presence of pests affecting the *ahuejotes*. Hence, two of the maps published in the present work only show the part relative to the 2006 season, when the perfected form was used in which this kind of deterioration in the leaves could be attested.

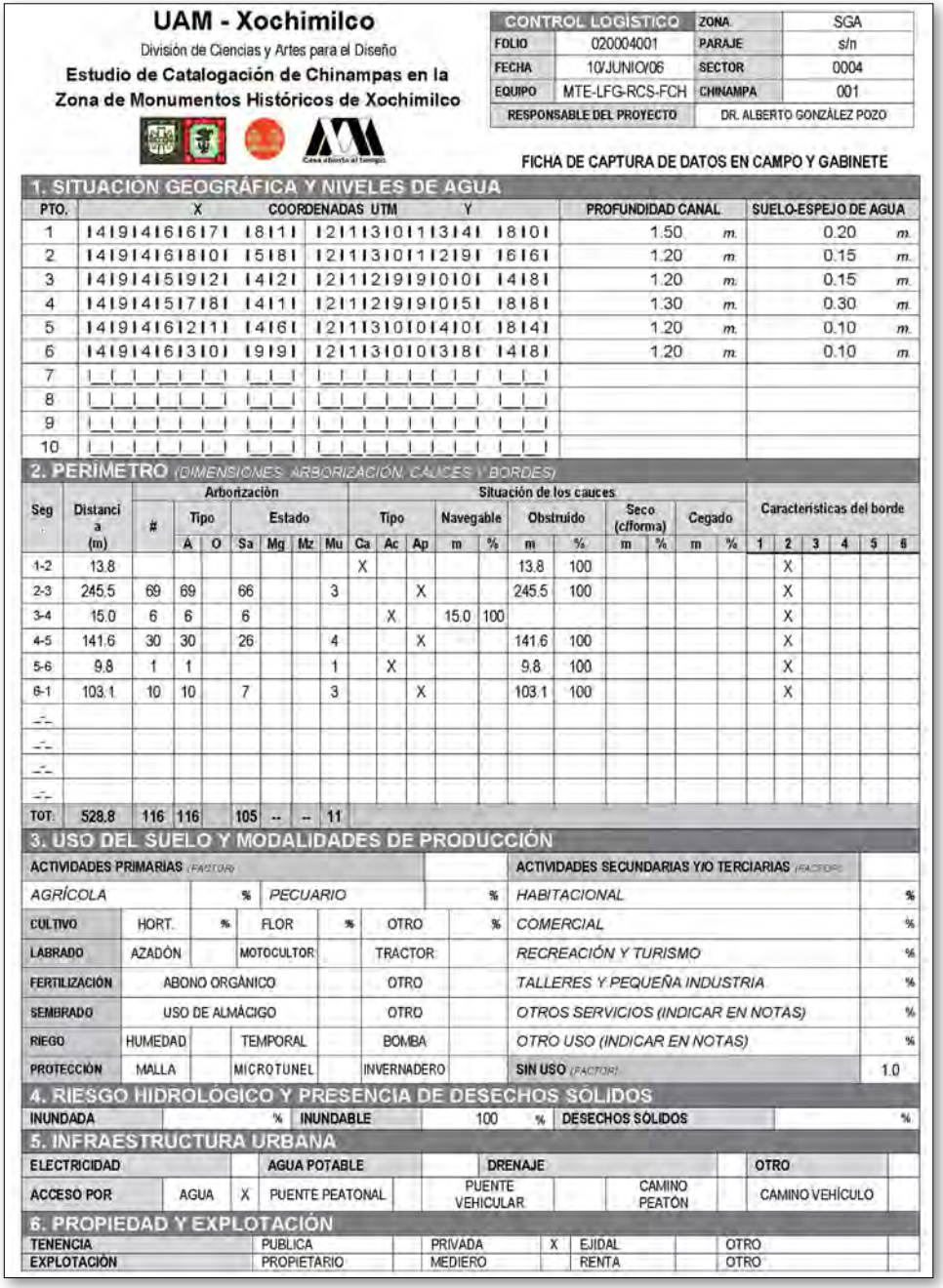
The enrichment of the form between 2005 and 2006 resulted in an appreciable increase in the number of fields available for numerical, percentage, affirmative-negative, qualitative, planimetric and photographic records, as can be appreciated in Table 1.

Once the first stage of the study was complete, a meeting was held with the heads of the National Coordination of Archeology (CNA) and the Historic Monuments section (CNMH) of the INAH, to inform them of the general premises underlying the project and the particularities of the cataloguing form; the study thus received their approval for its continuation. The form was also shown to the Inter-Institutional Commission for the Conservation of the Natural and Cultural Heritage of Milpa Alta, Tlahuac and Xochimilco, made up of representatives of the various agencies of the Federal Government, of the Mexico City Government and the three Boroughs concerned involved, who also expressed their support for the project.

Types of data	2005	2006
Logistic control	6	8
1. Geographical situation and levels	28	350
2. Perimeter	96	258
3. Land use and production	24	27
4. Environmental aspects (risk)	3	3
5. Urban infrastructure	8	9
6. Property and use	8	8
7. Notes	1	1
8. State of conservation	3	3
9. Photographs	1	4
10. Sketch-plan	1	1
Total recto	173	663
Total verso	6	9
Combined totals	179	672

Table 1. Registration fields available in the chinampa catalogue forms for 2005 and 2006

As it was foreseen that several teams would be collecting data simultaneously in the field, a small instruction booklet was designed from the start to guide each cataloguer and ensure homogeneity of criteria. The manual also evolved as the form was modified. Below, a sample form corresponding to the final version used in 2006 is shown, with the captured data already digitalized, followed by the manual for the cataloguer.



UAM - Xochimilco

División de Ciencias y Artes para el Diseño

Estudio de Catalogación de Chinampas en la Zona de Monumentos Históricos de Xochimilco

CONTROL LOGÍSTICO		ZONA	SGA
FOLIO	020004001	PARAJE	s/n
FECHA	10/JUNIO/06	SECTOR	0004
EQUIPO	MTE-LFG-RCS-FCH	CHINAMPA	001
RESPONSABLE DEL PROYECTO		DR. ALBERTO GONZÁLEZ POZO	

FICHA DE CAPTURA DE DATOS EN CAMPO Y GABINETE

1. SITUACIÓN GEOGRÁFICA Y NIVELES DE AGUA

PTO.	COORDENADAS UTM X	COORDENADAS UTM Y	PROFUNDIDAD CANAL	SUELO-ESPEJO DE AGUA
1	14 19 14 16 16 7	18 11	12 11 13 10 11 13 4	18 10	1.50 m.	0.20 m.
2	14 19 14 16 18 10	15 18	12 11 13 10 11 12 9	16 16	1.20 m.	0.15 m.
3	14 19 14 15 19 12	14 12	12 11 12 9 19 10 10	14 18	1.20 m.	0.15 m.
4	14 19 14 15 17 18	14 11	12 11 12 9 19 10 15	18 18	1.30 m.	0.30 m.
5	14 19 14 16 12 11	14 16	12 11 13 10 10 14 10	18 14	1.20 m.	0.10 m.
6	14 19 14 16 13 10	19 19	12 11 13 10 10 13 18	14 18	1.20 m.	0.10 m.
7				
8				
9				
10				

2. PERÍMETRO *(DIMENSIONES, ARBORIZACIÓN, CAUCES Y BORDES)*

Seg.	Distancia (m)	Arborización #	Arborización Tipo A	Arborización Tipo O	Arborización Estado Sa	Arborización Estado Mg	Arborización Estado Mz	Arborización Estado Mu	Situación de los cauces Tipo Ca	Tipo Ac	Tipo Ap	Navegable m	Navegable %	Obstruido m	Obstruido %	Seco (c/forma) m	Seco (c/forma) %	Cegado m	Cegado %	Características del borde 1	2	3	4	5	6
1-2	13.8								X					13.8	100						X				
2-3	245.5	69	69		66			3			X			245.5	100						X				
3-4	15.0	6	6		6					X		15.0	100								X				
4-5	141.6	30	30		26			4			X			141.6	100						X				
5-6	9.8	1	1					1		X				9.8	100						X				
6-1	103.1	10	10		7			3			X			103.1	100						X				
-"-																									
-"-																									
-"-																									
-"-																									
TOT.	528.8	116	116		105	--	--	11																	

3. USO DEL SUELO Y MODALIDADES DE PRODUCCIÓN

ACTIVIDADES PRIMARIAS *(FACTOR)*								ACTIVIDADES SECUNDARIAS Y/O TERCIARIAS *(FACTOR)*	
AGRÍCOLA		%	*PECUARIO*		%			*HABITACIONAL*	%
CULTIVO	HORT.	%	FLOR	%	OTRO		%	*COMERCIAL*	%
LABRADO	AZADÓN		MOTOCULTOR		TRACTOR			*RECREACIÓN Y TURISMO*	%
FERTILIZACIÓN	ABONO ORGÁNICO				OTRO			*TALLERES Y PEQUEÑA INDUSTRIA*	%
SEMBRADO	USO DE ALMÁCIGO				OTRO			*OTROS SERVICIOS (INDICAR EN NOTAS)*	%
RIEGO	HUMEDAD		TEMPORAL		BOMBA			*OTRO USO (INDICAR EN NOTAS)*	%
PROTECCIÓN	MALLA		MICROTUNEL		INVERNADERO			SIN USO *(FACTOR)*	1.0

4. RIESGO HIDROLÓGICO Y PRESENCIA DE DESECHOS SÓLIDOS

INUNDADA	%	INUNDABLE	100 %	DESECHOS SÓLIDOS	%

5. INFRAESTRUCTURA URBANA

ELECTRICIDAD		AGUA POTABLE		DRENAJE		OTRO	
ACCESO POR	AGUA X	PUENTE PEATONAL		PUENTE VEHICULAR		CAMINO PEATÓN	CAMINO VEHÍCULO

6. PROPIEDAD Y EXPLOTACIÓN

TENENCIA	PUBLICA		PRIVADA	X	EJIDAL		OTRO	
EXPLOTACIÓN	PROPIETARIO		MEDIERO		RENTA		OTRO	

Figure 24. Facsimile of the cataloguing form, recto. Contains fields with data identifying location, physical condition, modalities of land use, risk of flooding, presence of infrastructure and type of property and conditions of use.

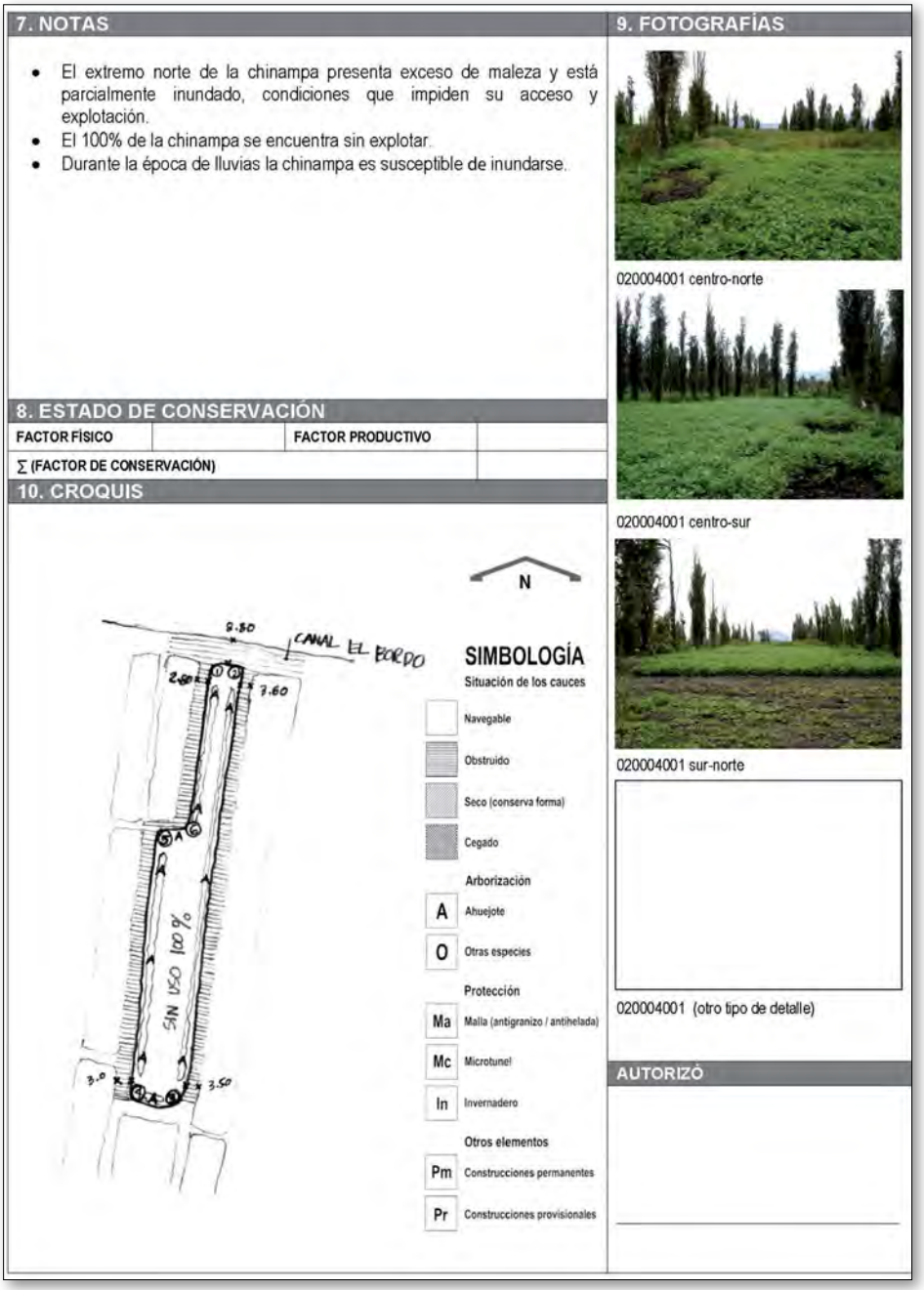


Figure 25. Facsimile of cataloguing form, verso. Contains fields for noting observations, assessing levels of conservation, drawing a sketch-plan of the chinampa, appending up to 4 photos and a field for official authorization.

MANUAL FOR THE USE OF THE FORM FOR *IN SITU* RECORDING OF DATA

Cataloguing Study of Chinampas: Historic Monuments Zone of Xochimilco

(FRONT)

FOLIO. Numeral resulting from the conjunction of the digits specifying: zone (two digits), sector (four digits) and chinampa (three digits).
FECHA. Note the date of capture.
EQUIPO. Note the initials of the team members.
ZONA. Note the zone key, three letters:

01. **XOC** = Xochimilco.
02. **SGA** = San Gregorio Atlapulco.
03. **SLT** = San Luis Tlaxialtemalco.

PARAJE. Note the name of the locality to which the chinampa belongs.
SECTOR. Note the sector number: four digits 0001.
CHINAMPA. Note the chinampa number: three digits 001.

1. GEOGRAPHICAL SITUATION AND WATER LEVELS.

COORDINATES. Note UTM ("Universal Transverse Mercator" Projection System), X and Y coordinates provided by the Global Positioning System (GPS) and ratified by means of a geographical information system, for each point of the plot; generally four. There is space for ten points, if more are required, the additional points are specified in the notes section. Data capturing begins at the northwest point.
DEPTH OF THE CANAL. Measure (with an oar or a reed) the distance between the water surface and the bed of the canal, and note it in meters.
GROUND TO WATER SURFACE. Measure and note the distance between the ground level of the chinampa and that of the water surface with relation to each point. (If the point in question is at a position already underwater, but another point can be found nearby, take the latter and mark it on the sketch plan).

2. PERIMETER. (DIMENSIONS, PRESENCE OF TREES, CHANNELS AND BANKS)

Seg. (SEGMENT) A pair of numbers identifies each segment. From point one to two, two to three, three to four and four to one in the case of a regular polygon. If there are more points the procedure will continue four to five, and so on until the polygon is completed.
Distance. Note the distance between pairs of points sequentially in meters.

TREES.
#. (NUMBER OF TREES) Not the number of trees along each segment.
Type. (TYPE OF SPECIES) Specify the number of *ahuejotes* (A) and of other species (O) along the segment.

Figure 26. Translation of first page of manual for the completion of the cataloguing form. This contains the instructions for assigning the reference code and specifying the location.

State. (STATE OF THE TREES) Note the number of trees that are healthy (Sa), infected with *muérdago* (Mg), attacked by *malacosoma* caterpillar (Mz) and those that are already dead (Mu).

SITUATION OF THE CHANNELS.
Type. (TYPE OF CHANNEL) Note whether the characteristics of the channel correspond to those of a canal (element of interregional connection), to those of an *acalote* (element of inter-sectoral connection) or to those of an *apantle* or ditch (element of connection between chinampas). Note even if it is already blocked but its recent existence is evidenced by vestiges. (trees, form and continuity with the contextual layout).
Navigable. If conditions permit navigation, measure that stretch in situ and obtain a percentage as regards the side where it exists.
Obstructed. This refers to obstruction of the channel by organic or inorganic matter; measure *in situ* and obtain percentage.
Dry, conserving form. This refers to the total loss of water from the channel, conserving only ditch defined by its banks; measure *in situ* and obtain percentage.
Obliterated. This refers to the total disappearance of the channel. In this case the indicator enabling it to be identified is generally constituted by the presence of vestiges. (trees, its form, and other characteristics proper to the layout).

CHARACTERISTICS OF THE BANKS.
Mark the box corresponding to the situation of the margins of each segment with regard to the following conditions:

1. Without apparent alterations.
2. With excess of weeds.
3. Eroded or crumbling.
4. Mixed reinforcement (done by the *chinamperos* themselves with sandbags, mesh, stakes, etc.)
5. Special reinforcement (Local Authority Program for Restoration of Chinampa Margins).
6. Without margins.

3. LAND USE AND PRODUCTION METHODS.

PRIMARY ACTIVITIES. Note the factor of TOTAL surface area of the chinampa that is devoted to this use. (Example: 0.8 for 80%).
Agricultural. Percentage of the factor of primary activities devoted to this activity.
Livestock. Percentage of the factor of primary activities devoted to this activity.
SECONDARY AND/OR TERTIARY ACTIVITIES. Note the factor of the TOTAL area of the chinampa devoted to this activity. (Example: 0.5 for 50%).
Dwelling, Commercial, Recreation and Tourism, Workshops and Small-Scale Industry. Percentage of the factor of secondary and/or tertiary activities devoted to this activity.
Other services and Other use. Percentage of the factor of secondary and/or tertiary activities devoted to this activity. Specify in notes.

UNUSED. Note the factor of the TOTAL area of the chinampa which is unused. (Example: 0.2 for 20%).

PRODUCTION METHODS.
Crops. Note the percentage of the TOTAL area of the chinampa which is devoted to cultivation of vegetables, flowers or other crops.

Figure 27. Second page of the manual, containing instructions for determining features pertaining to the trees, the situation of the channels and their banks, and part of the section on modalities regarding land use.

Tillage. Mark the box referring to the predominant methods used to prepare the soil (mattock, two-wheel tractor or tractor). In the case of mixed methods mark the corresponding boxes.
Fertilization. Mark whether the chinampa is cultivated using organic fertilizers (water lily, residues of previous harvests, manure, etc.) or other types of fertilizers, including agrochemical products.
Sowing/Planting. Indicate whether the *almácigo* technique or some other method of planting is used. Obtain surface dimensions and specify in sketch plan.
Irrigation. Mark the corresponding box for the predominant method of irrigation. That for "Humidity /Ground moisture" should be reserved for those cases in which the chinampa is narrow and situated between two canals and the distance between its ground level and the water surface does not exceed 40 cm. "Pump" will be marked when the *chinampero* uses simple pumping appliances (gasoline-driven pump mounted on canoe) to extract water from the canal, to conduct it by hosepipe to a distributor tube on the chinampa. "Seasonal" will be reserved for the large or high chinampas that lack these means and depend exclusively on seasonal rainfall. In the case of mixed methodology mark the corresponding boxes.
Protection. Indicate whether the cultivation of the chinampa is protected by mesh (anti-hail or anti-frost), *microtunnel* (generally for the *almácigos*) and glasshouse. In the case of mixed methods mark the corresponding boxes and specify on sketch plan.

4. HYDROLOGICAL RISK AND PRESENCE OF SOLID WASTES.

Inundated. Indicate the percentage of the total area of the chinampa under water. Specify on sketch plan.
Subject to flooding. Indicate the percentage of the total area of the chinampa that is subject to inundation. Specify on sketch plan.
Solid wastes. Indicate the percentage of the total area of the chinampa that is invaded by solid wastes. Specify in notes and on sketch plan.

5. URBAN INFRASTRUCTURE.

Electricity. Mark whether the chinampa disposes of electrical infrastructure. Specify on sketch plan.
Drinking water. Mark whether the chinampa is connected to drinking water network. Specify on sketch plan.
Drainage. Mark whether the chinampa is connected to drainage network. Specify on sketch plan.
Means of access. Mark the modes of access to the chinampa. If mixed, mark the corresponding boxes and specify on sketch plan.

6. PROPERTY AND USE.

Property. Indicate conditions regarding landholding. Specify in notes.
Conditions of use. Indicate the conditions under which the land is farmed. Specify in notes.

(REVERSE)

7. NOTES. This section specifies relevant information that could not be summarized in the various sections comprised in the form.

Figure 28. The third page concludes the instructions for identifying the modalities of land use, hydrological risk, elements of urban infrastructure and the characteristics of ownership and terms of exploitation of the chinampa.

8. STATE OF CONSERVATION. This refers to the obtaining of a factor, product of the sum of that obtained from the physical and productive conditions; both result from the statistical treatment of the data by computer.

9. PHOTOGRAPHS. Note beneath each photograph the corresponding numerical key. There is room for four images. As a general rule two photographs will be taken from specific points depending on the orientation. If it proves necessary to show other relevant elements, an image will be taken and the situation it represents indicated. Examples: 020004001 north-south, 020004001 store.

10. SKETCH PLAN. Draw a sketch map of the chinampa indicating the relevant elements it contains. Use the symbols indicated. (Points of the perimeter, situation of the channels, location of *ahuejotes* and other species of trees, methods of protection of the crops, means of access, types of constructions, etc.)

Figure 29. The fourth and last page of the manual contains instructions for completing the fields relating to the state of conservation, appending representative photos and drawing a sketch plan of the catalogued chinampa.

VI. The Recording of Data in the Field

Fernando Roberto Chiapa Sánchez, Benigno Ángeles Escamilla and Manuel Montaño Pedraza

Each of the two fieldwork seasons began with a series of preparations. First an agreed version of the cataloguing form had to be established, and once that was achieved the selection and delimitation of the area to be covered was taken in hand. Then, attention had to be given to the material, human and logistical preparations for starting the work. Once the work on site was finally underway, practical problems began to emerge involving the gathering of information that would have to be resolved in the field: exceptional aspects or unexpected limitations that would require an individual approach. In this process the work of the team members was decisive, but to the help received by all from the *chinamperos* was also indispensable This chapter gives an account of these details.

1. Selection and delimitation of the zones studied

From the start it was clear that the study should begin at San Gregorio Atlapulco, because on previous visits it had already been observed that, despite the transformations of the twentieth century, this was the area where the original features of the chinampa system are best preserved. In the 2005 season the major problem was to select within the chinampa zone of San Gregorio a surface that could be covered with the resources and time available,

taking into account the immensity of the entire area — more than 300 hectares. Hence initially we opted to cover an area of 17.82 hectares, with a sufficient number of chinampas to test the effectiveness of the catalogue form we had designed. We ascertained that the area to be covered would be delimited clearly by navigable canals, and thus an area situated to the south of the confluence of the El Bordo and San Sebastián canals, beyond which the swamp or "lagoon" of San Gregorio begins, which is a level plain that is periodically flooded, especially in the rainy season. At the other extreme of this elongated zone is the Canal Nacional, an important waterway beyond which the settlement of San Gregorio gradually begins.

This initial decision had repercussions on that taken the following year, when we decided on the possible extent of cataloguing during 2006, since it was decided to proceed towards the west from the zone already studied. Since little time needed to be wasted in adjustments to the cataloguing form, and the experience already obtained enabled us to work faster now, in the second season we were able to delimit an area of 75.74 hectares, still between the Canal del Bordo and the Canal Nacional.

In both cases maps or plans were lacking with which to situate the chinampas with precision. The local Borough authorities only possessed some rather imprecise plans of the main canal network; otherwise we would have to rely on a digitalized cartography of the entire Distrito Federal that existed in the Centro Universitario de Estudios Metropolitanos (CUEM) of the UAM. Alternative resources included orthophotographs obtained between 1985 and 1994 in the possession of the Xochimilco Borough authorities, and various other items that could be digitalized and built up into a mosaic. There were, for example, georeferenced and digitalized aerial photogrammetric surveys of the south of the Distrito Federal, obtained in 2002, and one more from 2005 that was only available to us in late 2006. All these cartographic supports were certainly useful and offered a somewhat approximate panorama of the situation of many of the chinampas and the canals surrounding them, although a significant percentage of those details had to be verified in situ for a number of reasons:

firstly because some chinampas that appeared to be very big in the aerial photos were in fact the results of processes of aggregation of two or more chinampas; secondly because not all the features that appeared to be waterways were in fact what they seemed but were, rather, just dry ditches or footpaths; and thirdly because while the aerial photos showed clearly the rows of *ahuejotes* flanking each chinampa when the trees were situated a few meters apart or their foliage was thick, the clarity was lost when only a few remained standing or when just a few trunks crowned with dry branches attested to their recent existence.

We were also able to use a set of aerial photographs at 1:10,000 scale, provided by one of the three principal researchers of the team; Ignacio Armillas' father, Dr. Pedro Armillas, had used these for his research in the area during the 1960s. For our work in 2005 and 2006 they were invaluable for establishing beyond doubt the changes that had taken place in some places, particularly those that were flooded from the 1980s onwards.

What soon became clear was that, at the start, we would not have at our disposal a real cartography of the chinampa zone, with all its features, and that the only dependable map or plan would be that obtained as a result of the work of cataloguing itself.

2. Preparations and distribution of tasks

The first visits to the area of study in 2005 were agreed on with José Luis Reyes Rodríguez, the Xochimilco Borough's Director for Rural Development, who authorized logistic support for the transport of the work teams to the chinampas, as well as the active participation of officers under his authority, principally the biologist Cuauhtémoc Peralta, who took us to the selected area and spoke to some of the *chinamperos* in order to explain to them the reason for our presence. In the 2006 season, a similar introductory process took place, but reduced to a minimum since we were already familiarized with both the selected zone and the *chinamperos*.

Figure 30. Fernando Chiapa and Gerardo Feijoo learning to handle a canoe.

Figure 31. Mereguildo Toledo crossing a bridge over an *acalote*.

The preparations for both seasons also included the acquisition of equipment ranging from such elementary items as tape measures and clipboards for filling out the forms to handheld digital GPS devices and cameras for taking photographs of each chinampa. In 2005, some minor incidents had taken place (almost all the members of the team had received the "baptism" of slipping and falling into an *apantle*); and, since in 2006 we planned to make incursions into flooded (or saturated) chinampas, we also acquired clothing more appropriate for these purposes: waterproof overalls and Wellington boots.

In both seasons the tasks were distributed between several teams working simultaneously, each consisting of three or four participants with professional training in different fields (basically architects and environmental planners, as well as a sociologist). In 2005 three teams were formed, each for cataloguing a sector containing an average of 35 chinampas. This task took four months, since the first six months had been taken up in the design and adjustment of the form and the necessary preparations. For 2006, on the other hand, although it was also necessary to perfect the catalogue form, less time was lost in preparations in general and a period of more than six months was available for fieldwork; hence four teams were set up, which enabled a further six sectors to be catalogued, completing the ten sectors analyzed.

Each of the fieldwork teams was headed by a coordinator assisted by two or three other members. The names of the participants have already been recorded in the Introduction, so we shall only

Figure 32. Brigade assigned to cata-logue sector 4 formed by Mereguildo Toledo, Fernando Chiapa, Gerardo Feijoo and Rogelio Canto.

mention here that some teams changed coordinators in the second season, that sometimes a team finished work in its sector early and went on to help others complete theirs, and that all teams participated in the last of the ten sectors analyzed in 2006. Thanks to a prevailing spirit of comradeship and the ambition to complete the work satisfactorily, many obstacles were overcome, making up for time lost through bad weather conditions and other problems normal to a task of this nature. In any case, as experience was gathered, the work of cataloguing showed a notable increase in productivity, and there is every reason to suppose that this could be increased even further.

Once the sectors had been defined and the work allotted among the different teams, the next stage was the timetabling of the work of data gathering in the field. Each team planned on a weekly basis the group of chinampas it would visit, attempting to situate them against some of the available photogrammetric images.

3. Peculiarities of the *in situ* research

In general terms, access to the south and central sectors of that same zone did not present difficulties since most of the chinampas were at a distance of half a kilometer or less from the built-up area and

one could get to almost all of them by footpaths and provisional bridges (not much more than a plank or a beam across an *apantle*). However, from the center to the northern edge of the zone, in chinampas that could be at a kilometer or further from the urban zone, conditions of mobility were difficult because nearly all the islets were surrounded by *acalotes* or *apantles* of greater depth without any means of crossing, however provisional. They could only be reached on board small flat-bottomed canoes or *trajineras*. At first, the *chinamperos* themselves took us to the islets, but then, once we had finished our work, we had to wait for them to come back. Hence we gradually learned to use those fragile craft that were lent us on a temporary basis by local people who had got to know us and were pleased to help.

Once present on a chinampa we had to identify its northwest corner, since the idea was always to proceed from that point, following the borders of the chinampa in a clockwise direction. The information previously gathered regarding that point by means of the techniques of aerial photo interpretation and geo-reference was verified with the manual satellite geo-positioner and the reading obtained was noted on the form expressed in terms of UTM (Universal Transverse Mercator) geographical coordinates. The pocket size and light weight of these instruments made them ideal for use in the field, but their precision is only approximate, having a margin of error of ± 4 m. The problem resides in the number of satellites they are linked to and the quality of the signal those satellites emit, besides the waiting time required at each of the points to be identified. As the latter inconvenience had slowed down much of the fieldwork, a mixed technique was adopted consisting in limiting the GPS reading only to the starting vertex of each chinampa; this enabled us to locate that point in the digitalized photogrammetric survey, and to read directly in the latter the coordinates of the remaining places, as long as they coincided in the longitudes and alterations of direction observed in the field, where such existed.

Then, between two members of the team, the lengths of each one of the sides of the quadrangle (or polygon in some cases) were measured with a surveyor's tape, while another member drew up the sketch plan of the chinampa and the crops within it, took photos and noted particular details in box seven of the form.

The data referring to the characteristics of the watercourses were obtained using other techniques. First the channels were classified by size as (i) *canals*, which are means of inter-regional communication and have a breadth of over 6 m (there are only three of these — the Canal del Bordo, the San Sebastián, and the Nacional); (ii) *acalotes* (of lesser breadth, between 4 and 6 meters), and (iii) or *apantles* (from 2 to 4 meters, allowing only for service to the *chinampas*). Once the watercourses and their conditions of navigability had been identified, the second step was to obtain measurements concerning the water levels in each of the channels surrounding the chinampa: its depth and the distance between the water surface and the ground level of the chinampa. For this purpose a hardwood instrument known as a *remo* or *carrizo* was used, of 2.5 to 3 meters in length; this is in fact an oar used by the *chinamperos* for steering and propelling their canoes when navigating along the canals. To make the measurements it was necessary to board of one of these vessels and, on reaching each point of crossing or change of direction of the canals surrounding the chinampa, the oar was submerged until touching the bottom of the lake bed. It was then withdrawn from the water and the length of the part that had been submerged was measured with a tape measure. For gauging the height of the chinampa above the water surface the oar proved equally useful.

Only by being present in each chinampa was it possible to obtain empirical data that could not be detected by photo-interpretation. One such item was the navigability of the channels, which depended not only on the existence of a minimum depth of half a meter between the water surface and the canal bed, but also on the absence of obstructions to the flow of water, such as formal or informal dikes (known as *costaleras* since the *chinamperos* form them out of sandbags in order to slow down the movement of water that tends to run quite rapidly towards the north of the zone), or simply dense accumulations of water lilies or solid detritus (in particular in the vicinity of the built-up areas) that prevent the passing of the canoes. It was frequent to find stretches of canals only partly navigable; in these cases a note could be made in percentage terms in respect of each side of the islet.

And of course, there were chinampas flanked by dried out waterways —reduced to ditches where water no longer runs— or by old canals that had been filled in and converted into footpaths. There were even cases of plots of 12 or 18m across, or more, where any vestige of the divisions between the original, narrower islets had been obliterated.

Another datum that could only be verified in the field concerned those sectors that had been partially or entirely flooded. In such cases, their condition was noted along with the percentage of inundation in the section on hydrological risk.

Finally, for recording the remaining data for inclusion on the form, the technique used was that of direct observation, expressed in a scale drawing, and the obtaining of the images included on the reverse side of the catalogue form.

At the end of each day's work a report was given on the number of chinampas catalogued; particular situations were remarked on that had been entered as notes in the corresponding section of the form and the material was prepared for the following day. Once the fieldwork tasks were concluded, the teams reorganized themselves to support the off-site work of data processing, an operation that will be described in the following chapter.

4. Exceptions, changes, anomalies and impossibilities

As regards the geographical and environmental situation, one of the first aspects for reconsideration was how to obtain information on the group of chinampas that were periodically under water,[1] situated to the north of the chinampa zone of the village of San Gregorio Atlapulco.

[1] This group of 44 chinampas, covering approximately 9.2 hectares, form part of sector *0007* included in the second stage of the Cataloguing Study.

In those cases, we limited ourselves to registering in the section reserved for *notes* that the chinampas of this sector were under water throughout the greater part of the year, and so from the productive point of view they are unusable.

5. Participation of the *chinamperos*

The historical conception of the chinampa from the point of view of the agricultural communities is not restricted to its character as a territory of production, consumption and generation of a surplus. It is, above all, the socio-cultural space that has functioned as a support to the construction and permanent reconfiguration of *chinampera* society.

The conception of the chinampa from this perspective —and the understanding that for the *chinamperos* the socio-cultural significance of their plots is even more important than their economic value— represented a key point for the development of the fieldwork.

From the outset, the team was well aware of the importance of making the *chinamperos* participants in the tasks to be performed. Nevertheless, during the initial stages the latter often showed an attitude of distrust or annoyance; even questioning the usefulness of the study.

In view of this situation, the strategy adopted was to explain to them briefly the role to be played by the cataloguing process in the conservation plans. The *chinamperos* had to be helped to understand that, in order to achieve the salvaging and conservation of a cultural property, it was necessary to quantify and qualify their characteristics.

After a few days, however, the chinampa community began to understand the point of what we were doing, which meant a substantial advance for the subsequent development of the project. Not only were the *chinamperos* beginning to appreciate the aim of the study, but they were also involving themselves in such a way that their participation led them, at times, to become occasional members of the team. After several weeks in the field, we were

benefitting from the understanding and acceptance of the *chinamperos*, which represented a considerable advance for the performance of our work. Some not only helped to facilitate the means of transport for penetrating the aquatic network of the area of study, but also became an invaluable source of information and knowledge that enabled us to attain, to a large extent, the fundamental objective of the project.

Unfortunately, neither the specific aims nor the time available permitted us to record systematically all the conversations we had with the *chinamperos*. Nevertheless, we could not resist including here some fragments of three testimonies we gathered from three producers from San Gregorio Atlapulco regarding their perception of the problems they face.

First testimony

Don Joel Gómez Chapa, aged 71, is proud of having been born and raised in San Gregorio and of having carried on there his productive activity in the *chinampas*, a historic legacy inherited from his ancestors, among whom he recalls the name of Sóstenes Chapa, local chronicler and author of the first monograph on his village. Don Joel owns two of the biggest and most productive chinampas, situated at places bearing the names Cuapantitla and Tlamelaxi; both are in an excellent physical and productive state, and he continues to practice the inherited techniques of the *chapín* and the *almácigo*.

He deplores the state of abandon in which both owners and authorities have left the chinampas, the loss of lands to other uses, the resistance of the local population to doing hard work, the general shrinking of the chinampa territory, the relative loss of fertility of the soil, the constant threat of invasion by the built-up area, the disappearance of both the principal waterways (canals) and the minor ones (*acalotes* and *apantles*), the flooding in certain sectors, and at the same time the shortage of water due to the unequal subsidence and consequent changes in levels experienced in the zone, and the pollution of the few remaining canals. As

Figure 33. Rogelio Canto, with waterproof overalls and boots, exploring the flooded area of a chinampa.

Figure 34. Fernando Chiapa and Cecilia Rodríguez observe the laying out of an *almácigo*.

for the economic aspect, he points to the lack of support for small producers or, alternatively, the misuse of credit that is manipulated to benefit certain individuals in exchange for their votes in local elections…

He remarks on the depressing panorama of the continuing deterioration of the zone, and the absence of an immediate solution, which has led to the partial or total abandonment of market gardening by his fellows, leaving in oblivion their chinampas and that excellent activity inherited from pre-Hispanic times… He notes with sadness the disregard by some owners of neighboring chinampas, that have been left unattended. He supposes that they have been discouraged by the main problem, which is the insufficiency of water, or perhaps it is just the lack of interest of the younger generations, who have no desire to work the land because of the lack of incentives or motivation from the competent authorities.

He insists that the main problem is the exhaustion of the water that used to flow from the large springs of the zone; these sufficed not only for the chinampas but also for the population as a whole. With this liquid the canals were always at a high level…. He recalls that the limpid water rose almost to ground level —just about a foot (30 cm) below the surface of the chinampa— and the sky was clearly reflected in it. The earth produced a great variety of products, including maize, beans, squash, mint, *acelgas*, cauliflower…, and other products that have more recently been replaced by vegetables such as *verdolagas* and lettuces.[2]

At one time, he says, when the local authorities became aware of the serious problem of water shortage, they thought of remedying it by constructing sluices, with the avowed purpose of maintaining water in the chinampas; this appears not to have been done, since the water has never risen to its former levels, and not only that, but the canals are now almost dead, with

[2] Translator's note: *Acelgas* is a type of chard, similar in appearance to a thick-leaved spinach (*Beta vulgaris* var. *cicla*); *verdolagas* is common purslane (*Portulaca oleracea*).

only a minimal amount of dirty and polluted water, since the waterways have started to be used as rubbish tips.

He remembers the times when water was plentiful; there was a *góndola* that used to carry his products to the Jamaica market where they were sold.[3] In those days there was no central market[4] and all transportation took place by water, principally the Canal Nacional. Now what is left of this waterway is clogged up, partially blocked on its way through the village, and what is most to be deplored is that the local population or the small producers are themselves responsible for filling in the ditches since there is no water in the *apantles*, when the obstruction is not due simply to the accumulation of organic material. This situation has made it necessary to transport the produce in wheelbarrows to the street where there are carriers who take it by road to the Central Market. With the exception of a few producers who have their own means of transport, most use the collective service.

He added that the chinampa activity not only provides a livelihood to the local people but also to outsiders who come in search of work from the states of Puebla, Tlaxcala Veracruz and Oaxaca, among others. This activity, besides being productive also generates sufficient resources to live on.

He suggested that the universities should generate projects to benefit this area in particular, but he also proposed that there should be continuity in such projects, that should be carried

[3] The so-called *góndola* was a flat-bed wagon or wheeled platform that made regular journeys along the tramlines that connected Xochimilco with the historic center of Mexico City. The service was finally withdrawn in the 1960s.

[4] Translator's note: the modern *Central de Abasto* in the Borough of Iztapalapa was opened in 1982, transferring most of Mexico City's wholesale trade in foodstuffs and household goods from the variety of traditional markets such as Jamaica, La Viga and La Merced.

out conscientiously for the benefit of the community. They shouldn't just come to visit, do their research and then forget all about the place. Sometimes he wonders what those studies lead to, because then many people come poking around and making the same questions. This happens so often that he and his neighbors prefer not to reply. The strangers intrude on their chinampas and are careless with the crops; they tread where they shouldn't and that makes more work for the farmers who have to turn the soil over again so as to loosen it for setting the *chapines*. He, nonetheless, is always prepared to cooperate wherever possible.

Second testimony

Mr. Edelberto Sabino Galicia, aged 61, resident of the same village is the son of Pedro Sabino Gerardo, aged 93. The old man is still the actual owner of the chinampa, but on account of his advanced age he can no longer work it; his son is now in charge. The latter states that he is the only one of three brothers with an interest in working the land. For forty years he had only worked part time on the chinampa, since he alternated it with a permanent job in the electricity supply board; but in 2000 he finally took retirement and now devotes himself full time to work on the chinampa.

He says that young people nowadays don't want to work on the land; they prefer to go and rent places in the city, where here there is a source of work that generates an income, or at least provides what one needs to eat if it is attended to properly.

He states that the main problem is the lack of water and recalls the words of his parents who commented on the beauty of the place, where the springs of San Gregorio, such as *El acuario and San Juan*, which are now extinct, were notable for their abundance.

In his opinion, economic assistance for the chinampas has been almost non-existent: "They only help you if you agree to attend their meetings, and often you lose more than you gain since you neglect your activities, and all they give you in return are small things that later you have to sell or pawn to buy the things you really need, like wire mesh, seeds or even tools. The little help they give

is badly directed, they only give it to the people who have time to get mixed up in politics".

Another problem is drainage, not only that generated in the village and which flows into the canals, but also the polluted waters that arrive from the villages further to the south — villages higher up such as San Pedro Actopan and Milpa Alta. This is a something that was already experienced by the grandparents of those young today, who remember how in the 1950s the village of San Pedro was inundated by a heavy downpour that overflowed the drains. In other words it is a problem that has been around for many years.

He adds: "When the works were undertaken they told us that they would be sending the village rain water, channeling the surface water into the canals, but it isn't true… they sent us polluted water! If you don't believe me take a turn down there and have a look for yourselves and you'll see how the water that comes down is dirty and foul-smelling; it's sewage water. A committee was set up to complain and they convinced us that they would channel this water to a treatment plant that would be set up between San Luis Tlaxiatemalco and San Gregorio Atlapulco before pouring it into the canals. The discharge took place in the area of the public wash-house, since disappeared, and in view of the protest the works were continued on the banks of the Canal Nacional toward the east, but the project was never properly finished and in the end the waters were badly directed towards the chinampas. At present the discharge comes out behind my chinampa."

He mentions that his chinampa is an object of much envy. It is situated between the area with little water and the part that enjoys more. In the place there is a kind of little dam or islet which the neighboring *chinamperos* make use of: "it serves them for passing their hosepipes across my land in order to supply themselves with the water they need for their chinampas. If I were selfish I would deny them access and that would complicate the irrigation for them."

He also states that the culture of the grub-hoe or mattock and the canoes has been lost. He still has his canoe but only a few of the channels are still navigable since most are blocked up.

He suggests relocating the outlets of treated water, that regularly flow into the lower-lying areas or in the wrong places. It would be better to locate them at the higher parts of the chinampas so that the water would flow by gravity and not remain stagnant, since this generates bad smells.

He also proposes that the salvaging of the flooded chinampas should be undertaken, most of which are under water nearly the entire year. It is only possible to sow them when the rains cease, but then there is insufficient water to irrigate them.

They should stop spending money on projects of poor quality, such as the dams that that were good for nothing, and channel the money to the *chinamperos* in the form of loans, but with the condition of their producing more.

He proposes salvaging the channels, at least the most important ones, so as to avoid the water remaining stagnant. He also proposes that awareness-building programs should be carried out with the *chinamperos*, exhorting them to stop filling them in but, on the contrary, to conserve them.

Third testimony

César González, another resident of San Gregorio and devoted full-time to activity in the chinampa, remarks that formerly the chinampas were narrower and did not need the pumps that are used nowadays, since they remained always moist due to the high level of the water in the surrounding channels. It was only necessary to use buckets to carry water a short distance to the parts furthest from the edges; there was always plenty of water.

He has a chinampa inherited from his father in the part known as La Espejera. This part is often flooded in the rainy season, and in such cases the chinampas have to be rehabilitated. He says he has recovered some using techniques he remembers his father describing. The method was to introduce provisionally organic materials such as the broad-leafed grass known as *zacate gordo* and the water lily known locally as *huachinango*. These are piled up so as to raise the surface of the chinampa while maintaining its humidity.

Another problem is the invasion of houses in the area of what was once the San Juan spring. The houses are now a *fait accompli* and the local authority is now unlawfully regularizing their status.

He believes the chinampas can be saved but that this needs much honesty on the part of the authorities as well as the *chinamperos*. And he concludes by stating that unless attention is given to these problems the chinampas are unlikely to survive more than another fifty years.

Fourth testimony

Mr. Pedro Xolalpa Sarralde says he no longer works in the chinampas of San Gregorio; he is only visiting, but every time he comes he enjoys going to work on his ancestors' plots, cleaning the beds of weeds. He himself inherited one of the chinampas in sector 6 of our study.

He states that the main problem is the polluted water, but that even his own friends who live beside the Canal Nacional drain their residual waters into the canals. Unfortunately this water is what is used to irrigate crops in agriculture and as it comes complete with nutrients everything looks very nice, but the produce is contaminated. He also mentions that every year the canals are in a worse condition: above all the one that supplies the whole zone, the Canal Nacional.

VII. Management, Organization and Presentation of Data

Carlos Eduardo Arriaga Téllez, José Gabriel Castro Garza and Mereguildo Toledo Esteban

As has been explained in the previous chapters, the ultimate purpose of our research was to catalogue a special cultural heritage. And from the beginning, we had to bear in mind the dual purpose which this catalogue was to satisfy: on the one hand, to give a result that would show clearly the set of attributes that distinguish such a special cultural heritage; on the other to serve as a guide for practical actions in the future aimed at its conservation and restoration. At the same time the instrument we were creating to serve these purposes represented a double challenge: it should be suitable for gathering in situ information in a field that many consider to have been already exhaustively studied; it should also facilitate the analysis and processing of the information obtained in the field in such a way as to satisfy both purposes.

In view of the number of chinampas that were catalogued between 2005 and 2006 (a total of 544) and the quantity of data that potentially could be accumulated in each catalogue form, we very soon became aware of the need to use digitalization tools that would make it possible to display, combine, compare, correlate and regroup easily the data from each chinampa with those of the whole group studied.

Hence the present chapter takes in all the processing work that was carried out as the data came in from the field, with the aim of advancing and showing significant results as

Figure 35. Growing area in a chinampa.

clearly as possible. The use of methods of digital systematization simplified the interpretation of what was really happening in the chinampa zones.

Taking advantage of the diverse abilities of the members of the team, various programs for capture and processing of digitalized information were used: a statistical program, a computer-assisted design program (CAD), a geographical information system (GUS), spreadsheet, and word processor.

It should be noted that the explanation that follows does not necessarily follow the actual sequence of the operations, because some activities, particularly those concerning each of the ten sectors catalogued, were performed independently of each other, the results being introduced into the whole only as they were being concluded. For this reason, in order to help the reader to understand the operations in detail, examples are displayed, mainly from sector 1 and in particular its chinampa 001, catalogued in 2005.

Preliminary tasks

Before going on site, drawings were done using a computer-aided design program (CAD), following the boundaries clearly visible in aerial orthophotos from 2003, rectified, digitalized and geo-referenced, that formed part of the official registers. On assigning a folio number to each chinampa, these first maps functioned as guides for the field survey. The enumeration of the chinampas in each sector follows a north-south and west-east order, and the enumeration of their vertices follows this same logic.

As the territory was gradually covered throughout the two stages, the preliminary maps were compared with the measurements taken on site — an operation that enabled us to put together, a piece at a time, a digital map, unified, real and detailed, that reflects more faithfully what is actually happening in the chinampa zones. Not infrequently, a chinampa that appeared in the aerial photo as a single unit, in reality consisted of several original islets of whose previous separate existence evidence still remained, in the form of footpaths, dried out or blocked canals, or even some rows of *ahuejotes* whose alignment denoted the past existence of a contiguous canal. The criterion adopted in these and other similar operations

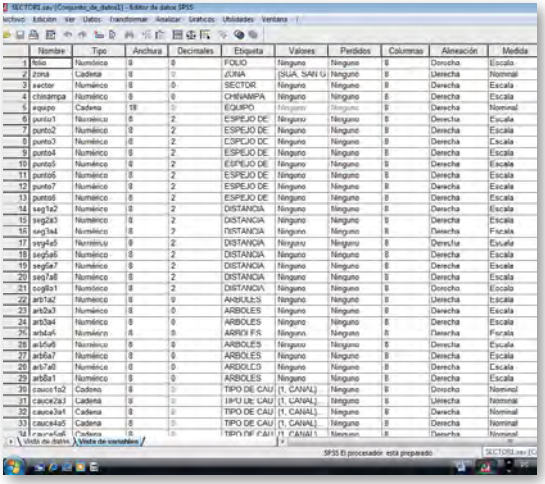
was to respect such evidence and to consider that these individual chinampas, now in a process of fusion, could and should be recovered as separate units.

Codification and data capture in digital analysis programs

When processing the information gathered, the importance of statistical development for this kind of study became evident. Hence the methodology used included the transcription of data by means of the computational program known as Statistical Package for the Social Science (SPSS), which was chosen for its ability to codify the data gathered and reduce the time taken in data input.

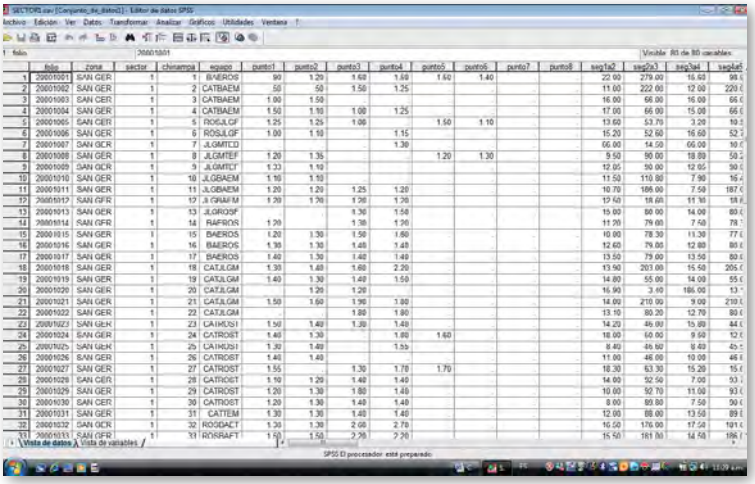
This program was used to capture the contents of the catalogue forms. However, in order to take advantage of its capacities for analysis a "page" was opened for each catalogued sector, which in turn comprises several dozen chinampas. Each "page" requires the completion of two versions that are each consulted via their own tab in the lower margin: one that defines the type and identification codes of the variables that will be analyzed and another in which the qualitative or quantitative data are entered that correspond to the attributes catalogued in each chinampa, beginning with the above-mentioned folio data, that serve to identify each chinampa and appear on the front-side upper margin of each cataloguing form. The processing of data begins with their input in the SPSS program, as is shown in the following image in which the folio column appears in the first place. Once the first virtual page has been completed with the codification data of the sector, the variables that have been described in detail in the chapter concerning the cataloguing form are entered on the other (see Figure 1).

Figure 1. Pages of codification of variables and information input in SPSS program.



	Nombre	Tipo	Anchura	Decimales	Etiqueta	Valores	Perdidos	Columnas	Alineación	Medida
1	folio	Numérico	8	0	FOLIO	Ninguno	Ninguno	8	Derecha	Escala
2	zona	Cadena	8	0	ZONA	{SUA, SAN G...	Ninguno	8	Derecha	Nominal
3	sector	Numérico	8	0	SECTOR	Ninguno	Ninguno	8	Derecha	Escala
4	chinampa	Numérico	8	0	CHINAMPA	Ninguno	Ninguno	8	Derecha	Escala
5	equipo	Cadena	18	0	EQUIPO	Ninguno	Ninguno	8	Derecha	Nominal
6	punto1	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
7	punto2	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
8	punto3	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
9	punto4	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
10	punto5	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
11	punto6	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
12	punto7	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
13	punto8	Numérico	8	2	ESPEJO DE ...	Ninguno	Ninguno	8	Derecha	Escala
14	seg1a2	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
15	seg2a3	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
16	seg3a4	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
17	seg4a5	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
18	seg5a6	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
19	seg6a7	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
20	seg7a8	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
21	seg8a1	Numérico	8	2	DISTANCIA ...	Ninguno	Ninguno	8	Derecha	Escala
22	arb1a2	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
23	arb2a3	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
24	arb3a4	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
25	arb4a5	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
26	arb5a6	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
27	arb6a7	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
28	arb7a8	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
29	arb8a1	Numérico	8	0	ARBOLES	Ninguno	Ninguno	8	Derecha	Escala
30	cauce1a2	Cadena	8	0	TIPO DE CAU...	{1, CANAL}	Ninguno	8	Derecha	Nominal
31	cauce2a3	Cadena	8	0	TIPO DE CAU...	{1, CANAL}	Ninguno	8	Derecha	Nominal
32	cauce3a4	Cadena	8	0	TIPO DE CAU...	{1, CANAL}	Ninguno	8	Derecha	Nominal
33	cauce4a5	Cadena	8	0	TIPO DE CAU...	{1, CANAL}	Ninguno	8	Derecha	Nominal
34	cauce5a6	Cadena	8	0	TIPO DE CAU...	{1, CANAL}	Ninguno	8	Derecha	Nominal

Table 2. The table shows the SPSS interface in which the chinampas are enumerated by their catalogue key or folio number.



	folio	zona	sector	chinampa	equipo	punto1	punto2	punto3	punto4	punto5	punto6	punto7	punto8	seg1a2	seg2a3	seg3a4	seg4a5
1	20001001	SAN GER	1	1	BAEROS	90	1.20	1.60	1.60	1.60	1.40			22.00	279.00	15.60	98.0
2	20001002	SAN GER	1	2	CATBAEM	.50	.50	1.50	1.25					11.00	222.00	12.00	220.0
3	20001003	SAN GER	1	3	CATBAEM	1.00	1.50							16.00	66.00	16.00	66.0
4	20001004	SAN GER	1	4	CATBAEM	1.50	1.10	1.00	1.25					17.00	66.00	15.00	66.0
5	20001005	SAN GER	1	5	ROSJLGF	1.25	1.25	1.00		1.50	1.10			13.60	53.70	3.20	10.5
6	20001006	SAN GER	1	6	ROSJLGF	1.00	1.10		1.15					15.20	52.60	16.60	52.1
7	20001007	SAN GER	1	7	JLGMTED				1.30					66.00	14.50	66.00	10.0
8	20001008	SAN GER	1	8	JLGMTEF	1.20	1.35			1.20	1.30			9.50	95.00	18.80	59.2
9	20001009	SAN GER	1	9	JLGMTEF	1.23	1.10							12.05	50.00	12.05	50.0
10	20001010	SAN GER	1	10	JLGBAEM	1.10	1.50							11.50	110.80	7.90	16.4
11	20001011	SAN GER	1	11	JLGBAEM	1.20	1.20	1.25	1.20					10.70	186.00	7.50	187.0
12	20001012	SAN GER	1	12	JLGMAEM	1.20	1.20	1.20	1.20					12.60	18.60	11.10	18.8
13	20001013	SAN GER	1	13	JLGROSF			1.30	1.50					15.00	80.00	14.00	80.0
14	20001014	SAN GER	1	14	RAEROS	1.20		1.30	1.20					11.70	79.00	7.50	78.1
15	20001015	SAN GER	1	15	BAEROS	1.20	1.30	1.50	1.60					10.00	78.30	11.30	77.0
16	20001016	SAN GER	1	16	BAEROS	1.30	1.30	1.40	1.40					12.60	79.00	12.80	80.0
17	20001017	SAN GER	1	17	BAEROS	1.40	1.30	1.40	1.40					13.50	79.00	13.50	80.0
18	20001018	SAN GER	1	18	CATJLGM	1.30	1.40	1.60	2.20					13.90	203.00	15.50	205.0
19	20001019	SAN GER	1	19	CATJLGM	1.40	1.30	1.40	1.50					14.80	55.00	14.00	55.0
20	20001020	SAN GER	1	20	CATJLGM		1.20	1.20						16.90	3.40	186.00	13.1
21	20001021	SAN GER	1	21	CATJLGM	1.50	1.60	1.90	1.80					14.00	210.00	9.00	210.0
22	20001022	SAN GER	1	22	CATJLGM			1.80	1.80					13.10	80.20	12.70	80.0
23	20001023	SAN GER	1	23	CAMJOS1	1.50	1.40	1.30	1.40					14.20	49.80	15.80	44.0
24	20001024	SAN GER	1	24	CATROST	1.40	1.30		1.80	1.60				18.00	60.00	9.60	12.0
25	20001025	SAN GER	1	25	CATMOS1	1.30	1.40		1.55					8.40	46.60	8.40	45.5
26	20001026	SAN GER	1	26	CATROST	1.40	1.40							11.00	46.00	10.00	46.0
27	20001027	SAN GER	1	27	CATROST	1.55		1.30	1.70	1.70				18.30	63.30	15.20	15.0
28	20001028	SAN GER	1	28	CATROST	1.10	1.20	1.40	1.40					14.00	52.50	7.00	53.5
29	20001029	SAN GER	1	29	CATROST	1.20	1.30	1.80	1.40					10.00	92.70	11.00	93.0
30	20001030	SAN GER	1	30	CATROST	1.20	1.30	1.40	1.40					8.00	80.80	7.50	59.0
31	20001031	SAN GER	1	31	CATTEM	1.30	1.30	1.40	1.40					12.00	88.00	13.50	89.0
32	20001032	SAN GER	1	32	ROSDACT	1.30	1.30	2.60	2.70					16.50	176.90	17.50	191.0
33	20001033	SAN GER	1	33	ROSRAFT	1.50	1.50	2.20	2.20					15.50	161.80	14.50	186.0

Table 3. Another view of the same table presents the interface on which the variables identified in each chinampa are entered.

The figure exemplifies the two alternatives offered by the capture form in SPSS applied to the data obtained only for Sector 1 during 2005, a phase in which 80 variables were codified. The first option, on the left, shows the sheet which is accessed via the tab labeled *Vista de variables* ("View Variables"), which presents the codes used to identify each variable, whereas on the right is the sheet that appears if the tab *Vista de datos* ("View Data") —which presents the qualitative or quantitative data gathered with the catalogue forms— is selected.

As was explained in Chapter 5, the comments on our work made at the "First Seminar-Workshop on Safeguarding and Conservation of Mexico City's Chinampa Zones" held in 2006, obliged us to introduce new fields in the survey form. This situation implied an increase in variables from 80 to 106, for the survey of that year. The increase in the size of the matrix, while enabling new factors of analysis to be included, did not modify the methodology adopted for evaluating the state of conservation.

After the data input in SPSS, the following step consisted in exporting the information to a spreadsheet that enabled the summations to be made and to obtain percentages as well as various diagrams. In this way, elemental physical characteristics such as perimeters, surfaces, average dimensions of depth in the canals or between the topsoil of the chinampa and the adjacent water surface were quantified, as well as the total number of trees bordering each chinampa. On the other hand, with the help of the same data, incorporating them in the GIS, it was possible to draw up most of the maps that accompany the present study.

After carrying out the summations. the 80 variables that had been captured in SPSS, were reduced to 11 variables that were judged to be decisive; these were entered on a spreadsheet, as is shown by the following example:

Figure 2. Reduction of variables in Excel spreadsheet program, on the basis of the previous processing stage.

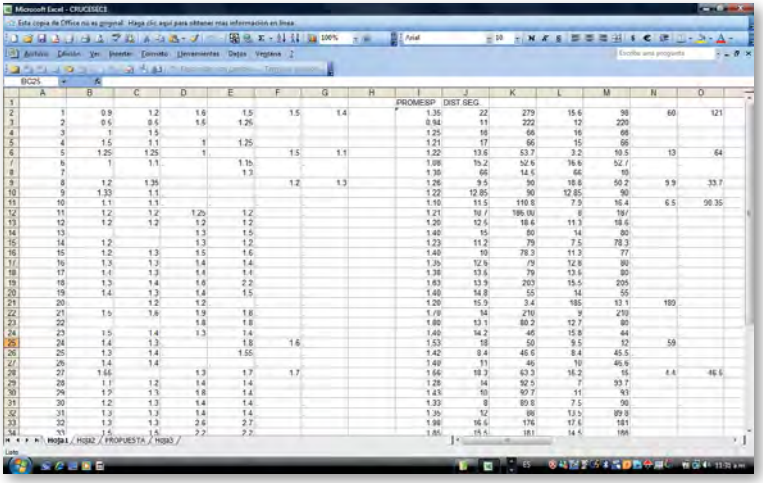


Table 4. Tab 1 of the Excel spreadsheet showing the variables imported from the SPSS file.

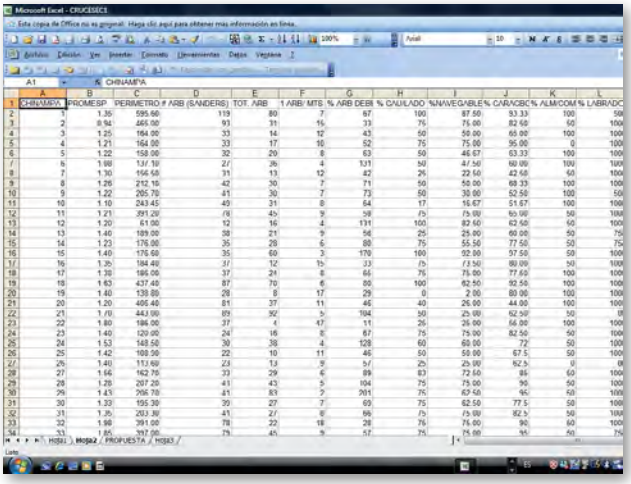


Table 5. Tab 2 of the spreadsheet. Shows the variables reduced by conversion to percentage form.

Figure 2 shows once again two versions of the spreadsheet, corresponding to the two tabs at the base of the sheets. On the left, the table identified as *Hoja 1* (Sheet 1), which is the result of importing data from the SPSS package, that is to say the 80 variables captured with the peculiarities of each chinampa. On the other hand, the table on the right, identified by the tab *Hoja 2* (Sheet 2), shows the reduction of the variables after conversion to percentage data.

In general terms, by means of the spreadsheet program the simple statistical questions were resolved.

As will be observed, the use of various digital processing platforms for different operations implied greater care as regards coordination and control so as to avoid errors in the passage from one platform to another, but at the same time that mixed method facilitated the distribution of tasks, since not all the members of the team enjoyed the same skills and experience.

It was this mixed method that was used to bring into focus a more complex datum: the evaluation of the present state of the chinampas from the points of view both of their physical condition and productive conditions. It is a procedure that doubtless can be perfected, and hence it is worth describing in greater detail in what follows.

Determining the indices of conservation

The starting point was a first approach, of a merely descriptive nature, aimed strictly at comparing the historical references with the present reality. Most of the authors consulted who have dealt with the chinampas agree on at least eight aspects that characterize the chinampa system, some of a physical and others of a productive nature. Among the former are: 1) a pe-

rimeter formed by canals; 2) navigability in the latter; 3) margins that are well defined and in a good state, and 4) regularly spaced trees along the edges. The productive aspects comprise: 5) use of *almácigos* for starting the productive process; 6) fertilization using natural compost or manure; 7) predominantly manual techniques of tillage, and 8) traditional methods of irrigation. All these premises are described in detail in Chapter 3 above, and with them —adapting them to present conditions— a method was constructed for weighing up separately the index of conservation of the physical state and that of productive conditions of each chinampa, from the sum of which was obtained the integrated index of conservation. This procedure explains why it was preferred not to register the impression of the cataloguer regarding the state of conservation directly on the survey form in the field, but to postpone analysis of this to the stage of information processing as will be described below.

Nevertheless, in order to achieve the projected analysis and to possess sufficient elements for evaluating and offering proposals, it was indispensable to perform correlations of the data at our disposal. Consequently, a form of multi-factor analysis was chosen that would facilitate the reduction of variables. These can function as a new indicator for subsequent analysis and allow for regressions in order to identify which is the factor or the variable that marks a difference in the assessments.

In order to carry out the above-mentioned evaluation it was decided to use the Statistical Program for the Social Sciences (SPSS) to perform a Principal Components Analysis (PCA) which allows an index to be obtained by using the following formula:

$$IPC = \sum_{i=1}^{n} WFi\ ((Xij - Xi) / Di)$$

Where:
IPC= Index of Principal Components
WFi= Weighting Factor of variable **i**
Xij= Value of variable **i** in the chinampa **j**
Xi= Average Value of variable **i**
Di= Standard Deviation of variable **i**

The reason for using this method is that the chinampa has to be understood as a system in which not only physical, but also social and cultural conditions come into play. By means of Principal Components Analysis it is possible to reduce the set of correlated variables in order to explain the existing variability. The method favors multivariate interpretation by establishing from the outset the level of correlation between the different variables. With its assistance physical and cultural variables, or (which amounts to the same) quantitative and qualitative aspects, can be weighted alike.

However, before analyzing these variables, a test was made to see whether they provided sufficient correlation, that is to say, whether the variance as a whole, or total variance explained, corresponded to the variation of each one.[1] The total variance explained was analyzed first for the physical aspects, obtaining as a result 71% of correlation with the first variable; as for the productive aspects, the correlation was 74%. These values confirmed the utility of the proposed variables, since the statistical norms indicate that the correlation is greater to the

[1] Luis Redondo, *Estadística para las investigaciones sociológicas*, Pueblo y Educación, Mexico City, 1991.

degree that it approaches 1 (that is to say, 100%) and less when it approaches zero.[2] Hence, it was established that there is a satisfactory correlation in the proposed variables. Thus it was verified that PCA is an adequate method for obtaining results that are easily transferred into concrete actions.

Principal Components Analysis has to be fed with data expressed in percentage terms; in other words it was necessary to define the eight characteristics mentioned above against an optimum with value 100; hence each variable had to be the product of a comparative analysis that is described as follows:

Variable 1F.- Channels

The chinampa has been described as an island or islet, i.e. a piece of land bordered on all sides by channels, a situation that together with the permeability of its soil favored constant production without depending on rainfall. At present, this condition is not fulfilled in all cases.

During the survey the sides of each chinampa flanked by a channel were registered, distinguishing them from those where the channel had been filled in or one plot had fused to another one.

The number of existing channels was compared with the number of sides, expressing it as a percentage:

V1F= % channels per chinampa = (number of channels / number of sides) * 100

[2] José Moral de la Rubia, "Análisis factorial y su aplicación al desarrollo de escalas", in René Landero, and Mónica T. González, *Estadística con spss y metodología de la investigación*, Universidad Autónoma de Nuevo León-Trillas, Mexico City, 2006.

Figure 36. *Apantle* with little depth of water, somewhat polluted. The water surface is at a considerable depth below the level of the chinampas that it is supposed to irrigate. The *Apantle* is also interrupted a little beyond the intersection with another transversal watercourse.

Variable 2F.- Navigability

The channels bordering the chinampa have also represented the means of communication by means of small canoes (*chalupas*) and punts (*trajineras*). The condition of the channels was classified according to four aspects, defined as a) navigable, b) obstructed, c) dry, d) obliterated (conditions described in detail in Chapter 5). The quantification of conditions b, c and d enabled proposals for actions of maintenance, conservation and salvaging of canals, described in detail in the following chapter, to be attended to.

To sum up, for the evaluation of the channels only the measurements of the navigable stretches were taken into consideration, comparing them against the total perimeter of the chinampa and expressed as a percentage of the latter.

V2 % Navigable channels = (∑ navigable channels per chinampa / perimeter of the chinampa) * 100

The procedure for evaluating variables 1 and 2 was the same in both phases of the study (2005 and 2006), nonetheless, variables 3 and 4 showed some modifications in the process of construction.

Figure 37. Narrow chinampa, only 6 meters across, with *ahuejotes* in good condition and channels on both sides, although one of them is dry. Temporally in disuse, as can be seen from the grass that covers it.

Figure 38. Canal Nacional, a narrow but navigable stretch.

Figure 39. The surface of this *acalote* is covered by *chichicastle*. Slight presence of water lily or *huachinango*.

Variable 3F.- Trees

Santamaría [3] mentions an average spacing between *ahuejotes* of 4-5 m., hence in our evaluation we took as a referent the maximum limit of this range, i.e. 5m. between any two trees. Using the same source we calculated the desirable number of *ahuejotes* that ought to exist in each chinampa catalogued according to its perimeter. The referent was consigned as the historical or optimal number of trees and the result was expressed in percentage form:

V3F = present % of trees = (number of trees at present / historical number of trees) * 100

This formula was unvarying throughout the two phases; nonetheless, for the survey carried out in 2006, two characteristics of tree growth were included: sick or dead trees. Considering that the forestation in either of those conditions did not offer the same benefit for the chinampa, it was proposed that before considering them in the evaluation, the trees should be attended to, either by curing their diseases or replacing them with new saplings. Therefore, in the second phase (2006), a field was included on the form for detailing chinampas in which sick or dead trees were found, with a view to facilitating remedial action; this is dealt with in Chapter 9. It is worth mentioning that the trees were classified according to type (*ahuejotes* or other species), and that accounts of sick trees were broken down into: (i) those affected by semi-parasitic relatives of the mistletoe known generally as *muérdago* (in particular *Cladocolea loniceroides*); (ii) those affected by larvae of moths of the Malacosoma family, or (iii) by both types of pest.

[3] Miguel Santamaría, *Las chinampas del Distrito Federal. Informe rendido al señor director general de Agricultua por el agrónomo Miguel Santamaría*, Imprenta y fototipia de la Secretaría de Fomento, Mexico City, 1912.

Figure 40. In areas abandoned or under water, the contiguous channels are often infested by water lily. In this case, also, the *ahuejotes* are further apart than is desirable.

Figure 41. Here the *ahuejotes* show a satisfactory spacing.

Variable 4F.- Condition of the Borders

Finally, we proceeded to evaluate the margins of the catalogued chinampas. The condition of the banks was evaluated, marking it on a scale according to the state in which they were found. These conditions were included in the survey form, registering the characteristics most frequently detected, eight situations being commonly found. Values were assigned to these, weighted in accordance with the state they presented: without apparent alterations (10); presence of weeds (9); eroded (8); reinforced with stakes (7); reinforced with sandbags (6); mixed reinforcement (5); replaced by a road or footpath (4); bordering directly on another chinampa (3).

Each margin was evaluated by the predominant condition, and the sum of all the evaluations on the total of edges was compared against the optimal possible valuation. Supposing that all the edges deserved the score of 10, this relation was calculated as a percentage.

V4F = % weighting of borders (Σ qualification of borders / number of borders*10) * 100

Figure 42. Navigable *apantle.* The chinampa on the left is fringed by sufficient *ahuejotes*, but the right-hand bank is devoid of trees.

Figure 43. *Apantles* with a clean water surface, high and navigable, but the *ahuejotes* of the chinampa are further apart than is desirable.

For the 2006 phase the analysis was simplified by reducing the number of categories from the three types of reinforced borders (stakes, sandbags, or mixed) and limiting it to two — combined or special (which may be stakes, as the Xochimilco authorities now prefer); likewise, the present existence of footpaths where previously there were canals is not a factor favorable for the preservation of the chinampas, so the corresponding variable is stated as "without border". The result was the reduction to six characteristics and the scores varied as follows: without apparent alterations (10), with excess of weeds (8), eroded or crumbling (6), mixed reinforcement (4), special reinforcement (2), without border (0).

On the basis of the above variables an analysis was performed of the principal components. The results of the PCA are expressed with respect to a relation with the standard deviation existing for the introduced variables and their average. The results can be evaluated relative to zero, so that positive or negative quantities imply, respectively, better or worse conditions in relation to the desirable mean.

Variables for the physical evaluation:

- V1F % channels per chinampa
- V2F % navigable channels
- V3F % of existing trees
- V4F % state of the margins

Figure 3. The example shows the results of the PCA (ICP) obtained to qualify the state of physical conservation. At top left the variables processed for the evaluation of aspects are listed; below an example is shown with the results of the percentages assigned to chinampa no. 1. To the right a sheet of the SPSS package is shown that presents the calculation of the same value for all the chinampas in Sector 1.

Number of chinampa	Channels %	Channel % navigable	Existing trees %	State of borders (weighting %)	Physical conditions
1	100	87.5	67.2	93.3	1.32882

Table 6. Example of percentages obtained for assessing the state of the channels in chinampa number 1.

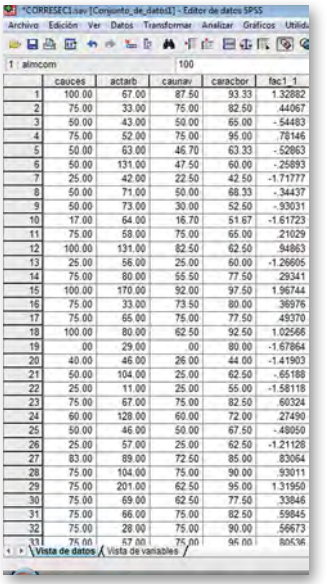


Table 7. Fragment of SPSS interface where the results of the conditions of the channels in all the chinampas of a sector are stored.

With the results obtained five ranks were constructed, respecting a scale of values: *good*, *fair*, *acceptable*, *deficient*, *bad*. For the purpose of establishing them we did not seek to impose an ideal image offered by the historical sources on the chinampas, but rather to accept the recent adaptation to the present conditions of this anthropized landscape. Nonetheless, those negative factors that affect, or may affect, chinampa production are conserved.

Productive aspects

To obtain this second index it was necessary to measure the relation between the original productive systems and present-day methods of production. This evaluation also took into account as a referent the literature on chinampas.

In fact, we have insisted that understanding the soils as specifically chinampa soils implies maintaining their condition of productivity. In this respect, practically all the authors consulted agree on the importance of the manual method of working, natural fertilization, the use of the *almácigo* and the *chapín* and the form of irrigation. It is worth mentioning that in the literature reviewed there is considerable emphasis on the manual method of irrigation, using the same *cuero* with which the slurry is extracted. Nowadays, however, practically all the *chinamperos* use petrol-driven water pumps connected to metal tubing or hosepipes to extract water from the canals for irrigating their crops.

The percentage conversion of the productive variables had a logic of its own, due to the fact that there is no other indicator to which this information can be compared; the weighting of values was direct, depending on the modernization of methods of cultivation.

Figure 44. Crop ready for harvesting.

Figure 45. Al In the foreground, growing crop; behind, in another sector, two *chinamperos* are planting out *chapines*.

Figure 46. Plot with furrows prepared for planting out *chapines*. The *apantle* flanking it on the left is navigable, and the water surface is at a sufficient height, but there are few *ahuejotes* on its margins.

Variable 1P.- Form of Tillage

As concerns the methods of tillage, the predominant modalities detected are four, to each of which a percentage value is assigned directly:

Use of the mattock 100%.
Mixed tillage (mattock and power tillers) 75%.
With the help of a power tiller 75%.
With the help of a tractor 25%.
Untilled chinampa 0%.

Variable 2P.- Use of *Almácigo*

Regarding the use of the *almácigo* and compost, only two possibilities exist, either they are used or they are not; hence the weighting was direct in both cases:

Yes 100%
No 0%

Variable 3P.- Use of compost

Chinampa agriculture has based its productivity on the wealth of organic material in the soil; this begins with the way in which the chinampas were constructed, but it is maintained

and renewed through the administration of slurry in the fallow season. Furthermore, when the *chinamperos* remove water lily from the channels they spread it over the chinampa, thus adding organic nutrients. This natural wealth is damaged by the use of chemical products, whether fertilizers or substances for pest control. During the fieldwork the method of fertilization used in the chinampas under crops was registered. In this case once again the options were yes or no, hence the same criterion was applied as in the previous variable:

Yes 100%
No 0%

Figure 47. Broad and extensive chinampa. In the foreground heaps of straw can be seen deposited for spreading between the recently planted seedlings, in order to protect them and avoid the growth of parasitic weeds.

Figure 48. Broad and extensive chinampa, without surrounding channels and practically deforested. Requires irrigation by hose. The water is extracted from the nearest watercourse using a hand-operated mechanical pump.

Variable 4P.- Method of Irrigation

In former times, the chinampa required very little additional irrigation; the original narrow dimension of the islets and the relative porosity of the soil ensured hydration mainly by the simple contiguity of the surrounding canals, but this is rarely the case nowadays, and only in parts that are on the point of being inundated.

The irrigation of chinampas has been mechanized practically everywhere with the use of manually operated mechanical pumps. This is not viewed as a motive for negative evaluation, since the shortage of water and the present breadth of chinampas no longer favors the continuing use of the traditional methods. Hence the use of mechanical pumps received a score of 100% and only the chinampas that are not cultivated were evaluated as 0%.

Considering that two of these variables (methods of tillage and irrigation) have to do with the inevitable presence of mechanization and the other two (use of the *almácigo*

and compost) with the culture of traditional production, before entering them in the SPSS, they were averaged out together, so that the evaluation by means of PCA was carried out with only two variables.

Variables for evaluation of productivity

% *Almácigo* and compost (Average V1P and V4P)
% Tillage and irrigation (Average V2P and V3P)

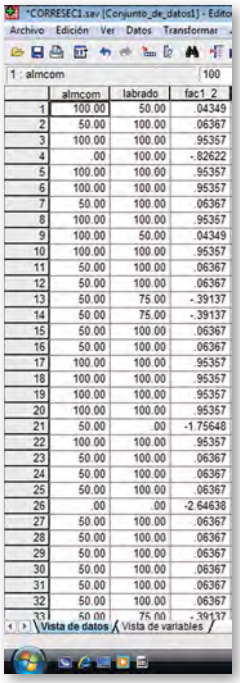


Figure 4. Shows the result of the evaluation of productive aspects in PCA: above left the variables processed for evaluation of productive aspects are listed; on the right a fragment of the evaluation sheet / spreadsheet for of productive aspects with all the chinampas of Sector 1; below is an example of the result with the percentages of chinampa no. 001 in Sector 1.

Number of chinampa	*Almácigo* and compost %	Tillage and irrigation %	Chinampa productive methods
1	100	50	0.04349

Table 8. Example of percentages obtained for evaluating the productive condition of chinampa number 1.

Table 9. Fragment of SPSS spreadsheet on which the results of the state of the channels in all the chinampas of one sector are stored.

Figure 49. *Ahuejotes* infested by *muérdago*. It is still not too late to eradicate the parasite.

As has already been mentioned, the PCA can correlate both objective and subjective aspects; however, the variables were never run together, since the intention was to detect, chinampa by chinampa, what variable needed to be attended to and to what extent. This leaves the door open to other analyses that might be done in the future on the same universe.

Nonetheless, in order to obtain a general index of conservation for each chinampa the sum of both variables was drawn, in which the weight represented by each of the two conditions of physical or productive conservation can be appreciated in comparison with the other. As regards the example used previously (chinampa 001).

Chinampa	Index of physical conditions	Index of productive conditions	Σ= Integrated index of conservation
1	**1.32882**	**0.04349**	**1.37231**

Table 10. Example of physical condition of the chinampa number 1.

In other words, the reading of the overall index of conservation enables the establishment of ranks of priority in the attention required by each chinampa.

From the results obtained from the action described above, once again starting from the zero referent, four temporal ranges were established for assessing the priority of attention in the short, medium, or long term, or indefinite, employing the following ranges to determine them:

Short term. Chinampas with the lowest evaluation (evaluation less than -1) that require urgent attention.

Mid term. Chinampas with an evaluation below the average (evaluation less than 0), requiring attention soon.

Long term. Chinampas with an above-average evaluation that present certain deficiencies (evaluation between 0 and 1) but, while requiring some attention in order to improve them, this can be deferred for some time.

Without term (indefinite). Chinampas with the best conditions during the survey (evaluation greater than 1), that require no more attention than the actions of maintenance that their owners regularly provide.

These ranges were incorporated in the maps and the tables of results that were delivered in 2005 and 2006 to the Local Authority and were reworked for this publication.

Part Three

VIII. The Most Significant Results

Alberto González Pozo and Ignacio Armillas Gil

Catalogues of cultural assets are intended to provide details on each of the components constituting a cultural heritage site. The researcher fixes his attention on them, recording their attributes systematically, so as to provide a testimony to the existence, location and state of conservation in which each item is found at the moment of cataloguing. Hence the data gathered become a fundamental source of information for planning any action regarding the conservation of the asset or any one of its components.

The set of 544 forms making up the catalogue of chinampas at San Gregorio Atlapulco gathered between 2005 and 2006, the databases accumulated in both seasons, and the photographic archive digitalized during the same period show a wealth of information from which interesting results can be obtained. That was the material handed over to the Borough of Xochimilco in two successive deliveries, one for each season of work in the chinampas. What we seek to present in this chapter —in abbreviated form and without technicalities— is a combined account of the two stages. For this purpose we have followed the order and subject matters of maps E to R which were drawn up in order to present the results concerning the area catalogued in the two phases.

The chapter ends with a preliminary reflection on what the reading of the maps tells us regarding the problems faced for conservation of the area studied. The authors of this

publication plan on deepening this reflection at a later stage and we hope to receive from many readers other observations and, perhaps, questionings regarding the material presented herein.

The most significant results

The maps are of great importance, since they synthesize decisive information for drawing up relevant conservation proposals: they show data related to the surface areas of the chinampas, their predominant orientation and the reality of the hydraulic risk, which has to do with the average depths and the predominance of dry channels and extinct watercourses that have been "blinded" (supressed) by filling in with earth, a fact that clearly limits navigation through the canal system.

They also register the elevation of the chinampa above the water surface, which affects the extent to which the soil can absorb moisture for cultivation; this is one aspect of the dramatic state affecting the canal network. The condition of the banks is likewise precarious in many cases and the density of trees lining them is also diminishing; in many cases common insect and plant parasites contribute to this. The percentage of dead trees fluctuates between 10 and 30 percent.

Factors of great importance are the prevalence of traditional means of chinampa cultivation and the methods used to protect the soil and new crops from intense sunlight, hail or birds; such traditional elements still subsist, alongside abandoned or disused chinampas. Other factors affecting the chinampa zone include the unbridled growth of irregular settlements, urban infrastructure and buildings, that are threatening to convert this rural area into an extension of the conurbation. All this information, which is extracted from the maps, is of considerable relevance for the proposals for future conservation actions.

MAP E. Ranges of surface area

The surface areas of most chinampas fall into the range of between 600 and 6000 m^2, and the general average proves to be slightly over a tenth of a hectare per chinampa. On the other hand, the map is interesting because it enabled us to determine an average net breadth for all the chinampas of 12 m. However, there are a few chinampas of only 6 m breadth and another minority of extra wide islets, of some 18 meters or over. The longitudinal measurements, on the other hand, show considerable variation: few of them are short, measuring less than 100m; many more oscillate between 100 and 250 m, and in a not inconsiderable number of cases the length is greater.

The great majority of chinampas follow lengthwise a dominant orientation averaging 15° 30´ East of North, although there are quite a few with variations of ± 2° in respect of that orientation. This is a feature that has been pointed out by other researchers such as Michael D. Coe (see Chapter two above),[1] who mentions the coincidence that this orientation follows the urban layout of Teotihuacán and its principal avenue, the *Calle de los Muertos*, which automatically leads to questions regarding the reason for this agreement: is it a simple coincidence or is there a causal relation between both cases? The interesting thing about this catalogued feature is not only that it bears out that datum, but that it leaves it open to interpretation. Was it because the original orientation of these drained fields was a norm imposed by an external power very much superior to the decision-making capacity of the *chinamperos* who originally constructed them, or was it the result of an agreement between the various communities that have exploited them from Xochimilco to Chalco.

[1] Michael D. Coe, "The Chinampas of Mexico", *Scientific American*, vol. 211, no. 1, July 1974, pp. 90-98.

Figure 50. Very broad chinampa with an obliterated channel on the left-hand side. In the foreground an *almácigo* can be seen with seedlings ready for planting out. Behind, the soil prepared to receive them.

All these oscillations between sizes, proportions and longitudinal orientation reappear in the other maps that are commented on below, but there is an additional feature that is worth noting here: independently of the longitudinal direction which overwhelmingly prevails, there are some chinampas whose direction is transversal to all their neighbors. They would be anomalous unless an explanatory hypothesis may be offered later on, dealing perhaps with their function in the general hydraulic function of the system, probably slowing the flow of liquid between small differences in higher and lower levels.

Figure 51. Growing crop. Behind can be seen some recently pruned *ahuejotes*. New foliage can be seen sprouting from the trunks.

MAP F. State of the canal network

State of the canal network (2005 and 2006)

Channels*	Surf.	%	Length	%
Navigable	6.2	42.8	19.0	29.7
Obstructed	4.0	27.6	16.0	25.0
Dry	1.4	9.6	7.5	11.7
Obliterated	2.9	20.0	21.5	33.6
Totals	**14.5**	**100**	**64.0**	**100**

* Data of surface in hectares and length in kilometers.

The actual situation shown by this map is a clear warning of the serious hydraulic risk already affecting the chinampa areas in general, above all in view of the fact that the catalogued area corresponds to one of the comparatively better preserved zones.

The northern and southern limits of the areas studied show the most important canals identified by their names. The Canal de San Sebastián, measuring some 8m across, runs north to south with the same longitudinal direction mentioned above, and is still navigable. It reaches the confluence with the Canal del Bordo, of a similar width, where the direction changes towards the west, but this is only partially navigable, because the course is soon obstructed by a thick mantle of water lily. At the northwestern end a stretch of the Canal de la Espejera can be see, which follows a direction parallel to the Canal del Bordo. The most important channel to the south is the Canal Nacional, which extends from the east following

Figure 52. The *costaleras* (simple dams made of sandbags) are used to interrupt the flow of water; this causes the appearance of detergent foam with the falling water.

a partially sinuous course, with a considerable and variable breadth reaching as much as 20 meters and a with a good depth of water; that first stretch is thus fully suited to navigation. But as the canal follows its sinuous course first towards the southwest and then towards the west, the channel shows severe obstructions that prevent its use by watercraft. The obstructions affect several stretches of the canal, while the width in other stretches barely reaches 3m. Further on, now outside the area of study, the Canal Nacional follows its course past various obstacles until the bridge known as Puente de Urrutia. From then on it takes the name Canal de Caltongo, broad, navigable and on a lower level. This waterway, consisting of several stretches, was one of the most important of the whole canal network in the chinampa zones, since part of its flow came from the Amecameca river —which carried water from the melting snows of the volcanoes— while another part was enriched with the contributions made until the early twentieth century by the springs that formed on the southern margin of the great original body of water that formed in the Xochimilco-Chalco sub-basin. It was an important means of aquatic communication which, on reaching the chinampas of Xochimilco changed direction towards the north and led via the Canal de La Viga to the centre of what was, successively, the capital of the Aztecs, the Viceroyalty and the Republic.

Between the north and south confines of the area studied is what we call the "fine mesh" of canals, formed by a few *acalotes*, which are waterways of intermediate importance, between 2 and 6 m breadth measured across the surface, and the great majority of *apantles* or channels of 1-2 m breadth, along which it is possible to navigate only in small punts (*trajineras*).

What map F reveals is dramatic, for only 29.7% of the canal network is still navigable, while 25% still has a certain amount of water, but not enough to be navigable — whether because the depth is insufficient (less than 60 cm), or because of obstruction by dense mats of water lily, or both factors combined. In 11.7% of the network the channels still exist, but

have dried out, while in 33.6% they have been eliminated by filling in with earth and, for the most part, are now used as footpaths running between plots.

The map also shows seven sluices or locks built in recent times in reinforced concrete in an attempt to regulate the difference of levels between the northern and southern extremes of the area of study, a phenomenon that we will deal with when describing the following two maps. Only a few of these sluices still function today.

Figure 53. Simple *costalera* installed to prevent water from flowing too rapidly towards the northern part of the zone, which has become lower as a result of differential subsidence.

Figure 54. Narrow chinampa measuring only 6 meters. There are few left of this size. This one is temporarily inactive.

Figure 55. A very narrow *apantle* with very little depth, making navigation impossible. At a short distance it can be seen to stop at a point from which it has become obliterated.

Figure 56. Functioning sluice. As well as serving to retain water, it opens to allow canoes to pass from level to another, the land towards the south being higher than that to the north.

Figure 57. Another functioning sluice. The formation of detergent foam can be appreciated as the water falls from one level to another.

MAP G. Average depths of water

Figure 58. Southern bank of the Canal Nacional, in the vicinity of San Luis Tlaxialtemalco. Some buildings can be made out, marking the transition to the urban area.

This map shows details relating to the average depth between the water surface and the beds of the waterways surrounding each chinampa. Unlike the two previous maps, this one only shows the situation in the sectors surveyed in 2006 because in the 2005 season this feature in particular was not examined. Interpretation of the map suggests that the greater depths, varying from 1.5m to 3m, are to be found predominantly in the north of the area studied, above all in those parts that are on the verge of being flooded; interme-

diate depths of between 1m and 1.5m are scarce and are found mainly in the intermediate part; depths of less than 1m are located both in the center and the south. At some points depths of even less than 0.5m are found, thus severely disrupting navigation of the channels. There are not many of these, however, and they become scarcer towards the southern edge of the zone, where one might expect to find them in a greater proportion.

Figure 59. Northern bank of the Canal Nacional in the vicinity of San Gregorio, very close to San Luis.

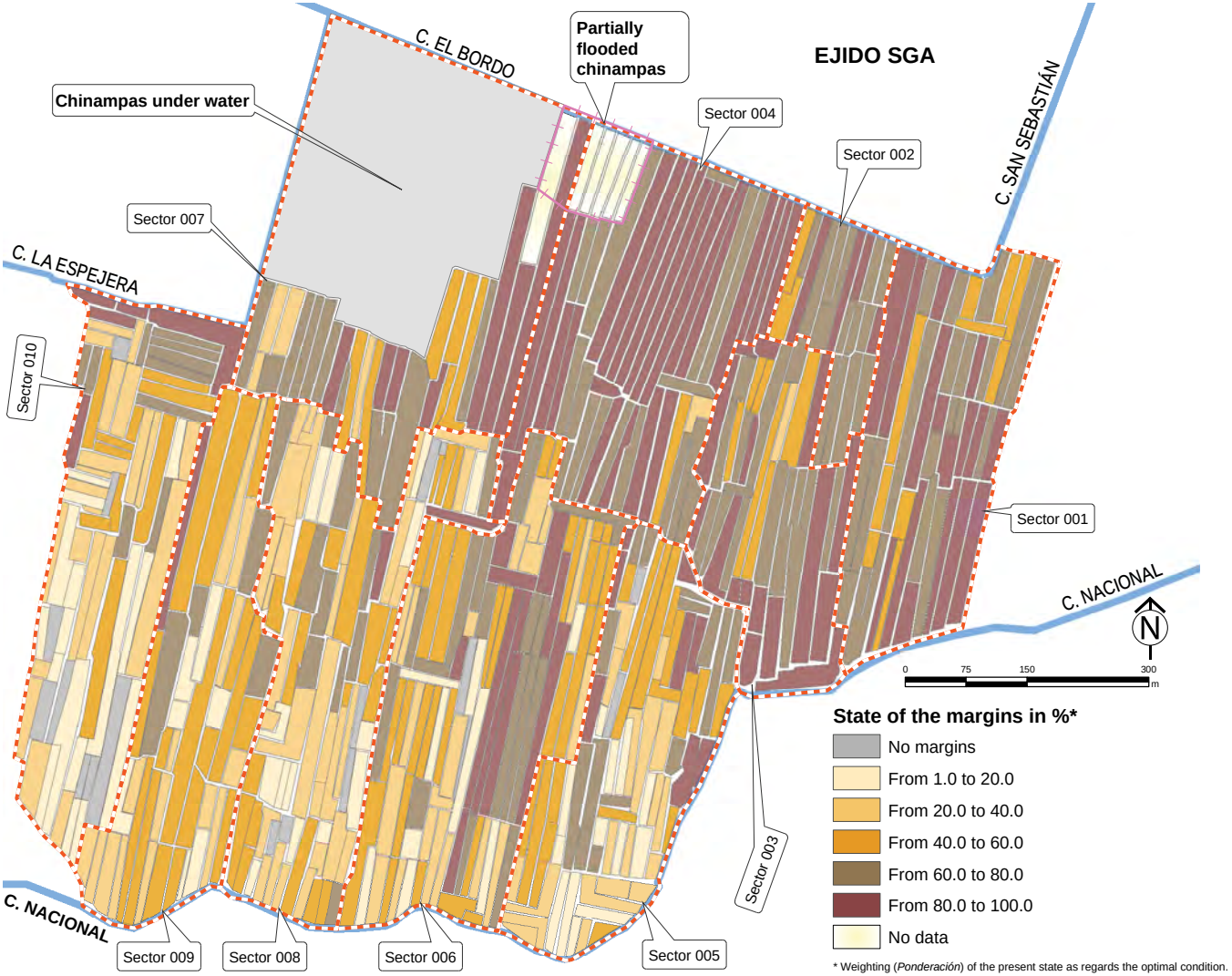
MAP H. Average ground to water-surface distance

This map represents an average value per chinampa, regarding the distances between the water surface in the surrounding channels and the surface of the cultivated soil. This distance is optimal when it ranges between 0.8 and 1.5 m, since this favors a satisfactory degree of moisture in the crop-growing soil adjacent to the waterways and facilitates many of the operations taking place between the chinampa and the canals or vice versa, such as irrigation with *cueros* or with buckets, as well as the extraction of slurry from the beds of the canals as described in Chapter 3. The lesser distances prevail in the northern part of the area studied, precisely in zones that are close to being flooded, while on the southern side the distances are enormous, as much as 3.5 m and sometimes even more, which makes the hydration of soil difficult by capillary action as well as many of the operations involving the canals.

Maps F, G and H confirm the results of other data and studies that point to a differential subsidence of two or more meters between the central zones of the original lakes and the former banks, where settlement is less. This in itself provides an important part of the explanation of the dramatic conditions affecting the canal network as a whole. Many authors, such as Santoyo and others,[2] have pointed out that this situation is due to the indiscriminate extraction of water from the formerly lacustrine subsoil in order to provide 60% of the requirements of Mexico City, and if the process carries on in the same way the differential subsidence will continue to increase.

[2] Enrique Santoyo *et al.*, *Síntesis geotécnica de la Cuenca del Valle de México*, TGC Geotecnia, Mexico City, 2005.

MAP I. State of the margins



The banks of the canal network are protected by the roots of the *ahuejotes*, which secure the soil of the chinampa and consolidate the firmness of the vertical or sloping banks that descend from the surface of cultivation to the canal beds. When the canals are broad the banks are usually steeply sloped, while in the case of the *apantles*, where it is important not to lose any of the breadth of the channel, vertical banks predominate, in which case rustic reinforcements of planks or narrow trunks tend to be used in order to avoid the erosion of the bank. Another feature that is considered for assigning a percentage to the state of conservation of the edges is the presence or absence of parasitic vegetation on the surfaces of the banks, something that is common on sloping banks. One also notices, particularly in narrow channels, eroded banks where certain exogenous species, such as carp, burrow into them to form refuges. The combined result of all these factors is expressed in percentages whose magnitude corresponds to the state of conservation of the borders surrounding each chinampa.

Figure 60. Corner of chinampa flanked by well irrigated *apantles*. The *ahuejotes* in front are still saplings.

MAP J. Perimeter trees

In this map, the density of trees that persist on the perimeter of each chinampa is expressed in the form of a percentage in respect of an ideal situation, where 100% indicates concordance with a norm that was inferred from the observations of Miguel Santamaría in San Gregorio Atlapulco itself, as has already been mentioned.[3] In accordance with the methodology adopted by the cataloguing team, the perimeter of each chinampa was divided by the number of trees registered, so that a result equal to 5.00 (which expresses the average distance between *ahuejotes*) was considered equivalent to 100% of ideal forestation, while the greater or lesser average distances gave percentages correspondingly greater or lower than the desirable minimum. The result is surprising, because a fair number of chinampas have a density superior to the norm and others vary between 76 and 100 percent; nevertheless, more than half present greater deficits (expressed as percentages of 75% or less). There are even some, fortunately a minority, that are totally, or almost totally, devoid of *ahuejotes*

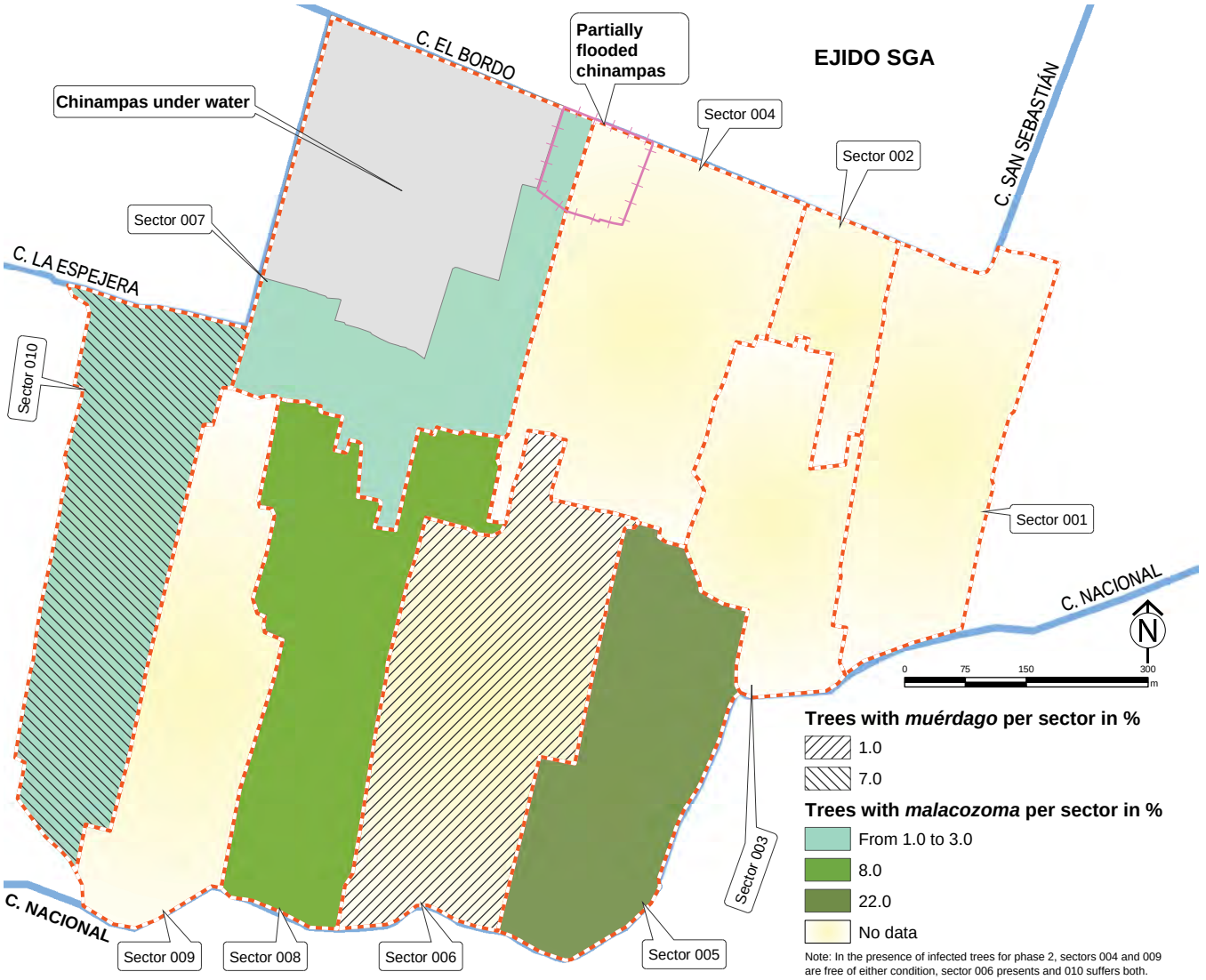
[3] Miguel Santamaría, *Las chinampas del Distrito Federal. Informe rendido al señor director general de Agricultura por el agrónomo Miguel Santamaría*, Secretaría de Fomento, Mexico City, 1912.

Figure 61. Soil prepared for planting out of *chapines*. The unhealthy *ahuejotes* in the background indicate the beginning of the flooded zone.

Figure 62. Protected from hail and the incursions of birds by a fine mesh, the transplanted seedlings continue their growth to maturity.

Figure 63. Abandoned chinampa in a zone that is often flooded. In the background, the dead *ahuejotes* indicate the presence of the permanently flooded area.

MAP K. Infested trees



The same map shows two types of infestations affecting the *ahuejotes* in the area of study: the *muérdago*, a parasitic plant related to the mistletoe that grows on the branches and foliage and steals nutrients, damaging the tree's functions and vitality, and the *malacosoma*, a caterpillar that damages the foliage, to sometimes to the extent of killing the tree. The percentages of trees affected by *muérdago* are still minimal, but it has been detected in sectors 6 and 10, especially the latter, which averages 7%. The case of the *malacosoma* is more worrying, since the greatest percentage reached in sector 5 is 22%, followed by sector 8 with 8% while the rest of the sectors are less affected. Percentages of less than 1 are not represented, for which reason a detailed map showing the case for each chinampa was not drawn up, but rather the infestations are averaged for each sector analyzed.

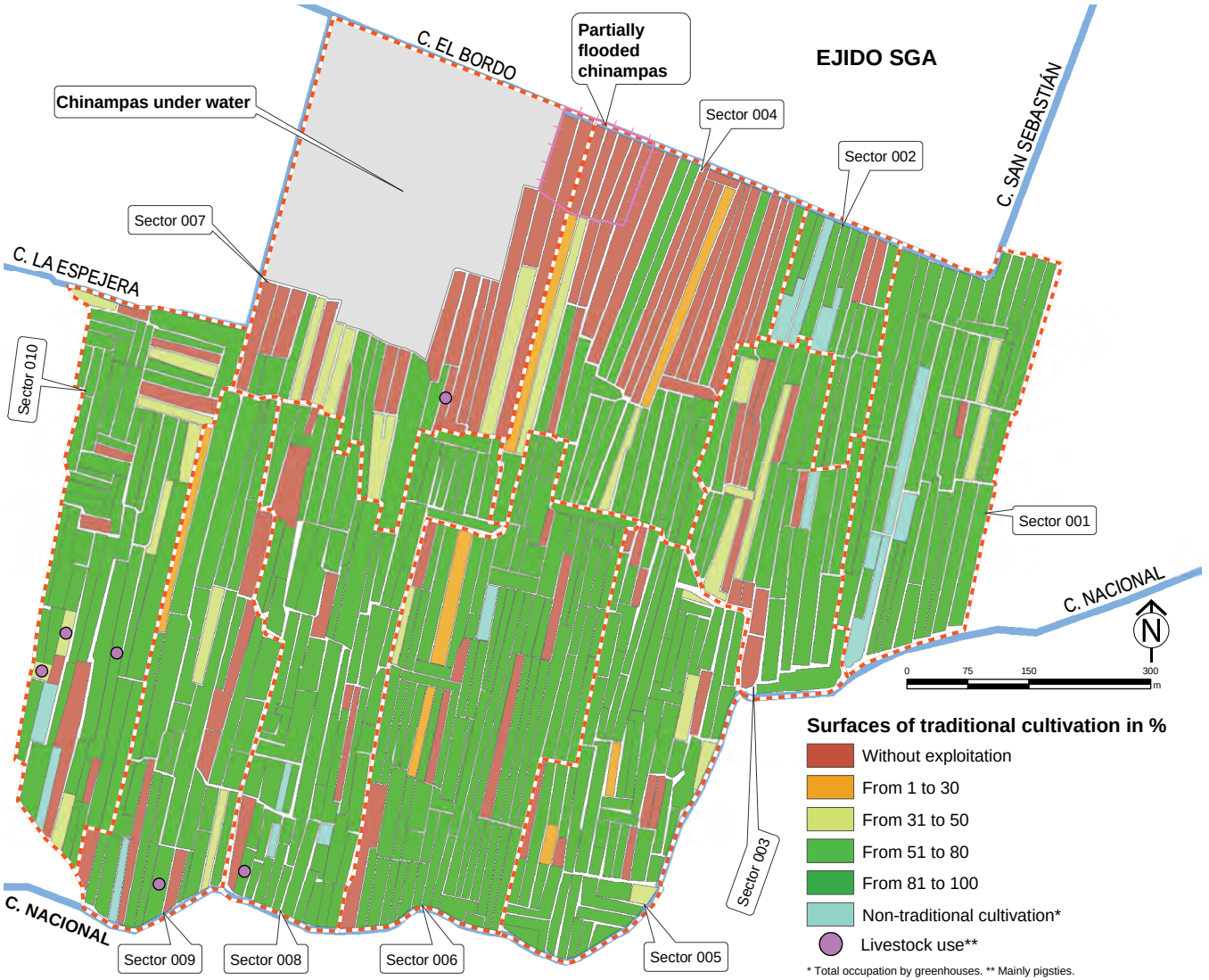
Figure 64. Some inactive chinampas are also much affected by insect pests and parasitic plants on the *ahuejotes*, and the presence of certain exogenous species is also noted.

MAP L. Dead trees

The losses in the forestation of *ahuejotes* —due not only to their moribund situation owing to the parasites that infest them but also to occasional flooding in the rainy season— are visualized in this map. As in the case of maps G and K, the results do not include the area catalogued in 2005, since in that season this datum had still not been included in the cataloguing form. In the north, a numerous group of chinampas in sector 4 —one of those most subject to flooding— shows percentages of dead trees superior to 10%, 20% or 30%. Sector 10 also shows a certain incidence of dead trees, although in lower percentages than the former. In the remaining sectors analyzed, the incidence is lower.

Figure 65. The insect pests and parasitic plants that infest the *ahuejotes*, the flooding or both factors together, lead to the death of these trees so characteristic of the chinampas.

MAP M. Predominance of traditional forms of cultivation



The map presents the set of factors that indicate the prevalence of traditional forms of cultivation in the chinampas, expressed in percentage of presence. Among the main features of that presence we took into account:

- predominance of vegetable or floral crops;
- use of the technique of the *almácigo* and planting out of *chapines* to the place where plants will mature;
- irrigation of soil surfaces in hot, dry seasons with the help of *cueros* or buckets and poles (or with hoses drawing water from the canals with the aid of a pump);
- preparation of the soil with hand tools (or manually controlled mechanical tools, such as single-axle tractors or power tillers);
- the exclusive or partial use of natural, organic means for fertilizing or protecting the soil, or for counteracting pests and parasites;
- provisioning with inputs or marketing of crops using combined means of terrestrial and aquatic transport (where the latter is still a possibility).

All of which, linked to the fertility of the system and the rapid ripening of several crops per annum, is in turn closely linked to the intensive use of labor and consequently the generation of employment.

There are a few chinampas close to the southern zone of the area of study where partial use of land for cattle or pig raising is found. These are enclosures or pigsties for a few animals and, because of the closeness to the urban zone that begins to the south of the Canal Nacional, are regarded as destined to either home consumption or to small scale commerce.

In a minority of chinampas, the accumulated percentage of all those factors is relatively low, less than 50% or even 30%. And in a very few, particularly those that possess permanent greenhouses, it is assumed that modern techniques of cultivation predominate. In particular, modern methods are encountered for storing produce while buyers are found; this is particularly the case among producers of flowers. The following map has more to say about the latter.

Finally, the map also shows a critical situation in the extreme north of the area of study, where considerable groups of unexploited chinampas appeared at the moment of cataloguing. The reasons for their remaining almost permanently inactive are mainly two:

- their distance from the urban area by land, which is now the principal means for marketing production, combined with the obstructions, interruptions and changes of levels in the canal network, which prevents passage by water, which in the past was the simplest means for transporting the harvest;
- and the imminent threat faced by many of the chinampas at the northern edge of the area of study, where periodic or permanent inundations occur.

Figure 66. Manual implantation of seeds in the *chapines*. The *chinampero* deposits one or two seeds in each one and then covers them with a thin layer of mud. Later, other temporary protections such as straw or micro-tunnels may be used while the seedlings are germinating and beginning to grow.

MAP N. Protection of crops

This map indicates the artificial means used by the *chinamperos* to protect the soil and the crops from various threats such as excessive exposure to the sun or heavy rainfall, hail, frosts and predatory incursions by certain birds. However, it is worth noting that if we include the inactive chinampas, 40% of the total lack any kind of protection. In the remaining 60%, the lightest forms of protection are the fine meshes of plastic material that are hung at an average height of 2.50 m, covering the plots entirely or in part, so as to avoid the effects of both ravaging of certain crops by birds or those of occasional hailstorms. Another method of protection is the use of micro-tunnels, which are provisional greenhouses for protecting the tender seedlings in the *chapines*, highly vulnerable to excessive rainfall or hail; and of course there are chinampas that combine both forms of protection. In a few cases formal greenhouses are constructed, as shown in map N, except that here they are identified in two ways: in the zone studied in 2005 only with the letters T and P, which indicate that the chinampa is totally or partially covered by these structures, lightweight, but no longer so provisional. While in the sectors analyzed in 2006 other keys were used to identify the different combinations of these resources.

Two aspects are worth noting regarding the presence of greenhouses. The first is their positive economic returns for the producers of flowers against the investment needed to install them. The second is that, unlike micro-tunnels and mesh —which, on account of their small size or lightness, go almost unnoticed— greenhouses do have a negative impact on the chinampa landscape. Likewise, they function more as coverings for the storage of flowering plants in pots than for production and cultivation of the soil. Their presence is most evident in San Luis Tlaxialtemalco and around the Canal de Caltongo in the chinampas of Xochimilco, while in San Gregorio they are still scarce.

Figure 67. The crop, already planted out, is protected from occasional hailstorms and the incursion of certain species of birds by the use of mesh. In this case, the mesh adopts a semi-cylindrical form and is supported by light steel structures. Below, the straw between the plants avoids loss of moisture and the growth of parasitic weeds.

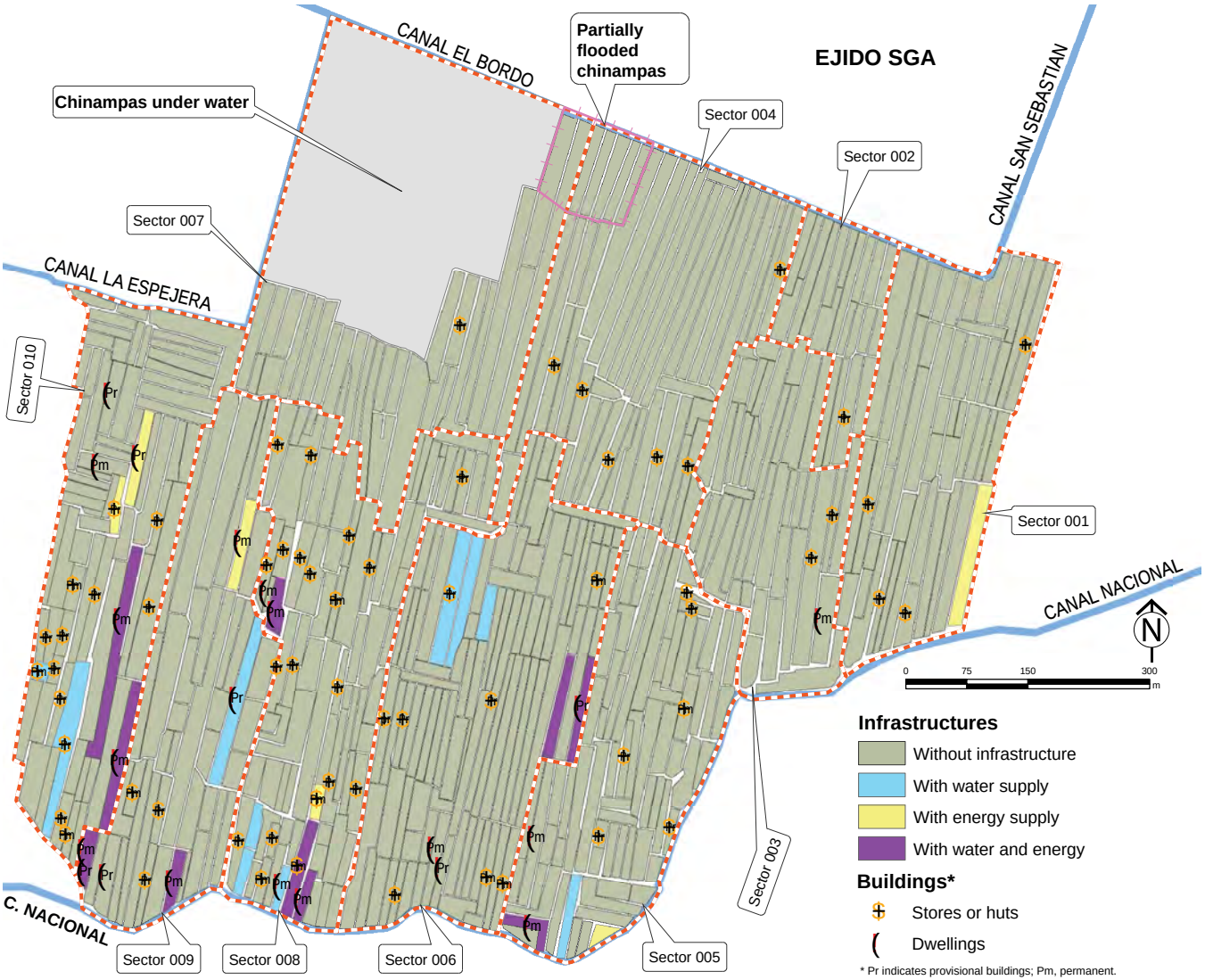
Figure 68. Other arrangements take simpler forms with the mesh supported on fewer supports.

Figure 69. Method of stretching out a mesh.

Figure 70. The use of plastic instead of mesh is becoming more common in the case of delicate crops, such as certain species of vegetables and flowers.

Figure 71. Plastic sheeting very close to the ground is also used to protect young crops or *almácigos*.

Map O. Urban infrastructure and buildings



In the southern sectors of the area of study, separated from the urban zone of San Gregorio only by the Canal Nacional, a gradual process of extension of some networks of the urban infrastructure is underway; this in turn favors the appearance of new irregular settlements with houses which, at first scattered, announce a future dynamic that, later, may well transform this eminently rural area into just one more peripheral suburb among those that surround Mexico City. The electrical energy network is the one that most easily extends across the canal network with overhead cables. The drinking water supply passes by means of fixed or "provisional" bridges and, it is enough for the hydraulic pressure to be the same as that of the municipal network for the water to reach its destination. No formal drainage networks have been detected, since these would be impossible without the intervention of the local authority (that cannot infringe the existing regulations). Consequently, the irregular dwellings that already have a supply of drinking water discharge their waste waters directly into the canals, with the consequent worsening of the situation. Other clandestine discharges, that come from some dwellings in the village of San Gregorio contiguous to the Canal Nacional, exacerbate it even more. In addition to that, these irregular dwellings built in conventional and relatively heavy materials (rubble walls and concrete slabs) are unlikely to be able to resist differential subsidence in the soft chinampa subsoils and for the same reason will be much more vulnerable in the case of earth tremors.

The occupation of chinampas with buildings deserves a treatment apart, since there are sufficient data to affirm that in all historical periods not only dwellings but also minor ceremonial constructions have been erected, or neighborhood chapels during the Viceroyalty. But these were scattered constructions of very low density, and in cases of greater density they occupied border areas between the land and lacustrine zones, such as banks or islets. Parsons is of the opinion that this scattered occupation in the central chinampa zones

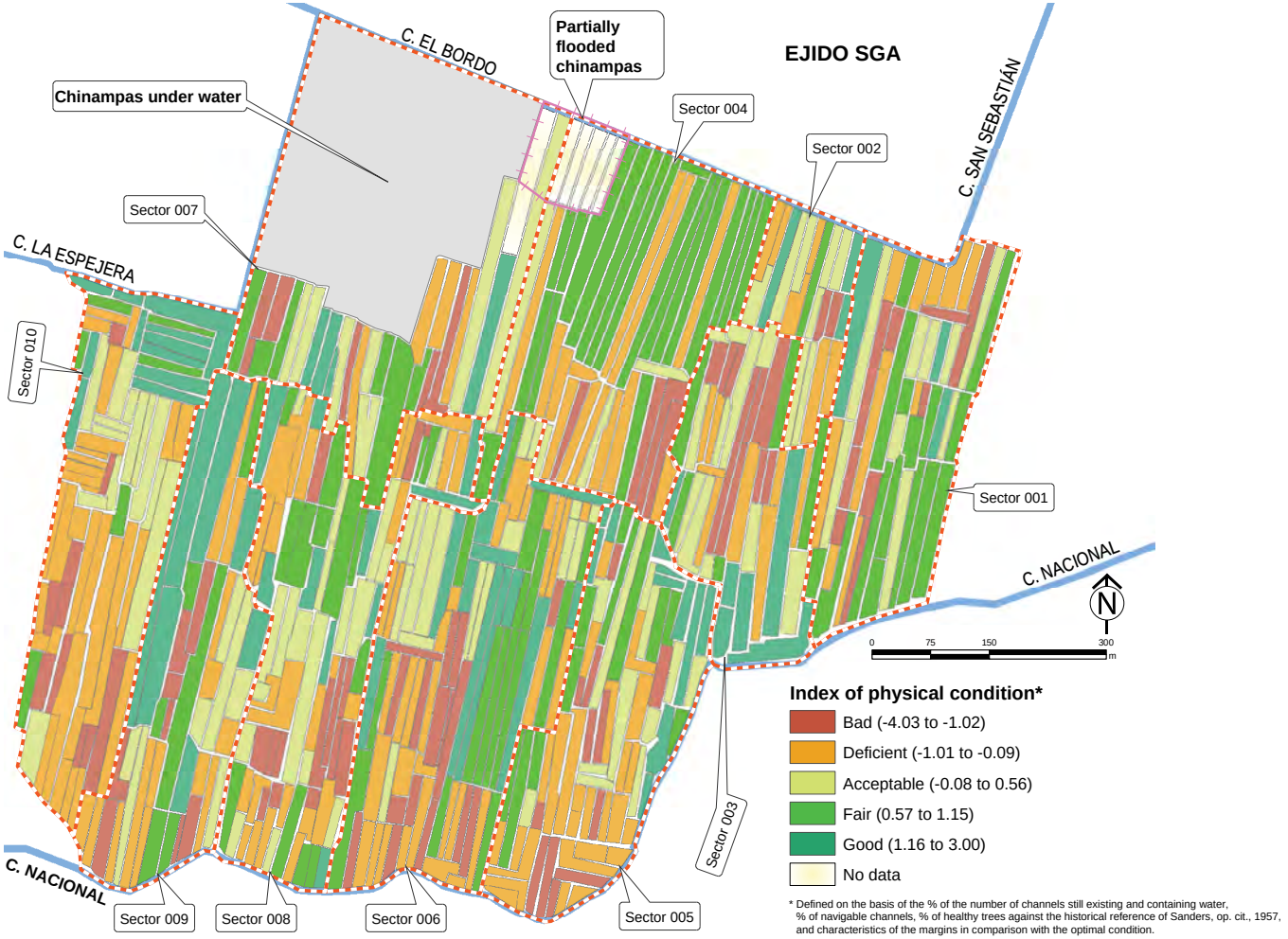
—most notable at the height of the Aztec empire— answered to purposes of local vigilance and control rather than any predilection for those locations as dwellings.[4] And between the late nineteenth and the mid twentieth centuries several authors have gathered photographic evidence of this type of construction: they were single story buildings with tall pitched roofs thatched with straw, and with framed clad walls with the same reeds or rushes that can be gathered in the marshes. In the famous film "María Candelaria" of the 1940s some of those houses can still be seen. But they were few and scattered dwellings, of light materials that the soft soil of the chinampa could bear without any difficulty. Drinking water was supplied from the canals themselves (which in the mid twentieth century still carried clean, fresh water supplied from springs or from the melted snow, and not water polluted with wastes as is now the case); domestic excreta were deposited as manure on the chinampa without contaminating the hydraulic network.

[4] Jeffrey R. Parsons, K. Kintigh and S. Gregg, *Archaeological Settlement Pattern Data for the Chalco, Xochimilco, Ixtapalapa, Texcoco and Zumpango Regions*, Mexico, Technical Papers, University of Michigan Museum of Anthropology, no. 14, Ann Arbor, 1983, pp. 14-19.

Figure 72. Formal house, with all services, good finishes and domestic garden in one of the chinampas in the south of sector 9, next to the Canal Nacional.

Figure 73. Pigsty on a chinampa in sector 10. The presence of domestic animals is common in the village, but when they are introduced in the chinampa area they contribute to the pollution of the water in the canals.

MAP P. Indices of physical condition



The following paragraphs seek to characterize the overall state of conservation of the chinampas studied. This, of course, is the principal result sought by a catalogue which sets out not only to identify and describe briefly cultural properties but has the additional obligation to show their present condition. The latter has been qualified by means of three indices: one refers to the conservation of the factors proper to the chinampas, another to the conservation of the traditional productive attributes and the last to the combination of both factors in one single factor that resumes it all.

As already pointed out in Chapter 5 when describing the cataloguing form, section 8 on the reverse side of the form was reserved for noting the three indices (physical condition, productive condition, and a combination of the former two) which are those we are dealing with now. When filling out this part of the form, it was preferred not to consign the state of conservation of the chinampas as a simple appreciation of the observer, but to obtain this data in the office by processing a number of values accumulated in the database through a method of weighting that was described in the previous chapter.

Map P, therefore, is the result of the evaluations of the attributes registered in the cataloguing forms relative to sections 1 and 2 on the recto of the form, with whose results maps 3 to 10 of the present work were drawn up. The calculated index has a maximum value of 3.0 for the chinampas best conserved as regards their physical condition and a minimum value of -4.0 for those in the worst state.

What the map reveals is that little over half of the chinampas conserve their physical attributes to an acceptable or good degree and tend to be situated towards the north of the zone, while the rest show deficient or bad indices and are to be found predominantly towards the southern part, where the absence of water in the canals, or the low levels as regards both the surface relative to the ground, or the depth of water and relative deforestation of the *ahuejotes* tend to be greater.

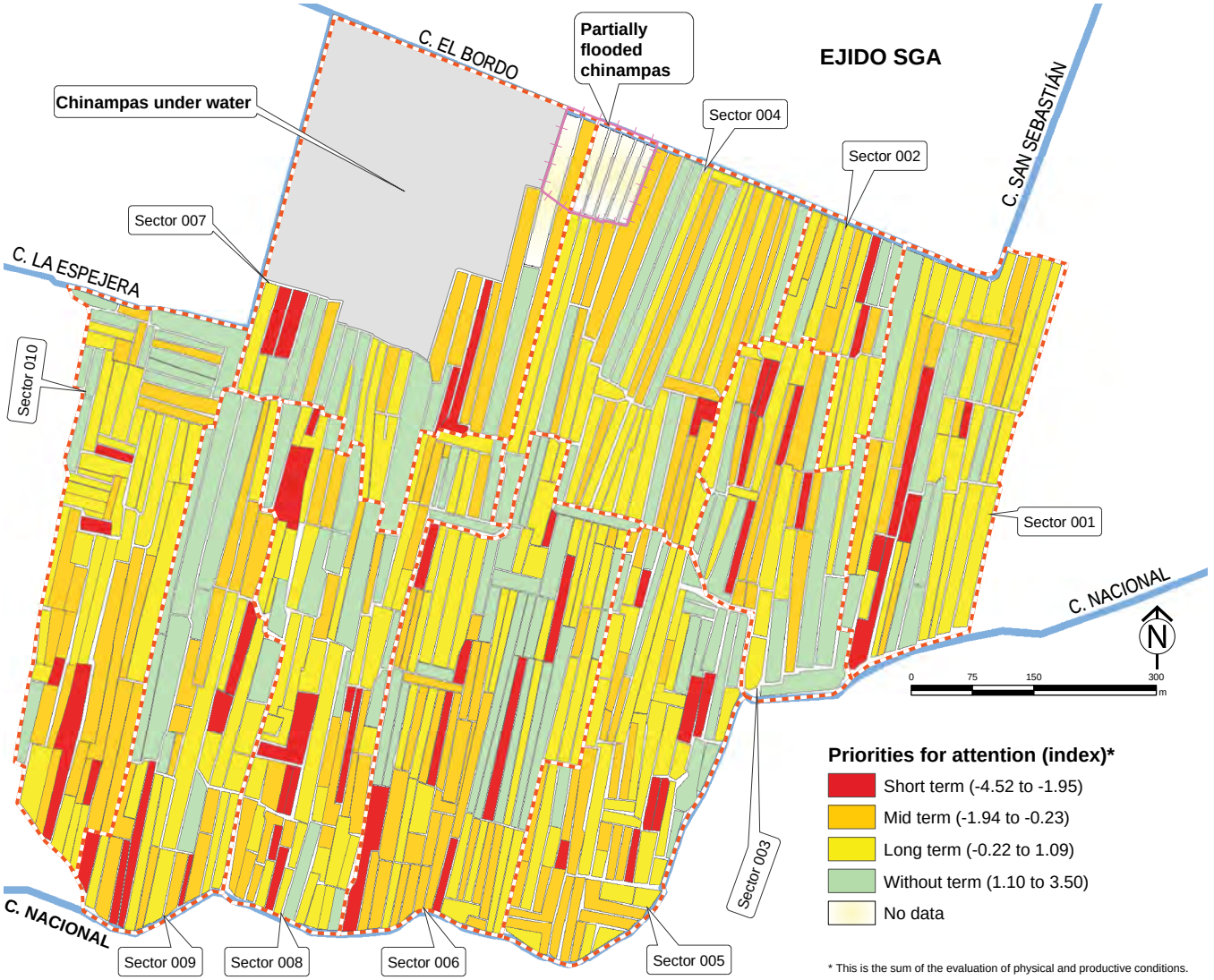
MAPA Q. Indices of productive condition

The attributes represented here as a result of the same process of analysis and weighting consigned in the database of the catalogue refer to parts 3 and 6 which are found on the front of the form, in which the modalities of agricultural production, use of the soil and other characteristics that form part of the chinampa culture are registered. The values in this case go from 1.50 for the best to -3.50 for those in the worst productive state. From this point of view the chinampas in the best productive condition form a small fringe between a large majority of plots in a fair state in the south and a minority with deficient indices. The worst indices belong to those that are abandoned or temporarily out of use, and these are dispersed around both the center and the south of the area studied.

Figure 74. Construction of micro-tunnels over *almácigos*. The plastic is supported on several curved steel rods as can be seen to the right of the photo.

Figure 75. The crop is growing satisfactorily, and soon it will be time to begin harvesting. But the protection with straw between the furrows is maintained until that moment.

MAP R. Priorities indexed for attention



The contents of this last map can be taken as simply a final summary of the state of conservation of each of the chinampas, but it also has an instrumental utility, since the map shows the combination of the two indices commented on regarding maps 14 and 15. It is the integrated and final result that enables us to establish where, and within what period of time conservation actions are required, with very negative factors between -1.95 and -4.50 for the most critical cases, which require urgent and thoroughgoing attention, negative factors between -0.23 and -1.94 for those cases that require some corrective or preventive intervention which, desirably, would take place in the middle term (within about 6 years), and factors varying between 0 and 1, more specifically -0.22 to +1.09 for those cases that only require attention in some aspects and can wait for a longer period (12 years, let us say) in order to recover their good state. A significant minority registers indices of between 1.10 and 3.60, and represent the chinampas in best conditions due to the daily or seasonal maintenance they receive from their own farmers and for the moment do not require any action, and so no term at all is assigned them.

In fact the map can already be used as a guide for setting in train any work of conservation, as is shown in the final part of this chapter.

Reflections suggested by the results

The interpretation of the data obtained and their spatial location in the maps is not very positive and some alarming aspects appear. Probably the most serious, on account of the obstacles it presents for the safeguarding of the chinampas, is the state in which the canal network of San Gregorio Atlapulco finds itself. The fact that a fair number of *apantles* have been blinded would suggest that islets are becoming fused, transforming them from chinampas that exploit the natural moisture of the canals into broader (and also longer) arable fields depending on artificial irrigation or simply on seasonal rainfall. This is something that happened years ago in much of the chinampa zone of Xochimilco and Tláhuac. Maps 4-7 on various aspects of the state of the canal network between 2005 and 2006 leave this conclusion beyond doubt. The process of drying out of the *apantles* is becoming generalized across the whole area of study, but it also shows different grades. It is clear that in the southern half of the area of study nearly all the *apantles* are blinded, while the canals that have become obstructed —a preliminary step in their eventual drying out and elimination— predominate in the northern part that borders on the El Bordo canal. For the most part, the main canals are still navigable in significant stretches in the area of study and continue to function as means of aquatic transport, providing access to the cropped fields. But this should not stop us from recognizing that in the north too there are already stretches obstructed by layers of water lily that impede navigation, while in the Canal Nacional on the southern limit, broad and deep sections excellent for navigation alternate with narrower stretches with the water surface far below the margins or even completely dry or blocked.

The loss of canals and *apantles* has implications beyond the changes that these imply for traditional chinampa agriculture and the facility of transport. Because the canals, besides providing the moisture required for the crops with little or no additional effort, were also an important part of the cycle for maintaining the soil fertile and productive, by facilitating access to the slurry obtained from their beds. Likewise the aquatic flora and fauna in them also included edible species complementary to the diet of the inhabitants or useful for other purposes.

Beyond the negative effects the loss of channels represents for chinampa horticulture, the fact that many islets are merging calls for a series of questions that deserve further investigation. Because the fusion of islets could reflect, for example, a gradual consolidation in land holding, in which the farmer acquires or obtains the right to work the contiguous plot. If this is the case, it could suggest that the ownership of chinampas is gradually becoming concentrated in the hands of a decreasing number of *chinamperos*.

Data are also shown regarding the characteristics of the canals that limited each chinampa, specifically the average depth of the water surface below the land surface and that of the bed below the surface of the water. Map G shows that the deepest channels are concentrated in the northern part of the area of study, that which borders on the zone of flooded chinampas. It is hardly surprising that it is here that we find the greatest concentration of chinampas with the smallest average ground-to-water distance. It is evident that the same process of land settlement that has led to the flooding of the chinampas in the northwestern corner of the area of study is continuing and setting at risk those adjacent to the part already affected. As we move from the north towards the south, towards the Canal Nacional, the average ground-to-water surface distance increases. This is a general pattern. The average ground-to-water

surface distances increase gradually from less than 80 cm and between 80 and 150 cm in the northern and central sectors to reach in a few extreme cases over five meters. The latter plots can no longer be regarded truly as chinampas, since in reality they are raised fields that require seasonal rain or pumped water for their irrigation. This aspect indicates the urgency of reestablishing water levels and consequent hydrological equilibrium in the chinampa zone.

The uneven subsidence in the northwestern part of the area of study is part of a much broader problem that affects not only the valley of Xochimilco-Chalco, but the whole Anahuac basin: the over-exploitation of subterranean aquifers causes the subsidence of the surface. This practice has accelerated notably in the Xochimilco-Chalco valley in recent decades, and the parts situated in the centers of the original lake beds are the ones that suffer the most accentuated rhythms of subsidence. The results have been dire both for the chinampa zones and for the built-up areas that advance towards them.

Although the physical condition of the islets varies considerably, almost the entirety are under some form of partial or total exploitation. The unexploited chinampas are in the part bordering on the flooded chinampas, where many of them are partially affected for at least part of the year. It is also worth pointing out that the productive condition index (Map Q) indicates that nearly the whole area of study has an acceptable or fair productive condition. Nearly all the chinampas with a deficient productive condition are concentrated in the part bordering on the flooded zone, while there is a concentration of chinampas with a productive condition regarded as good just to the south of this zone. Nevertheless, some changes or modifications in the traditional system of cultivation are detected, especially as regards the introduction of new forms of protection of the seedbeds and crops. One of these transformations concerns the use of micro-tunnels which are used for the protection of the seedlings. Another is the use of large greenhouses, whether covering part or the totality of

the chinampa. This practice has appeared in recent years and apparently, although still infrequent, is extending. Another significant modification is the use, already quite generalized, of irrigation with water pumped out of the canals, and in some cases metal piping has been installed for distributing water across islets when several have been merged.

Another general reflection, after seeing the results mentioned above for Maps J, K and L concerning the state of the trees, requires relating these data with other aspects such as the diversity of distances between the chinampa ground and water surfaces, the presence of flooded areas in the northwestern part of the area and the evidence of incipient urbanization on the southern edge of the zone. In general, one can appreciate the gradual loss of *apantles*, which leads to the fusion of the two or more islets and has an influence in the suppression of *ahuejotes*, while, on the contrary, the density of canals regularly spaced and with water levels neither very high nor very low coincides with those chinampas where the density and the state of conservation of the *ahuejotes* is satisfactory. It can also be observed, however, that the most serious problems of infestation that affect the trees tend to be concentrated in the southern sectors, where the urbanizing pressure is strongest; and that on the contrary, the remains of dead trees are most abundant in the north, with predominance of areas that are under water or nearly so. Doubtless, these dry and leafless trunks and branches remain there as witnesses to the effects of a serious hydraulic disequilibrium that has not been attended to and less still remedied.

Other factors on which data were gathered included access to infrastructure, water and electrical energy specifically, and the existence of buildings, whether for storage or dwelling purposes. These data were compiled and included in the catalogue since it was felt that they would give indications regarding the silent process of change from agricultural to urban use — a process that has already put paid to a considerable part of the chinampa zone. Map O shows constructions for use as stores or sheds. These are found scattered throughout the area of study, without detecting concentrations of this kind of construction. However, along the south and west edges some buildings used as dwellings were detected. Likewise it was noted that the few chinampas that already have an electricity and/or piped water service are situated in the southern part of the area of study. It is worth remembering that the southern fringe of the area borders on areas that are already urbanized and that in this zone a large number of canals that are already blinded are concentrated. These factors make manifest that the process of urbanization has begun to overflow onto these parts, and this will be impossible to revert once it takes hold and hence requires urgent attention if it is to be prevented.

The reflections aroused by the last three maps (P, Q and R), which show the states of physical and productive deterioration and the sum of both, are of another kind. Although the physical condition of the islets varies considerably, almost all are under some kind of partial or total exploitation, The chinampas without exploitation are concentrated in the area contiguous to the flooded chinampas, where many of them are already partially affected at least for part of the year. It is also worth pointing out that the index of productive condition (Map Q) shows that almost the entire area of study has an acceptable or fair index of productive condition. Almost all the chinampas with a deficient productive condition are concentrated in the part contiguous to the inundated zone, while just to the south of this zone there is a concentration of chinampas with indices of productive condition regarded as good.

If we set out to qualify the whole set of deteriorations originated by the ill adjustment between the levels of water in the canal network and the ground surface of the chinampas, the drastic reduction of the natural springs that provided the zone with water and the profusion of healthy *ahuejotes* that consolidate the banks of the islets, what claims the attention in these last three maps is that the areas in the interior of the zone analyzed show very variables types and degrees of deterioration, forming a heterogeneous pattern, a kind of mosaic showing marked differences between one islet and another. This pattern is very similar to that seen in urban neighborhoods in a process of decline, where individual properties appear in differing states of conservation without forming obviously homogeneous zones. This suggests that the area of study is in transition, where each plot or islet presents a particular situation with marked differences between them, although the area as a whole shows unmistakable signs of decadence.

The above implies that besides the factors of deterioration that affect the zone as a whole, the islets meet with a great variety of responses of attention on the part of *chinamperos*, varying from the painstaking efforts of some in removing obstacles from the canals or constructing provisional dikes or *costaleras* that slow down the flow of water from the higher levels in the south to the lower levels in the north, to the total abandonment of the most affected parts. This diversity ratifies the value of cataloguing the islets individually, for it is thus possible to assess the level of attention that each one requires in order to revert the process of decadence of the whole.

IX. Some Interesting Applications

Alberto González Pozo and Carlos Eduardo Arriaga Téllez

By way of example, we present the result of a little exercise of application with which we hope to give an idea of the volumes of work that would have to be undertaken in order just to solve three types of problems in the area studied:

1. The rehabilitation of the channels;
2. The reforestation of the missing *ahuejotes*;
3. The consolidation of the banks of the channels.

Of course, there are other matters that ought to be seen to, but that would be part of a fully-fledged strategic conservation plan, that would go well beyond the aims of the present work. Let us visualize the results in the form of a matrix:

Sector/Zone	MINIMUM ACTION PROGRAM FOR 10 SECTORS IN SAN GREGORIO ATLAPULCO						
	Restore canals (linear meters)			Reforest chinampas		Consolidate margins	
	Clean and partially dredge	Dredge partially and rehydrate	Reexcavate completely and rehydrate	Number of chinampas	Ahuejotes to be planted	Number of chinampas	Meters of margins to consolidate
Sector 1	346	968	2 081	34	769	23	2 877
Sector 2	64	158	885	13	209	9	1 123
Sector 3	289	1 035	1 123	25	528	16	2 223
Sector 4	5 027	530	1 223	37	1 300	47	4 283
Sector 5	1 953	970	2 715	36	522	70	6 626
Sector 6	2 807	1 320	4 369	77	1 584	85	9 492
Sector 7	2 587	49	858	22	961	26	2 592
Sector 8	1 108	1 072	2 526	57	1 090	81	8 880
Sector 9	750	341	3 582	39	1 330	42	5 925
Sector 10	1 242	1 029	2 512	57	1 254	70	9 150
Total zone	**16 174**	**7 471**	**21 874**	**397**	**9 547**	**469**	**53 173**
% of chinampas				74		87	

Source: Data prepared by the authors

The figures obtained quantify the volume of tasks that would have to be undertaken in order to attack the problems detected as a result of the work of cataloguing. If one set out just to recover the deteriorated or lost channels in the area studied, it would be necessary to clean of water lily and junk and dredge partially 16.17 km of the total of 64 km of canals in this zone, to dredge partially and fill with water (rehydrate) a further 7.47 km, and also to re-excavate completely and rehydrate an additional 21.77 km.

As regards to the state of the trees that line the canals, actions of reforestation are needed in 397 chinampas, that is to say, 74% of the total in the zone, requiring the planting of 9,547 *ahuejotes*.

And if it is wished to consolidate the deteriorated condition of the banks of the canals, 469 chinampas would be involved, accounting for 87% of the total studied, implying tasks, relatively simple in themselves, throughout 53.17 km of the banks.

Clearly, with these results, any architect or engineer with a minimum of experience can convert these volumes into specific quantities of work with average unit costs from which a program can rapidly be drawn up in order to assign resources and effort.

The matrix also shows that, depending on the closeness of focus that one wishes to adopt for analysis, the database enables the quantities to be retrieved by sector or for the whole area studied (or, alternatively, chinampa by chinampa), which is not without advantages: enabling, for example, the planning of tasks to be undertaken by areas.

This little exercise is only offered as a demonstration of the potential utility of the catalogue in order to arrive swiftly at concrete conservation proposals that, in a cultural landscape such as that of Xochimilco-Tláhuac, imply actions in which a precise attention to each chinampa has to be combined with a holistic vision of the problems of the whole territorial context.

X. Is There a Possible Future for the Chinampas?

Alberto González Pozo, Ignacio Armillas Gil and Salvador Díaz-Berrio Fernández

The results of the work of cataloguing that took place in 2005 and 2006 illustrate the actual situation in a minimal part of the still subsisting chinampa zone of San Gregorio Atlapulco; they also elicit questions concerning the sustainability of this ancient cultural landscape, both for the near future and in the longer term. The subject cannot be passed over, because it is central to the discussions and divergences of opinion regarding the viability of the continued growth of the Metropolitan Zone of Mexico City. By the start of the twenty-first century a figure of over 20 million inhabitants had already been reached, and there is little reason to think that this growth will not continue. Nor is it possible to elude this question when we consider those non-urbanized areas that still exist within the political boundaries of Mexico City itself. For the original, essentially hydrological, character of the ancient Xochimilco-Chalco sub-basin —the most prodigal of all those that made up the complex lacustrine system of the Valley of Mexico— is undergoing a slow but sure process, of extinction. The slow transformation of those ancient lakes —which, during the pre-Hispanic era, were gradually covered over with chinampas— reached its climax just as the Spanish conquest took place; it was followed by a gradual process of decline throughout the Viceroyalty and the first two centuries of this country's independent existence, and now those same chinampa zones are finally confronting their final disappearance.

If this definitive extinction takes place it will represent not only the loss of a cultural property protected by national and international law, but also of an extensive wetland that, together with the green area of Chapultepec, form the priceless remains of the ancient anthropized nature that preceded the Metropolitan Area of Mexico City. Chapultepec and the chinampas of Xochimilco-Tláhuac, are green areas of very different characters but with several features in common: both are surrounded by the urban fabric of the national capital; they are sites favored by the migratory birds that arrive periodically and also fulfill the important environmental function of producing oxygen instead of consuming it. Besides, both house a cultural property both tangible and intangible that endows them with a very important symbolic charge in the popular imaginary. The marshes, bodies of water and wetlands of the ancient Xochimilco-Chalco sub-basin are also potential sites for regulating the hydrological surplus on those occasions —more and more frequent— when copious precipitations collect most rapidly in the lower and flatter parts of the city, since there are less and less woodlands on the slopes surrounding the valley to capture and infiltrate the rainwater in the soil.

If we accept the prognosis of some experts who consider the battle to have been lost,[1] the chinampa territory that still deserves the name is already unsustainable. Let us add here that this will certainly prove true if the urbanizing pressure exercised by the megalopolis upon its margins ends up invading this land and imposing new uses other than the high productivity horticulture which is proper to it, with new urban infrastructures spreading across the territory or new types of equipment operating within it. Likewise, if it fails to receive a larger quota of water of acceptable quality for its canal networks; or if no other

[1] Erwin Stephan-Otto, *Xochimilco hoy: una realidad insustentable*, Facultad de Ciencias Políticas y Sociales, UNAM, Mexico City, 2005.

remedy is found for dealing with the serious disequilibria caused by the increasing differential settlement between the central and peripheral zones of the ancient lake beds; or if, finally, the inhabitants of the ancient chinampa neighborhoods cease to be interested in their fields, if they cease to cultivate them or abandon them.

In reality, the question has to do with the maturity of the Mexican state before itself and the rest of the world. Shall we let an ancient cultural landscape, a territory anthropized in a sustainable way, a highly productive and symbolic site, a cultural asset of a national and universal character, a "natural" and supposedly "protected" area, disappear, as everything seems to indicate, sooner or later?

Those who took part in this study, and many more from different positions, who think that there is a possible future for the chinampa zones, though the path to be taken to achieve this is fraught with problems. This catalogue is barely a first step that needs to be followed by many other and various types of action. This is not the place to describe a complete project for ensuring the sustainability of the chinampa zones, but we do not wish to end this publication without sketching at least some of the fields that could and should be explored in this direction.

Consolidating the bases for understanding the problem

Knowledge concerning the chinampas is not the subject of a single discipline but of many that come together on a single reality. In Mexico and beyond there are many people and institutions involved in the various disciplines or professions that have a bearing on the chinampa zones: geography, hydrology, ecology, anthropology and archeology, history, biology, agronomy, economy, architecture, urban and regional planning, heritage conservation,

engineering and public administration. In three seminars held between 2006 and 2008 we were able to identify more than a hundred experts in those disciplines genuinely interested in what is happening in those zones and committed to studies that seek a better understanding and feasible solutions for their problems. The higher education institutions must foster contact and interaction between all these specialists as well as the consolidation and dissemination of the knowledge they have obtained in their respective fields.

In this context, the continuation and completion of the work of cataloging the existing chinampas may be a decisive element for agglutinating several of these disciplines. And this pending task must be of interest particularly to the institutions whose responsibilities include the conservation of the cultural heritage: the Instituto Nacional de Antropología e Historia and the Mexico City Government's Cultural Secretariat.

Ensuring the participation of the *chinamperos*

The participation of the chinampa producers is an essential condition in any process that aims at conserving and consolidating their productive territory, and this includes the contribution they can also make to enriching the field of knowledge, since they are the real experts in this matter. They must be listened to with attention, and the methods for gathering their experience can be those of oral history, audio or video recordings, meetings and interactive workshops between them and actors or experts in this or other fields and citizens in general.

It must not be forgotten that among the proposals made in the early 1990s for correcting the inordinate "ecological restoration program" that was then proposed, those of the *chinamperos* were the most intelligent, concise and feasible.[2]

It is also important to take them into account in the implementation of whatever restoration methods may be advisable. They have taken care since ancestral times to attend to many of the problems that nowadays affect the chinampa zones, and still today carry out many such labors of protection as are within their means. What they need is technical advice and financial support for some of the tasks that they could undertake, such as the cleaning of the canals, the consolidation of the banks, the reforestation with *ahuejotes* where these are missing, and the treatment of the infestations that affect them. This is apart from other kinds of support that public and private bodies could offer them to improve, stimulate or finance their means and processes of production and marketing.

Integral solutions for water shortages and use

Despite what the *chinamperos* have done, or can do, individually or as a group, there are tasks that are well beyond their reach. Even the local boroughs and the Mexico City government face limits where actions are concerned that involve not only the Valley of Mexico but the country's whole central region. Because the present situation as regards the system of water provision and the final disposal of surface and waste water goes beyond the confines

[2] Beatriz Canabal Cristiani, *Rescate de Xochimilco*, Universidad Autónoma Metropolitana-Xochimilco, Mexico City, 1991.

of the basin — and this in a territory of an endorrheic character and endowed with plentiful rainfall, in which civilizations and capitals of great importance have flourished.

Nowadays, 35% of the water consumed by the Mexican megalopolis originates in sources far outside the basin, some of them situated at lower levels, some as much as a kilometer lower than that of the valley bottom, while the remaining 65% comes from deep wells within the basin that are extracted mainly from below the ancient lake bed, leading to a process of differential subsidence that affect equally urban spaces, buildings and chinampas. And, paradoxically, instead of being filtered back through the soil, the rainwater that falls on roofs, patios and road surfaces simply joins the flow of waste water in the combined drainage networks that are fed into the great interceptor and outlet tunnels that discharge all the liquid outside the basin.

It is possible that some palliatives could be attempted to this situation without altering the bases of such an absurd form of behavior, to which have to be added the appalling culture of everyday water use that shows little concern for avoiding waste, and the loss through leaks in the old networks that are beginning to fail after many years of service. But a partial solution to this extremely irrational model of water management would do no more than postpone a more thoroughgoing solution which in any case is indispensable to undertake. Various authors, among them Jorge Legorreta,[3] have pointed to certain principles in this respect that are obtaining an ever greater consensus.

If a more rational model of water management in the Valley of Mexico is opted for, some of the basic problems that affect the chinampa zone as a result of the water shortfall

[3] Jorge Legorreta, *Ríos, lagos y manantiales del Valle de México*, Universidad Autónoma Metropolitana and Gobierno del Distrito Federal, Mexico City, 2009..

could be closer to finding the solutions they require. Among these would, very probably, be the following:

- Cleaning, restoration, and regulation of all the natural watercourses that descend from all the watersheds around the valley towards the ancient lacustrine basin. Construction of dams and impounding reservoirs, particular in the vicinity of the chinampa zones, to feed them. In this context, it is worth awaiting the results pending from two projects undertaken by the UAM recently: one in relation to the Sierra Nevada and the rivers descending from it and another involving recovery of the Canal Nacional between Ciénega Grande and Rio Churubusco.
- Construction of infiltration wells at the limits of the marshes in order to halt the differential subsidence and begin as soon as possible the recovery of the original levels. There are executive projects in this respect that were proposed by the FAO in its 1987 report. These could be revised and brought up to date if necessary.
- Do the utmost to remedy the sanitation of the urban areas bordering on the chinampas, avoiding clandestine discharges into the canal network by completing or extending the sanitary drainage networks in those zones. As a provisional measure, introduce filter barriers at strategic points of the canal network in order to improve the quality of the water. There are several institutions working now on prototypes for this purpose.
- The future of the marshes, especially the Ciénega Grande, depends mainly on the determination of the *ejidatarios* of San Gregorio who have defended this territory with the same vigor as their ancestors during the Viceroyalty and the Revolution. Although at present they act as flood-control reservoirs at times of heavy rainfall, it must not be forgotten that in the past they were also chinampa zones, and the

ejidatarios, many of whom are also owners of chinampas in San Gregorio, have not forgotten it. It is possible that even if they wished to do so it would not be feasible to entirely recover that ancient function, in which case perhaps the best thing would be to treat the lowest areas as wild wetlands more than as formal regulators. This would also contribute to the recovery of wildlife in the zone, particularly in view of the seasonal stopover made there annually by migratory birds. Other aquatic species could also be reintroduced successfully.

Exploring and facilitating viable technological advance for horticultural production

Since the sixteenth century the *chinamperos* have adapted themselves gradually to the technical advances that have penetrated from other cultures. The mattock or grub-hoe and the products cultivated were adapted to the demands of new eras in the same way that now the power tillers, gasoline-driven pumps, hosepipes, meshes, micro-tunnels and greenhouses —as well as crops such as broccoli, French or Italian lettuces— are more and more frequent and successful. In any case, it is the *chinamperos* themselves who have consciously appropriated these novelties and this is how things ought to proceed in the future.

This is not to imply that they should not be kept informed about advances in various fields of technology, so that they can be made aware of them, evaluate them and decide whether they wish to adopt them. Several institutions are working on solutions to problems involved in the productive process that are at the same time practical, economic, organic and non-polluting. One way of facilitating this process would be to create a Center for Experimentation in Chinampa Agriculture in the zone, with the obligation to disseminate

and extend whatever progress it makes. That would be the first step in advancing eventually towards a more formal institution for practical training, middle and higher education, and research serving directly the population of the chinampa areas. This could also be a suitable place for exploring, for example, simple systems for exploiting solar energy in greenhouses.

Recovering the symbiotic relation between Mexico City and its chinampa zones

The present publication and particularly its Chapter 3, has underlined continually the symbiotic, complementary relation maintained from the beginning, between the Mexican capital and the chinampa zones of the Xochimilco-Chalco sub-basin. This was a symbiotic, complementary relation without which neither the urban organism or the rural territory of prodigally high productivity in its vicinity could have achieved such progress and success over such a long period of time. Today, when urban growth has reached unsustainable limits and local horticultural production no longer seems indispensable for the survival of a metropolis that supplies its alimentary needs from the whole country and beyond its frontiers, it is necessary to reestablish that successful interdependence, perhaps on new foundations that overcome the increasing opposition between the immediate goals of urban development and the medium and long-term objectives of ecological equilibrium, agricultural development and the conservation of the cultural heritage.

In discussions on this subject almost nobody has reconsidered something we pointed out at the beginning of this chapter: the importance of the two main green areas possessed by Mexico City: Chapultepec and the chinampas of Xochimilco-Tláhuac. Both zones contain a cultural heritage of metropolitan, national and world rank. And both constitute

powerful reservoirs, infiltrating rainwater into the subsoil, absorbing carbon and producing oxygen, and thus helping to improve the climate and provide a home for many endogenous and migratory species. If they are conserved and developed adequately —Chapultepec as a recreational woodland of the first importance, and Xochimilco-Tláhuac mainly as a productive wetland— the apparent contradiction between urban development and conservation of culture and the environment would seem to vanish.

Disseminating a generalized awareness on the salvaging of the chinampas

But all the above is no more than a series of hypothetical possibilities; what is most immediately urgent is to strengthen an awareness that already exists in various sectors of society, beginning with the *chinamperos* themselves. For the more widespread the recognition of the value of the cultural landscape of the chinampas becomes, the greater will be the political pressure to prevent their disappearance. To this end an impulse must be given to efforts of research and dissemination such as this one fostered by the UAM and the Borough of Xochimilco with the support of SEDESOL in favor of increasing knowledge of the chinampa zones at the dawn of the twenty-first century. It is a modest beginning that covers a mere 4 or 5 percent of all the chinampas that still subsist, yet already unveils problems and suggests some measures to go about solving them. It is only a first step, but a firm one that needs to be followed by many more, from a variety of disciplines, without losing sight of the primary aim. A traditional dictum in Mexico has it that *Sin maíz no hay país* ("No corn, no country") — an adage that we support because it expresses the close relation between the genetic integrity of a crop and its intimate connection with the aboriginal diet and culture of the Mexicans; and to that we can perhaps add this other piece of wisdom: *Without its chinampas, no Mexico City is possible.*

Glossary of terms

Acalote: Canal of intermediate breadth, between 3 and 8 meters.

Ahuejote: (*Salix bonplandiana*), species of willow of elongated form which prospers on the margins of the canals.

Apantle: Narrow channel, between 1.5 and 3 meters.

Chichicastle: Aquatic plant with fine leaves that does not impede navigation in the canals. When harvested, it has various useful applications.

Chinampa: Islet raised artificially on lakes or wetlands for agricultural purposes, generally rectangular and elongated, ideally surrounded by canals that hydrate its cultivable soil.

Coa: Hardwood pole, pointed at one end, that the pre-Hispanic peoples used for preparing the soil for planting.

Cuero, Cuera: Leather bag that that can be filled with water from the canals for irrigating the soil of the chinampa, with the aid of a pole attached to it.

Ejido: "Institutionalized form of land-holding which consists in the government granting property rights to lands to a group of people authorizing them to work it and obtain the benefits of its exploitation" (*Diccionario del español de México*). In practical terms, an *ejido* consists of lands farmed by peasant farmers who have a family right to succession but where the state is the formal owner. Officially these plots cannot be sold or converted to other uses.

Ejidatario: Peasant farmer enjoying the right to farm land in an ejido.

Huachinango: Name given by the *chinamperos* to the water lily that infests the canals, covering them while nourishing itself from the water and impeding navigation.

Malacozoma: A moth whose larva infests the foliage of the *ahuejotes*, often causing the death of trees.

Milpa: Strictly, maize crop or fields used for growing maize, usually on rain-fed arable lands; nowadays sometimes applied to cultivated fields in general.

Muérdago: Parasitic plant that grows at the expense of the branches and foliage of the *ahuejotes*.

Trajinera: Type of punt, a flat-bottomed boat with minimal draught that is used to navigate in the canals and *acalotes*. The smallest type is called *chalupa*.

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On the southern edge of Mexico City lies a region of ancient historical and cultural tradition that has aroused the interest of both academics and authorities for many years: namely, the extensive areas of chinampas in the vicinity of Xochimilco. These have been studied from a diversity of perspectives: biological, anthropological, productive, social and even political; however, until now nobody had set out to catalogue these horticultural islets.

Since 2005, a group of researchers from the Division of Sciences and Arts for Design and other invited specialists, coordinated by Dr. Alberto González Pozo and supported by a collaboration agreement between the local Borough of Xochimilco and our University, has been engaged in this task.

This cataloguing process was a necessary step in the process of safeguarding and rehabilitating the chinampas of Xochimilco, which at present are regarded as a site of exceptional and universal value both from a historical or esthetic, and an ethnological or anthropological, perspective, in an effort to protect this cultural heritage that is of concern both to Mexico and to the international community. In other words, to contribute to the raising of awareness as regards the cultural value of the chinampas among as wide a range as possible of authorities, academics, *chinamperos* and visitors in support of their conservation. After all, what would Xochimilco be without its chinampas?

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