GIS and land use in texcoco municipality, Mexico:: contrasting local and official understandings

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GIS and Land Use in Texcoco Municipality, Mexico:

contrasting local and official understandings

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Declaration

No part of this thesis has previously been submitted for a degree at this or any other University.

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Abstract

Planning design in a 'top down' and technocratic way has not always been relevant to agricultural development. Decision-making on land use in Mexico is a complex process involving environmental, socio-economic and cultural issues. Land use at 'local level' is associated with access by individuals or groups to diverse resource bases. Fundamental issues for planning land use in these complex environments revolve around diversity of land resource, access to resources, social organisation, institutions for management of resources and the perceptions of the people about the resources and the associated decision-making process at grassroots. In this context, understandings of the complex set of resources available and the opportunities of land users to make a living in agriculture and its associated decision-making process by individuals or groups is essential.

This study has undertaken the task of analysing information produced in a municipality and *ejidos* in central Mexico using participatory methods for collection of information relevant for planning and the production of maps of resources at municipality and *ejido* level using participatory GIS. Participatory mapping of resources at municipality and *ejido* level not only allowed the mapping of resources according to the perceptions of the people, but also made the GIS accessible to people on the ground; they were able to make their own maps for understanding land use change and as a base for land use planning. This information was compared with maps produced either by official government agencies or from official statistics. In the former case the approach taken for map production was to use as a basis standard technical procedures for resources eg soil/land use classifications. This contrasted with the 'practical' approach adopted by the ejidatarios. In both cases the accuracy and reliability of the official maps and 'statistics' was open to question. Decision-making for land use based on information from the 'ground' emerges as an adaptive process, depending on government policies

and its adaptation by the people. The views of people on the 'ground' producing maps using GIS helped in understanding land use decision-making processes.

This research concludes that is vital for a successful path to agricultural development in Mexico to see land use planning not simply as a 'technical' pathway of government policy driving practice, but as a more complex interaction process. Also it is necessary a change to a more 'soft' land use planning process driven by the practices of local people. This requires a significant change in attitude from people involved in planning and implementation of agricultural programmes, as it requires policy makers and their agents to learn and understand the attitudes and traditions of the very people they hope to serve. Without this interaction and negotiation the future for agricultural policies in Mexico will be as unsuccessful as those of the past.

Dedication

To the ejidatarios and the agriculturalists of the Escuela de Agricultura de Chapingo who, with their blood, sweat and tears, have been irrigating the agricultural fields of Mexico.

Especially in memory of my Father

Donaciano Ojeda Ortega †

(Generation 1929-1935)

my uncles

Luciano Ojeda Ortega†

Zacarias Ojeda Ortega†

(Ejido Parras, Guanajuato)

and to my uncle

Ismael Trejo Silva

(Generation 1935-1942)

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Preface

Act of inauguration of the Escuela Nacional de Agricultura

Today, twenty third of November, one hundred and ninety twenty three, is opening in this Hacienda of Chapingo, the new Escuela Nacional de Agricultura, reformed in its methods, aims and aspirations according to the fundamental idea which boosted ten years ago the Mexican working class, to throw themselves to a Revolutionary fight against the social and economic conditions that have prevailed in this country since the conquest days.

A group of willing individuals, totally convinced by the immense desire of justice and truth that motivate the spirit of Mexican peasants, meditate planning, and lead to reality the reforms, methods and aims that shape the spiritual environment, the moral objectives and practices, which form today the life of this school. It has been intended to build here a nucleus of people that believe in the work as a unique and sacred instrument of human life. From here, will be raised, if the misery and moral backwardness of the elements of the society that antagonise with our ideas do not get in the way, wholesome free men, sons of the land who owed everything to her and have a harsh and quiet devotion to her, as all the great things deserve.

This Escuela Nacional de Agricultura has as an internal ideal of effort, a more modest point of view, but more sincere than all the schematic propositions of the agricultural capitalism of the age in which we are living, thanks to which exists millions of humans enslaved to the production task, while other millions are dedicated to raising the life costs, for the final benefit of a privileged few that take personal advantage of wealth and profit.

This school does not have a spirit oriented to ambitions to make profit nor to economic dogmas sealed with overcrowding of skulls and myriad ruins, as in the sad European collapse of 1914. This school advocates an ideal human being of modest comprehension and affected comradeship among the men that work the land, without trying to lead them towards the slope of the big agricultural exploitation that needs to flourish and prosper the suffering of enormous multitudes of wage-earning without any hope.

Here it is pretended that the small farmer will be the master of himself, friend of his region, supporter of the peasant citizenry. It is for this that we entitle as modest the educational programme of this school in this economic aspect, as working like that with an intimate desire to be guided by our social truth, we would go a very long way, knowingly how to prepare the ground to follow for future generations.

The land does not have owners, she is the loving and fruitful mother of all those who interpret the mission of the human being with humanity and loyalty; we advocate a philosophy of devotion to the effort without egoism, without slavery and without privileges; we believe that the supreme way to be free is to achieve that the agricultural organisations be devoted to production for the common wealth, and not to flatter the lustfulness of the masters. If it results that we are not called to achieve the big deed that we outline here, then others, stronger and better qualified than us pick up our campaign flag symbolised in the present fundamental idea:

> 'to teach the exploitation of the land, not the men'
> 'Enseñar la explotacion de la tierra, no la del Hombre'

List of Acronyms

AGEB	Area Geoestadistica Basica
ALES	Automated Land Evaluation System
APT	Agricultural Planning Toolkit
ASERCA	Programa de Apoyos a la Regionalizacion y Desarrollo de Mercados Regionales
CAEVAMEX	Cento Agricola Experimental del Valle de Mexico
Catarina	Santa Catarina del Monte
CIMMyT	Centro Internacional de Mejoramiento de Maiz y Trigo
CP	Colegio de Postgraduados
DDR 03	Distrito de Desarrollo Rural 03
DTM	Digital Terrain Model
FAO	Food and Agriculture Organization
GATT	General Agreement on Tariffs and Trade
GIS	Geographical Information System
IGECEM	Instituto Geografico de Estudios Catastrales del Estado de Mexico.
ILWIS	Integrated Land Evaluation System
IMF	International Monetary Fund
INEGI	Instituto de Estadistica Geografia e Informatica
INSTRUCT	Inter-American Network for the Study and Development of Natural Resource Use for the Transformation of the Community.
ITC	International Institute for Aerospace Survey and Earth Science
LECS	Land Evaluation Computerised System
NAFTA	North America Free Trade Agreement
Nativitas	Santa Maria Nativitas
NGO	Non Government Organisation
PC	Personal Computer
Pedro	San Pedro y Santa Ursula
PLT	Plan Lago de Texcoco
PRA	Participatory Rural Appraisal
PROBOSQUE	Programa de Desarrollo Forestal Del Estado de Mexico
PROCAMPO	Programa Alianza para el Campo

PROCEDE	Programa de Certificación de Derechos Ejidales y Titulacion de Solares Urbanos
PRODEFOR	Programa de Desarrollo Forestal
RAN	Registro Nacional Agrario
RPE	Regional Political Ecology
RRA	Rapid Rural Appraisal
SAGAR	Secretaria de Agricultura y Desarrollo Rural
SAP	Structural Adjustment Policies
SCM	Santa Catarina del Monte
SEDAGRO	Secretaria de Desarrollo Rural del Estado de Mexico
SMN	Santa Maria Nativitas
SPySU	San Pedro y Santa Ursula
SRA	Secretaria de la Reforma Agraria
UACH	Universidad Autonoma Chapingo
UNCED	United Nations Commission for Environment Development
UTM	Universal Transverse Mercator
WCED	World Commission on Environment Development

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Chapter 1 Introduction

1.1 Introduction

When I started this research, I was very impressed with the writings of Chambers (1986, 1992, 1994), Blaikie (1987, 1991, 1996), Booth (1994), Long (1989, 1992, 1997) in which they expressed their concern about impasses in environmental and social sciences. They pointed out that the approaches on sustainable development, environmental management and in agriculture were seen as the most written about, but least funded, and that these approaches were overshadowed by the neo-liberal and economic agenda.

Against my will and previous background I was thrown into the Neo-populist developmental agenda. This paradigm originated in the 1970s as a rejection of the classical top down technocratic techno-centric and state led model of technological transfer that leads to the reappraisal of previous development experiences. These models preach about the practice of participatory and indigenously based empowerment, and the 'development interface' between physical and social sciences.

The paradigms for development are seen by Blaikie (1996) as an ideal type and a model to be emulated. Each of these development paradigms is

' a system of thought , and in the development context, is internally consistent with a particular view of human decision-making, a set of development goals and theoretical and normative assumptions about social change. Their expansion and elaboration is brought about through the formation of epistemic communities in an uneven and often contradictory manner (there are contradictions in all "communities"),....... Theory and practice -and development is not the exception- is contextual, contingent and always changing. The notion of the paradigm is an abstracted, idealist and universalised model which make sense of this diversity, but necessarily freezes it in time. (Blaikie 1996, p8).

Gradually along with my readings and through the results of this research, I realised that for 20 years as an academic I had been following the main streams and narratives in land use planning designed by 'experts' in a 'top down' and technocratic way based mainly on optimal use or economic principles. In my home institution, the more technocratic an approach, the more funds it received from the Government or external agencies. However my personal concerns were rooted in sentiments such as the poverty that I found all the time in my contact with the rural communities during my work in different areas of Mexico. The sentiments for anti-centralised bureaucracy, and the focus on the peasantry that were sown by my father[1] and as student in my agriculture school were reborn again, and how to understand the peasantry and their problems became a concern in this thesis.

1.2 GIS and land use planning

The actual current mainstream in planning seems to emphasise sustainable land management taking into consideration grassroots information, with an actor oriented process of dialogue and negotiation and a wish to gain access to relevant information, networks or target groups (Blaikie and Brookfield, 1985; Long, 1997, Cecarelli 1996; FAO, 1997; Roling 1991, Roling and Wagemakers, 1998). This approach sometimes called a 'soft' approach that includes collection of data about the perception, needs and knowledge of land users about their resources. The approach is based in the use of methods for project identification and collection of data on the 'ground' such as RRA and PRA, promoted as mode of participatory situation and problem analysis as the 'starting process' for planning. The second step is the identification of problems and design projects, based on the demands and necessities of people.

However, it has been pointed out by several authors that the current models for planning and decision-making have been altered only in its phases with little changes in procedure (situation analysis, problem identification, goal formulation, selection of alternatives, implementation and evaluation). In essence, the models propose that change comes about through this kind of activity with still a top down approach (Rossiter, 1996; Cecarelli, 1997; Burrough, 1997; Dent, 1997; Leeuwis, 2000) .

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[1] My father was a senior office in the Secretariat of Hydraulic Resources, and head of the Department of Soils in the University of Chapingo. His colleagues of the National School of Agriculture of Chapingo (Actual University of Chapingo) were in charge of planning agriculture focused in irrigation projects, and in the ejido. However their approach to development was changed by the Green Revolution in the middle sixties. My father and his friends were for me an example of work and devotion to the land, and they followed always the slogan of their school 'Enseñar la Explotacion de la tierra, No la del Hombre' (Preaching the exploitation of the land, nor the exploitation of the men')

Participatory methods such as RRA have been included in the procedures of planning; however, analysis and planning are still mainly in government offices. PRA enhanced knowledge of the people and their competence and ability to make demands, and to sustain action. The agendas of most researchers, government and NGOs, however are mainly oriented to get funding, and decisions of resource allocation still remain at top (Leeuwis, 2000). Thus land use planning is still promoted as a "top down" approach implemented by funding of international agencies and governments to 'experts' for the identification of development projects with the 'experts' most of the time looking for national and international funding (Blaikie, 1990, Leeuwis, 2000).

Recent changes in land use planning are referred to more as a learning process or collective learning (Blaikie, 1985, Orstrom, 1990; Pretty and Chambers, 1994; Roling and Wagemakers, 1998, Long, 1997) more than as planning and decision-making models. Political ecology (Blaikie, 1985) and actor oriented approaches (Long, 1997) go further and ways are proposed to explain the complexity of rural development. The first seeks the identification of causes and significance of problems in the use of resources, considering the social dynamics at local level and interactions between resource use and social dynamics that influence the political economic process at the macro level. The second is based on the analysis of heterogeneity of the existing agrarian structures and farming systems, in which changes in the actual patterns of livelihood of rural people are the results of complex interactions between individual and groups endowed with different and changing amounts of knowledge and power. As a consequence rural development is a heterogeneous process involving multiple levels of values and realities such as local patterns of organisation and management of resources from local to regional to national development programmes and institutions.

In these new approaches to planning and decision making, GIS by its capacity to integrate information, production of new data and analysis is seen as a tool for the integration of data already available for planning and to produce, together with the users' information on 'ground', in a more formal and rapid way to be used for planning and decision making on land use (Edney, 1991; Taylor, 1991; Yapa, 1991; 1995; Rundstrom, 1995; Sheppard, 1995; Dunn et al, 1997; 1998; Harris an Weiner, 1998; Clark 1998, Abbot et. al, 1998).

As pointed out by Weiner (1995) however, the utilisation of GIS for research, planning, and project evaluation, frequently is in the mode of "top-down" data creation and expert "policy making" that empowers the powerful and disenfranchises the weak, where it is being used in a planning and/or decision-making capacity. GIS is an integral part of defining and implementing agency decisions and often reflects the internal rules and value systems of the agency controlling it. Decisions regarding what issues to address, what data to obtain and how the data should be classified and analysed, and what interpretations are drawn from them, are thus agency driven rather than community driven.

A sector of the academia is calling for a participatory decentralised GIS arguing that GIS is usually seen as an 'expert system' in development projects and programmes reinforcing the politics of power on which 'top down' development planning is based, also this elitist access is by the cost of software and the level of expertise required to manage it (Edney, 1991; Taylor, 1991; Weiner et al, 1995, Abbot et.al, 1998). The main concern of application of GIS in less developed countries is that it could reinforce top down development restricting access to data, software and the level of expertise required. To cope with this problem the development of participatory GIS has been propose as an alternative for the involvement of people using GIS technology (Yapa, 1991; Rainstorm 1995; Dunn et al, 1997; Abbotet.al, 1998; Harris and Weiner, 1998). In contrast with 'expert systems' participatory GIS is

> 'therefore, an attempt to use the technology of GIS in the context of the needs and capabilities of communities that will be involved with, and affected by, development projects and programme'..... 'Participatory GIS draws on the diversity of experiences associated with 'participatory development' and involves communities in the production of data and spatial decision-making' (Aboot et.al, 1998 p.28).

1.3 Thesis background and study area

This thesis explores land uses and their understanding by official and local people in the municipality and three ejidos in Texcoco, Mexico. It seeks for an integral understanding of the land use process through its changes, their characterisation through mapping by both official and local people, the analysis of their organisation for the use of resources; and finally the interface with government programmes is explored. Studies, which focus on two levels of analysis such as municipality and ejidos and integrate information of official and local information using GIS, have been few. This research aims at breaking new ground, especially in the context of mapping and understanding of the complex process of allocation of resources through a land reform and the associated decision-making on land use.

Agriculture in the municipality of Texcoco is rooted in Prehispanic times, with a long history of interaction among government and local people in the use of resources. As my previous background was mainly in soils and land evaluation, some of them on land use at municipality level, the research was an opportunity to expand the analysis by the integration of social data, and mapping on the 'ground'. This gave the opportunity to explore the issue of heterogeneity in resources and understandings on land use.

However, very early it was realised that the collecting information would not be as easy as earlier expected. Political and personal issues restricted information in government agencies and in both the municipality and ejidos which was often non-existent, incomplete or inaccurate. Similarly the inventory maps of resources were useless for the purposes of the research or some such as ownership were oversensitive. Also the people had been overexposed to interviews, and discussion as a result of constant participation in community activities. This made obtaining interviews difficult. Thus resort was made to open interviews, direct observation, mapping, and transects to increase the participation of the people.

From this work, contrasting views on land use emerged between official and local understandings.

1.4 Aims and objectives of the thesis

The approach adopted in this thesis rests on the understanding of land use and its changes, based on the description of the agrarian structure and allocation of land in the context of the municipality of Texcoco. The inherent complexity of land use and its associated decision-making hinges on wider environmental, socio-economic, politico-cultural and institutional issues, which are locality specific.

The aims and significance of the research are twofold:

1. Integration of information about physical resources, land tenure and government programmes, and production of maps on the 'ground' by the people at municipality and ejido level using GIS.

This approach adopted to 'fill the gaps' in information among official and local understanding of land resources and aimed to uncover the diversity and heterogeneity of land use and decision-making. This information was considered necessary to enable the development of a workable method for the use of GIS with an incremental approach in the municipality and ejido, to understand the organisation underlying land use and to informing policy formulation.

2. To describe the changes in land use produced by the application of government policies and land tenure legislation.

The role of the people, the changes in land use and management and the adaptation of land uses to the new conditions and its impact in land use in general was documented. The essence of this was to include the views of local people (both government officers and ejidatarios) to obtain information based on their experiences and perspectives.

To address comprehensively the issues raised above, the research had the following supporting objectives:

1. To integrate maps and databases at municipality and ejido level, from different government agencies, into a GIS.

2. To produce maps of the resource base of the municipality and ejidos both from official sources and participatory surveys in order to produce qualitative and quantitative records of resources and physical environment.

3. To develop a means of integrating qualitative information from PRA and RRA into a GIS, in a "participatory GIS" framework.

4. To describe the agrarian structure and its evolution in the municipality and ejidos to understand heterogeneity in allocation of resources.

5. To involve local people in the mapping and identification of land use, and to determine their response to Government Policies. From which and understanding could be made of their reactions and hence comparison could be made with the policy objectives and 'on ground reality'.

6. To study the dynamics of land use changes within a long historic and politico-cultural frame.

1.6 Thesis structure

In Chapter one, the context of the research problem and the conceptual issues that led to its understanding are provided.

Chapter two presents a literature review focusing on issues of land use and GIS. The review evaluates existing literature, while considering their characteristics foci, as well as summarising land use planning and the agrarian structure in Mexico. The review also covers issues of Participatory and Rapid Rural Appraisal, and the current approaches to rural development.

Chapter three provides the background to the study area providing a brief description of the municipality of Texcoco, in terms of its physical characteristics and socio-economic resources.

Chapter four explains the methodology used in the collection of information and mapping of resources.

Chapter five provides the historic evolution of the agrarian structure and related laws and the evolution of the dual system of tenure of land as private and communal in Mexico. The emphasis is on the land reform of the Twentieth Century and the reforms of the land tenure introduced in 1992.

Chapter six describes the process of allocation of land as ejido through land reform to the pueblos of the municipality of Texcoco and the programmes implemented for rural development are examined.

In chapter seven the space-time mapping of land resource base of the three ejidos using aerial photographs, satellite images, transects, participatory mapping is described. The interaction of people-land use is explored in an attempt to understand the changes in land uses, access to land, and change in income activities. The way in which the ejidos have responded to Government interventions is also considered.

Chapter eight presents a comparison of the three ejidos and attempts to explain the reasons behind the contrasting approaches to land use and responses to government interventions and regulations.

Finally, chapter nine concludes the study drawing together all the different strands relating to the overall investigation. It stresses the importance of appreciating the agrarian structure for the understanding of people-land use relationship and the complexity of the dynamic processes of adaptation made by the farmers to the government laws and policies.

Chapter 2 Land use planning, Geographical information systems, political ecology and rural development.

2.1 Introduction

Land use planning and management of land resources are issues receiving renewed attention in the face of ever increasing competition for land. This is linked to a number of factors including: growth in population, increasing demand for non-agriculture land use, unequal distribution and access to the land, unresolved land management and conservation problems more recently structural adjustment programmes (eg. IMF and the applications of Structural Adjustment Programmes, commercial agreements like GAAT and NAFTA) and specific politics like land reform that changes the relation between farmers and institutions (WCED, 1987; UNCED, 1993, Gordillo de Anda, 1993,1995; FAO, 1995a, FAO, 1995b, FAO, 1997)

In these new contexts of development approaches of land use planning have been proposed based on a grassroots level with an actor oriented integrated processes of dialogue and negotiation among the diverse agencies involved in planning rural development and people. GIS by its capacities of integrating information and analysis of spatial data is seen as a tool useful to support planning in this context, but usually is seen as an 'expert system' and access has been restricted to central government agencies specially in less developed countries. As consequence top down development planning using GIS is promoted. Participatory GIS is proposed as an alternative to promote grassroots participation in planning using GIS technology. Formal and rapid methods of information gathering and interpretation using GIS to support decision-making with a broader and more systematic information base for planning and decision-making have to be produced.

In Mexico agriculture development has been based on land reform. In a first step from 1915-1992, the emphasis was in redistribution of land and state support to promote rural development. However, since 1992, a second step of land reform based in modifications of the Agrarian law, to alter the existing Agrarian structure based on communal tenure was changed to promote private property and markets of land, and conditions for investment of private capital in the agriculture sector.

2.2 Land Use Planning and Sustainable land management

Land use planning can help decision-makers (such as government or land users) to use land in such a way that current land use problems are reduced and specific social, economic and environmental goals are satisfied (sustainability, income generation, self sufficiency). The main objective of land use planning is to identify the uses that best satisfy specific goals for different tracts of land and the formulation of projects, programmes or management plans to implement these uses.

International agencies and experts have promoted land use planning as a rational way to manage land resources for the implementation of polices in agriculture and rural development in less developed countries (Dent et.al, 1994)

In the 1970s the approach for land use planning was based in conventional methods of soil classification, and land suitability in less developed countries with already farmed land is limited for planning as Dent (1984, p.84) signals

> ‘ The utility of standard surveys and interpretations is limited, especially in third world countries that are already farmed to the limits or beyond the limits of the present capacity of the land. It is not helpful to a subsistence farmer to tell him that his land is not better than S3 for his staple crop! Decisions already taken or acted upon severely restrict room for manoeuvre. If they are undertaken mechanically, natural resources surveys and standard interpretations are addressing yesterday’s problems’

In the 1980s project development by less developed countries were based on the land evaluation framework developed by Food and Agriculture Organisation of the United Nations for the evaluation of the suitability of the land for different land uses in development projects of the Third World such as for agriculture (FAO, 1976, 1984); forestry (FAO, 1984); irrigated agriculture (FAO, 1985); steep land (Siderius, 1986) and extensive grazing (FAO, 1991) (of the United Nations for the evaluation of the suitability of the land for different land uses in development projects of the Third World) (Dent, 1994). Land evaluation is defined as the process of assessing the potential production for various land uses (Beek, 1978). This approach is based on the matching of qualities of different land units in a specific area, with the requirements of actual or potential land use. The results of land evaluation should be useful for rational land use planning (FAO, 1993).

In general the approaches to land evaluation have been advocated as a practical way to address the conflicts over land use by matching land use with the land's ability to support them. But these approaches have concentrated on either production at all costs or conservation at all costs. Neglect of the priorities of the people who directly use the land has lead to a failure of the implementation of plans (Dent, 1997). Land use planning in the FAO approach of land evaluation appears to be a rational response but is defined as ' the matching of land use with land' this makes rural land use planning usually advisory rather than prescriptive' (Dent et al, 1997)

After the 1980s the 'experts' on land use were looking for the increasing application of computer technology to shape the results from projects to particular circumstances and planning needs. The FAO framework has been applied using computers at different levels of detail, e.g. the Land Evaluation Computerised System (LECS) (Wood and Dent, 1983). The Agricultural Planning Toolkit, (APT) a modular computerised system for land evaluation developed by the FAO in Asia (FAO, 1991), MicroLEIS an evaluation system for crops and forestry in Europe (de la Rosa et al, 1992) and in a land mapping unit system based on an expert system approach, the Automated Land Evaluation System (ALES) (Rossiter, 1990; Rossiter and Van Wambeke, 1995). Land evaluation by map analysis techniques can be accomplished with any Geographical Information System; one such system designed for land evaluation is the Integrated Land Watershed Information System (ILWIS) from the ITC, Netherlands (Meijernik, et al, 1988). However, these surveys were built upon the major methodological of the Framework of Land Evaluation (FAO, 1976) but their scope was limited by the geological and soil survey tradition of the planners (Dent, 1997).

Thus conventional methods of land use planning and evaluation were conceived as a sector exercise implemented as an expert advice between FAO and Government with a normative and top down approach. (FAO, 1976, 1978, 1984, 1986, 1993) and with a resource oriented approach (Burrough, 1996). According to (Rossiter, 1996; Cecarelli, 1997) there is evidence of their inadequacy for the new global conditions.

In the 1990s the FAO approaches consider planning as a process that has to be achieved at grassroots level with an actor oriented integrated processes of dialogue and negotiation, where the development of an enabling environment for conflict resolution and active involvement of the multiple stakeholders is a pre-requisite (FAO, 1995a FAO, 1995b, FAO, 1997).

The community or nation is a land user in the sense that land is required for urban use for all kinds of facilities, for industry, recreation, ecological reserves. At national level primary goals may be to raise the standards of living and feed the population. The objectives of the community tend to be long term (to preserve natural resources for the future). It is thus evident that there is a basic difference between the objectives of the actual land users and those of the community. Land use planning becomes important when the government or land users feel that there is a need for land use change. This requires not only the political will and the ability (instrument, budget, manpower) to support and implement the plan but it is also essential that the planned changes are acceptable to the people and land users involved (FAO, 1995a, FAO, 1995b, FAO, 1997).

Simms (1993) pointed out that to those to have access to land, land is a resource used to satisfy needs. The immediate priorities in a situation where peasant farmers dominate may be to produce food and income. Their land use decisions will be taken in such a way as to optimise the achievement of these objectives. When making decisions, the farmers take into account the characteristics of the land, the available resources, and economic factors such as access to markets. The objectives of the individual farm family, particularly the poorest and even those of commercial farmers, tend to be short -term in nature. Future benefits tend to have a low priority. To be successfully adopted, agricultural development programmes must meet farmer objectives, and must include procedures to take full account of the social and economic factors of the environment within which farm families make their decisions.

Cecarelli (1997) signals that 'Land use planning in most countries is mainly concerned with design and control issues with a mainly "prescriptive", "statutory" function and a "normative" and "top down" attitude, vested in paternalistic or even authoritarian ideologies'. The methodologies recently suggested in support of the new planning perspective like the Planning Sustainable use of land resources procedure (FAO, 1995), and Sustainable Land Management Framework (Dumanski et al., 1994, 1997), are not always in coherence with the underlying objective, a normative and top down, rather than a negotiation and communication oriented approach is still promoted (Cecarelli, 1997, Burrough, 1996,1997)

Burrough (1997) discussing issues related to sustainable land management and geo-information, signals that the conventional procedures for the 'reliable' prediction of conditions that lead to sustainable forms of land use 'seems' only a slight modification of the aims of conventional land evaluation but still adopts a top down hierarchical approach.

Bie (1997) sees the problem as the lack of production of data sets that can be useful at farmer level. He pointed out that the available databases for use with Geographical Information Systems (GIS) are usually available in the national, regional or global level and have primarily focused on the capture storing and display of basic physical elements (Soil, water, bio-diversity, etc). Increasingly GIS technology has been used to include human elements eg. education, nutrition, health, cultural values, and major efforts are underway to create spatially referenced data sets for these components mainly at the national level. But rarely is the scale/detail of the data set adequate for the farmer level.

Mendoza Lawas (1997) proposes that a starting point for encouraging users to participate in the proposed sustainable management activities is the understanding of their unique knowledge or ways of using or managing their land. This includes comprehending their perception, actions or behaviour towards the land. She proposes the use of GIS and the application of statistical tools to make farmers knowledge relevant and accessible. The information considered for this, was for example: a) The qualitative and quantitative analysis of land use history to support better understanding of use development b) The analysis of farmers' cognitive views of their specific knowledge of their environment. c) An assessment of how spatial and non-spatial knowledge of the farmers can be stored, manipulated and analysed in the GIS environment, and to determine the spatial relationship between farmers' environmental knowledge and field activities. d) The examination and analysis of farmers' spatial crop decision-making behaviour.

Pieri (1997) proposes the use of participatory approaches and the creation of decentralised management systems for the stakeholders in the development of sustainable land management information systems. He notes that the first lesson from the past experience is the importance of assessing the needs and perceptions of the farmers and farm communities on issues important for land management and added that the identification of local perceived necessities is a prerequisite for sound land management strategies, and participatory approaches are often practical and cost-effective procedures for identifying indicators used for the farmers by monitoring their land resources.

He stressed the need for stronger links between public and private organisations to develop decentralised management information systems on land related issues.

Cecarelli (1997) working in the design of an information system for support planning in Africa stated that

> ' Despite the quest for participatory planning, stake-holders intervene only in the stages of negotiation and little or no attempt is made to specify the role of the rural communities in the very generation of the information and procedures to select land use options' (Cecarelli, 1997 p.12)

More radical changes to the models of land evaluation and sustainable land management are proposed by Burrough (1997), Roling, (1997) and Dent (1997).

Burrough (1997) proposes the use of a practical definition of land suitability

'namely that the actual land management is as efficient as possible, minimises wastes and degradation, and provides a long term stability for food production measured in terms of generations' (1997, p235).

He argues that the definition of sustainability is comparable with the new statistical concept 'stationary' in the sense that both can have strict and relaxed forms. Strict implies a closed system driven only by energy inputs from sources that are essentially limitless. True sustainable systems, are open and in contact with surroundings. Though change may be slow and difficult to detect, changes will and do occur. The second law of thermodynamics ensures that energy (and its surrogate forms) must be expanded to bring this about. Therefore we are looking for ways to match or harmonise the demands of people with the limitations of landscape such that serious imbalance will not occur. In order to achieve this he believes that the following must be considered: a) scale of the various kinds of spatial patterns in the area of concern. b) The nature and problems of a hierarchical approach c) data collection sample resolution and d) processes causing spatial and temporal change. The perception of the scales and structures of spatial patterns depends on whether we are: a) looking at the attributes of the landscape or b) describing land use and land cover, or c) dealing with individual plants/organisms or vegetation communities/ plantations.

He argues that we need to be aware that:

> 'Geoinformation and GIS are important tools for Land Evaluation and Sustainable Land Management, but they should not, nor do they need to, drive all the information collecting and processing activities. Rather we should: a) identify the physical and economic processes that control valuable (sustainable) land use b) identify the levels of spatial and temporal resolution, and the kind of data needed for characterise these processes. c) Enquire if the necessary data have already been collected in a suitable form, and if so obtain them, if not collect the required data using the correct level of resolution and the sampling level. d) Then identify the kinds of geo-information tools needed for the job' (Burrough, 1997 p.236).

Roling (1997) argues that sustainability has become an important issue in our society because of land degradation, erosion, loss of water retention capacity, loss of bio-mass, loss of bio-diversity and other problems; all he believes, caused by human activity. He argues that sustainability of land use can be defined using 'hard' criteria based on scientific indicators of carrying capacity or sustainable exploitation; it is inappropriate to apply the same 'hard' criteria to the evaluation of human activities. He added that natural sciences can deal with the biophysical consequences of human activity; however we have recently seen important shifts in our understanding of eco-systems. We now accept these to be complex, non-linear, chaotic, self-organising, non-equilibrium and discontinuous. As a result we have to accept that adaptive management rather than control, involving continuous, exploratory, probing, monitoring and adaptation of our interventions, are essentials for the sustainable management of land. He proposes a definition of sustainability, which posits sustainable land use as an emergent property of a 'soft' system, i.e. the outcome of processes of learning and interaction among the land users. This makes sustainability a social construct. The 'soft' definition emphasises sustainability as learned, negotiated and agreed upon. Sustainability thus becomes an outcome of human activity grounded in institutions, policies, culture and power. Sustainability becomes the interface between the human ability to learn and the biosphere of which we form part.

Dalal Clayton and Dent (1993) in a scrutiny of half century of development projects signals that there are some successes, but the experience of planning in less developed countries, is mostly bad. The main problems found in the revised projects are related with policy and information failures some of the most importance are:

a) Failure to address all the issues: The projects in many instances are focused in the increase of production such as selection of the most return cash crops, or conservation works centred in technical measures or constructions of earthworks to retain soil and water. The social and economic imperatives driving to the non-sustainability of the system are not included.

b) Failure of information: Lack of data, failure to make use of either detailed local knowledge or relevant technical knowledge, inability to integrate all the necessary disciplines and activities.

c) Failure of institutions: Failure to cope when systems are complex and reluctance of government and development agencies to address the problems of institutional weakness.

d) Failure to address the legitimate goals of stakeholders: failure to involve all the stakeholders in the planning of land use, or to empower them to manage resources in common. Fiats imposed from above are resented, resisted or ignored and ultimately, overturned.

Therefore, failure of implementation of plans in anything like the shape envisaged by planners.

To avoid these failures in new polices, Brinkman (1994), FAO, (1995); propose, first, that all the different groups who have a stake in land use have to acknowledge the legitimacy of each other's interests. Then the pivotal process in planning becomes negotiation between the stakeholders: first to establish the goals, then to identify land use problems and opportunities, and to make difficult choices between the various options for action.

One shortcoming of conventional land use planning is in cases where land users have been on the land for generations and where the physical environment or technical possibilities or the socio-economic conditions change significantly. The planning and management decisions made by these people in circumstances of no change tend to be near optimal within their total environment (optimal is meant here in the sense that is very difficult to find modifications of planning or management that would at least improve the economic or social situation of the land users in the short or medium term within the limits of the technology known to them and available to them). Such land uses in this type of situations generally do much less well when faced with a different (new or changed) environment (Brinkman, 1994).

In conditions of rapid change, the informal, gradual accumulation of local experience as basis of planning and management decisions becomes a too slow and expensive learning process. More formal and rapid methods of information gathering and interpretation are needed to support decision-making with a broader and more systematic information base (Brinkman, 1994).

In less developed countries especially, institutions responsible for land use are fragmented and compartmentalised. Land resource information, especially spatial information, has no established place in policy-making and land resource specialists rarely carry through this information to the point of decision. Everywhere useful data exist but often are discarded on the way (Dent et. al., 1994).

Sound policy starts from the ground upwards in two ways:

> 'First, from the perceptions' needs and objectives of the land users and, secondly, from their systematic knowledge of the resources (natural environment, water and land potentials, degradation hazard), present infrastructure and inputs available, existing policy environment, people's expertise and the availability of technology'. (Brinkman, 1994.p13)

Ideally, the land use plans of governments and their reflection in legal and institutional structures and physical infrastructure facilitate an environment within which land use decisions, by farm families, grazier communities and others can lead to optimal satisfaction of their objective functions (Brinkman, 1994). Moreover, the key problem in land use is to understand why land users continually take decisions that fly in the face of what planners consider being optimal. Clearly, land users are taking account of factors that are not being considered by the technical approach for planning. So planning methods that take on board the aspirations and perceptions of the land users are necessary (Vermeer and Dent 1997).

Brinkman (1994) pointed out that a plan based on perfect information but having the agreement and consensus of the people and the government is better than a perfect plan prepared without the people. Applications should be developed that enable groups of land used to explore and identify different land use options and management alternatives for their own land. A structure and procedure of negotiation, founded on a common information base on land and water resources and their potentials, is needed to asses governments and groups of land users to come to maximum degree of agreement on land use decisions and thus to aim for the creation of optimal economic and physical environments for agricultural development within the government's wider objectives (Brinkman, 1994).

The most recent approach to land use planning addressing this issue is the FAO (1995 b) publication negotiating a Sustainable Future for Land. It proposes an integrated approach to the planning and management of the land resources. Such an approach is viewed as holistic and interactive, where an essential prerequisite is the active involvement of the stakeholders, effective institutional support, and enabling environment for participation and conflict resolution. This new approach is based on informed decision-making in which variations in both land resources and the socio-economic circumstances of the land users are taken in account (FAO, 1995b).

Cecarelli (1997) argues that the approach envisaged for collecting and processing economic and biophysical in the recent FAO approach (1995b) data is rather standard, with little or no effort to specify how the view of the final users could be taken in consideration. The 'socio-economic' evaluation is in practice reduced to the simple collation of economic and social data for use in a final optimisation exercise. As a consequence the conceptual schemes to support decision-making on land use are not always in coherence with the objectives of the approach.

Two ways have been proposed to understand the process of land use planning and related decision-making. One is proposed by the followers of the FAO approach (Beek, 1997), which provides a framework, especially for the recent application of modelling and other computer assisted techniques that facilitate the objective evaluation of land for a wide range of uses (Chu, 1996, De Bie et. al. 1996, Cecarrelli, 1997). The other focus on the understanding of why land users continually take decisions that are difference to what the planners consider optimal (Dent, 1997). Dent (1997) suggests that the flow of information that is essential for decision making and meaningful negotiations in the use of the resources, could provide the link between top-down planning and policy development by governments, and bottom-up planning and management by local communities.

One important element required to achieve this is that the people coming together to manage the land have a common core of information about natural resources and economic opportunities together with technical skills including map and aerial photography reading, measurements and records keeping, and route maps to finding further information either from within their own communities or from outside.

Dent (1997) depicts the use of natural resource information in land use planning in developing countries as a process of integration of the information from both formal and informal knowledge- Dent understands formal knowledge to include the technical information that might reduce risks or increase production or sustainability in the use of resources or conservation practices. Whilst he sees indigenous knowledge of the farmers about land and water resources and their response to management. This later information would be generated by local groups, interpreting and acting on the information they need. Where there is a perceived need of information that is not available to the users of the land, this represents a risk, so decisions are conservative to minimise risk. He added that, by building this local database, putting together formal and informal knowledge, decisions about land use can be tailored to help local people interpret their own data, drawing not just on their own experience but, also, linking the experience from outside. In this way, the two worlds of formal and informal knowledge may be brought closer together. The essential outcome is that local people become their own experts and thus he argues there will be no problem with the implementation of plans (Figure 2.1).

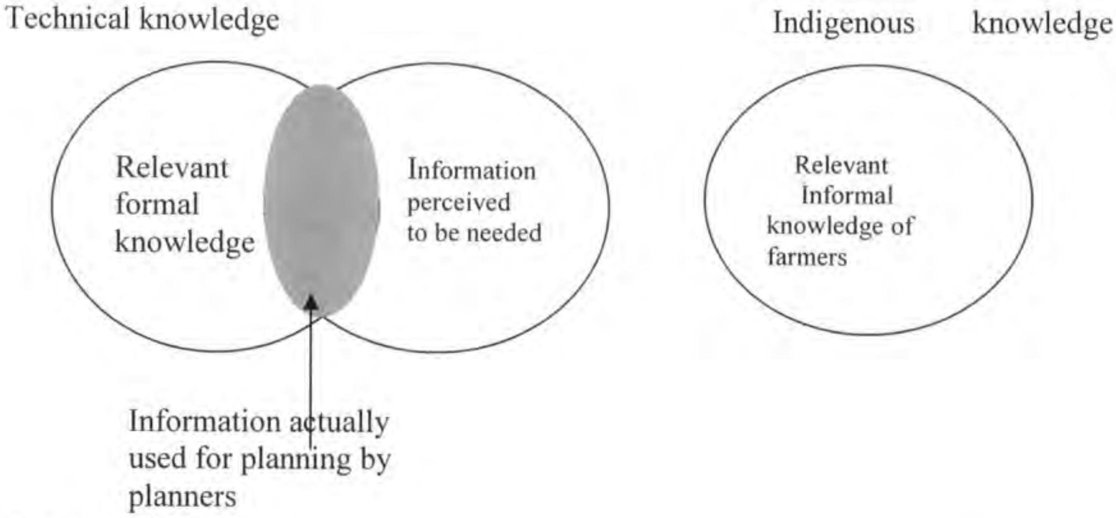
From the 1990s a new perspective of planning and sustainable land management based on a grassroots level with an actor oriented integrated processes of dialogue and negotiation has been developed. Conflict resolution and active involvement of the multiple stakeholders is essential, and in this new 'planning environment' more 'soft' approaches that includes the collection of data about the perceptions needs and objectives of the land users and their systematic knowledge of their resources are required. Moreover informed decision-making in which variations in both land resources and the socio-economic circumstances of the land users must be taken in account

2.3 Geographical Information Systems (GIS)

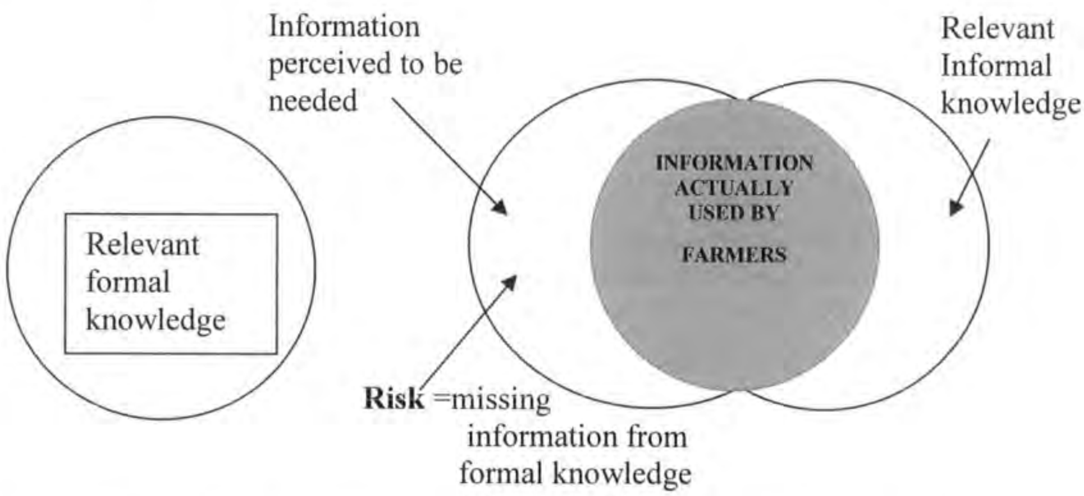
A GIS may be defined as a computer assisted system for the acquisition, storage, analysis and display of geographic data according to user-defined specifications (Laurini and Thompson, 1992). It has a digital database management system designed to accept large volumes of spatially distributed data from a variety of sources (Jensen and Christensen, 1986). The most powerful characteristics of GIS centre on their ability to analyse spatial data based on descriptive attributes. The use of GIS software can help to eliminate the data integration problems caused by the different geographic units to which different data sets are related (Burrough, 1986). GIS allows the overlaying of maps with different thematic data (e.g. soil and land use, watershed, district, village maps) and thereby facilitates map integration and analysis. GIS distance modelling makes it possible to assess the interaction of (potential) land uses, and the physical infrastructure and market. It also permits the combination of maps with data generated by models (Bronsveld, et al, 1994). In short, the primary goal of

Figure 2.1 Use of Knowledge in different worlds of planning (Dent, 1997 p 22).

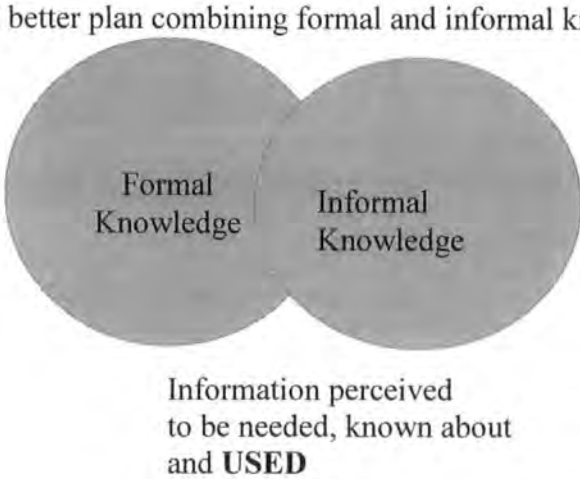
Professional plans



Land users' plans



Formulation of a better plan combining formal and informal knowledge together



Information perceived to be needed, known about and **USED**

GIS has been to take raw data and transform it, via overlay and other analytical operations, into new information, which can support decision-making processes.

GIS was introduced into developing countries during the 1980s, the key agents of delivery being various UN agencies. The approach adopted in the use of GIS was essentially top-down, with ARC/INFO used on mini-computers as the principal schema. As GIS developed, however, more inexpensive systems were introduced using microcomputers, e.g. ILWIS from ITC and IDRISI from Clark University. As these various GIS systems were introduced, both universities and research centres adopted GIS this encourage change took place in the application of GIS, with bottom-up approaches being developed, (Taylor, 1991).

Most of the regional GIS in developing countries are used for resource inventory, resource management and land capability evaluation. They are more related to resource management than to planning and most of the data stored in them are related to the physical environment, such as topography, soils, vegetation, land use and hydrology which can be obtained from maps and remote sensing. The end products are not plans, but research reports (Yeh, 1991). They could be used to improve cadastral mapping, land taxation and land entitlement (Angus-Leppan, 1989). Nijkamp and de Jong (1987) comment that coherent and integrated spatial planning is rare, and that systematic use of information in computerised systems is uncommon. Furthermore, to a large extent the implementation and development of GIS are performed by expatriate scientists or vendors in a technology-led approach (Taylor, 1991; Harris et al, 1995). The introduction of GIS, whether in top-down or bottom-up approach, has therefore, usually come from outside and so far GIS has been largely marginal to the solution of development problems. Hence Taylor (1991) argues that it is a necessary first step for indigenous scientists to gain a greater degree of knowledge and control of this technology.

Yeh (1991) identifies several restrictions for the implementation of GIS for planning in developing countries. First, few attempts have been made to apply GIS in deriving planning scenarios, in allocating regional investment and in evaluating development proposals. Second, the state-of-the art in planning has not advanced much in relation to how planners could employ GIS in conjunction with new planning. Third, the acute shortage of manpower and training has greatly restricted its use. Fourth, there is an over dominance of GIS technocrats in the use of GIS. Fifth, there is an over concentration of GIS development and technology in a few key universities and research centres and finally, developing countries need GIS most, but generally do not have the necessary funding to acquire it.

These problems are exemplified by Taylor (1991) in his study of the development of GIS in India, and can be summarised as: 1. The availability of databases for planning, and the cost of data collection or transformation to digital format. 2. Bureaucratic and political factors such as national security and the fact that so many institutions are involved in data collection that co-ordination is very difficult. 3. The 'top-down' model of GIS does not reach the level where the needs are greatest (the village). Taylor added that in developing nations, special attention must be given to the products of the GIS for the understanding, analysis and solution of pressing problems of socio-economic development. If GIS are to be useful and effective, indigenous scientists who understand both the technological and socio-economic context in which the systems are to operate must introduce them. The technology must be 'indigenised' and adapted to the needs and capabilities of the particular situation in which it is to be used. In a further study from India, Sahay and Walsham (1996) discuss the results of applying GIS in the Ministry of Environment and Forestry for the management of wasteland in the country. They conclude that the involvement of multiple actors, each with their own agenda and beliefs about GIS, makes the practice of GIS management an extremely complex task. They therefore recommend that a step in approaching this complex task is to develop an understanding of which groups influence the process of implementation, and their underlying beliefs, motivations, fears and expectations about GIS. With all these restrictions in the consideration of the implementation of GIS in developing countries, the conclusion of Yeh (1991, p 24.) is still valid:

> ' It is not really necessary to set up a GIS in order to obtain benefits to urban and regional planning in the developing countries. Thinking about setting up a GIS can already contribute greatly to planning. It can force planners to identify the data needed for planning, to look at data availability, and to examine ways of improving the existing planning methodologies to obtain the maximum benefits from GIS. GIS can be a co-ordinator for information in planning. In order for a GIS to be useful, many agencies have to contribute

data to the system. A GIS thus provides an opportunity for different agencies to co-operate, an objective which was difficult to achieve before'.

Yeh (1991) added that in developing countries it is necessary to improve the institutional arrangements and the application of GIS rather than the technology. The successful implementation of GIS will depend upon a clear understanding of the functions and needs of planning that are translated to system applications.

2.4 Geographical Information Systems and Planning

GIS has increasingly been used in decision-making, resource management and planning. However there are a number of critical issues by part of the GIS community concerning that political economy and epistemology of GIS and the politics of power relations associated with their use (Harris et al 1995; Miller P, 1995; Rundstrom, 1995; Sheppard, 1995; Dunn et al, 1997; 1998 Harris an Weiner, 1998; Clark 1998).

Weiner et al, 1995 signals that the use of GIS for research, planning, and project evaluation, in the mode of "top-down" data creation and expert "policy making" empowers the powerful and disenfranchises the weak, where it is being used in a planning and/or decision-making capacity. GIS can be integral to defining and implementing agency decisions and often reflects the internal rules and value systems of the agency controlling it. Decisions regarding what issues to address, what data to obtain and how the data should be classified and analysed, and what interpretations are drawn from them; all suggest that value-neutral GIS does not exist.

GIS as part of a "rational planning discourse" can be a technical legitimisation of historical power relations (Aitkin and Michel, 1995; Harris et al., 1995; cited by Weiner et al, 1995). GIS, it is claimed produces representations tied to the discourses of the status quo (Taylor, 1991; Pickles, 1993; Goss, 1993, cited by Weiner et al, 1995). The digital landscape becomes a terrain for elite planners to negotiate social differences and territorial conflict. In the processes workers, minorities, women, poor peasants and the unemployed becomes even further distanced from decision-making processes (Weiner, et al 1995). Moreover, due to lack of equitable access to GIS data and technology, small users, local governments, non-profit community agencies and non-mainstream groups are disadvantaged in their capacity to engage in the decision-making process (Edney, 1991). This is succinctly summarised by Taylor (1991 p.3):

> 'It is argued that the current developments in GIS are primarily technology-driven, and that such an approach has limited relevance to the problems of development of the Third World countries...GIS technology is not scientifically objective and value free.... The socio-economic realities and priorities of the 'Third World' are quite different to those of the 'First World'. If GIS is to be used to help to understand the challenges faced by developing nations, then it must respond to these realities and priorities.... Indigenous scientists have an important role to play as they have an appreciation both of GIS technology and the development problems faced by their home countries'.

A GIS approach allied to traditional developmental is likely to continue the reinforcement of knowledge distortion. So-called "expert" results from such a GIS represent one interpretation of the reality and must be carefully considered for the inherent value system and knowledge distortion that they contain. (Weiner et al, 1995)

Yapa (1991) looking for appropriate technology for community development at grassroots level, identifies the basic contradictory nature of GIS in the fact that it is expensive and needs high level of expertise and on the other hand appropriate GIS is complementary to community development because the tool can help in uncovering local resources.

> 'GIS bears a dual relationship to appropriate technology. On the one hand, they contradict the principles of appropriate technology because of the high cost and the need for the high levels of expertise. On the other hand, they complement appropriate technology because the tools are useful for uncovering local resources' (Yapa, 1991:56)

Harris and Weiner (1997) discuss the recent focus in the potential of GIS to help to empower communities, and they argue that GIS is a contradictory technology that both simultaneously marginalizes and empowers the people in the communities. As a result, the societal impact of GIS is contingent upon particular configurations of placed-based historical, socio-economic, political and technological conditions.

It is important to acknowledge that the representation of the landscape and the social relations of GIS and remote sensing technologies are materially and politically constituted. Issues of knowledge production and distortion, and "expert" and "local" knowledge all imply that multiple perceptions of the world exist (Aitken and Michel, 1995; Mark, 1993; cited by Weiner et al. 1995). Mark suggests that while people have different worlds and realities, which are constructed independently, they actually exhibit many similarities because of the similar nature of human bodies, sense, culture, language, and formal education systems (cited by Weiner et al 1995).

> 'None of these different worlds is correct or incorrect, of course. The representation of a particular view of the world within a GIS similarly does not represent a "correct" version of the world' (Mark, 1993,3).

Mark calls for the design of a GIS that is capable of incorporating the many ways in which potential users, especially from non-western societies, conceptualise space and the phenomena around them (Weiner et al 1995).

Weiner et al (1995) in the construction of a GIS in Kiepersol, South Africa argued that it is concerned with the multiple realities and the politics of resource access and the use of different scales of analysis. Two bodies of literature that are not generally associated with GIS and remote sensing inform the GIS production process: political ecology and post-developmentalism. Political ecology encompasses a number of loosely configured areas of scholarship (Peet and Watts, 1993, 240; Bryant 1992; cited by Weiner, 1995).

For Harris and Weiner (1995) the contradiction is also apparent in research on 'participatory GIS' in South Africa. Between a modernist 'development' paradigm which is 'technicist' and elitist, and the potential of incorporating local knowledge within an alternative GIS production in pursuit of a participatory land reform.

Blaikie and Brookfield (1987) have put this approach in to the context of regional 'political ecology' (RPE). They see this as a chain of explanation, which starts with local land managers and land use practices. Specific social relations of resource use are then contextualized more broadly in terms of their relations with each other and other land users within the state and the world economy. Regional political ecology is therefore concerned more with connecting scales of analysis than with the regional scale per se. Other important RPE concerns include the politics of resource use, environmental knowledge production and representation, the agency of nature, and multiple meaning and practice of sustainable development (Blaikie and Brookfield, 1987 cited by Weiner, 1995).

With participatory GIS the structural distortion potential in RPE and in the top down approach can be reduced by the inclusion of local knowledge from socially differentiated communities whose everyday lives are tied to local conditions. This requires an approach to complement more traditional planning methodologies with the incorporation of the expertise and knowledge of communities who have a long-standing relationship with the land (Weiner et al, 1995).

A sector of the academia also is calling for a participatory decentralised GIS arguing that GIS is usually seen as an 'expert system' in development projects and programmes reinforcing the politics of power on which top down development planning is based, also this elitist access is by the cost of software and the level of expertise required to manage it make it (Edney, 1991; Taylor, 1991; Weiner et al, 1995, Aboot et.al, 1998;). The main concern of application of GIS in less developed countries is that it could reinforce top down development by the access of data, software and the level of expertise required to manage it. To cope with this problem the development of Participatory GIS has been propose as an alternative for the involvement of people using GIS technology (Yapa, 1991; Rundstrom 1995; Abbot, 1998; Harris and Weiner, 1998). In contrast with 'experts systems' participatory GIS is

> 'therefore, an attempt to use the technology of GIS in the context of the needs and capabilities of communities that will be involved with, and affected by, development projects and programme'... 'Particpatory GIS draws on the diversity of experiences associated with 'participatory development' and involves communities in the production of data and spatial decision-making' (Abbot et.al, 1998 p.28).

They added that, the role for participatory GIS in this context are: a) a means of integrating previously isolated qualitative and quantitative information sources; b) as a help to legitimate local information and enable local people to use a modern argument c) a potential aid to conflict resolution and d) a means to consolidating and sharing ideas.

2.5 Participatory and Rapid Rural Appraisal (PRA and RRA)

The literature suggests a wide range of techniques available, all based on grassroots participation. All these authors have emphasised the usefulness of Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) (Farrington and Martin, 1988; Chambers 1988, 1992, 1994; Theis and Grady 1995). These methods are based on an exploratory and rapid learning approach by a combination of methods to gain information and insights about rural conditions in order to arrive at relatively quick assessments of development contexts and problems. The difference between RRA and PRA is that in the former information is elicited and extracted by the outsider as part of the process of data gathering, whilst the latter it is more generated, analysed, owned and shared by local people. The essence of the difference is found in the roles and attitudes of the participants; in RRA the outsiders dominate, whilst in PRA, outsiders encourage and allow to local people dominate (Chambers, 1994). In RRA the analysis of information is carried out later, outside the area of study, whilst in PRA the importance lies not just in the data collected but also in reflecting on the process.

Chambers and Guijt (1995) signal that the techniques of RRA are the better way for outsiders to learn, gaining information and insights from local people and about local conditions. The information produced is that which is important to input in their own planning to be able to respond more effectively to the needs and priorities of the people that they are meant to serve. The information generated using RRA provides policy makers with a greater understanding on local conditions, to make policy decisions more appropriate and responsive to local needs. In contrast PRA generally refers to a process that empowers the local people to change their own conditions and situations. It is intended to enable the local people to conduct their own analysis and often to plan and take action. PRA is not only seeking for information and generating ideas; it is also about analysis and learning by local people for building the process of participation, discussion, communication and conflict resolution.

The main dangers of RRA techniques have been pointed out by Chambers (1992). These include excessive speed and lack of commitment, which can compound errors; the problem of knowing when and what mix of techniques will be appropriate; RRA is not participatory and the initiative remains with the outsider people. For PRA the dangers include its focus on the participation of the people, so cross checking is frequently omitted. The main strengths of PRA are field learning, practice, innovation, improvisation and sharing.

Participatory Rural Appraisal (PRA) maps and transects built by the local people are seen as tools that help to consider human factors (Jones, 1996; Chambers, 1997, 1999). The construction of participatory maps helps the facilitator to break the ice with the people, to identify which elements are important for different groups and to take it as a basis for comparison of different perspectives in the use of resources.

Mapping of resources with people is perhaps the most widespread and common tool used in PRA and RRA (Mascarenhas and Kumar, 1991; Jones, 1996, Chambers, 1997). Aerial photographs have been used extensively in PRA and RRA with diverse purposes in several countries, also in some cases satellite images (Mearns, 1989, Sandford, 1995; Denniston and Leake, 1995; Chambers, 1997[1]). Sandford (1995 p. 18) found that the farmers in Ethiopia

> 'immediately recognised that this was a photograph of their land....could without difficulty indicate the boundary of the their land on the mosaic....had no difficulty in recognise features such as swamps, woods, their own huts, thrashing floors, areas under crop, etc. could take one to any spot on their land shown to them on the mosaic ...could identify their position at any point of walk round the land'

2.6 Political Ecology and land management

Political ecology according to Thrupp (1993) searches for the identification of causes and significance of problems and systematically analyses interactions between resource use and social dynamics at a local level, and responses and influences of political economic processes and policies at the macro level. To do this, information at a "local level" is required and techniques of systematic interviewing/or participatory action research methods are used for gathering the information. The local informants are the farmers, heads of rural households, or state agricultural officials, who are actors affecting the particular resources or technology. It is necessary to analyse systematically societal factors that influence the farmers'

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[1] Local analysis of aerial photographs or satellite imageries is included in the menu of methods of participatory Rural appraisal (Chambers and Guijt, 1995)

practices. It is then necessary to analyse the historical socio-economic (or structural) context in which the local problem is situated, and similarly to trace the links of causation to factors in the wider political economy. This requires the examination of documentation of historical and economic development processes, power relations, land tenure system and institutional surroundings involved in the use of resources and technology. The analyst elucidates the interplay of power among different social groups, the control of information and technology and the role of state and interests of private enterprises that influence agricultural development, land use, human and natural resources.

New politics can change the dominant relations of production, the whole structure of income opportunities and necessary access qualifications and hence the land use decision-making process in land management (Blaikie, 1985). The political economy thus both determines and provides the dynamic for changes in the agrarian structure that is reflected in the change of circumstances of the land manager. This change may also alter land use and management (Blaikie and Brookfield, 1987).

Blaikie (1985) proposed a scheme based on land use and political economy. The approach used is bottom up starting with actual people making decisions on how to use land, and involves a conceptual scheme involving the relations between people and environment. The scheme combines a place-based concern with a non-place base concern for political-economic relations. The scheme is placed within a location framework, upon which the political economic relations are superimposed, and hence find geographical expression at a specific location. The end product of the processes is the production of a map of decisions on land use that may well show marked spatial clustering for two reasons. First, groups of households with similar access profiles are sometimes spatially marginalized and are obligated to carry on their marginal uses in similar marginal places (areas of poor soils, steep slopes, riskier and scantier rainfall). Second, specific income opportunities (which involve land use) are either to be found at a specific location (irrigated land) or are more profitable at one location because of distance criteria, suitability of the soil for a particular crop, and other considerations labelled as location comparative advantages.

The approach for explanation of land use and management in a specific area is called Regional Political Ecology (RPE) and follows a chain of explanation. Figure2.2 shows the decision-making approach for land management proposed by Blaikie and Brookfield (1987). A comprehensive enquiry into land management decisions requires the use of nested set of scales: local and site specific which include small groups making the relevant decisions; the regional scale involving more general patterns of physiographic variation, types of land use and property relations and settlement history; the national scale in which the particular form of class relations give the economic, political and administrative context for land-management decisions

The scheme is outlined by Blaikie and Brookfield (1987p 69-74). It indicates a simple decision-tree, which traces through the stages in decision-making if and when the capability of the land declines. A number of social-environmental data are considered as the starting point as the initial desiderata[2] of the ongoing land use and use and management practice. The ongoing use is determined by access to resources and determines land use and management decisions. The political economy is exogenous to the model and changes in policies determine the changes in the agrarian structure. Changes introduced in the desiderata, may or may not improve the capability of land. If land capability is maintained the cropping system and land management will remain unchanged. If land capability declines it may or may not be perceived by the decision-maker. When it is perceived the next step is diagnosis, if the diagnosis is that land degradation is the cause, an array of strategies, which lies within the knowledge of the decision maker, are considered. If feasible strategies are identified modifications to the ongoing land use and management take place. However the availability of compensatory strategies (more land available, migration, wage labour) the modifications in these cases it is easier to distinguish land management from land use. These models are concerned with present investments to maintain or enhance a future income stream. The schema for decision-making in land management is shown in Figure 2.2

[2] The data consist of the socio-economic characteristics of the decision-makers and their access to resources. The intrinsic properties of the land system (soil, fertility, slope, etc.) are also essential elements

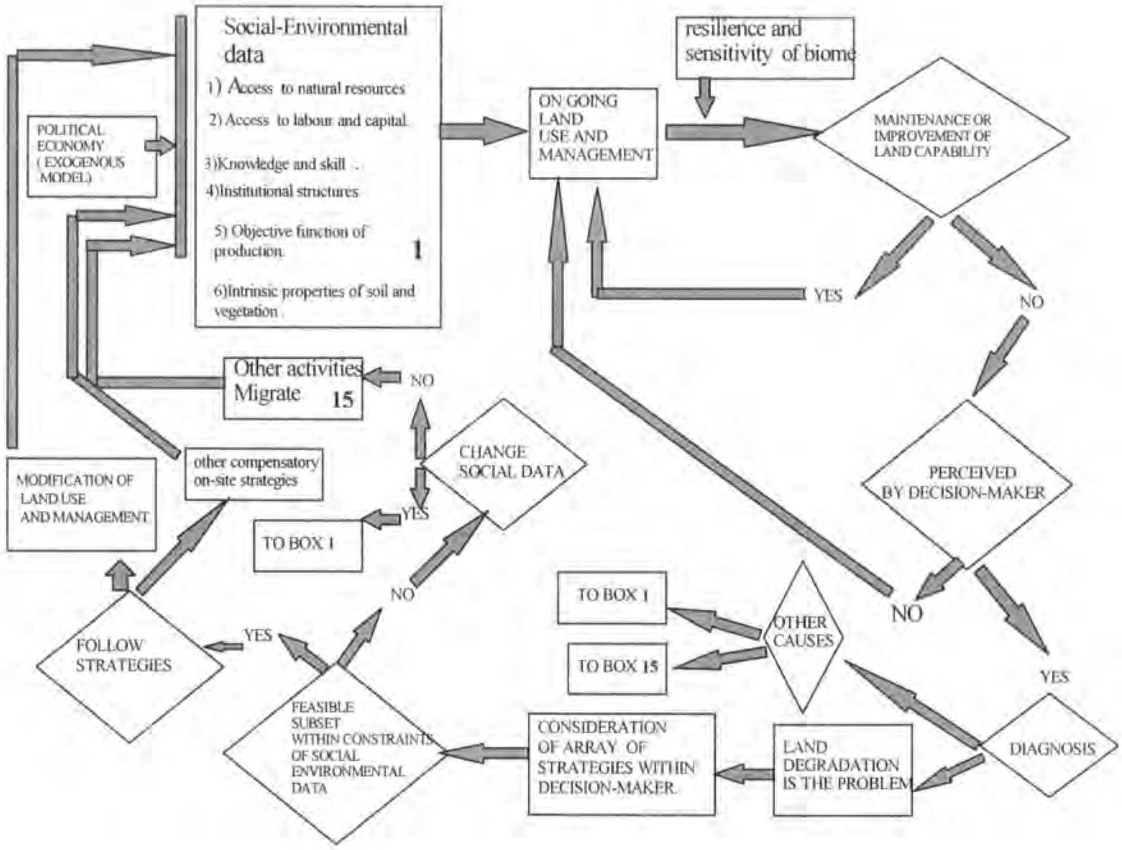


Figure 2.2 Decision-making in land management (Blaikie and Brookfield, 1987, p.69)

Blaikie and Brookfield (1987) pointed out that the conclusions drawn from the application of the model will show: firstly that models of land use and management based on intensification or de-intensification will founder; Secondly that governments who seek to intervene to change the ongoing land management may have to alter a great deal of parameters in the decision-making processes in order to achieve their objectives; and third that is important to identify who the decision makers are and their social and environmental data and identify who it is that perceives, diagnose and consider strategies. It may well be that it is the individual or local institutions or both together that are the decision-makers.

2.8 Rural development and actor oriented approach

Booth (1994) signals that the formerly influential theories in social science research of the 1980s ignored, more or less deliberately ignored the complex heterogeneity of the real world of development. The social research agenda in the 1990s included diversity and heterogeneity in development as central point of inquiry. The main focus in social research moved to: a) explaining significant variations in patterns of development in different local, regional and national settings and b) as diversity implies choice, and some sort of choice is the key for effective action, the research is focused in development policy and practice. Booth (1994) further argued that the changes of approach in rural development research on meso-diversity and micro-diversity sectors.

Haan and Long (1997) proposed an alternative problem oriented perspective for research in rural development. Rural social life is portrayed as a multidimensional and contested reality with particular focus on contrasting interpretations of rural development policy and practice, diverse forms of rural living and experience, differentiated institutional power domains, or local and regional patterns of agriculture, ecology and enterprise. In these 'realities', there are differences between 'scientific' and 'folk' perceptions and representations of reality but also the co-existence and contestation of varying everyday versions of 'reality'. As consequence rural development is an heterogeneous process involving multiple levels, of values and 'realities' such as local patterns of organisation and management of resources local to regional and national development programmes and institutions.

Long (1997) proposes the actor-oriented approach and interface analysis of rural development as an alternative to the general theories or models of agrarian transformation, which are propelled by market integration, institutional incorporation and state or international intervention. These models he points out have as their main shortcoming a failure to explain adequately the sources and dynamics of heterogeneity in agrarian structures as they focus on how national and international institutional and economic orders condition the parameters and possibilities of rural development, rather than on the interplay of global/local relationships in the making of rural development. The problem addressed in the local context has to be focused on how, in differing historical and cultural contexts, rural development interventions and livelihood are materialised and socially constructed through interplay and negotiation in the domains of social action.

A central concept in the actor-oriented approach is 'livelihood', that is expressed by Long (1997 p11) as

> ' individuals or groups striving to make a living, attempting to meet their various consumption and economic necessities, coping with uncertainties, responding to new opportunities, and choosing between different value positions'.

The study of livelihood entails the identification of the relevant social units and fields of activity. The making of a livelihood relies on material or economic capital as well as the circulation of information, management skills and relationships and group identity. Long also stresses that the identity construction process inherent in the pursue of livelihood, is especially relevant, since it entails the building of relations with others.

Haan (1997) discussing the concept of locality and how global trends are translated into place-specific processes signals that as human behaviour is situated in different overlapping contexts ranging from concrete 'face' to 'face' relationships to abstract 'systems', cannot therefore be understood without analysing different modes of embedded ness. This means the connection of the micro (local) and macro world systems. The implicit assumption in this concept is that observed behaviour and events at one 'level' should be connected with a sort of aggregate, often abstract encompassing level. Concepts such as 'integration', 'dependency' and 'articulation' are used to express the relation between the specific and the general. He said

> 'What all these linkage concepts have in common is the idea that the real world is made up by people living in specific places, but that their lives are subject to invisible, external forces' Haan, 1997 p156).

Haan states that these types of models ignore the significance of local conditions, and how farmers themselves experience the processes. Locality could be used as a descriptive unit or a 'local social system'. The first refers to a geographical or administrative unit, for instance a municipality or village. If an administrative unit is taken as unit of analysis, its characteristics may not be limited to that region. If however, a regional unit is defined on the basis of communal features, like population density or landscape and ecological aspects, the locality acquires the meaning of territorial uniqueness. Locality as a 'local social system' (Crown and Allen, 1994 Cited By Haan, 1997) refers to the spatial co-ordinates of social relations and social processes. Physical space must be transformed into social space, and this only happens through prolonged 'face' to 'face' interaction, shared experience, shared practices and dependence on local resources. The local social system is relevant in two ways: first as a significant frame of reference, in terms of meaning and reflection and second especially in farming communities, in terms of interdependence through kinship, neighbourhood, property and labour relations. This practical side of locality implies that people's dependence on place is rooted in social relationships giving access to material and human resources (Haan, 1997).

He concludes that

> 'the process of differentiation at local level then involves the struggle over access to limited natural resources and thus property relations. The central issue is not how the local is integrated in to the global system and how the farming is becoming de-localised, but how global trends are integrated and internalised locally, thereby de-globalised. In summary 'local developments' are not mere expressions of global trends, but complex, hybrid forms, reflecting the assimilation of globality' (Haan, 1997 p 157).

Hebineck and van der Ploug (1997) propose that farming is a social construct as the outcome of actors projects involved in agriculture such as farmers, planners, politicians, implementers. Based on the analysis of the approaches developed in agrarian change they propose the notions of styles of farming that is constituted by three interrelated and mutually dependent levels: a) specific culture repertory, composed of shared experiences, knowledge insights, interest, prospects and interpretations of the context in which farms operate; b) a style of farming is an integrated set of practices and artefacts i.e. fields, crops varieties, instruments and so on, combined in such a way that they constitute a rational and internally coherent constellation; c) style of farming comprising a specific ordering of the interrelationships between the farming unit on one hand, and markets, institutions and technology. The styles of farming are to be interpreted as the results of goal-oriented actions and related strategies, thus as actors' projects carried out in particular historical context and arenas. Finally they conclude that heterogeneity is of strategic importance for analysis that deals with agrarian and rural development in less developed countries. They believe that it is extremely important that heterogeneity levels often brings the researcher to a reservoir of interesting and mutually contrasting responses to the processes of change and problems that characterise the less developed countries.

2.8 Land tenure and rural development in Mexico

Distribution of land in Mexico by land reform lasted 75 years (1915-1992) and was carried out with the intent to redistribute the land among peasant communities. The land expropriated was granted as a corporate patrimony of each community of beneficiaries (*ejidatarios*) and was not alienable. Over 75 years the Mexican government used the power of the state to alter access to the land for specific categories of households in regions where there were population pressure on the land and to redefine land rights to those with rights of access to the land (Rusell, 1977,1978; Sanders, 1984; De Janvrey, 1998). The redistribution varied across the country in terms of amount of land redistributed and its quality. This was according to the commitment of the government with the program of land reform in different periods through the last 75 years.

Russel (1977) argues that the distribution of land in Mexico suffered from lack of proper land surveys and insufficient land classification studies, which would show the distribution of soil, slope, and water supply. As a result, the land allocated to many ejidos was not suitable for crop production at all, and they had no source of water allocated to them. De Janvry et al (1998) pointed out that in many situations, beneficiaries received bad quality and marginal lands that had become decapitalised in the process of expropriation. Moreover as the allocations of land in different places and with different qualities were distributed to the communities at different times, the history of land reform can be characterised as a pattern of pressure and government response. But in general, during this process the land has been redistributed to the peasants following a principle of social justice for the peasantry and not economic principles (Sanderson, 1984).

According to the classification of land made by the government[3] the land distributed between 1917 and 1976, was as follows: irrigated 1,714,828 ha, seasonal land, 10,875,055 ha, pasture 47,817,379 ha, forest 8,788,916 ha desert 673,277 ha; and uncertain quality 9,389,428 has. The quality of land allocated to individual ejidos depended on its availability. In fact most of the ejidos were allocated several types of land, but in general all the ejidos have an area of individual parcels (irrigated or seasonal) and, depending on the availability of land, and the types of resources in the area, other land such as forest, pasture and grassland (Sanderson, 1984).

Additionally other factors were: the number of people claiming land in each region, eligibility of all over 18 years, and availability of land. The distribution of land was frequently, not following economic principles; rather it was a policy of response to the pressure on the land by the landless. These produced in general a regional complex pattern of land tenure with an eclectic mixture of private, individual and collective ownership around all the country (Rusell, 1977).

The result of this was that most of the types of resources allocated during the land reform were non-cultivable land (pasture, forest and desert). The 1990 census gives an idea of the type of resources allocated to the ejidos, area of ejido subdivided in parcels is 27,797,605 millions hectares and from this the cultivated plots are 14,574,200 hectares (SRA 1999) and the area of communal land without plots (forest, grassland and desert) was 75,492,494 ha. This means that some 85.89 % of the land is not adequate for cultivation (INEGI, 1995).

Land reform, in itself, does not however necessarily ensure economic development and is therefore not a guarantee of rapid progress. To be successful, it must be accompanied by appropriate planning and followed up by a whole series of institutional innovations in the field of credit, marketing, processing price structures, agricultural research and extension. Through the period of land reform 1917-1992, the Mexican government carried out a multiplicity of different polices in the rural sector, oscillating between two principal strategies; a political one for satisfying peasant

[3] This data is for the period 1917-1976, and comprises 79,258,333 ha were granted in this period. This is 77% of land granted by the government.

demands of land and an economic one of increasing food production.

As several authors have pointed out (Hewitt de Alcantara, 1980, Esteva, 1987, Thiesenhusen, 1995, Gordillo, 1997, De Janvry, 1998) once the distribution of land was in place, the beneficiaries were as rule forgotten by policy makers who were more concerned about catering for the commercial sector of agriculture and the urban import substitution industrialisation than the productivity of the reformed sector. Beneficiaries were left without sufficient access to credit, technical assistance, modern inputs, or education, that was necessary to enable them to keep up with the private sector. A successful initial phase of expansion in the reform sector was achieved based on large-scale public irrigation projects in the north. This was not sustained, in part due to the severe government control over the beneficiary's decision-making. Public authorities, more interested in monopolising rural votes than in promoting production, stifled individual innovations and prevented adaptation to local circumstances. The government support was mainly in the ejidos with centralised management of access to market and supportive organisations. This itself was focused mainly in the ejidos with most productive land but the support was rarely offered to ejidos with small plots or marginal lands (de Janvry, 1998).

The implementation of the land reform was the result of the complex interactions between the policies of the State and Federal government officials and social economic and political conditions that have temporal and spatial dimensions. Different policies (formulated in reaction of different perceived realities) have influenced and motivated the redistribution of land. In addition, marked regional variations in demography, social and economic and resource conditions, and political structure of the countryside have resulted in uneven distribution of land. Some ejidos received different resources (cultivable land, irrigated or seasonal, forest and grassland), and some ejidatarios received large plots of cultivable land and others received plots too small or of too poor in quality to be commercially viable.

In general the programmes of land reform both in Mexico and Latin America have not, resulted in the kind of transformation envisaged in the original design. Governments were either unable, or unwilling to implement a full land reform. The programmes were universally under-funded so that needed services, inputs, and institutional development could not take place, or took place too late. Finally, they were bureaucratically top heavy and did not build on (or create) a self-sustaining farming system (See Thiesenhusen, 1995). This poor performance of the agriculture sector led to a second phase of land reform initiated in Latin America in the 1980s with Structural Adjustment Policies (SAP) imposed by the World Bank and the International Monetary fund. These policies emphasised the promotion of market forces and reduction of the role of the state. In particular land that was held collectively ought to be allocated individual tenures. It is under the generalities of these SAP advocated policies that Mexico embarked on its Second Land Reform programme started in 1992, and is focused in three areas-

a) a reform of the legal framework that regulated access to land and modifications of the instruments of agricultural policy;
b) the redefinition of the relations between the State and households;
c) a change in the public institutions serving the sector.

The first reforms saw the removal of restrictions on the sale of land under Article 27 of the Mexican Constitution, under which the State deemed to have ownership of the land redistributed under the earlier land reform programme. Thus there was total prohibition on both sale and renting of ejidal lands. By changing the law, the government was aiming to encourage the development of new, competitive smallholding. The change in legislation is a tenancy reform. The objective of the reforms is to stimulate the investment in the ejidos by both ejidatarios and private sector by the opening of land markets (sale and rent or mortgage of land) and the consequent improvement in the economies of scale. The investment could be from the entrepreneurial ejidatario by the bought of ejidal rights[4] or from private investors by contracts of association with the ejidatarios for periods up to 30 years extendable.

By December 1998 PROCEDE has certificate 18,621 ejidos giving the rights over parcels of 2,243,054 ejidatarios, and produced 5,146,865 certificates of ejidal rights and maps covering an area of 54.2 m ha. This leaves 9108 ejidos in process of

[4] The amount of land that one individual ejidatario can held under the regimen of ejidal rights is limited as a maximum of five percent of the ejidal land, or an area equivalent to that states for small property art 47 Agrarian law (1993).

certification (SRA 1999). However one of the main objectives of the project of titling and issuing certificates has not been fulfilled, since 0.28% (54) of the 18,621 ejidos certificated had changed their regimen of tenure from ejidal to '*Dominio pleno*[5]' private tenure (SRA, 1999).

The second element of the reform saw the de-institutionalisation of the state support services, as direct consequence of which most *ejidatarios* lost access to credit, technical assistance modern inputs and crop insurance.

The third element of the reform involving changes in the public institutions serving the sector, envisaged the development and implementation of a series of rural development programmes. The revised programmes were to be based on grass roots initiatives and the reconstruction of rural institutions.

The programmes of rural development comprise three projects:

i) PROCAMPO This was designed as a temporary support for the small farmers and peasants to change the patterns of crops form basic crops to crops with competitive prices in the market. It provides a direct hectarage income subsidy to farmer production for seven crops corn beans, wheat, soybeans, sorghum, rice, cotton and safflower. It was to be phased out over a period of 15 years starting in 1994. In 1994 13.5 m ha received government. support, of this area 70% of the land was in plots over 5 ha and 30% under 5 ha (Appendini, 1996). From 1994 to 1999 the number of hectares to be subsided by the program averaged of 13.743 m ha per year with an average investment of per hectare of 475 pesos (£35.2), this area was farmed by 2.949 million farmers.

[5] Under the new Agrarian Law in ejidal tenure the ejidatarios can sell their parcels to other ejidatarios or avecindados (individuals over 18 years old living in the ejido and recognised as avecindados by the ejidal assembly) or rent it to non-ejidatarios. Under '*Dominio pleno*' the individual *ejidatario* can decide to change the *ejidal* tenure to 'private property', the *ejidatario* that wants to do this has to request the deletion of the certificate from the database of the *Registro Agrario Nacional* (National Agrarian Register) as *ejidal* land and afterwards he register the parcel as private property land in the database of the *Registro Publico de la Propiedad.*

ii) The other "modernisation[6]" programme *Alianza para el Campo* (Alliance for the countryside) focused on to the farmers that had control over the productive resources but were not economically strong to survive as competitors in the international market. These comprise the majority of ejidatarios and small producers who will need continued government support if they are to begin to incorporate new technologies and reconfigure cropping patterns. The supporters of this model expected that the government would legitimise its restructuring of rural institutions through negotiations with the so called social sector. (Appedini, 1997).

The Program *Alianza para el campo* (Alliance for the countryside) introduced in 1995 is focused on producers and ranchers who have access to credit. It does not comprise and thus excludes all ejidatarios or small proprietors with lack of capital for investment. The alliance means the co-participation of government and farmers in the investment for improvement of technology and infrastructure for production. It is series of programmes established by the government and proposed to the farmers for participation. The government finance in each programme is a percentage of the cost with the farmer providing the other.

The programs are diverse, and are selected in the premises that lack of capital and organisation are the major drawbacks in agriculture. The program proposes investment for mechanisation, equipment, use of fertilisers, genetic breeding of livestock and the organization and training of the farmers for the increase of their efficiency in production.

iii) Programa of Desarrollo Forestal (PRODEFOR) (Programme for forest development). The forest policy reformed in 1997 promotes the association of the ejidos with third parties and the cession of communal rights over forest areas by maximum periods of 30 years renewable. The law also promotes the reorganisation of the government agency in charge of these affairs by: a) the simplification of the government dealings to obtain permission for forest exploitation b) the segregation of the activities of surveillance from the forest agency (Klooster, 1997, Merino, 1997).

[6] The producers were categorised as "economically viable", "Potentially viable", "non viable" or "marginal". The latter group is supported by PRONASOL poverty alleviation program (SAGAR, 1990)

The PRODEFOR programme promotes the association of private investors with the owners of the forest, as a measure for the capitalisation of the sector; also it promotes the establishment of forest plantations with species of rapid growth (Merino, 1997). The private investment national and foreign in plantations will be subsidised with the 65 % of the cost of production incurred for the establishment of a plantation during the first 7 years for plantations with a minimum size of 25 ha (Klooster, 1997, Merino, 1997).

However in this program the resources allocated to support the ejidos are very low. Pare y Madrid (1997) signals that the government policy of 1994, 1997 was oriented to favour the private sector considering the financial support form the government, that is 24 million pesos for the forest development (that is the money that can be invested in the ejidos) and 250 million pesos for the plantations (190 million pesos for plantations to supply paper companies and 60 million for other plantations).

These new programmes proposed for rural development are treated with scepticism. As Grindle (1986) points out, local communities in Mexico are often highly fractionalised as the result of local politics usually involving land distribution, control of access to resources. Thus expecting an enthusiastic response to local initiatives is not guaranteed. Furthermore local communities have a long history of being manipulated or indeed threatened by state agencies. One anonymous public officer stated of course the peasants are distrustful; they have reasons to be:

'Government and party officials have come over and over again making promises which they never keep and at times deceiving and taking advantages of the people' (quoted in Grindale 1986:147).

Thus uptake proposals put forward by the new institutions are highly unlike to be adopted without query.

Chapter 3 Description of the municipality of Texcoco.

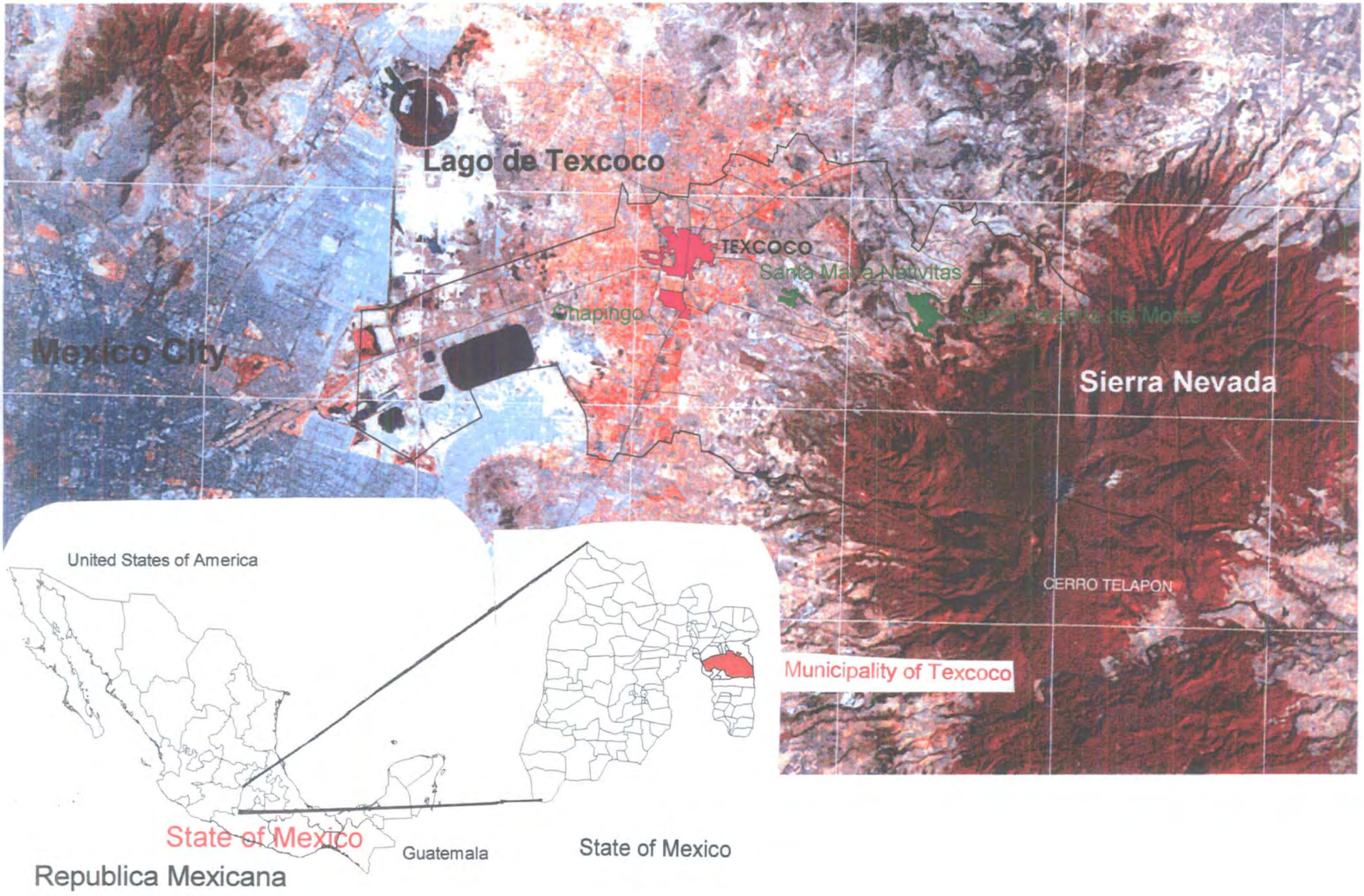
3.1 Introduction

The municipality of Texcoco is in the state of Mexico, 25 km east of Mexico City and is the largest municipality in the east side of the State of Mexico with an area of 418.69 km^2 (Ayuntamiento de Texcoco, 1997) (Figure 3.1). Since the 1970s the government has promoted its development as a periurban area of Mexico City by the improvement of communications, promotion of housing, and relatively low land costs.

Agriculture and forest have been important activities in the municipality since the colonial period, with 4637 people holding land, 11,000 ha are under agriculture, and forested areas with potential for wood production being 14,000 ha (INEGI, 1990; Ojeda, 1994). The ejidal sector is the most important with 4100 *ejidatarios and* 23,000 ha. The *ejidos* of the municipality have a diverse resource base of irrigated and seasonal agriculture, grassland, forest and quarry mines. It is most important to state at the outset though that it depends more on wages outside agriculture in secondary (industry) and tertiary (services) sectors. The higher mobility is in the young people (Sokolosky, 1995; INSTRUCT, 1998) and employment in the agriculture sector has been reduced gradually in Texcoco (INEGI; 1980, 1990). The municipality's location near to Mexico City has facilitated daily commuting patterns for people whose residences remain in the *ejidos*. The main sources of employment include masons, labourers, shopkeepers, traders, and blacksmiths. Agriculture for some people gradually becomes a complementary activity, carried out in spare time.

However for some, especially the poorest and uneducated *ejidatarios* agriculture remains the main source of income. The households are organised as small agriculture units for the production of crops and livestock for self-consumption, with small parcels of land, most of them with sizes of less than 1 ha. In the *ejidos* with forest and grassland the income is complemented by extraction of wood and firewood, and extensive livestock grazing. The diversity in sources of income, with each holding having irrigated and seasonal agriculture and communal land as forest, grassland, the differences in quality of soils, and amounts of seasonal and irrigated land by each

Figure 3.1 Map of Location of the Municipality of Texcoco (Author, 1998; satellite image SPOT, 1989) .



ejidatario, make the understanding of the decision-making on land use a complex issue in the municipality.

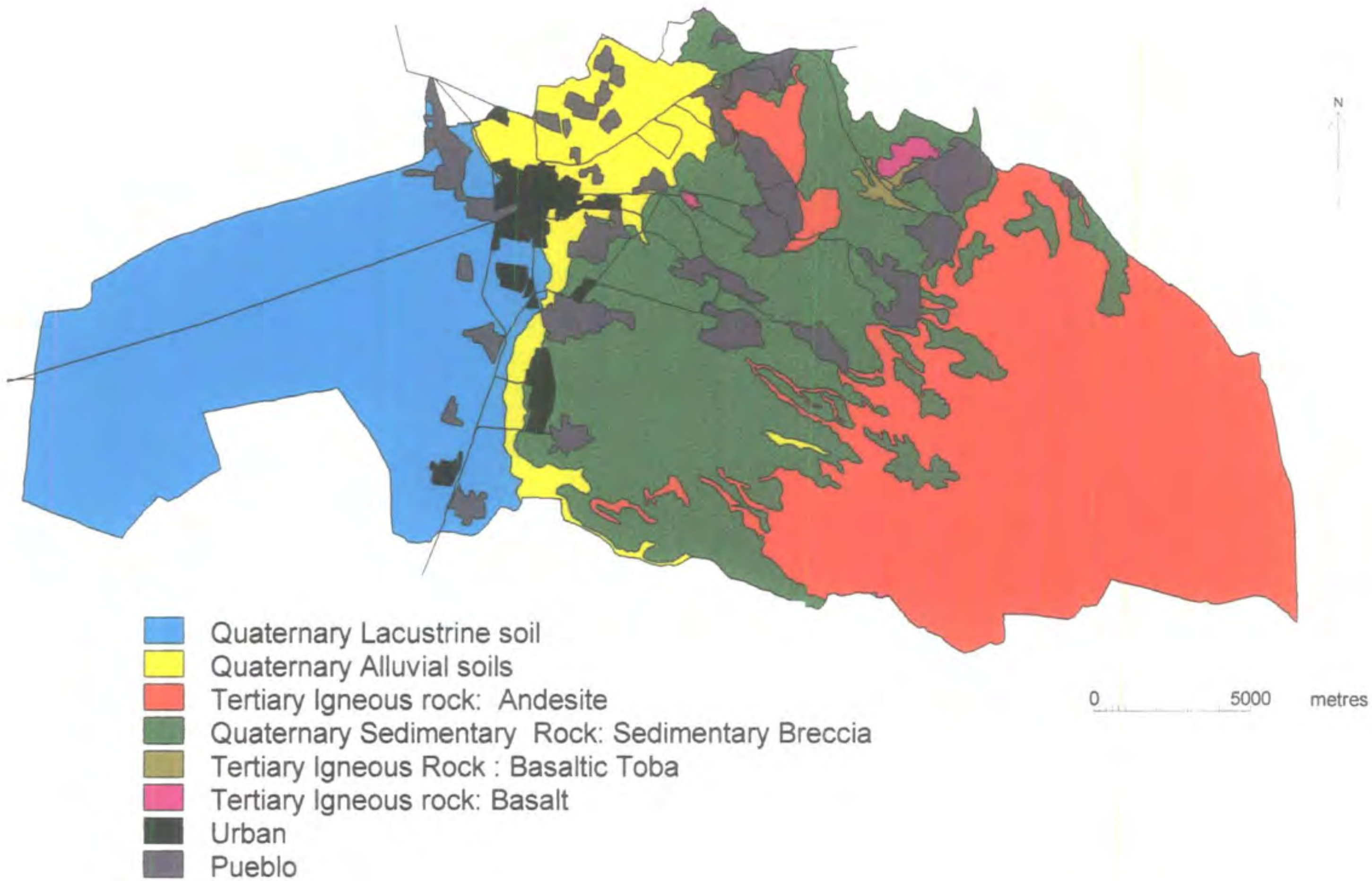
This chapter describes the physical basis, resources bases available and the socio-economic background of the municipality.

3.2 Physical description

3.2.1 Geology

The municipality is in the central part of the basin of Mexico (hydrological unit of 7500 km^2) that lies on the southern edge of the neo-volcanic axis, an upland formation of late Tertiary origin. The Sierra Nevada which rise to 4100m and run from North to South, dominate the landscape at the eastern edge of the municipality. They comprise Tertiary andesite and an area of basalts in the north. The lower areas at the foot of the Tertiary structures are covered by Pliocene alluvial fans, hardpan (tobas) and volcanic breccias. During the Quaternary, erosion excavated rivers in the volcanic complex. To the north of the area are the hills of San Miguel Tlaixpan a small semi-circular andesitic structure formed in the Pliocene. At the end of the Tertiary and start of the Quaternary, new tectonic movements resulted in volcanic activity in the south, which closed the exit from the Basin of Mexico to the Balsas basin to the south. The watershed became endoreic and a system of lakes orientated north to south were formed in the west of the area. This area was filled with alluvium and lake deposits during the Quaternary and formed the lake of Texcoco (Mosser, 1963, INEGI, 1975) (Figure 3.2)

Figure 3.2 Geology of the municipality of Texcoco (Author, compiled from maps E14B21and E14B31, Scale 1:50,000 INEGI, 1982)



3.2.2 Climate

In the Valley of Mexico the climate is tropical by its latitude. Several factors affect the climate, the most important being the winds from the Gulf of Mexico, and cyclone and tropical storms from the Pacific and Atlantic oceans from June to October. These events bring air with enough humidity to produce rain. During the dry season winds come from the west, the Sierra Nevada intercepts the winds from the Gulf of Mexico producing a rainfall shadow, and the intricate topography produces microclimatic variations in precipitation and temperature (Palerm and Wolf, 1972). Between 2200m and 2300m the annual mean temperature and rainfall are 15°C and around 600 mm, respectively. From 2400m to 2700m in a distance of only 8.5 km annual mean temperature is 12 °C and precipitation increases to 800 mm. Finally over a distance of 6 km the height changes from 2700m to 4200m, and the annual mean temperature and rainfall are around 10 °C and 1200 mm, respectively. The rainfall period is between May and October, the heavier rains in July. Rainfall between July and October is around 80-90 % of the total annual rainfall. Temperatures fall below 0°C between September/October until March/April. The number of days with below 0°C decreases from around 100 to 120 days in the Sierra to 40 to 60 days in the lake basin (Ortiz, 1975). According to the Koppen classification of climate there are four different distinct climates in the municipality, which are related to landforms (Garcia, 1978). (Table 3.1; Figure 3.3 and Figure 3.4).

Table 3.1 Landforms and climate in the municipality of Texcoco (Garcia, 1978)

Land form	Type of climate	Average annual rainfall (mm) and season of rainfall.	Average annual temperature (°C) and range of temperature
Ex-lake Basin	Temperate semi-dry	600 in the summer	12 to 18 5 to 7
Flat and hilly lands	temperate sub-humid	700 in the summer	12 to 18 5 to 7
Piedmont of the sierra	temperate sub-humid	800 in the summer	12 to 18 5 to 7
Sierra	temperate sub-humid	1200 in the summer	10 to 14 5 to 7

Figure 3.3 Climate in the municipality of Texcoco (Author, compiled from map E14-2 scale 1:500,000 INEGI; Climatic classification of Koppen, modified by Garcia, 1978)

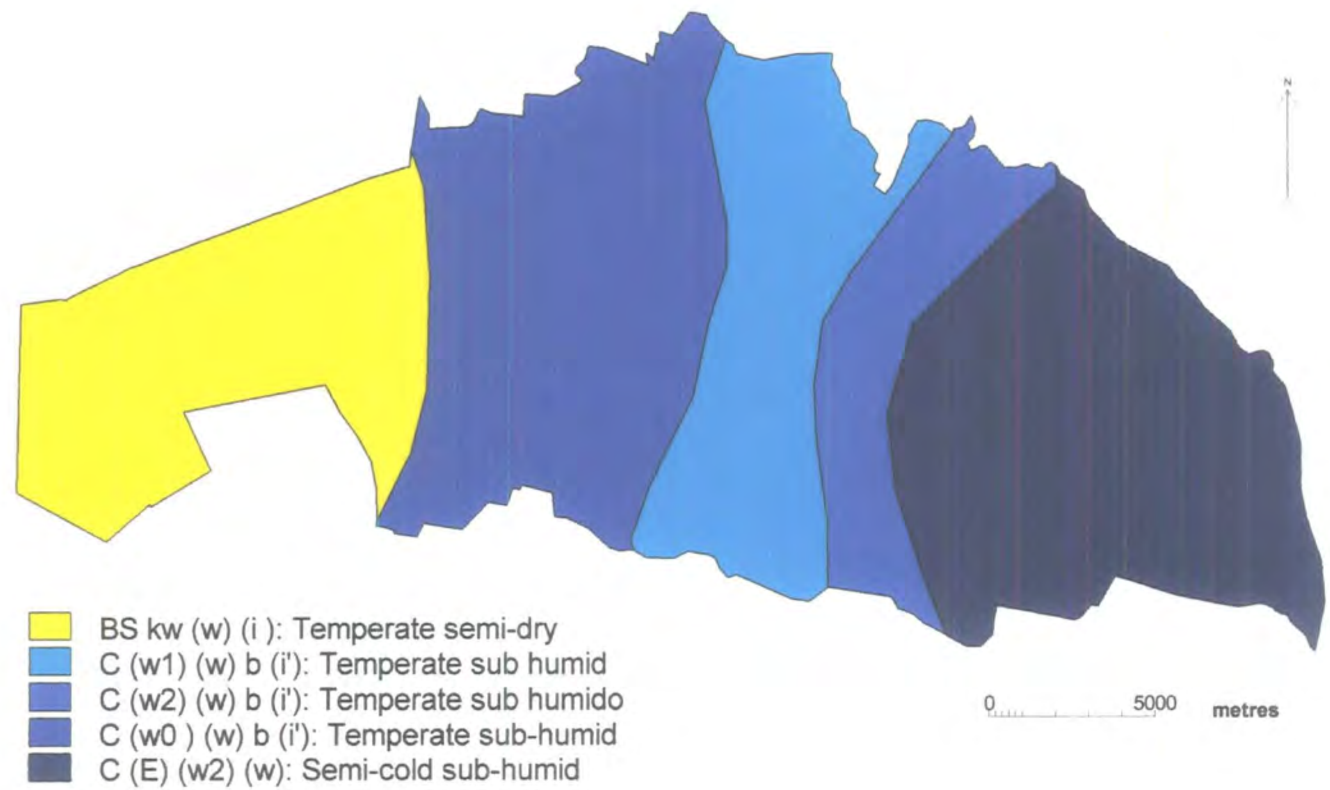
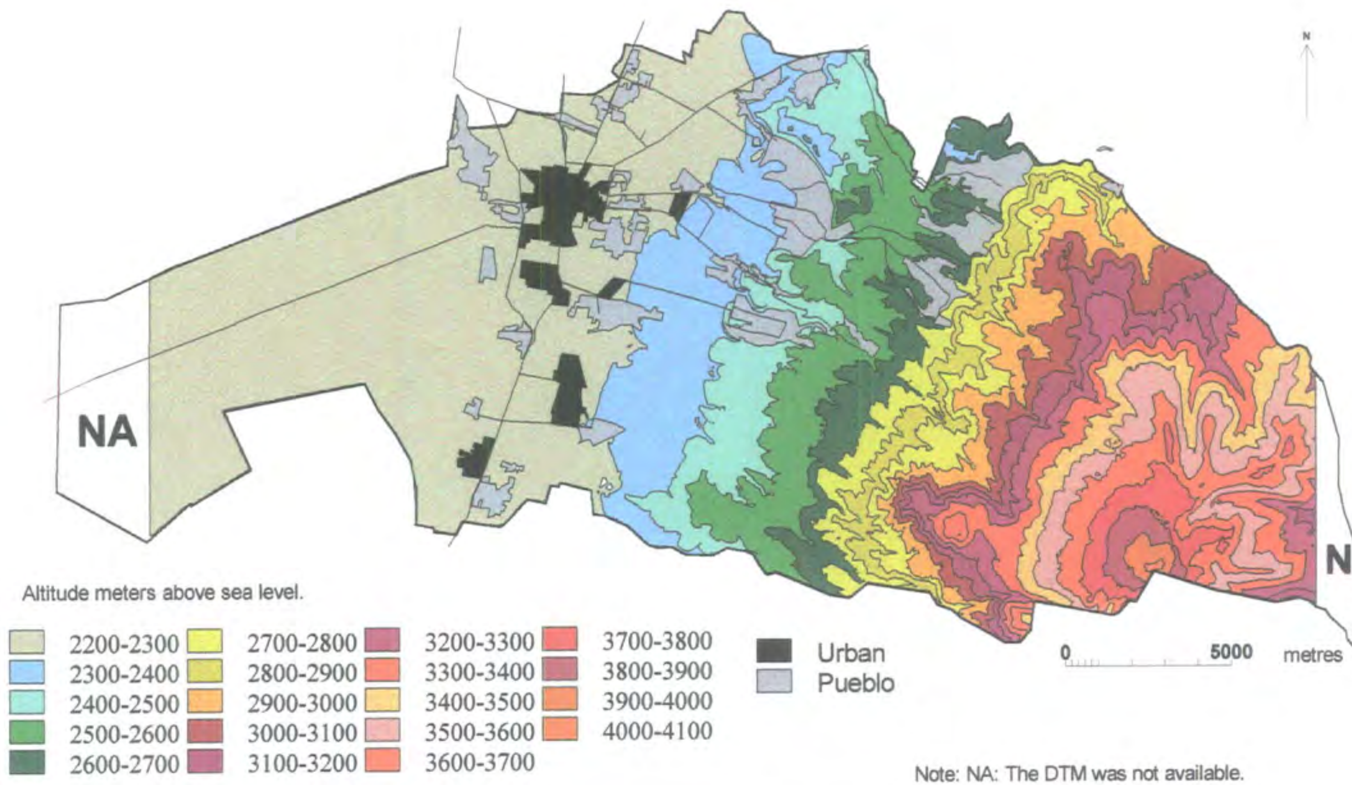


Figure 3.4 Altitude in the municipality of Texcoco
(Author, compiled from Digital Terrain Models E14B21 and E 14 B31 INEGI,1994)



3.2.3 Hydrology

3.2.3.1 Surface water

The municipality is located on the watershed of the Moctezuma river in the sub-watershed of Texcoco-Zumpango, which has an area of 4900 km^2 (INEGI, 1978). The hydrological system is naturally closed but actually is artificially drained[1]. It comprises six small watersheds with seasonal streams: Texcoco, Chapingo, San Bernardino, Santa Monica, Xalapango and Coxacoaco, all of which have their source in the Sierra Nevada. The general direction of the drainage system is east west following the fracture system in the high and middle parts of the Sierra. In the lower part (below 2300m) water flows in artificial channels to the Lago Nabor Carrillo (Figure 3.5). The annual volume of runoff water is around 9 Mm^3 (Table 3.2) and water flow is controlled in the upper stream in the rivers of Texcoco by 681 gabions (Plan Lago de Texcoco, 1994). Superficial flow is stored in small dams and excavated tanks (about half hectare and 5 m deep), which were constructed in the last twenty years in the hilly area. Over the last twenty years the sewage system of the upstream communities has been connected directly into the streams by government programmes, resulting in the contamination of the drainage system downstream (Muro, 1994; INSTRUCT, 1998).

3.2.3.2 Subsurface water

During the 1930s the water used in the municipality was supplied by springs, collection of superficial water in small deposits in the urban zone of the hilly area, and by extraction from shallow wells (10 to 20 m deep) in the flat areas surrounding the Ex-Lake of Texcoco basin. In the 1940s, the government started drilling irrigation wells in areas with alluvial soils for the establishment of dairy farming.

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[1] A system of three shallow lakes covering an area of 1500 Km^2 in the Valley of Mexico running from North to South existed prior to the Spanish Conquest. The lake of Texcoco was the largest and lowest elevated lake (with saline water). After the conquest the level of the lake was controlled to avoid the flooding of Mexico City by the construction of three channels (between the 16th and 17th century) that drained its excess water to the valley of Mezquital in the north (Mallen, 1994). In the 1960s the lake was totally dry and in 1971 the government started the "Plan Lago de Texcoco". This Program contemplated the reclamation of saline soils in the basin and the reclamation of eroded lands in the watershed and their reforestation (Mallen, 1994; Muro, 1994).

Figure 3.5. Watersheds and streams in the municipality of Texcoco
(Author, compiled from Topographic maps E14B21,E14b31;Scale 1:50,000, INEGI, 1972).

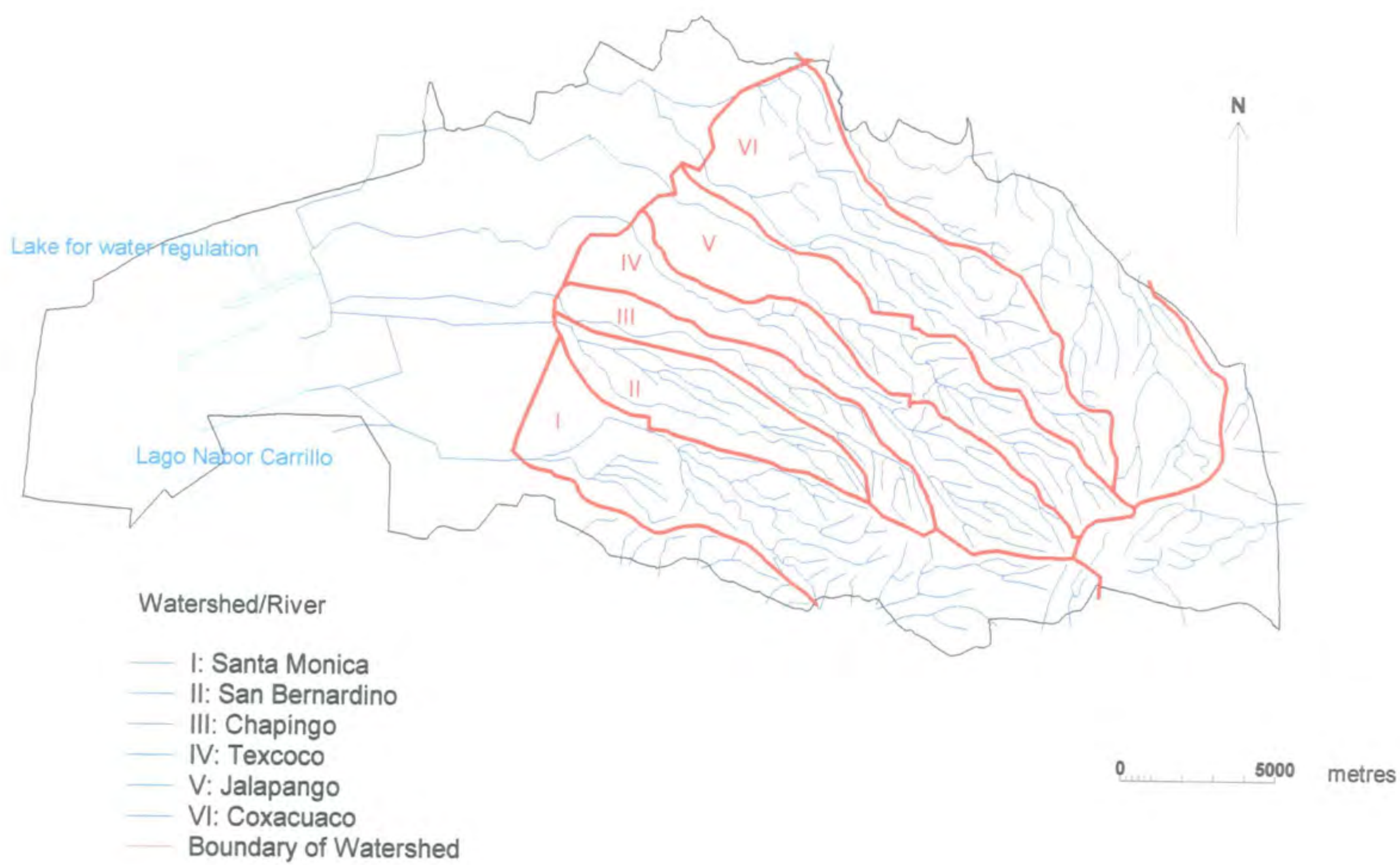
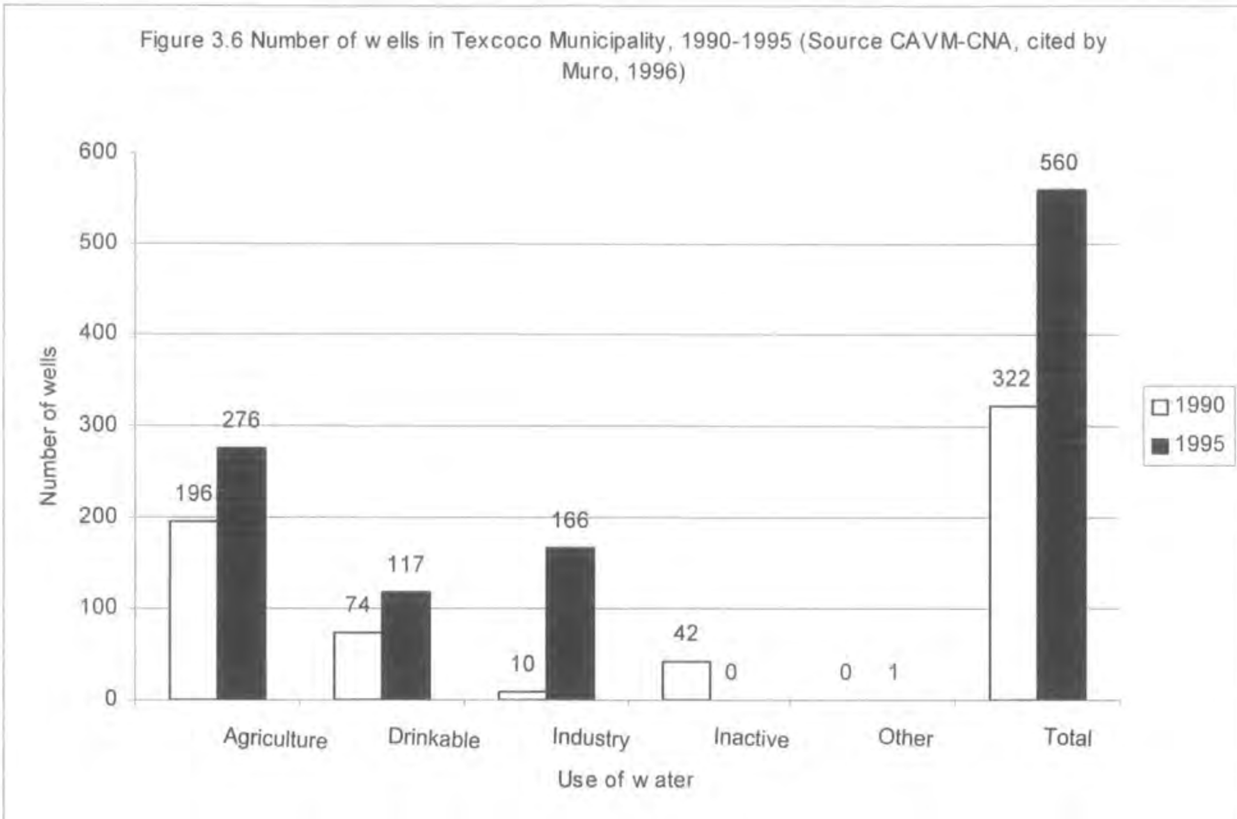


Table 3.2 Area of the watershed and average annual volume of runoff water in the rivers of Texcoco (Source Ramirez, 1992).

River	Watershed Area km²	Mean annual Rainfall (mm)	Rainfall Volume (Mm³)*	Water runoff (Mm³)	Hydrometric station
Coxacoaco	61.5	775	48	2.2	San Andres
Texcoco	31.2	690	22	1.3	Texcoco
Chapingo	21.4	675	14	1.2	Chapingo
Sn. Bernardino	17.0	650	11	1.3	San Mateo
Coatlinchan	55.8	680	38	1.2	Tejocote
Coatepec	33.7	580	20	1.2	Los Reyes
TOTALS	220.6	690	153	9.0	*Million of m³

The number of wells drilled in the municipality for different purposes increased from 240 in 1972 to 312 in 1990 and 560 in 1995 (Figure 3.6). This increase has occurred despite the fact that in 1972 the government launched a decree banning the drilling of wells in the Valley of Mexico (Muro 1994). As a consequence, the volume of extraction of underground water has increased, from 55.8 Mm³ in 1972 to 105 Mm³ in 1990 (Comision Nacional del Agua, 1990 cited in Ramirez, 1992) and was calculated to be around 140.2 Mm³ in 1995 (Muro, 1994). This extraction rate exceeded the natural recharge of the aquifer calculated as 28.7 Mm³ (Figueroa et.al, 1972).

The increase in the exploitation of the aquifer has had two consequences for Texcoco: first, from 1972 to 1995 the underground water level fell by 30 m in the lower lands and is around 110 to 120m below the surface in the foothills (Muro, 1996, Ramirez, 1992); second, the drilling of wells in the lower area and the intensity of extraction of water, has intercepted the natural flow of underground water to the saline aquifer of the lake of Texcoco; a situation that has produced a reversal of the natural flow, and now the flow of water is from the saline aquifer of the lake towards the central part of the valley (Figueroa, 1972, Ramirez 1992). As consequence drinkable sources of water in the City of Texcoco are at risk of contamination by saline water, a situation, that threatens the exploitation of the aquifers of the area (Figueroa, 1972).



Figueroa (1972) and Ramirez (1992) make recommendations for the management of the aquifer regarding the supply of water to the urban area and its use for irrigation. They predict a shortage of water in the future in the area of Texcoco, since by law the use of water for urban supply has priority over its use for crop irrigation. Figueroa (1972) and Ramirez (1992) conclude that the consequences of the rates of extraction are twofold: first a continuous fall in the level of underground water and an increase in the cost of extraction; second, an increase in the inversion of the flow of saline water from the lake and its intrusion in the underground water in the area of Texcoco City. Figueroa proposes a reduction in the extraction of water for irrigation by one third of the amount extracted, to 15 Mm³ per year. Ramirez (1992) argues that as agriculture is one of the most important economic activities in the municipality, there should be more rational use of the water in both the city and the irrigation areas.

3.2.4 Soils

INEGI (1978) have produced soil map at a scale of 1:50,000 and Ortiz, 1977 a map of land systems with the classified on the basis of suitability for agriculture. It is on these sources that the following discussion is based. Cambisols with high organic matter content and lithosols with shallow depths and outcrops of rocks are found in steep slopes of more than 15%. The suitability of these soils are class V and VII respectively with severe limitation for their use in agriculture, due to their susceptibility to erosion (Ortiz, 1977). In the hilly areas with slopes between 5% and 9% phaeozems dominate; these are relatively shallow soils and in the hilly area often overlie a hardpan (tepetate) at depths between 10cm and 90 cm. In terms of suitability for agriculture, terraced the soils are grade II and III having limits due to precipitation, soil depth and erosion, which limit the range of crops that can be grown (Ortiz, 1974). The main restrictions for agriculture are depth in class II soils and erosion in class III soils (Ortiz, 1977). In the area between the piedmont and the lake basin, vertisols dominate, which are soils derived from alluvial deposits with a high clay content. Slopes of between 1% and 5 % characterize them and soil suitability is I and II (limited by climatic and workability problems). Finally in the area of the former lake basin, with slopes of 1% to 2%, solonchak and solonetz soils dominate with high sodium and salt content. These are not suitable for agriculture due to salinity and problems of low rainfall and seasonal flooding (Ortiz, 1977). (Figure 3.7)

3.2.5 Agriculture

Agricultural activities in the municipality occupy about 11,128 ha. In the alluvial area around the basin of the lake about 4210 ha. are under irrigation with the remaining 6918 ha under seasonal agriculture (Ojeda, 1994). The main crops are maize, wheat and beans, sown in an extent of 8885 ha. cultivated in both irrigated and seasonal agriculture. In the irrigated lands other crops are sown such as alfalfa and other fodder crops (forage maize, oats and sorghum) as well as some intensive vegetable production (green tomato, artichoke, cauliflower, carrot,). In seasonal agriculture the main crop is maize, beans, broad beans, and grains used as forage crops such as oats, wheat and barley as well as plantation of Maguey[2] and nopal. In the lands settlement areas of the pueblos, in the hilly area, and those the base of the sierra, with irrigation the main crop is maize, flowers in the open air or in greenhouses, fruit and plants used in traditional Mexican dishes, or -medicinal purposes (Table 3.3).

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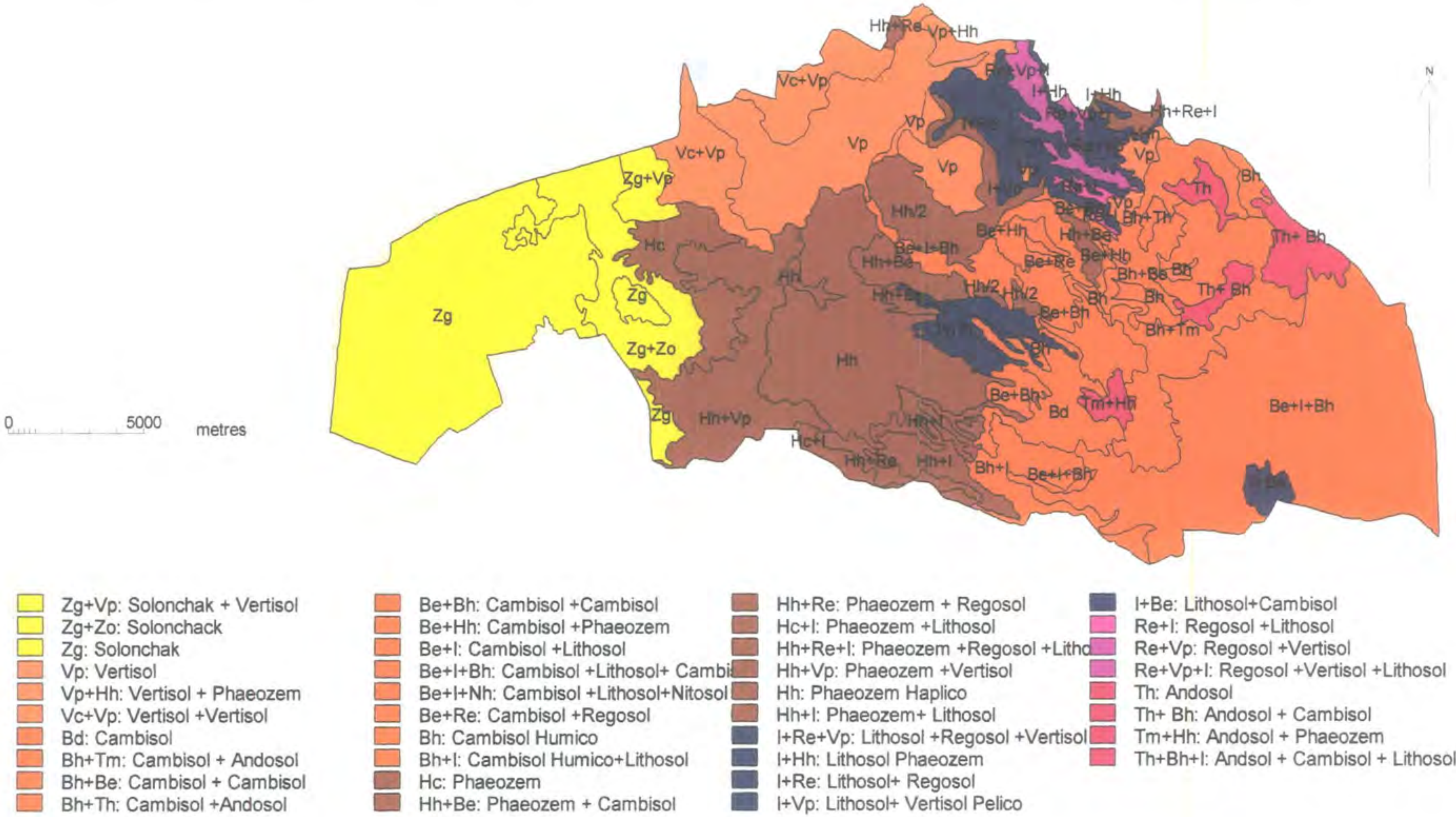
[2] *Maguey* is a plant from which a traditional alcoholic drink made by the indigenous people by fermenting a liquid *(aguamiel)* extracted from it. *Nopal* is a edible cactus

Figure 3.7 Soils of Texcoco(Author, compiled from maps E14B21 and E14B31, Scale 1:50,000, Classification, FAO/UNESCO, 1968; INEGI, 1978)



Note:The cartographic units are aggregated by colour, and the soil units in each cartograhic units are indicated in the map.

Table 3.3 Main crops in Texcoco (Ojeda, 1994).

Crop	**Area (ha)**
Maize	7134
Alfalfa	1081
Wheat	1020
Beans	631
Forage maize	298
Maguey	144
Zucchini	151
Barley	126
Broad bean	108
Green tomato	73
Nopal	69
Oat	53
Forage Sorghum	51
Artichoke	50
Peach	25
Sorghum	25
Cauliflower	23
Carrot	20
Forage oat	17
Other (potato, chili, coriander, cabbage, etc.)	29
Total	11,128

Agricultural activity varies according to agro climatic characteristics, land tenure and access to natural resources and infrastructure and for irrigation can be broadly divided into three zones:

a) The land of the plain area with access to irrigation by pumping water and with good soils, with intensive agriculture and dairy farming, with maize, fodder crops and in a less extent vegetables. Production is oriented to market and in ejidal to both market and self-consumption. The land tenure is mixed private and ejidal.

b) The hilly area with most of the land under seasonal agriculture with limited access to water for irrigation in the settlement areas supplied from springs and stored and regulated in tanks. There are extensive areas degraded by erosion, some reclaimed through terracing and incorporated into agriculture. Agriculture is mainly oriented to self-consumption including crops such as maize, broad beans and beans. In the irrigated areas maize is the main crop, with some crops oriented to market such as flowers (open air and greenhouses), medicinal herbs and fruits. Livestock comprises mainly sheep and some cattle, in backyard production, and seasonal grazing in the communal land. Time devoted to crop production or livestock for most of the people is by the different family members after their daily journey to work, and some only during weekend. The land tenure is largely ejidal with a small amount of land being private.

c) Settlements near the sierra have both seasonal and irrigated agriculture with water sources from the springs. Land near the settlements is degraded by erosion, and most of the agriculture in the settlement area is in terraces built since the Prehispanic period. Land has been recently reclaimed by terracing and soil formed by the breaking up of tepetate with machinery. Agriculture is mainly oriented to self-production in seasonal agriculture lands producing crops such as maize, broad beans and beans. In the terraces maize and beans are combined with production of flowers and fruits mainly produced in the borders of the irrigated parcels. In the agricultural lands of the sierra crops resistant to frosts are grown such as potatoes, wheat, oat and barley. Some people are engaged in income activities outside agriculture but most of them have agriculture as their main activity (Aldana, 1994; Ayuntamiento de Texcoco, 1997; Palerm, 1993; Sokolosky J, 1995). The land tenure in these lands is in three forms: ejidal, communal (land is held as Comunidad Agraria) and private in the settlement areas.

3.2.6 Grassland and Livestock.

Grassland in the municipality is concentrated in the communal lands of the *ejidos* and along the edge of streams and roads. The main areas for grazing are located in the saline grassland that surrounds the lake Texcoco, in the forest area and on the outskirts of the settlements. Sheep and goats are grazed during the rainy season on the communal lands, and along streams and edges of roads, after harvesting when the residues of maize and wheat are left in the fields and are freely grazed[3] (Arbiza and Lucas, 1992, cited by Llanderel, 1995). In interviews several shepherds said that grazing of the agricultural lands after the harvest is a common practice in the *ejidos*.

[3] This practice came from Hispanic times: Castilian law allows free grazing after the harvest.

The size of flocks varies from five to 50 head. The market for the livestock is the local market, but the communities consume most during local fiestas.

3.2.7 Forestry

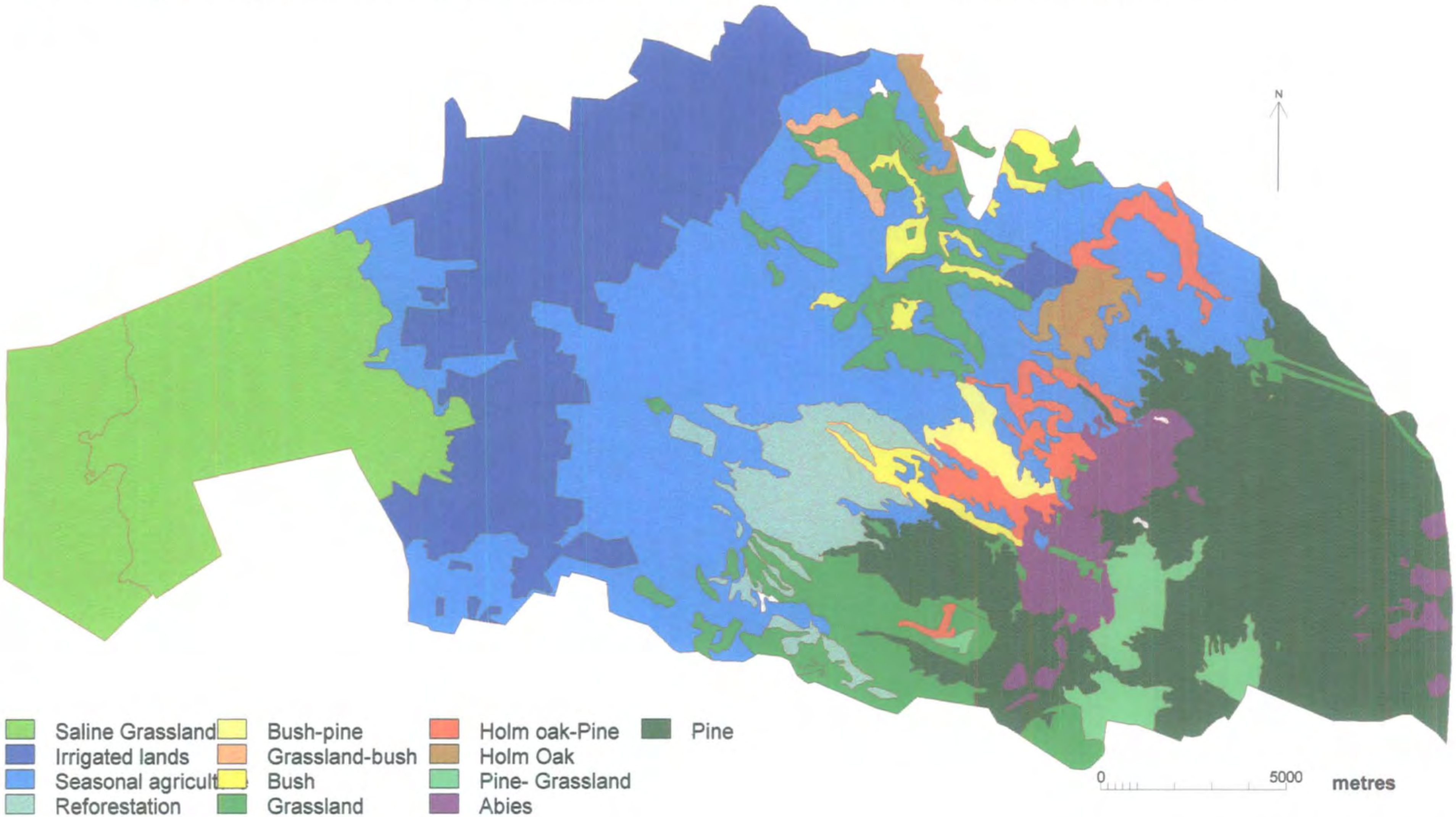
The forested areas of the municipality cover in excess of 14,000 ha (Ojeda, 1994), and are located on the eastern edge of the municipality along the Sierra Nevada at heights above 2350m (Figure 3.8). The dominant species are pine, oyamel and holm oak. The distribution and presence of dominant species and their association with other species of trees are determined by height above mean sea level. The main species of tree species and their distribution is shown in Table 3.4.

Table 3.4 Types of tree species by range of altitude in the municipality (extracted from Gonzalez, 1993, from different studies of vegetation (1964-1979) in the Valley of Mexico).

Height above mean sea level (m)	Dominant species	Associated species
2900 to 4000	*Pine(Pinus hartweggi)*	
2700 to 3000	Pine (Pinus rudis)	Quercus, Alnus or Juniperus)
2500 to 3100	*Pine (Pinus montezumae)*	*Sometimes Pinus, Quercus, Abies, Alnus*
2350 to 2600	*Pine (Pinus leiophylla)*	*Quercus*
2700-3500	Oyamel (Abies religiosa)	
2800 to 3100	*Holm oak (Quercus laurina)*	*Q. crassifolia, Q. rugosa. Abies, Juniperus*
2500 to 2800	*Holm oak (Quercus rugosa)*	*Q. mexicana Q. crassipes.* Ocassionally *Pinus and Cupressus*
Under 2500	*Holm oak (Quercus deserticola, Q. Latea, Q crassipes and Q. obtustata).*	*Pinus leiophylla*

Commercial forest exploitation in Texcoco was in concession to the company of San Rafael from 1945 to 1990 and from 1990 to 1995 the exploitation of the forest was banned for protection of the forest areas of the State of Mexico. Despite the ban on the extraction of wood and firewood imposed to the *ejidatarios*, which restricted the extraction of firewood from dead tress and wood for self-consumption. To extraction of firewood and on a smaller scale the extraction of wood for sale continued as a source of income for the *ejidatario* as an outlaw activity (Palma, 1996, INSTRUCT,

Figure 3.8 Land cover in the municipality of Texcoco (Author, compiled from Land use maps E14B21 and E14B31, scale 1:50,000 INEGI, 1982).



1997). In 1995 the ban on the exploitation of the forest was lifted and new legislation issued and the exploitation of the timber is now allowed by the presentation of forest management programmes in the Environment Secretariat. In 1996 the total extraction of wood in the municipality was reported as 1000 m^3 (Ayuntamiento, 1997). Changes in Forest Law of 1994 allowed again extraction of wood from the forest and the first permit for exploitation in 1997 to the *ejidos* of San Jeronimo Amanalco authorised the extraction of 5000 m^3 of wood per annum during a period of ten years from its forest. During the fieldwork for the present research there was evidence of intensification of forest exploitation of forest, with more permits given by the government for extraction of wood to other *ejidos*.

The forest vegetation is highly degraded near the settlements and in these areas the forest has been removed to open up areas for agriculture or has been degraded by overgrazing (INSTRUCT 1997; Ortiz, 1974). Economic activities in the forest include extraction on a smaller scale for self-consumption and for market of firewood, and to a lesser extent of wood (Palma, 1996). Other important uses of the forest lands are extensive livestock grazing mainly in flocks of sheep, goats and some cattle, extraction of non- forest products such as mushrooms and peat and extraction of other products for local craft for the production of brooms and Christmas decorations (Ayuntamiento de Texcoco, 1997; Sokolosky, 1995; Palerm, 1993; Aldana, 1994).

3.3 Population and socio-economic background

3.3.1 Growth of population and urbanisation

Changes in population in the municipalities surrounding Mexico City are strongly linked to the history and development of Mexico City itself (Muro, 1996, Aguilar et al. 1995). Population growth in Mexico City has accelerated rapidly from 1950. Much of the high growth of Mexico City is due to the continuous arrival of migrants from the economically depressed rural areas (Goldani 1977; Stren, 1977; Unikel, 1974. Cited by Aguilar et al, 1995). Population has spread into the adjacent municipalities of the state of Mexico by the process of sub-urbanization, assisted by the building of new communications and transport that reduce travel times to Mexico City. This has allowed people to find cheaper land to build dwellings or in the residential states built by the government agencies (Aguilar et. al, 1995).

The impact of these factors on migration in Texcoco is evident by the analysis of population data. 1960s and 1970s growth rates reached 5.42% and 6.08 % respectively, three points above the rate of 3 % found in previous decades. Population almost trebled in number from 65,628 inhabitants in 1970 (Censo de Poblacion, 1970) to 173,106 inhabitants in 1995 (INEGI, 1995) and its density has risen from 135-inhabitants/ km² in 1970 to 414 inhabitants/km² in 1995.

The process of urbanisation has been taking place fastest in the municipality in areas with access to services and communications in areas surrounding Texcoco City and along the main roads to Mexico City. The main developments have been promoted by both the government and private estate agents, and much of this has been in the best agricultural land formerly used for dairy farming (INSTRUCT, 1997; Muro, 1996). The state government has promoted this urbanisation by the municipality's plan of Strategic Centers of Population by the government of the state of Mexico.

Texcoco municipality consists of 66 settlements (Table 3.5). Figure 3.9 show the distribution of the main 48 settlements. The main concentration of settlements, with the highest concentrations of population, urbanisation and public services are those surrounding Texcoco city, and alongside the main roads to Mexico City. A second belt of settlements is located in the hilly region with deficient provision of public services. Finally the third is in the outskirts of the mountains, where there are several settlements also with poor provision of public services. The government uses the criterion of number of inhabitants to classify a settlement, and in this way localities with more than 2500 inhabitants are considered as urban[4]. Using this criterion, there are thirteen urban settlements in Texcoco, in which 90.6 % of the population lives and with the largest numbers in the city of Texcoco with 51.7 % of the total population i.e. 89,524 inhabitants.

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[4] This criterion does not take into account the provision of basic services. If the criterion for classification of urban settlement takes in consideration how much of the urban area has access to services such as tap water, surfacing of streets, sewage water. In base of this the city of Texcoco, is the only settlement in which more than 90 % of the urban area is covered by this services (p.26 Ayuntamiento de Texcoco, 1997)

Figure 3.9 Distribution of 48 main settlemets in the municipality of Texcoco (Author, based in mosaics of aerial photographs at scale of 1:20,000, Satellite Imagery of 1994 and field observations)

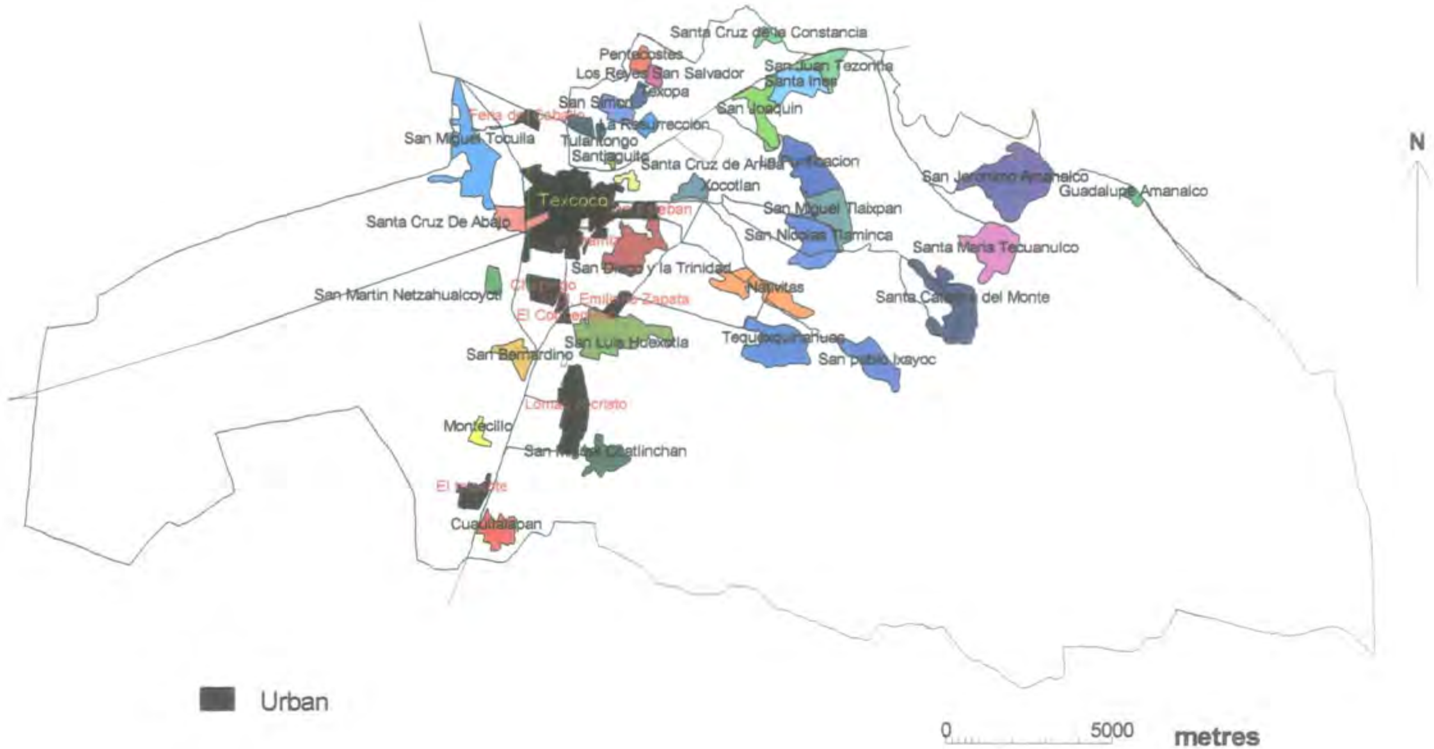

Table 3.5. Number of inhabitants by settlement in 1995 (INEGI, 1995).

No. iof inhabitants	No. of settlements	Total No of Inhabitants
More than 15000	1	89,524
5000 to 15000	4	40,824
2500 to 5000	8	27,852
500 to 2500	6	9,993
100 to 500	16	3,424
Less than 100	32	1,509

The accelerated growth of population in the area and the urbanisation policy of the government of the state and municipality, are changing the land use from agriculture to urban. In 1997 the municipality identifies 9 areas of accelerated urban growth. Modifications to the agrarian law in 1992 provided a basis for urbanisation of ejidal land that made land available for urbanisation in the *ejidos* in public and private partnership (see Gareth and Pisab, 1999).

3.3.2 Economic activities

Economic activities are classified according to the census of population (INEGI, 1990) as the population with an economic activity[5] during the week of the survey and by the sector in which the activity is performed: primary[6], secondary[7] and tertiary[8]. The number of people working in the primary sector has remained almost unchanged since 1970, although as a percentage of those employed it has fallen from 34.7 to 13.0, but the number of people with activities in the secondary and tertiary sectors has grown by almost 300% and more than 400%, respectively (Table 3.6). Most people in the secondary and tertiary sectors are employed as workers in stores or public offices[9], or in transport, with many commuting to Mexico City.

Regarding employment in the primary sector, from the 5169 persons working in 1990, INEGI reports that 2675 worked as peons[10] and 1352 as farmers in agriculture and

[5] People above the age of twelve years old that have an economic activity in the week of the survey and received a salary or payment in kind.
[6] Such as agriculture, livestock forestry and services related with these activities.
[7] Such as industry, electricity, water, construction, exploitation of mines or oil.
[8] Such as trade, transportation, communication and services.
[9] The 40 % of the people with economic activity are working in three government institutions based in the municipality (INSTRUCT, 1997)
[10] Peons persons engaged as temporary workers in agriculture activities (labourers).

Table 3.6. Economically active people by sector in Texcoco (Direccion de Estadistica, 1970; INEGI, 1980; INEGI, 1990)

Year	Total population	No of economically active people	% of economically active people	Primary sector	Secondary sector	Tertiary sector	Inactive people[11]
1970	65,628	16,472	Nr	5,716	4,019	5,551	Nr
1980	105,581	30,965	44.94	6,257	5,959	9,278	37,952
1990	140,368	39,668	40.44	5,169	11,631	21,724	58,427

Nr. Not registered.

livestock (INEGI; 1990). This means that the numbers of people with direct employment in agriculture were 4027 in 1990.In contrast to the increase of people working in the secondary and tertiary sectors in the period 1960-1990, the number of persons in primary activities has remained almost the same since 1960. This suggests a contraction of agricultural activities in the municipality.

Several authors signal that until the middle 1960s the main sources of employment in the ranchos of the municipality were oriented to milk production. After the middle 1960s the increase in dairy farming in other areas of the country, such as the Bajio and North Mexico (La Laguna), and the control of the price of milk by the government, resulted in several ranchos closing their activities due to financial problems, and employment declined gradually (Ayuntamiento de Texcoco, 1997; Muro, 1995, INSTRUCT, 1998). Ceron (1988, cited by Muro, 1995) reported that the number of dairy farms in the municipality fell from 41 ranchos with 30,000 head of cattle in 1942 to 16 ranchos with 16,000 cattle in 1975 and 14 ranchos with 6350 cattle in 1987. Muro (1995) notes that in 1995 only two ranchos with less than 2000 head were still active in the municipality. Although there is no similar information available for the *ejidos*, in the present research the *ejidatarios* commented that dairy farming has decreased gradually due to low milk prices and continuous increases in the cost of production of feed crops and medicinal treatment of cattle.

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[11] Persons above twelve years old and without any economic activity are considered inactive. For example: students, housewives, disabled people and pensioners.

Chapter 4 Methodology

4.1 Introduction

A multi method approach for the collection of information for a case-study at two units for planning, municipality and *ejidos*, is proposed in this research. The focus on the method is in problems of collection and integration of information coming from different sources. GIS is proposed as a tool to help in the building of the understanding of processes of land use and decision-making by:

1. The involvement of the local users in the collection of information relevant for land use and identification of related problems.
2. The collection and use of the existing data in government agencies, but integrating the information at municipality and *ejido* levels, changing the methods of data processing using GIS and integrating existing remote sensing, resource surveys and field data and the clear presentation of the results.
3. The change in the focus of planning from data-driven approach to a demand driven approach by the users of information;
4. To look further at the various tools to collect and manipulate information such as participatory techniques for collection of data and GIS as a tool for the production of resource maps on the ground.

4.2 Multi-method approach

Several authors have argued that the understanding and characterisation of land use patterns and the decision-making processes that produce them involve a range of factors that must be taken into account. Data about the biophysical and socio-economic environment must be considered together in planning methods. Recently human factors relating government institutions and the desires and views of local people have been included as sources of information. This calls for the need to link information from the physical and biological sciences with social values and political realities in a participatory process of establishing goals and making decisions (Beatty, et. al, 1979; Mather, 1986; Fresco, 1994; Mcfarlan, 1995; FAO, 1997; Roling, 1998; Roling and Wagemakers, 1998, Woodhill and Roling, 1998).

More recently Woodhill and Roling (1998) argue for a more creative, forward thinking and socially engaging process of change focused on integrating the creative capacities of the people, whether they be land users, lay people, natural scientists, social scientists, policy makers or politicians. The process of social change, cultural transformation and institutional development necessary to achieve this has been called social learning. To address environmental issues effectively from an integration of biophysical and social dimensions requires an understanding of decision-making and action across all levels of society.

The process of collecting of information is more difficult when more sources of information are taken into account and the conflicts among the competing land uses have multiplied due to the increase in the diversity of land uses or land value (Beatty, et. al. 1979). Additional to this, in the case of lower-income countries, factors such as an increase in population and poverty produce pressure on the resource base available (Harrison, 1979,1987). In some cases damage or destruction of natural resources are produced by the introduction of inappropriate land use.

As argued before the context, in which decisions are made must be considered for the understanding of the related land use and decision-making processes. For the present research a case study is used as an appropriate approach because types of land use and associated decisions are not readily distinguishable from their context. A case study is defined by Yin (1984, p 130) as.

> 'an empirical inquiry that investigates contemporary phenomenon within its real life context, addresses a situation in which the boundaries between phenomenon and context are not clearly evident and uses multiple sources of evidence'

In other words in the present context, decisions about the use of land involve a multiplicity of factors: government objectives, the objectives of the land user, the process or means by which he or she reaches a decision, and the background of factors that consciously or unconsciously influence the decision (Mather, 1986). The inclusion of the context as a major part of the study creates technical challenges for the gathering and analysis of information. First the richness of the data means that the study cannot rely on a single data gathering method; second distinctive strategies are needed for research design and analysis; and third there is a need to consider the role of theory in establishing expectations for analysing case-study empirical evidence (Yin, 1994).

4.3 Selection of the units of analysis for land use in Mexico

The unit of analysis for the case study should allow that local priorities regarding land use or management of the resources between government and the users of the resources could be established. It is also necessary to take into consideration the levels at which decisions related to land use are made. In Mexico the government has developed two levels that have spatial significance for land use planning. The municipality is the basic unit for planning and allocation of resources from the federal and state government and the *ejido* is the unit that was granted to landless people during land reform, during which 27, 391 *ejidos* were created and around 103 million of hectares of land granted.

Wilkie (1967) pointed out that; although the municipality does not correlate with other natural, cultural or social organisation it has in itself created accentuated regional differences. Federal, state and local government investments and social reforms vary considerably encouraging certain types of regional development, social conditions and productive activities (Wilkie, 1967 cited by Lieverman and Caverty, 1992). Furthermore census and other government reports usually organise the data at this level, and thus guide the perceptions and plans of the municipalities. Moreover this level is the level at which government programs are implemented. More recently the municipality has been central in the decentralisation process started by the state government for increasing the efficiency and responsiveness of the government to local demands (H. Ayuntamiento de Texcoco, 1997; World Bank, 1995).

The municipality selected for study here is Texcoco in the central part of Mexico. This area was selected for a number of reasons: first, it has a contrasting bio-physical and socio-economic resource base; second, it has a long history of government interventions in the use of land resources; third, the municipality is an area with which I am personally familiar so problems in accessing specific study areas, secondary information sources and local people are likely to be surmountable.

The *ejido*s were selected as the second level of analysis for different reasons: Their number 36, and different sizes, ranging from 10 to 2477 ha and covering a contrasting set of environmental conditions; the *ejido*s have the highest index of poverty in the municipality (Ayuntamiento de Texcoco, 1997); *ejidatario*s are involved directly in the decision making-processes for the use of natural resources related to agriculture, livestock and forestry; the *ejidatario*s have a long history of participation in government programs.

4.4 Gathering information for the municipality and *ejidos*

One approach to understanding the processes of land use planning and related decision-making is that proposed by Dent (1997) this focuses on the understanding of why land users continually take decisions that are different to what planners consider optimal. Dent (1997) suggests that the flow of information that is essential for decision-making and meaningful negotiations in resource use could provide the link between top-down planning and policy development by governments, and bottom-up planning and management by local communities. Important elements on this respect are: people coming together to manage the land with a common core of information about natural resources and economic opportunities; and technical skills including map and air photo reading, measurements and record keeping, and the tools and means to produce and find further information, required for planning, in either their institutions, or from the beneficiaries of their plans or programs.

Dent (1998) added that one of the main problems related to land use data in the support of planning and decision-making is the lack of data sharing among institutions and land users. This may arise for one of a number of reasons: i) data exist but those making planning decisions are either unaware of their existence or they do not have access to them; ii) data exist, are accessible, but are not comprehensible to those making policy and land use decisions; iii) data do not exist.

Consequently the creation of a common core of information about natural resources and opportunities is essential for land use planning and decision-making. In the present research, information collected for the two spatial levels (municipality and *ejido*) was made by covering different agencies including federal, state, municipality, government, universities and in the *ejido*s themselves.

Several restrictions exist in attempting to collect information from government institutions in lower income countries. The institutions are fragmented and compartmentalised and the information dispersed in different ministries or offices. In addition access can be difficult due to bureaucratic and political factors; problems of access to central information such as ownership patterns, with institutions reluctant to release data on ownership, or officials that possess information view it as a scarce resource to be exchanged for commodities or influence (Popper, 1978; Fox J, 1991); Land resources information, especially spatial information, is not all used in policy decision-making, and is often not available in digital format (Taylor, 1991; Dent et. al. 1994).

The social organisation of the *ejido*s with their long history of government interventions makes information collection an onerous task. Several authors have pointed how *ejido*s have a long history of having been manipulated, coerced, or threatened by the policy institutions of the state and are often characterised by highly contentious internal divisions relating to issues of power, land distribution, and unequal control over economic resources (Ronfeldt, 1973; De Walt, 1979; Warman, 1980; De la Peña, 1981; Grindle 1988). Thus, based in previous experiences, most of the ejidatarios are not very willing to collaborate in the programs of the state agencies. In addition recent modifications of the Agrarian law and the on-going program of certification of *ejidal* rights make the people in the *ejido* very reluctant to release information about matters related to the *ejido*. The use of methods of participatory and rapid rural appraisal considered the most suitable tools to carry out information collection in *ejido*s in an attempt to overcome some of these difficulties.

Data collection for the municipality consequently involved two approaches:

1) Identification of available formal/official data sources.

2) Use of unofficial sources, involving a range of techniques including eliciting perceptions and views of municipality officers and agents.

The information collected was integrated in a Geographical Information System (GIS) and its facilities for the management of spatial information are used to build up an inventory of the resources at municipality and *ejido* level. These inventories are used for the identification of three *ejido*s with contrasting resource bases. In these *ejido*s more in-depth information about the processes of decision-making, resource base and organisation are taken using participatory methods. Finally the identification mapping and characterization for land use in the *ejido*s is generated and from them recommendations for planning in critical areas are identified for municipality and *ejido*s. The methodological framework followed during the research is shown in Figure 4.1.

4.4.1 Information collection from institutions

Those agencies concerned with rural development programmes or issues related to land and resources were identified and contacted in order to obtain access to 'official' information. Institutions in the Federal, State of Mexico and municipality government and *ejido*s were contacted and subsequently visited. This allowed the collection of a range of data from institutions with responsibilities from the national to ejidal level, and also gave access to information that is dispersed in the different Ministries or offices. The sources of information were the:

- Secretariat of Agriculture and Rural Development (Secretaria de Agricultura y Desarrollo Rural),
- Secretariat of Land Reform (Secretaria de la Reforma Agraria),
- Government of the State of Mexico (Gobierno del Estado de Mexico)
- Municipality of Texcoco Government (Gobierno del Municipio de Texcoco).

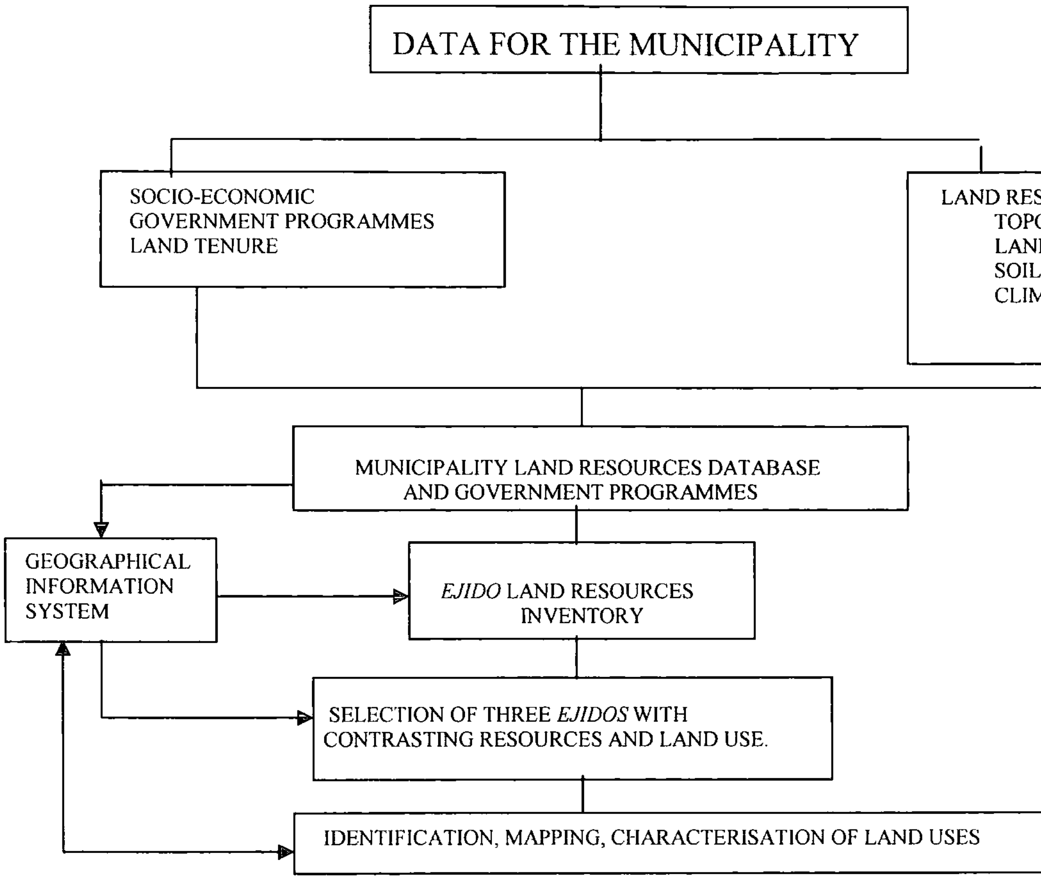

Figure 4.1 General methodological framework at municipality level.

- Plan Lago de Texcoco
- Program of Ecological Restoration of the Valley of Mexico.

Specialised agencies such as:

- National Institute of Statistics, Geography and Informatics (Instituto Nacional de Estadistica Geografia e Informatica, INEGI),
- State of Mexico Institute of Geography, Statistics and Cadastral studies (Instituto de Geografia, Estadistica y Catastro del Estado de Mexico, IGECEM).

Institutions carrying out research based in the municipality such as:

- The University of Chapingo (Universidad Autonoma de Chapingo)
- Colegio de Postgraduados (Institucion de Ensenanza e Investigacion en Ciencias Agricolas)

Additionally during fieldwork information was obtained directly form the municipality agents in charge of programmes such: as the program of certification of *ejidos* (PROCEDE); Alianza Para el Campo (PROCAMPO), and the programme of Ecological restoration of the Valley of Mexico.

All of above institutions and organisations were contacted and authorisation to access information about their programmes and other information relevant for the research at municipality and *ejido* level requested from the chairman of the institutions. In December 1996 the Central offices of INEGI, in Aguascalientes, Mexico were visited and officers conducting the programme of PROCEDE, the National Census in INEGI and the Rural Development District 03 of Texcoco (Distrito de Desarrollo Rural 03 de Texcoco, DDR03) were interviewed to develop some rapport with the people who ran the programmes.

Most of the data collected in this stage were not integrated at municipality level; it was in the form of reports and tables, neither structured to inputting directly into the GIS. The information was the product of programmes implemented separately in different agencies. Data obtained from government agencies are summarised in Table 4.1.

4.4.2 Problems of access to databases from INEGI

Data requested to INEGI agency were that produced by the office National Agricultural census and that of the Program for certification of ejidal rights PROCEDE: The Agricultural census data are collected by rural production unit (4, 407,408 in the country, 5200 in Texcoco), and *ejidos* (29,983 in the country 36 in Texcoco). Data collected are about characteristics of the unit of production or *ejido*, crops, technology of production, livestock, and comprises 186 variables. As the data was aggregated by Area Geografica Estadistica Basica (AGEB)[1](basic geographic statistic unit) as the data published in census were at AGEB level data were requested by unit of production and *ejido*.

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[1] AGEB is a Basic Geo-statistical Geographic Area. In the Agrarian an *ejidal* census is the aggregation of several *ejidos* with similar socio-economic and production conditions. Texcoco is divided in 14 AGEB.

Table 4.1. Institutions and information collected for the municipality of Texcoco.

Institution	Socio-economic	Bio-Physical
Instituto de Estadistica, Geografia e Informatica. (INEGI).	1.Census: Population (1990,1995) (CD-ROM) Census Agrarian and Ejidal (1990). (CD-ROM) 2. Map of Boundaries of the 33 *ejido*s (1:50,000). 3. Digital maps of 22 *ejido*s with boundaries of the communal and parcel areas (PROCEDE).	1. Maps of resources (Soils, topography, geology and land use (1:50,000). 2. Digital terrain model from map 1.50,000 and 1:250,000.
Instituto de Geografia , Estadistica y Estudios Catastrales del estado de Mexico. (IGEECEM)	Atlas del Estado de Mexico. Boundaries of the municipality.	3. Aerial photography (1:19,500) 4. Mosaics with georeference (1:20,000 and:10,000).
Distrito de Desarrollo Rural 03 Texcoco (DDR 03). SAGADER. Gobierno del Estado de Mexico. SEDAGRO	4. List of rural development programs in *Alianza para el Campo.* 5. List of *ejido*s and *ejidatario*s receiving support from PROCAMPO. 6. List of irrigation units with maps and names of *ejidatario*s.	5. Database on soil fertility at municipality level (232 samples)
Municipality of Texcoco	Municipality plan of development 1997-2000	
Instituciones de Enseñanza Investigacion: Colegio de Postgraduados(CP) y Universidad Autonoma Chapingo(UACh)		6. Land use map municipality level (1:10,000) 7. SPOT images: 1989 and 1994. 8.Thesis and research reports.

Previous to fieldwork, in December 1996, the offices of the Agriculture census and PROCEDE were visited, and the interviews held with the heads of the offices of PROCEDE and census. They were willing to provide the data as requested. However the data provided were not as expected. The information of the census was 5200 interviews with the 186 variables collected in the census, but without the column of data with the identification by *ejido*. No data from the *ejidal* census were released. When I asked to the officer for the code for identification of *ejidos* the official argue that the articles 38 and 42[2] of the Statistical law of information ban the release of data by individual or *ejido*.

[2] Articles 38 and 42 of the law of statistical information states that 'the data and information released by the persons are for statistical aims ....the information will be handled under the principle of strictest confidence and can not be communicated in any case in nominative or individualised form.....(Cited in INEGI, 1991).

The data of the census available in CD ROM were analysed, the municipality was divided in 14 AGEB; however, when the spatial distribution of the AGEBs was analysed, it was observed that AGEBs aggregate several *ejidos*, and some of them own land in different AGEBs. These data were considered not appropriate for the research.

A similar situation was faced with the data in PROCEDE. The maps provided with the location of *ejidos* at municipality level were two topographic maps at a scale of 1:50,000 with the boundaries of the *ejidos* and private property. However they were draw by hand, and as the photocopy was in black and white, the *ejidos* differentiated by colours, were very difficult to identify. The Arc/Info coverages provided were of 22 *ejidos*[3], but when I display the data in Arc/Info, the map have only the boundaries of the area with parcels, communal land and infrastructure, but not the delimitation of individual parcels, and tables of attributes associated with parcels as requested. I asked for the data and the officer told that he couldn't release the data at parcel level, that it was the RAN (National Agrarian Register) who have that faculty and that by law the information about land tenure is in the public domain. During fieldwork the office of the State of Mexico was contacted and the chairman said that the maps have a cost of £75 each, and I fill a form to order the production of the maps.

However during fieldwork and afterwards, my order never was processed. A officer of the Procuraduria Agraria who was willing to help me to get the maps of this agency, told me that he was told

> 'that the problem for the release of the data with names of ejidatarios was that the municipality elections in Texcoco, were lost in the past elections, and that as the elections will be in this year. The officer in charge was worried, because I could use this information with electoral aims'.

Summarising: INEGI the institution producing information about statistics and geographical data aggregate the information at municipality level. PROCEDE produced information about the *ejidos* aggregated at municipality level. The Censo

[3] The digital data from PROCEDE were in Arc/info format .E00. The maps were about boundaries of the plot, communal area of the *ejido*. However the database with name of *ejidatarios* and location of plots in the plot area were not included.

Agricola (agricultural census) produced the data aggregated at the level of Area Geografica Estadistica Basica (AGEB)[4](basic geographic statistic unit) and municipality.

An interesting fact related with access to information during my visit to PROCEDE was that the officer in charge during the interview asked me two personal questions, Are you personal friend of the general director? Are you relative of the Ojeda[5] Family in Monterrey? After my honest response that I did not have any relation with the General Director of INEGI and that I don't know any people in Monterry, the willingness of officer to release information turned off.

As stated by Fox (1991) some of the problems for adopting spatial information technology in most countries are related with politics, censorship, and autonomy of agencies, rigid bureaucracies, sensitivity of land ownership. He added (p61) that sometimes

> 'a central official holding all the strings and making all decisions concerning the release of data on a 'case by case' basis....officials who possess information view it as scarce resource to be exchange for commodities or influence of equal or great value'.

The technology and information are available for increasing the ability of planning agencies. The use of the data produced by central agencies could be used for purposes of planning at local level or research, with an "added value" to the data already produced. However, the integration of these data in planning or GIS is not constrained by technical problems but by social, economic and political factors.

These difficulties in access meant that further information had to be collected during fieldwork for mapping the *ejidos* of the municipality and the elaboration of maps of plots for the selected *ejidos* and databases about ownership. Another source of information for *ejidos* was the Secretariat of Agrarian Reform (SRA), which is the government agency in charge of *ejido* affairs. Having the experience gained in the

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[4] AGEB is a Basic Geo-statistical Geographic Area. In the Agrarian an ejidal census is the aggregation of several *ejido*s with similar socio-economic and production conditions. Texcoco is divided in 14 AGEB.

[5] The Ojeda Family is one of the richest families in the city of Monterrey and well renown in political environments that have the same surname as me.

process of accessing of data from INEGI together with similar experiences in the SRA from other researchers of the department of Rural Sociology in the Colegio de Postgraduados indicated that obtaining information from this agency would be extremely difficult if not impossible and certainty extremely time consuming. Given the limited time for data collection it was decided that attention would be focused on alternative data sources on *ejidos* ranging from the municipality to the ejidatarios themselves.

4.5 Fieldwork and collection of data at municipality and *ejidos*

Fieldwork was undertaken from November 15th 1997 to April 25th 1998. In co-ordinating the process of data collection the following factors related with land use and decision-making within the *ejido*s were considered:

- *Biophysical* factors: these define the type of resource base available to the *ejido* as shaped by a land reform process ruled more by social than economic issues

-*Socio-economic* factors defined by access of the communities to government programmes and the contrasting available resource base

-*Cultural* factors with communities characterised by different cultural backgrounds at varying stage of integration with urban areas

-*Institutional* factors with a long process of government intervention that has caused uneven access to resources

These factors were related to land access to the people of each *ejido*-pueblo (see chapter VI) and therefore the first stage of the fieldwork was focused on the collection of information about land tenure, soils and land uses in the municipality with both government agents and *ejidatario*s.

4.5.1 Selection of *ejidos* with contrasting resources

For the analysis of land use and processes of land uses and decision-making from the 36 *ejido*s in the municipality three *ejido*s with contrasting resources were selected for detailed study. The selection of *ejidos* was made based on five criteria related to the resource base, land tenure, cultural background, infrastructure and government programmes as follows:

1) The distribution of natural resources in the municipality is physically determined by topography and climate. The *ejido*s selected must be located in areas, which are representative of these different conditions.

2) The amount of cultivated and communal land is different in each *ejido*. The *ejido*s variation in amount of land and types of access must be represented by the selected *ejido*s.

3) Access to infrastructure, irrigation, terraces and government programmes is different in each *ejido*. The *ejido*s selected must illustrate these different aspects.

4) There are four agrarian communities. One of these must be selected because the organisation of the *comunidad agraria* is different to the organisation in the *ejido*.

5) The willingness of the people to participate in the research, since without this gathering of local information could be impossible.

For the selection of three representative *ejidos* as first step transects and interviews were carried out to obtain detailed information about land use and the willingness of the local people to participate in the research. Eight transects were done through the municipality to collect data in the field, the transects cover the different biophysical, socio-economic, institutional and cultural conditions. Information on soils, land use, slope and problems and opportunities in their use was collected from municipality agents and ejidatarios. To reflect the variation in the resource base in the municipality in a first step three *ejido*s (colour, blue, gold and green in the Table 4.2) were chosen from each zone with variations in climate, topography. In terms of resource access (Table 4.2), the *ejido*s in each zone were chosen to reflect the variations in terms of type of resources (agriculture, forest and grassland), access to

Table 4.2 Information about issues that the municipality agents consider relevant for the differentiation of ejidos in the muncipality of Texcoco (fieldwork, 1998)

Ejidos	No of Ejidatarios	Area of Ejido(ha)	Tenure		Agriculture		Land Resource					
			Parcel	Communal	Irrigated	Seasonal	Forest	Reforest	Grassland	Gardens	Quarry	Tourism
Zone I												
I a Saline soil and Grassland												
S.L. Huexotla y San Mateo	196	251	Yes	No	Yes	Yes	No	No	Yes	No	No	No
San Martin Netzahualcoyotl	75	329	Yes	No	Yes	Yes	No	No	Yes	No	No	No
San Bernardino	146	399	Yes	No	Yes	Yes	No	No	Yes	No	No	No
San Felipe y Santa Cruz	340	864	Yes	No	Yes	Yes	No	No	Yes	No	No	No
San Miguel Tocuila	310	972	Yes	No	Yes	Yes	No	No	Yes	No	No	No
Ib Soils of good quality												
San joaquin Coapango	37	11	Yes	No	Yes	Yes	No	No	No	No	No	No
Santa Cruz de Arriba	26	19	Yes	No	Yes	Yes	No	No	No	No	No	No
Los Reyes San Salvador	42	52	Yes	No	Yes	Yes	No	No	No	No	No	No
San Jose Mecatillo	51	88	Yes	No	Yes	Yes	No	No	No	No	No	No
Tulantongo	66	94	Yes	No	Yes	Yes	No	No	No	No	No	No
Montecillo	50	129	Yes	No	Yes	Yes	No	No	No	No	No	No
La Resurreccion	69	136	Yes	No	Yes	Yes	No	No	No	No	No	No
San Simon	83	144	Yes	No	Yes	Yes	No	No	No	No	No	No
Pentecostes	87	184	Yes	No	Yes	Yes	No	No	No	No	No	No
San Pedro y Santa Ursula	52	167	Yes	No	Yes	Yes	No	No	No	No	No	No
Zone II												
San Miguel Coatlinchan	353	2477	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
La Purificacion	158	251	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No
S.Diego y La Trinidad	116	141	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Xocotlan	22	53	Yes	No	Yes	Yes	No	No	No	No	No	No
San Nicolas Tlaminca	62	204	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No
San Miguel Tlaixpan.		1960	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Resort
Santa Ines	32	110	Yes	Yes	No	Yes	No	No	Yes	Yes	No	No
San Juan Tezontla	55	228	Yes	Yes	No	Yes	No	Yes	Yes	Yes	No	No
San Dieguito Xochimaca	110	757	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Santa Maria Nativitas	126	843	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tequexquinahuac		1693	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Zone III												
San Pablo Izayoc	124	977	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Santa Maria Tecuanulco	n.a	1475	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
San Jeronimo Amanalco	108	1995	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
San Jeronimo AmanalcoC.A	33	1736	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
C.A. Santa Catarina del Monte.	254	1737	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Santa Catarina del Monte	132	694	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes

Continuation Table 4.2

Ejidos	Water Resource			Infrastructure		Government programmes				
	Spring	River	Wells	Terraces	Gabion dams	PROCAMPO	PROCEDE	Alianza	ASERCA	PRECVM
Zone I										
Ia Saline soil and Grassland										
S.L. Huexotla y San Mateo	No	Yes	Yes	No	No	Yes	Yes	Yes	No	No
San Martin Netzahualcoyotl	No	Yes	Yes	No	No	Yes	Yes	No	No	No
San Bernardino	No	Yes	Yes	No	No	Yes	Yes	No	No	No
San Felipe y Santa Cruz	No	No	Yes	No	No	Yes	No	No	No	No
San Miguel Tocuila	No	No	Yes	No	No	Yes	No	Yes	No	No
Ib Soils of good quality										
San joaquin Coapango	Yes	No	No	No	No	Yes	Yes	No	No	No
Santa Cruz de Arriba	No	No	Yes	No	No	Yes	Yes	Yes	No	No
Los Reyes San Salvador	No	No	Yes	No	No	Yes	Yes	No	No	No
San Jose Mecatillo	No	Yes	Yes	No	No	Yes	Yes	No	No	No
Tulantongo	No	Yes	Yes	No	No	Yes	Yes	No	No	No
Montecillo	No	No	Yes	No	No	No	Yes	Yes	No	No
La Resurreccion	No	Yes	Yes	No	No	Yes	Yes	Yes	No	No
San Simon	No	No	Yes	No	No	Yes	Yes	Yes	No	No
Pentecostes	No	Yes	Yes	No	No	Yes	Yes	No	No	No
San Pedro y Santa Ursula	No	Yes	Yes	No	No	Yes	Yes	No	No	No
Zone II										
San Miguel Coatlinchan	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
La Purificacion	Yes	No	Yes	Yes	No	Yes	Yes	No	No	Yes
S.Diego y La Trinidad	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	No
Xocotlan	Yes	No	Yes	No	No	Yes	Yes	No	No	No
San Nicolas Tlaminca	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	No
San Miguel Tlaixpan.	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Santa Ines	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	No
San Juan Tezontla	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
San Dieguito Xochimaca	Yes	No	No	Yes	No	Yes	Yes	No	Yes	No
Santa Maria Nativitas	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Tequexquinahuac	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Zone III										
San Pablo Izayoc	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Santa Maria Tecuanulco	Yes	No	No	Yes	Yes	Yes	No	No	Yes	No
San Jeronimo Amanalco	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
San Jeronimo AmanalcoC.A	Yes	No	No	Yes	Yes	Yes	No	No	Yes	No
C.A. Santa Catarina del Monte	Yes	No	No	Yes	Yes	Yes	No	No	No	Yes
Santa Catarina del Monte	No	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes

Continuation Table 4.2

Ejidos	Machinery		Problems						Participation	
	Tractor	Harvester.	Salinity	Erosion	Soil Fertility	Urbanization	Sewage irrigation	Boundary Problems	Authorithies	People
Zone I										
Ia Saline soil and Grassland	18									
S.L. Huexotla y San Mateo	7		Yes	No	Yes	Yes	Yes	No	Yes	No
San Martin Netzahualcoyotl	4		Yes	No	Yes	Yes	Yes	No	Yes	Yes
San Bernardino	11	2	Yes	No	No	Yes	Yes	No	No	No
San Felipe y Santa Cruz	4		Yes	No	No	Yes	Yes	No	Yes	No
San Miguel Tocuila	8		Yes	No	Yes	Yes	Yes	Yes	Yes	No
Ib Soils of good quality	18									
San joaquin Coapango	1		No	No	Yes	Yes	No	No	No	No
Santa Cruz de Arriba			No	No	Yes	Yes	No	No	No	No
Los Reyes San Salvador	1		No	No	No	Yes	No	No	Yes	No
San Jose Mecatillo			No	No	Yes	Yes	No	No	No	No
Tulantongo	2	1	No	No	Yes	Yes	No	No	Yes	No
Montecillo	4		No	No	No	Yes	No	No	Yes	No
La Resurreccion	2		No	No	No	Yes	No	No	Yes	No
San Simon	2		No	No	No	Yes	No	No	Yes	No
Pentecostes	1		No	No	No	Yes	No	No	No	No
San Pedro y Santa Ursula	3		No	No	Yes	Yes	Yes	No	Yes	No
Zone II	16									
San Miguel Coatlinchan	10		No	Yes	Yes	Yes	No	Yes	Yes	Yes
La Purificacion	4		No	Yes	Yes	Yes	No	No	No	No
S.Diego y La Trinidad	8		No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Xocotlan			No	No	Yes	Yes	No	Yes	No	No
San Nicolas Tlaminca	3		No	Yes	Yes	Yes	No	No	Yes	No
San Miguel Tlaixpan.	4		No	Yes	Yes	Yes	No	No	Yes	Yes
Santa Ines			No	Yes	Yes	Yes	No	Yes	Yes	No
San Juan Tezontla	2		No	Yes	Yes	Yes	No	Yes	No	No
San Dieguito Xochimaca	2		No	Yes	Yes	Yes	No	No	No	No
Santa Maria Nativitas	4		No	Yes	Yes	Yes	No	Yes	Yes	No
Tequexquinahuac	N.A		No	Yes	Yes	Yes	No	Yes	Yes	No
Zone III	35									
San Pablo Izayoc	1		No	Yes	Yes	No	No	No	Yes	Yes
Santa Maria Tecuanulco	1		No	Yes	Yes	No	No	Yes	Yes	No
San Jeronimo Amanalco		1	No	Yes	Yes	No	No	Yes	No	No
San Jeronimo AmanalcoC.A	8		No	Yes	Yes	No	No	Yes	No	No
C.A. Santa Catarina del Monte.	1		No	Yes	Yes	No	No	No	No	No
Santa Catarina del Monte			No	Yes	Yes	No	No	No	Yes	No

resources (infrastructure, government programmes, machinery) and their problems. For example in the *ejido*s of zone I the *ejido*s were divided first in two groups by the difference in type of resources, the *ejido*s in the shore of the lake with grassland and saline soils (Ia), and the other group with soils of good quality (Ib). Afterwards the differences among the *ejido*s of each group were identified. The *ejidos* in the group Ia have differences in access to sources of water, machinery, soil fertility[6], and problems of boundaries. The *ejido*s selected were two with differences in water source (one with wells, and one with wells and water from the river), soil fertility (one with and one without), and problems of boundaries (one with and one without). Finally the criterion was the area and San Bernardino (399 ha) and San Miguel Tocuila (899 ha). San Miguel Tocuila was selected from these two; Tocuila was selected from these two because the problem of boundaries that was considered important for the research. Similar procedures were followed for the selection of three *ejido*s in the other two zones.

Variations in the resource base were corroborated against the satellite image by overlay of the map of *ejido*s. The nine *ejido*s selected were: La Resurreccion, San Pedro y Santa Ursula and Tocuila in zone I; San Diego y la Trinidad, Santa Maria Nativitas and Tequesquinahuac in zone II; and San Pablo Ixayoc, San Jeronimo Amanalco and Santa Catarina del Monte in zone III (Figure 4.2). The ejidal authorities were contacted, and the objectives of the research explained. Following these discussions the nine *ejido*s were reduced to three: San Pedro y Santa Ursula, Santa Maria Nativitas and Santa Catarina del Monte, the decision being based in their contrasting resource base and the willingness of the authorities to co-operate in the provision of information.

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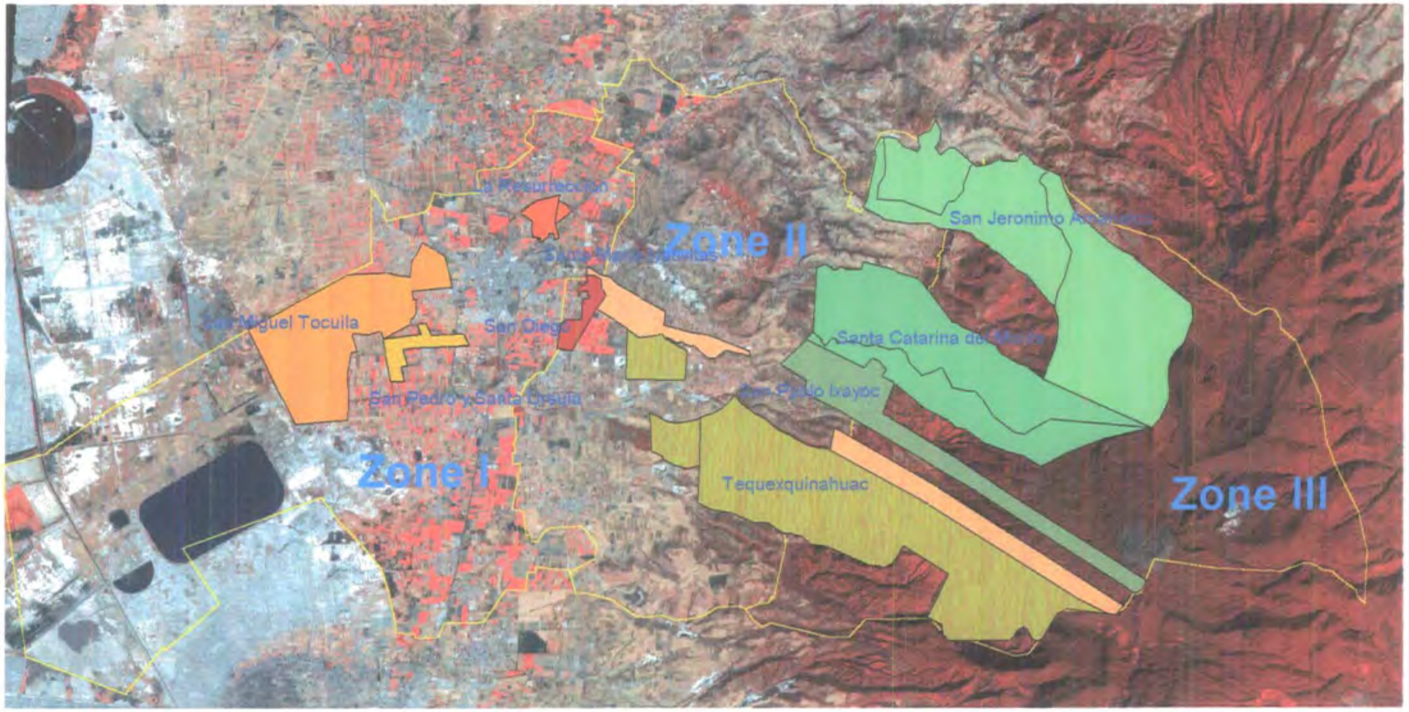
[6] The *ejidos* without problems of soil fertility were those with dairy farming, where organic matter is applied regularly.

Figure 4.2 Location of the nine ejidos, in the zones with different land uses and climatic conditions.



Note: yellow line is the boundary for climatic variation and zones of land uses

- San Miguel Tocuila
- San Pedro y Santa Urs
- La Resurreccion
- San Diego y la Trinidad
- Tequexquinahuac
- Santa Maria Nativita
- San Jeronimo Amanalco
- Santa Catarina del Monte
- San Pablo Izayoc

4.5.2 Gathering of data in the *ejidos*

As previously discussed many official data about the *ejido*s were not available, nevertheless, some were found in the different municipality offices and in reports and archives in the *ejido*s themselves. Much however was either not accessible or not collected, and thus data on individual *ejido*s were gathered by using a number of techniques in the field.

The methods used at *ejido* level were mainly qualitative drawing on Participatory and Rapid Rural Appraisal techniques. They were oriented to gathering information in a multiple method approach because land use and decision-making in the *ejido*s is related to the availability of resources, social structure and government institutions. Limitations of time and of economic resources in the fieldwork also made these methods the most appropriate.

In this study RRA was used to provide complementary data about resource problems and opportunities and for triangulation of information coming from municipality agents and *ejidatario*s about land use and decision-making. PRA techniques such as participatory mapping, transects and historical profiles were used to gain the views of local people about the resource base and land use and as an aid to reveal conflicts in the use of land resources by the government and *ejidatario*s.

The intended application of PRA in focus groups proved problematic, in one *ejido* since other institutions were working in the *ejido*s a few months prior to my fieldwork, using participatory methods and focus groups and questionnaires. When I proposed a meeting based on issues of land use people were very reluctant to participate. This reluctance comes from the recent 'overexposing' of people to these techniques, therefore, made the application of PRA difficult by this situation. However, semi-structured interviews, transects, mapping of resources and time lines of land about, land use and other resources (water and forest) were used successfully. The *ejidatario*s participated in these activities, I think, because they were face to face, involved a reduced number of people, were outdoors, and they do not related this techniques with those used frequently by government or researchers to elicit information[7].

The checklist of approaches and technique used in the *ejido*s during the fieldwork Comprise the following points:

- Contact of ejidal authorities and collection of information.
- Checking boundaries of the *ejidos* using aerial photographs and satellite images and maps available and field survey.
- Mapping of the settlement areas over the aerial photographs.
- Infrastructure available (dams, roads).
- Transect across the *ejidos.*
- Mapping of areas with different land uses (irrigated lands, seasonal agriculture, forest, badlands, and other uses).
- Crops and calendars.
- Information about land reform in the *ejidos.*
- Organisation of access to resources

The techniques used to yield the required data were: revision of secondary sources, semi-structured interviews, direct observation, transects and participatory mapping of soils and land uses.

4.5.3 Review of secondary sources.

Secondary materials such as the reports of government programmes, census statistics, and reports of research were collected from libraries and archives in the government offices and *ejidos*. The search for references in the library was for information at municipality and *ejido* level. The first search in libraries was general

[7] Yearly the government agents present the agriculture programmes to the *ejidatarios* in the *ejidal* assembly, and the *ejidatarios* associate the group meetings with the government. Also the students of the neighbouring school of Agriculture are frequently interviewing the *ejidatarios* about problems related with agriculture and management of resources. Also when somebody requests data about the *ejido*, or interviews people, he/she has to present what the research is about, to the *ejido* assembly, and how the *ejidatarios* can help her/him.

by the heading Texcoco and yields 150 references. The search of references and topics was iterative, for example: during an interview when I explain the objective of the research, I was told that somebody did similar research, ten years ago and gave me the name of the researcher. As the idea that the resources were managed as communal, other topics not considered in the search of materials were emerging as important for this context such as laws, historical data about land tenure, water management, and folk soil classification. Also in the institutions data about government programmes, budgets were available.

Most of the research conducted by the institutions has as its focus of analysis the municipality, the pueblo, and only five were focused in *ejidos* (about response of people to programmes of rural development). Research about natural resources was focused in the watershed of Texcoco and conservation of soil in a ten year research project conducted by the Colegio de Postgraduados. Researchers involved in these projects were also interviewed to get more detailed data. Also the researchers of the International network for the study and information in the use of natural resources for the transformation of the community (INSTRUCT) a project run by the University of Chapingo, the Colegio de Postgraduados, and the University of Trent in Canada that started in 1997, were interviewed and the reports on the project collected.

4.5.4 Semi-structured interviews with ejidatarios and government agents

A semi-structured interview is a guided interview where only some of the questions are predetermined, with new questions arising during the interview. The questions asked during the interviews were built around a list of subtopics that was oriented to questions related to land tenure, land use and the use of resources such as water, forest and grassland. Specific focus was maintained around decision-making processes involved in selection of crops, access to resources, variation in soils and climate, structure and implementation of government programmes, organisational issues around the use of resources, as in the case of access and distribution of water from springs and streams in the *ejido*s, and conflicts related to land use. Other sets of questions were built around the aerial photographs and maps produced. During the interviews informants with more 'knowledge' about the topic were identified and if necessary contacted later to obtain more in depth information by further interview. Key informants were also consulted to clarify ideas about processes of land use and decision-making.

The intention was to record all interviews, however, many participants were reluctant for this to take place and thus only 12 interviews were recorded. Thus reliance has to be placed on note taking during the remaining interviews. In total twenty-nine interviews were carried out with *ejidatario*s from the nine *ejido*s and twenty with government agents of different ages and backgrounds (Table 4.3).

Interviews with government agents were arranged in advance by appointment. In the *ejidos* several visits were made to carry out appointed interviews but on a number of occasions, the *ejidatarios* did not keep the appointment. In view of this, many of the interviews carried out in the *ejido*s were not pre-arranged, and most were spontaneous during the visits to communities and whilst undertaking transects. For example all of the initial nine *ejidos* were part of the research project INSTRUCT in which participatory techniques and questionnaires were conducted. This repeated interviewing so soon after the previous might explain the poor response. However when the staff of the project was contacted they too reported a poor response. In Santa Ursula when the program of PROCEDE was finished one group of *ejidatarios* was in favour of the privatisation to change the land tenure *ejido* to private property. The conflict between the two groups produced grievances and the assembly removed the ejidal authorities. For these reasons it was very difficult to interview the people on matters related to the *ejido*. Finally the people of Santa Catarina has been exposed to constant interviewing for research (Palerm and Tah, 1986; Canhua 1986, Zarate 1990, Gonzalez R 1993; INSTRUCT 1997, H Ayuntamiento 1997). A ejidatario said

> 'people are tired of outsiders. All the time they come to obtain information about crops or how we living, arguing that is for research in the school (university) or the information is required by the government to implement a programme to help the people'. They said 'this information will produce results that might improve the yield of crops, or a new government program for the benefit of the town. However they never came back with the

Table 4.3 Number of interviews, type of participation and background of participants in the research.

Ejido	No of semi-structured interviews	Status in the *ejido*	Type of participation	Age
Nativitas	9	*Ejidal* authority 2 *posesionarios,* 4 *ejidatarios* 3	Interview Transect, mapping	72,28,53, 60(female), 38, 42, 45, 28, 26
Santa Catarina del Monte	5	*Comunero,* 2 *ejidatarios* 3	Interview ,Transect Mapping	60, 52,45,38,20
San Pedro Y Santa Ursula	3	Ejidal authority 1 *ejidatarios* 2	Interview Mapping	68, 50(female), 40, 38,
Tequesquinahuac	4	*Ejidal* authority, Committee of dams	Interview, Transect	70, 38,40,40
Coatlinchan	3	3*Ejidatarios*	Interview	70,50,40
San Jeronimo Amanalco	2	*Ejidatario*, Committee of dams	Interview, Transect	45,45
San Pablo Ixayoc	3	2 *Ejidatarios*, *Ejidal* authority,	Interview ,Transect	86,,50,36
San Diego	2	2 *ejidatarios*	Interview, Transect	38,40
Tocuila	1	*Ejidal* authority	Interview, Mapping	55
Total	32			
		Chairmans		
Direccion de Agricultura, Toluca, Mexico.	1	Subdirector of Agriculture	Interview	60
SEDAGRO, Texcoco	1	Director SEDAGRO Texcoco	Interview	40
DDR03, Texcoco	1	Subdirector DDR Texcoco	Interview	50 (female)
		Municipality agents		
DDR03, Texcoco	2	Agriculture Program Water Program	Interview Transect mapping	45(female), 50
SEDAGRO, Texcoco	1	Livestock program	Interview Transect	40
Program of Ecological Restoration	2	Director of program Technician	Interview Transect mapping	42,45
Procuraduria Agraria	2	Advisor Texcoco Programme Director	Interview, Transect	45,50
SEMARNAP	1	Technician forest	Interview	42
PROBOSQUE	2	Director Technician	Interview	45
CP	2	Researchers	Transect, interview	40,50
Chapingo	1	Researcher	Interview	38
Lake of Texcoco	1	Director	Interview	60
Ecological Commite	2	President Technician	Interview, Transect	45,30
Total	19			

results of their studies or the programs are almost never implemented' (*Ejidatario*, 60 years, SCM).

The keys informants of SMN also shared this view. It is considered that all these reasons may be help to explain in part the reluctance of the people to co-operate with any initiative proposed outside of their communities.

Finally when I started to grasp in the ways in which the government control people by the identification of agents of the Secretariat of *Gobernacion* in the *ejido*s, and personal talks with one *comisariado ejidal* about his experiences in these matters. He told me that there are an under-world in the *ejidal* life, and talk about two of his experiences: The first when an entrepreneur wanted to build a real estate in the *ejido*, he was offered with a hand suitcase full of money, that could be for him if he promotes the plan and gets the authorisation of the assembly, to sell ten hectares of land for urban development. The second experience was that the government has special office in charge of monitoring, activities in the *ejido* political life. He said that the methods of co-optation are offering support to the *ejido*s or individuals with government in exchange of loyalty to the government, and most of the funding is negotiated in these levels. I suppose that he was one of them, because he suggested me several times that he can arrange an interview with the agent of the *Gobernacion* in charge of the office in Texcoco. I guess that I was assessed as a non-harmful person to the government because I was an academic. I thought my friend help to reach this perception.

I have an insight about how this under-world works, because in San Jeronimo Amanalco there were confrontations among the people and government authorities in 1996-1997. The first was a demonstration of the people in the city of Texcoco regarding problems with the increase in cost of public transport that ended in riot with vandalism in the bus station in Texcoco. The second confrontation was among people of the town of San Jeronimo and forestry agents, when the agents try to arrest the *ejidatario* charging him with illegal cutting of wood. The people of the town protect the *ejidatario*, the agents call for more public forces and the incident was in the brink of a bloody confrontation among police and the people. When I get data about permits of extraction of wood, just after the incident related with extraction of wood, the government extend a permit to the *ejido* of San Jeronimo to extract during a period of ten years, annually 5000 m3 of wood from their forest. I thought that these aspects were very important to build an understanding of the decision-making. But I prefer to go back and deal with the data produced for the non-harmful academic world.

Key informants were selected on the basis of their knowledge and involvement in the activities of the *ejido*. Four key informants were contacted during the different steps of the fieldwork: one in each *ejido* and one agent of the Rural Development District. Different topics were discussed with them to clarify ideas about processes such as the organisation of the *ejido*s, and the use of resources. By these means cross checking among the information on the interviews and the knowledge of the key informants, show contradictions in information about land uses.

4.5.5 Direct observation

Direct field observation of land uses such as the harvest of wood, visits to family gardens and parcels was made to generate interview questions. For example, after observation of the diversity of plants sown on terraces with irrigation in Santa Catarina, questions were raised about why they grew such diversity of crops? Or in the case of the unused sand quarry of Nativitas why the extraction of sand was abandoned, or for San Pedro y Santa Ursula why they are using sewage water for irrigation and is it legal?

4.5.6 Transects

Transects are used to explore the differences in location and availability of land uses and resources by encompassing as many land uses and resources as possible. Chambers and Guijt (1995) recommend during the transects an attitude of observing, asking, listening, discussing, learning, seeking problems, solutions and opportunities as observed by the people, and the diagrams of resources and findings.

The transects were with municipality agents with different backgrounds to cover the diversity of resources found through the transects, for example the transect of the

Plate 4.1 Ejidatarios in transect number 8 in the forest of Santa Maria Nativitas

Plate 4.2 Comuneros in transect No. 9 Santa Catarina del Monte

eroded area with the people in charge of the program of conservation and in the forest with the people in charge of the forest. The forest transect, and that in the eroded area were with both *ejidatario*s and agents, while in the other transects only *ejidatarios* participated (Table 4.4).

Table 4.4 Purpose and participants in transects

Ejidos	Purpose transect or map	Time (hours)	Participant
Santa Maria Nativitas.	Land use	3 (Walk)	1 posesionario 1 *ejidatario*
Sn Miguel-Sta Maria-Sta Catrina	Eroded land and terraces	2 (Vehicle)	Government agent
San Jeronimo	Boundaries, land use Livestock	3 (Vehicle, walk)	2*ejidatarios*, 1 municipality agent
Tocuila	Soil map	2(walk)	1 *ejidatario*
Sta. Catrina	Land use, Forest	1(walk)	2 *comuneros*
San Diego	Land use	3(walk)	1 *ejidatario*
Nativitas (Venturero)	Check Boundaries	3 (walk)	2*ejidatarios* , 2 government
San Pablo Ixayoc	Land use, forest use Check, boundaries	3(vehicle , walk)	*Ejidatario*, municipality agent
San Pablo Ixayoc, Nativitas and San Dieguito.	Forest use, Boundaries	5(vehicle, walk)	*Ejidatario*s of three *ejido*s, 2 municipality agents
Nativitas	Soil maps, land use	6(walk)	3 *ejidatarios*
Tequesquinahuac	Soil map, land use	(Walk)*	*Ejidatario* and researcher
San Pedro Y Santa Ursula	Land use	Walk	*Ejidatario*
Tocuila	Soil map , land use	(walk)*	*Ejidatario* and researcher

Eight Transects in the municipality were planned using the satellite image, to cover the variation in landscapes and uses, along the areas observed with more variations and looking for the views of the agents and *ejidatarios* about problems and opportunities in land use. Differences in landscape such as slope and depth of soils, and type of crop, were the main criteria used by the *ejidatario*s to differentiate the cultivated lands, and slope and changes in type of vegetation in the forest area. In transects through the municipality where long distances were involved, the transport was by vehicle. Some sites selected in the aerial photographs where more variation difference in land uses, were observed, and in these places discussions took place. The location of transects in the municipality is shown in Figure 4.3

Schematic diagrams of the transects show the data collected about soils, erosion, land uses, altitude, slope, classification of soils by land suitability, suitability for irrigation and the problems and opportunities as seen by the municipality agents *ejidatarios* and from secondary sources. Transects 1,6,8 are shown below, and schematic diagrams of the other transects are presented in Annex 1.

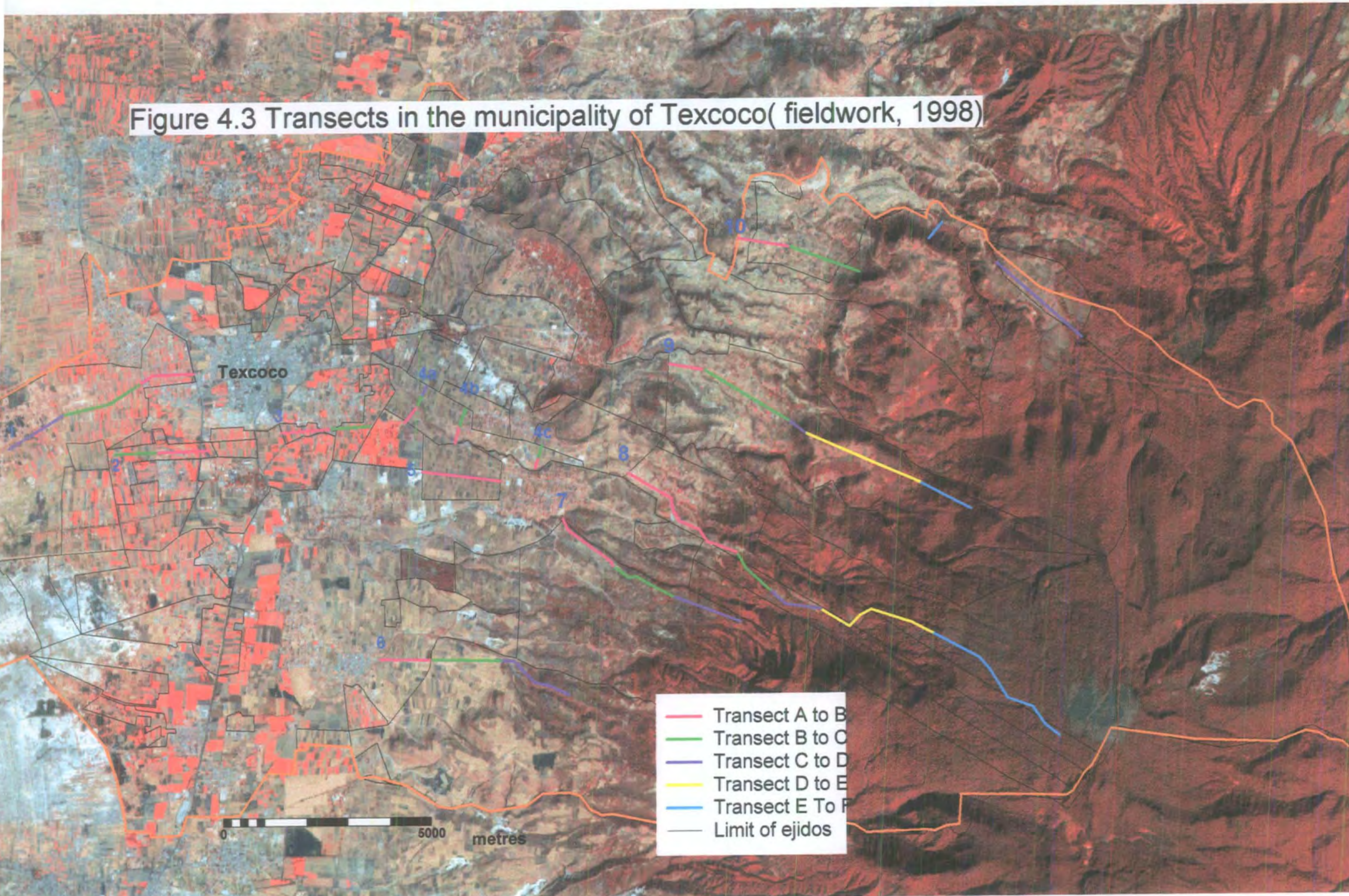
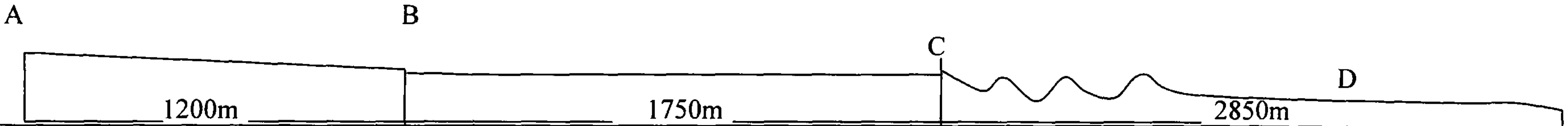


Figure 4.3 Transects in the municipality of Texcoco(fieldwork, 1998)

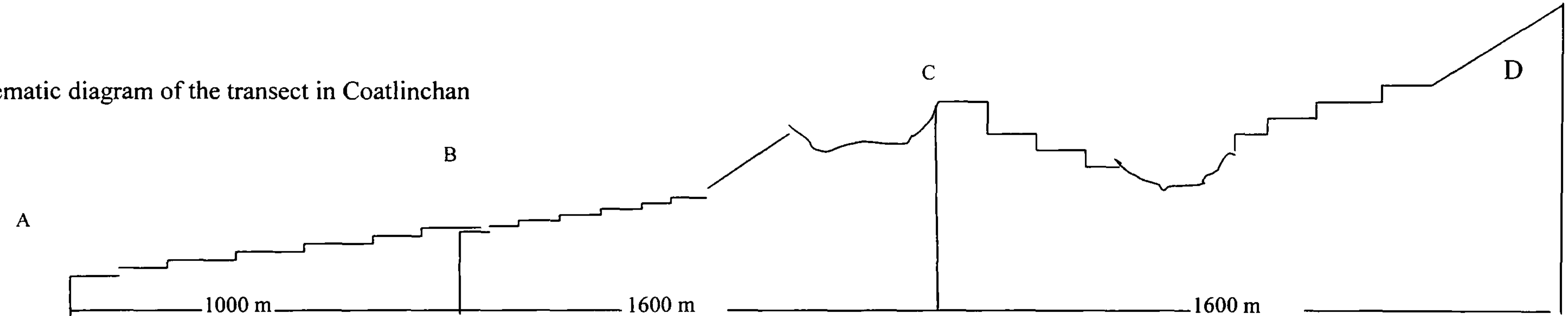
Table 4. 5 Schematic Diagram of Transects 1, 6 AND 8 (author , fieldwork, 1998)

Transect 1. San Miguel Tocuila



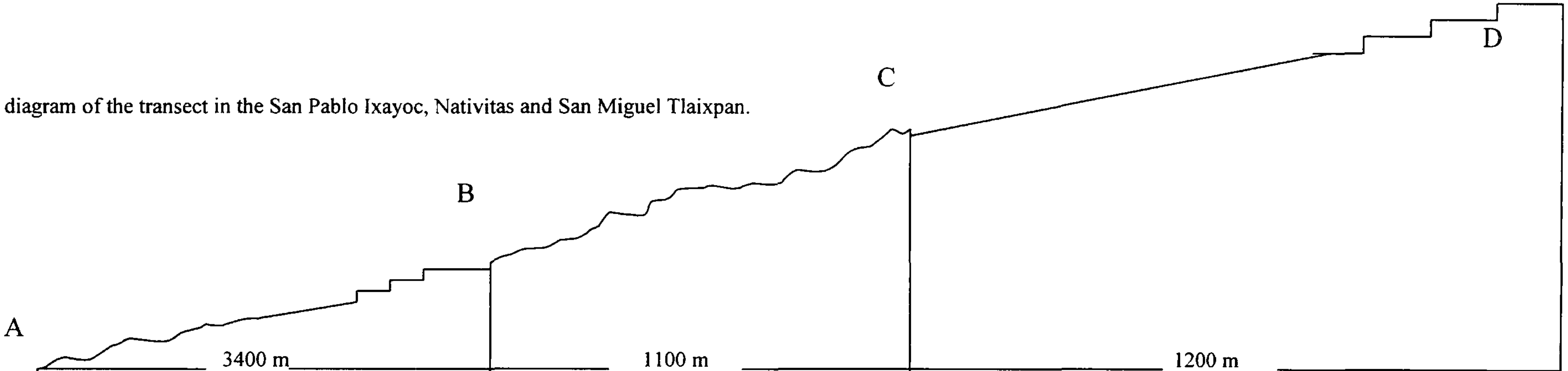
Topics	1200m	1750m	2850m
Soils	Depth to 90 cm. The ejidatarios call this soil generic name "Blanca". The best soils of the ejido.	Depth from 50 y 70 cm. Water level to 50 to 70 cm. This soil is called by the ejidatarios "jaboncillo".	Depth 50 to 70. Water table between 50 and 70 cm. Saline soils. Texture clay, this is the former basin of the lake Texcoco.
Building of houses	Area of settlement of the ejido, houses associated with cultivated plots of 0.5 ha. There are two or three houses per parcel belonging to members of the same family.	Building of houses in some plots.	Area of 23 has of land was illegally urbanised in lots of 200m² to outsiders in 1990.
Land cover	Irrigated crops: maize, alfalfa, oats and small area of vegetables. House occupy 250 to 500m of the parcel. Back yard livestock.	Maize and alfalfa irrigated with sewage water.	Crops maize and alfalfa irrigated with non-treated sewage water. The ejidatarios comment that they have been reclaimed the soils by the sue of sewage water.
Problems	Increase of construction houses in parcels by both increase of population and migration.	Excess of water in the profile of soil. Problems of drainage in the rainy season, and outcrops of salts in the dry season. The grass is adapted to salinity, and this area is used for grazing. Levelling of soil is required for irrigation.	Levelling is required. The area urbanised flooded every year in the rainy season. Problems in the stability of houses by subsidence of the soil. The ejidal comisariado was charged with a fine of £20,000b by the illegal sell of plots There is no communal land, all the land has been subdivided among the ejidatarios.
Opportunities	Sale of plots for housing. Intensification of agriculture by the introduction of dairy farming (2-5 heads) backyard raising of pigs (5 to 20) .	Building of drainage system. Construction of a plant for treatment of sewage water. Reçuperation of saline soils by addition of manure or irrigation with sewage water. Levelling of soil is required.	Recuperation of saline soils using sewage water. Also the water form the river during the rainy season is discharged in the parcels, and as there are a lot of sediments form erosion upper streams, after several years of flooding the soil improves and can be cultivated..
Slope	1 to 2%	1 to 2%	Less than 1%
Land capability Classification USDA (Ortiz, 1975).	IIe-2 compact layer between 40 to 70 cm that limits the growing of roots	IIIh-1 Water table varies from 50 to 70 cm that limited the development of roots.	Saline and sodium, slow drainage and flooding
Classification for irrigation	III s-2 Slow drainage	IIIs-2 water table is near the surface from 50 to 70 cm. Slow drainage.	Water table 50 to 70 cm. Salts and sodium. Slow drainage.
Altitude (masl)	2242		

Transect 6 Schematic diagram of the transect in Coatlinchan



Soils	Depth 30 to 50 cm limited by tepetate. Sandy texture	Depth 10 to 50 cm limited by tepetate from 10 to 50 cm	Terraces with reclaimed soils from tepetate. Ravine with Patches of soil with depth 0-10cm. Outcrop of rocks and tepetate.
Erosion	Contour lines and Terraces	Severe in some areas with steep slopes	Erosion severe the tepetate is exposed in some areas. Terraces with reclaimed soil form tepetate. Reforestation in the terraces in the 1970's.
Land cover	Maize, wheat with maguey and trees in the boundaries of parcels	Maize, wheat with maguey and trees in the boundaries of parcels. Ejido sand Mine nor exploited	Reforestation with eucalyptus and pine in the terraces. Grass in the areas with soil
Problems	Variable starting of rainy season May-June. Drought in August. Stones in the surface and in the subsoil. Low retention of water. Mono-crop maize. Non addition of manure. Low rates of fertilisation 40 kg of urea. No incorporation of manure. Grassing of cattle in the parcels after harvest Production of maize among 1000 to 1500 kg	Shallow soils stones in the surface and subsoil. Mono-crop maize. Low rates of fertilisation. Urea 40 kg / ha. Non addition of maunure Low yield 500 to 1000kg	Severe erosion. Grassing of small herds (sheep, goats and cows) in reforested areas. Reforestation was 15 years ago, but the trees are small in some areas three to five meters height. Most of the plantation area Eucalyptus. The reforestation had controlled the erosion but has not any commercial value.
Opportunities	Addition of organic matter Use of fertilisers: Control of grassing after harvest.	Application of fertilisers. Rotation of crops. Addition of organic matter	Reclamation of tepetate, and reforestation. Control of grassing.
Slope	3 to 5%	5 to 10%	15 to 30 %
Land capability Classification	IV-s3	IV-s3	VIIes-1
Classification of Irrigation	VI s-1	VI s-1	No apt
Altitude (masl)	2360-2440m	2440-2500m	2500-2600

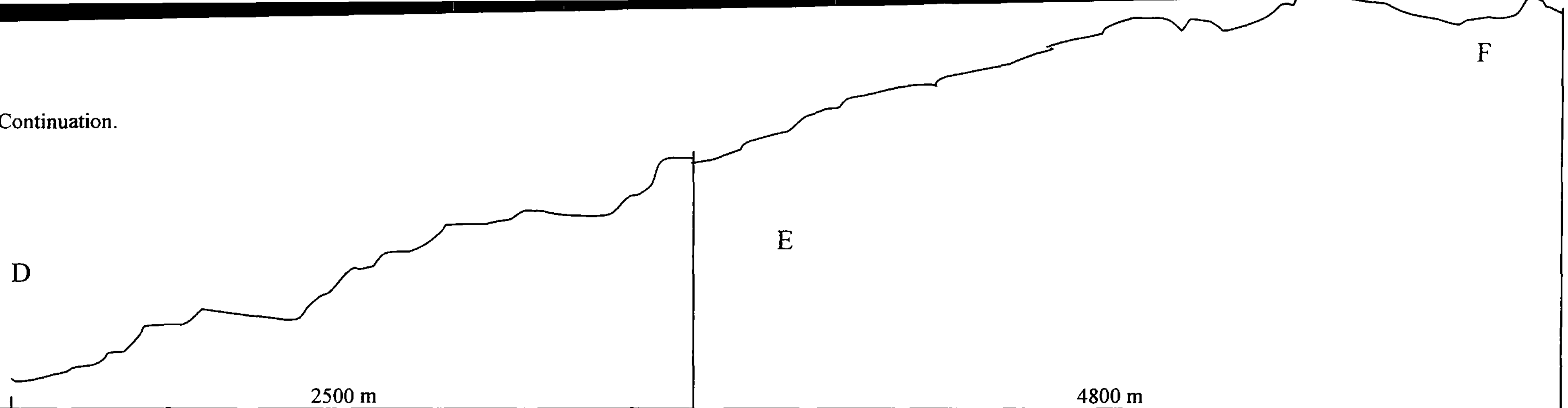
Transect 8. Schematic diagram of the transect in the San Pablo Ixayoc, Nativitas and San Miguel Tlaixpan.



Soils	Tepetate exposed. Soils depth 50-90 cm in agriculture land. Texture clay.	Depth 30 to 90 cm.	Depth of soil 50 to 90 cm. Terraces in the depth steep slopes.
Land cover	Patches with soil, grass and bushes. Reforestation eucalyptus and pine in the terraces. Patches with vegetation of oak. Areas of agriculture cultivated with maize.	Forest of Oak (quercus sp.)	Vegetation of pine, bushes and grassland. Crops are wheat, barley and oat. Some of the fields not cultivated by several years.
Erosion	Severe erosion formation of gullies. In areas with vegetation of grassland and bushes. Erosion in channels in the cultivated areas.	Severe erosion with formation of gullies in areas where the forest has been cut and are not cultivated.	Sheet and channels. Some small gullies (50cm of depth)
Problems	Erosion in ravines and outcrops of tepetate. Terraces with reforestation built twenty five years ago. Erosion. Distance to settlement around 5 km.	Severe erosion in ravines.	Erosion. Decline of soil fertility. Abandonment of the cultivated lands because decline of yield and distance to the settlement.
Opportunities	Reclamation of areas with tepetate by terracing and brake up of tepetate. Cultivation in contour lines in cultivated land. Temporal source of employment in government programmes for reforestation.	Conservation works. Starting of rainy season in April or May.	Rains starts in March, and are well distributed. There is no period of drought in July. The land is cultivated using machinery. In 1997 an area of 10 has was reforested and protected by fences. People of San Pablo Ixayoc Nativitas hired for the works.
Slope	9-15%	15 to 35%	5 t0 9%
Land capability Classification (Ortiz, 1975).	No use	VII e	VI-e
Altitude (masl)	2700-2800	2800-2900	2900-3000m

Transect 8. Schematic diagram of the transect in the San Pablo Ixayoc, Nativitas and San Miguel Tlaixpan.

and Maria Nativitas. Continuation.



Soil	Depth of soil variable 10-30 cm to 50-90cm	Depth 10-50 cm outcrops of rocks in the areas of deep slope.
Land cover	Forest of Oyamel (Abies) 3000-3300m masl. In some areas pine and oyamel are mixed. Small areas (2-5 ha) of compact plantations of pine (20 to 40 years old).	Forest of pines. Areas of grassland in the areas deforested. The density of pines is low. Grassland under the forest.
Erosion	No evident	Channels In areas of deep slope without vegetal cover.
Problems	Grassing of cattle in the rainy season. Usually grass under the forest is burn in the dry season. Extraction of wood using axes and some people chainsaw. NO surveillance of the forest by the ejidatarios, illegal cut of three by ejidatarios of neighbouring ejidos. Decline in the production of mushrooms since the seventies attributed to a change in rainfall regimen. The extraction of wood and firewood by ejidatarios decline from 1945 because a ban for the exploitation by the government and the decline of markets of firewood. The exploitation of the forest has been neglected for several years in some ejidos Problems in agreement on boundaries among the ejidos of San Dieguito, Santa Maria Nativitas and Tequexquinahuac. Extraction f diverse products nushrooms, hay, peat, ,moss, wood, ,firewood in small amounts through all the year. Tradition of families of woodcutters by generations in the towns of the sierra.	Grassing of cattle by people of the ejido of Rio Frio. Burn of the grass in the dry season and slow regeneration of the forest. The has low density. The trees are not adequate for the extraction of wood. From 1945 to 1990 This area was exploited by the company of San Rafael with the ejidos of San Miguel Tlaixpan, San Dieguito Xochimacan and San Pablo Ixayoc.
Opportunities	The exploitation of the forest is allowed since 1995. In 1996 400 m³ of wood were extracted and negotiations for a permit to extract wood is in process.	Commercial exploitation of the forest, some areas reforested.
Slope	35-45%	25-45%
Land capability (Ortiz, 1975).	VII-e	VII-e
Altitude (masl)	3000-3500	3500-3900

4.6 Analysis of qualitative information

The analysis of qualitative information coming from different sources (*ejidatarios* and government agents) is by a range of techniques: semi-structured interviews, review of secondary data, transects, participatory mapping, and direct observation occurred in some extent simultaneously with data collection. Analytical notes as stated by Burgess (1984:174)

'can form the core of the preliminary analysis. Such memos may include summaries written at the end of the day in the field in which the researcher indicates themes that have emerged, and concepts that can be developed, together with preliminary thoughts about the analytical framework'.

The use of different techniques, informants, and scales to gather data (municipality, *ejido* and *ejidatarios*) complemented by the analysis of secondary sources, helped in the cross checking of the qualitative information. In this research the strategy is primarily an ethic one, in which the language and ideas of the researcher are used to explain the processes of land use and decision-making, which are followed by the *ejidatarios*. But I am also using emic data in the form of ideas of the interviewees from their statements as to why and how they are using their land resources. Contrasting their own information with the information from other sources eg proved the validity of the statements made by the people from the government and other *ejidos*.

The qualitative data generated were used for: a) identification of the problems perceived by the government and *ejidatarios*; b) description of the history of access to the resources and the negotiation process between the *ejidos* and the government; c) description of the decision-making processes of land use and identification of income activities; d) the identification of conflicts in the perception of land use between government and *ejidos*.

4.7 Use of GIS in the municipality

GIS was found to be used in three institutions: Colegio de Postgraduados, Universidad Autonoma Chapingo and the Plan Lago de Texcoco. The platform used is Personal Computers (PCs) and IDRISI and ILWIS as software. Research in these institutions has been focused on remote sensing and production of maps, and the most common operation is the overlay of INEGI maps for land suitability. The other institutions visited in the municipality do not have direct access or training in the use of GIS technology. However PROCEDE has developed software (Geographical information system of ASERCA). This system has the purpose of verification and control of the register of farmers registered in PROCAMPO and update the database. The system allows the linkage of data to the maps of tenure of PROCEDE, and the input of data at parcel level (Control Data, 1998).

A municipality agent with training in GIS commented on his experience in the municipal institution:

> 'I received training in the use of the GIS in central offices. The Secretariat of Agriculture has Arc/Info and the most update hardware in Mexico City. Recently I received training in the use of the GIS Aserca to update the database of PROCAMPO. The software was very good; using it I could save a lot of time in my work. However as in Texcoco, the computers here are very old, and not able to run the software. With my computer at home, I can work with the programme, however, when I ask in central offices, if I could install the software in my computer to do my job, the officer in charge argue that the program could only be installed in the 'official' computers in the office. This is really crazy, I bought a computer for my son that is 15 years old, with the last in technology, but the government with all its money cannot buy a computer for the municipality office. With a PC with the latest technology in the office, the productivity in our work could be increased. I could teach other people to use GIS ' (Government agent 48 years).

Although GIS technology and information is available in many organisations whilst using GIS at State and National level such as INEGI and SAGAR, is not accessible to the people 'on the ground'. This very much reflects a 'top down' approach. The government institutions concentrate on personnel and infrastructure in central offices with workstations for software such as ARC/INFO and ERDAS. On the other hand the universities and government institutions with low budgets have PCs platform[8]

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[8] Most of the agencies in the municipality gradually are updating software to Windows 95. they themselves have bought the government agents PC in recent years. They are using PC's and software such as spreadsheets, and databases to improve their work. They are very proud because his/her abilities as 'computer experts' are well appreciated by his/her colleagues and bosses.

using IDRISI or ILWIS. But the municipality agents are without access to it at all.

From this step in the research it could be concluded that:

a) the information produced by government agencies is centralised in government agencies, in a 'top down' mode;

b) spatial information available from the agencies at municipality level was not useful for the objectives of the research

c) spatial information available at municipality and *ejido* level in Mexico, should be integrated in GIS to produce cartography at municipality and *ejido* level in order to make available data and technology of GIS to local people.

4.7.1 Selection of software and use GIS in the research

The software used for this research was the Integrated Land and Water Information System (ILWIS). The decision to use ILWIS instead, for example, of ARC/INFO that is available in government agencies at top level and IDRISI, software that is available at the university, was a key decision, because this selection meant that more time and finance was required in order to obtain and install the software. However it was taken considering different criteria, such as the availability of hardware and software in the municipality, the type of data produced by the institutions and the advantages and disadvantages of the three available GIS systems to integrate the data available from institutions. Finally it was decided that ILWIS was the most appropriate software as it for the forthcoming reasons:

a) Flexibility to integrate the information collected from other GIS such as ARC/INFO and IDRISI; its capabilities to import satellite images and aerial photographs (TIFF and raster format) and to import tables from different software (EXCEL, DATABASE, LOTUS).

b) It is the software that is being used in municipality institutions (Colegio de Postgraduados, Universidad Autonoma Chapingo and Plan Lago de Texcoco).

c) ILWIS runs on a PC platform with Windows 95. Most of the institutions in Texcoco have this platform, which means that in future it will be possible to continue to use ILWIS as software. This will allow the integration and updating of the database produced (during the research and by the institutions in the near future).

The creation of a common database and the updating and integration of the information would help to improve the relationship among the research institutes, and the government institutions in the municipality and the *ejidos*.

d) Furthermore it is used internationally, particularly for land information systems by institutions such as The International Institute for Aerospace Survey and Earth Sciences (ITC) based in Netherlands and is oriented in training and research for less developed countries.

Moreover recently there are a number of software and hardware advances with have been relevant to GIS. These include massive increase of memory, size, speed and higher resolution graphics with decreases in costs for personal computers (PC). Also with improvements in networking capabilities and increase in communication and transfer of digital data became increasingly available to small institutions and individuals. All these point to the gradual increase in number of small government institutions, civil organisations and individuals in local data holdings at lower levels such as regional offices (municipalities), civil organisations and small Universities in Mexico.

The proposed approach for the introduction of a computerised technology such as GIS in the municipality in this chapter is incremental and user driven (Fox, 1991). Incremental means the gradual replacement of manual methods of data collection and analysis with computerised methods, lead by the people who normally collect and use these data. As they learn to use GIS to accomplish part of their jobs they will become enthusiastic supporters of the new technology. The problems to address should be the actual problems, such as the automation of the database of PROCEDE or training of the *ejidatarios* in reading of maps and use of GIS. In this way gradually, they will be able to manage the technology and make suggestions about planning of land use with more complex objectives.

GIS is a computer assisted system for the acquisition, storage, analysis and display of geographic data, and is an important tool to support planning and decision-making because both it allows access to different sorts of information required in the process and provides facilities for the maintenance and update of the database. The use of GIS also allows the integration of spatial information coming from different sources, including satellite images, aerial photography, maps, ground surveys and statistical census, which facilitates the opportunity to collaborate and exchange information by the people within the framework of a common generic tool.

GIS in this research was used with several purposes: i) the production of maps and the integration of information gathered at municipality and *ejido* level and ii) integration of the databases on land use and land tenure already available with the data gathered from the *ejidatarios* and government.

GIS was used to fulfil the following objectives:

First to use its capabilities for handling and manipulating raster data and their visual interpretation for the planning of transects, identification of *ejido* boundaries, identification and differentiation of land uses such as forest, grassland, irrigated or seasonal agriculture, identification of features (roads, dams, urban areas) in a more objective way during the fieldwork. Additionally the overlay of vector and raster maps allowed the drawing of maps over the imagery or aerial photography. This was used for mapping in the field with the participation of the informants.

Second given the diversity of primary and secondary data gathered (vector, raster or tabular data) and the different levels of processing with, for example, some already digitised in ARC/INFO, others such as paper maps, as census reports or captured in spreadsheets (Lotus 123 and Microsoft Excel) facilitate data integration through the use of GIS.

Third, the capabilities of spatial analysis such as the overlay of maps, measurement of areas and extraction of features allowed the production of maps about specific attributes such as resource base by *ejido*, spatial distribution of land in the municipality, access to government programmes, access to different types of land, spatial distribution of property by *ejidatario*.

Fourth maps of land tenure and resource base were produced as participatory maps to develop a provisional 'participatory GIS'. The general steps followed using GIS are showed in the Figure 4.4.

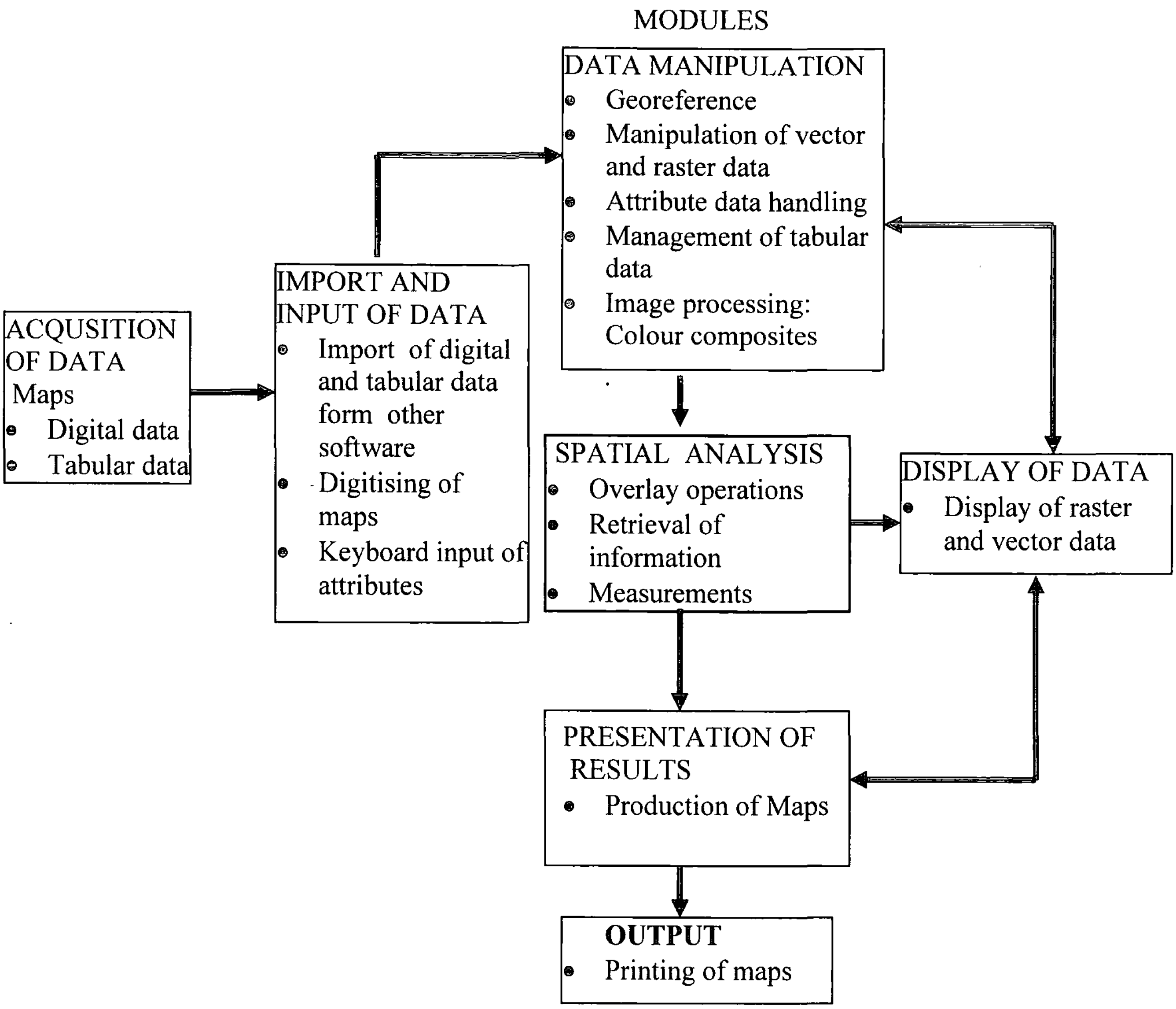

Figure 4.4 General steps followed for the use of GIS.

4.7.2 Participatory mapping of resources in the municipality and *ejidos*

The objectives of the participatory maps were to produce a spatial distribution of key elements such as location of settlement, land uses, access to land (communal or plots). The mapping was carried out using participatory analysis of aerial photographs and by the local analysis of secondary sources from government agencies.

The participatory analysis of aerial photographs and satellite images was considered the most effective method for the production of maps, as the *ejidatarios* had experience using them during the program of Certification of their plot rights by PROCEDE. They were able to identify their parcel on the aerial photographs and had acquired some experience of the identification of features from aerial photographs. The cartographic materials used for the drawing of maps were mosaics at a scale of 1:10,000, aerial photography at scale of 1:19,000 and SPOT Satellite images.

The integration in GIS of an interface of data (vector) and image data (raster) in GIS allows the direct digitisation of maps over satellite images or aerial photographs on screen; this capability of GIS software makes the use of aerial photographs for participatory mapping of local resources very attractive and could improve together with their participatory visual analysis the communication among people and policy-makers for planning. Moreover as stated by Chagarlamuli and Plunkett (1993) the integration of GIS and remote sensing could be a low cost alternative for mapping in less developed countries.

The methods used for mapping were diverse by the background of the people; for example, the municipality agents that participate in mapping have a background in aerial photo interpretation (two as agronomist and one as forester). The maps of the *ejidatarios* were more in the fashion of PRA encouraging the people to map soils and land uses as perceived by them. In participatory mapping mosaics and paper aerial photographs were used, however the maps were produced by on screen digitisation using as background the satellite images and aerial photographs.

The procedures for the production of maps with the municipality agents were those based in techniques of photo interpretation for the identification of objects using the principle of convergent evidence for photo identification first creating keys for the identification of objects, and afterwards identify the objects by association. Most of these techniques were already known by the municipality agents.

The production of participatory maps has several objectives in the research: a) the inventory of resources with the people (soils, agricultural, forest, grassland); b) to raise issues that affect or are affected by these resources; c) to analyse their present status or condition and d) to create a focus of interest in discussion over resources.

The approach used in the research is 'participatory' in the sense that the maps represent the land resources as perceived by *ejidatarios* and government agents to produce their spatial representation. The procedure was in part in RRA fashion, by the fact that I dominated the technical aspects of production, selection of materials for mapping and use of GIS. However elements of PRA were involved, such that the maps were produced by the *ejidatarios*, and discussion in the production of maps such as what have to be represented, and the fact that the maps are representations of the resources as perceived by them. Also the maps contain information on resources of their *ejido*, and show what they have, how they are using it and could empower them with information for the analysis of the spatial distribution of resources, and how they are using it. GIS is a tool for communication and production of ideas, that can be presented to others (government and their own fellows *ejidatarios*).

The maps produced allowed the quantification of the available areas of different resources at *ejido* level. At the same time the maps depict the spatial distribution of resources to compare them inside and among the *ejido*s, their relative importance and location. Additionally these maps could be used for the creation of a focus of attention over the resources and enable the localisation of places for future projects or research.

Four exercises, of participatory mapping with satellite images and aerial photographs were conducted in the research: a) a map of zones for the identification of the three *ejidos* representative of the municipality with the participation of the municipality agents, b) the map of land tenure for the municipality, checking doubtful boundaries of *ejidos,* with government agents and *ejidatarios* and producing the map over the satellite image, c) participatory maps of soils and land uses with the *ejidatarios* and d) historical maps analysing of ancillary data, information elicited from time lines of access to land tenure, aerial photographs and interviews with the *ejidatarios*.

4.7.3 Procedure for mapping of resources

Mapping of land tenure and land resources was undertaken using aerial photographs and satellite images as background for mapping. ILWIS 2.2 allows the creation of segment maps over raster maps directly on the screen of the computer. As a portable computer[9] was available, it was decided to produce maps during fieldwork using this facility of GIS. The advantages of the use of on screen digitisation were: a) overcome the problem of lack of access to a digitising board during the fieldwork; b) allows the direct involvement of the people in the process of identification of resources over the satellite image and aerial photographs using this technology; c) improve the mapping as the criteria used for identified resources and differences can be discussed the boundary changed in the spot; d) production of maps is expedited and boundaries and output such as maps can be done quickly, with the suggestions of the people.

The satellite images were used for the location of transects and selection of point for description of resources and mapping of resources. Three municipality agents participated in the elaboration of transects, for the selection of three *ejidos,* production of a map of agro climatic zones and location of boundaries of *ejidos*. In the mapping of resources in the forest of Nativitas the participants were three, however, as the mapping was simultaneous with the checking of boundaries of three *ejidos*; other *ejidatarios* provided feedback. Also in the office other people made suggestions to include other features on the maps, such as the inclusion of the area of land irrigated with sewage water, or that some parcels that were under irrigation were not included.

The digitisation was done in the office, *ejidal* or agency, except for one *ejido*, where this was in the field. The boundaries of the maps were drawn in paper satellite images or aerial photographs (produced with the GIS) and later digitised on screen. The people that participated in the mapping were also present during the digitisation on screen, as facilities of zoom were available; they suggest some changes in boundaries when I was using the zoom for more precision in the location of boundaries. For example, areas with pale red colour, where identified by them as bushes, and then this was delineated as bushes. A municipality agent, who approach

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[9] Texas Instrument Extensa 61O, 133MHZ, 16 megabyte RAM, and hard drive 1.2 gigabytes.

to see what we were doing, after our explanation, and the units identified, saw the image and suggested that the black areas near the ex-lake were sewage water that is discharged in the open air in that area, the agents then suggested that a new unit has to be identified with the *ejidos* that were using sewage water for irrigation.

Most of the digitisation was made by myself[10]; as both the mouse pad and the mouse were used, some practice is required. However, as the people was familiar with the identification of features they were willing to have a go, and digitised some boundaries, and it seems to me that they got practice in digitisation very quickly.

4.7.4 Mapping of zones for selection of *ejidos* in the municipality

The participation in the production of the map was by three municipality agents two with background on agronomy and one in forestry. Most of the work was done in the office, and during transects some boundaries checked. The maps were produced outside of the office hour's work, and it takes about three afternoons around 12 hours of hard working.

To identify zones with contrasting environments in the municipality for the subsequent selection of representative *ejidos* it was decided together with the agents of the rural development district of Texcoco, that the map should be produced by the agents themselves. In the process I acted as the expert in GIS and mapping of resources, listening what were their proposal for mapping and producing the maps. However as they knew how to do the things in the GIS they eventually did the digitising and production of maps by themselves. The data used were the satellite images and the maps of INEGI already produced in GIS in the previous stages (Figure 2.1-2.5).

Based on these maps areas with similar characteristics in vegetation, soils, geology and climate were differentiated over the satellite image; the agents decided that the

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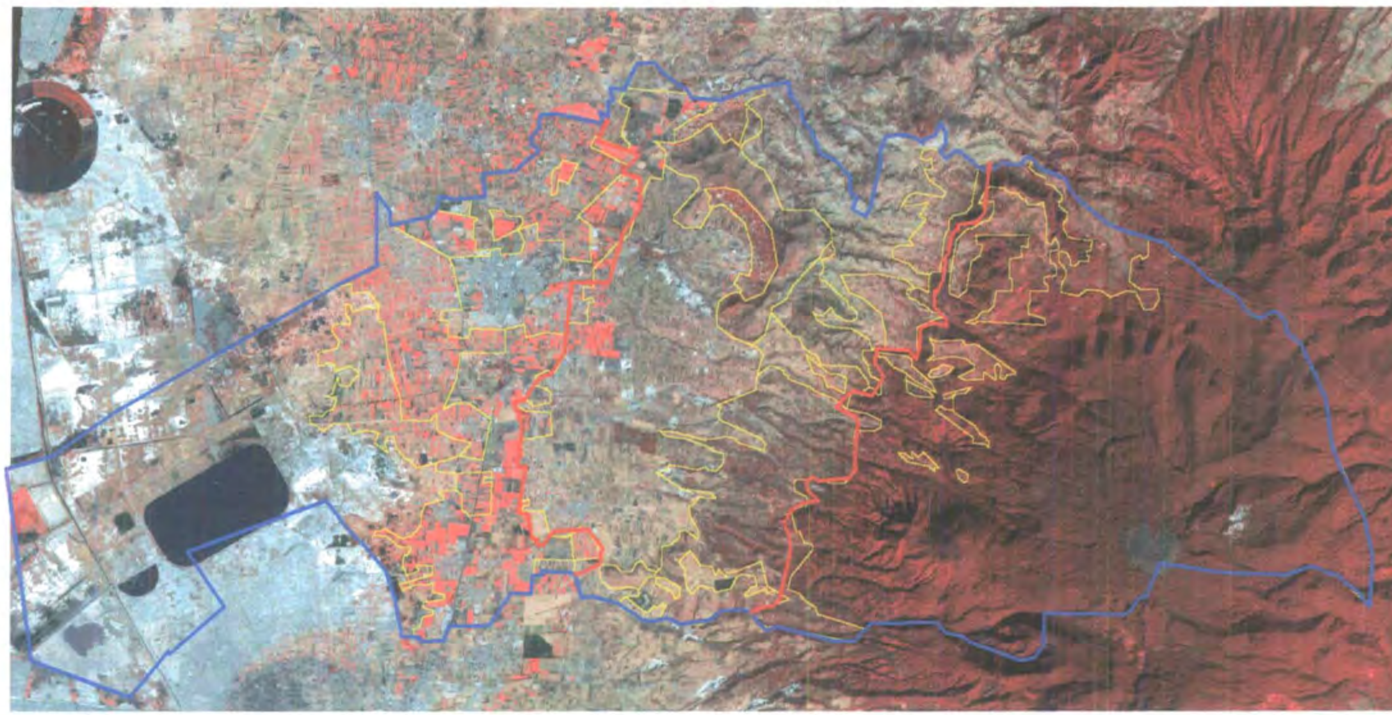
[10] The digitising was done in my own portable computer in the office of the agents and fieldwork. I was afraid that during the process of teaching the use of GIS the computer could be damaged and I did most of the digitisation.

two criteria for differentiation were topography and afterwards vegetation and land use. The first stage was the creation of simple keys for identification of objects in the image using criteria such as: shape, size, location and colour. Features such as straight lines represent roads and sinuous lines streams, or geometric objects represent cultivated parcels. The objects to identify in the image were the land use and vegetation such as: irrigated, seasonal agriculture, grassland, reforestation and forest vegetation. The keys for the identification of patterns were by the principle of convergent evidence and association of objects. The general process was first the identification of the more evident patterns and afterwards, the identification of more complex patterns. For example the first differentiation was the areas with forest vegetation and those without forest. The areas of forest have red colour in the image and sinuous lines (streams). The yellowish or brownish colours were the areas with seasonal agriculture, and in the irrigated there were a geometric pattern with red colours. The previous analysis of the maps of INEGI yield information about the location of land uses that was used as convergent evidence for the identification of patterns. Also the mosaics of aerial photographs were used to have a more accurate location of boundaries during the interpretation of boundaries.

Figure 4.5 shows the boundaries drawn by the municipality agents on the satellite image: in blue the boundaries of the agroclimatic zones and in yellow the boundaries of the zones identified with different land uses. In the image, the pattern for the identification of the main land uses are identifiable, forest in the west in red, irrigated agriculture in reticular pattern with small geometrical shapes, and in between this the area of seasonal agriculture. The Ex- Lake Texcoco is identified by the white colour of the saline soils and its location.

In the map zones (Figure 4.6) the contrasting environments in the municipality are shown, the land uses identified by the agents are composite, integrating information about different aspects such as climate, access to infrastructure such irrigation or terraces, tenure, problems such as salinity, use of sewage water and erosion, and their own activities such as reforestation.

Figure 4.5 Land uses and climatic zones in Texcoco municipality identified by the municipality agents over the SPOT satellite image of 1989.



Red line:climatic zones

Yellow line: land uses

Figure 4.6 Climatic zones and land uses in Texcoco municipality as identified by municipality agents from a SPOT 1989 SPOTimage.

Land uses

- Saline soils (Ex.Lake Texcoco)
- Irrigated AgricutureSewage water.(recovered saline soils)
- Irrigated Agriculture in Ejidos.
- Irrigated agriculture small properties
- Irrigated and seasonal agriculture Small property
- Seasonal Agriculture in Hills.
- Agricultural lands with terraces
- Seasonal Agriculture in terraces and shallow soils (areas with erosion)
- Seasonal agriculture (High lands in the sierra)
- Grassland (areas with erosion)
- Reforestation (Tree plantations)
- Forest

Zones with variation in rainfall and temperature

I Average annual rain < 600 mm Average annual Temperature 12 to18 C
II Average annual rain 600-800 mm. Average annual temperature 12 to 18 C
III Average annual rain >800 mm. Average annual temperature 10 to 14 C

4.7.5 Map of land tenure of the municipality

The maps available for land tenure cover the entire municipality at a scale of 1.50,000 [11] (INEGI, 1991), a map at a scale of 1:100, 000 (DDR03, 1989), and digital maps of 30[12] polygons of 22 *ejidos* covering only 2254 ha from the 23,000 ha under *ejidal* tenure in the municipality (PROCEDE, 1998) (Figure 4.7).

The first step was the digitisation of the maps at a scale of 1:50,000; however, when this was finished it was found that the map was imprecise in the number of *ejidos* and location of boundaries (Figure 4.8). The importance in this research of the spatial distribution of *ejidos* in the municipality, the previous experience in collection of data on tenure, which was not accessible from the agencies, and the fact that in the information available in digital format covers less than 10 % of the ejidal land in the municipality[13]. All these together make sensible to produce a procedure for the mapping of *ejidos* in the field for the municipality.

A strategy for mapping the tenure of the municipality was implemented taking advantage of the resources available, (mosaics of aerial photographs, satellite images, and digital and paper maps), my knowledge of boundaries of *ejidos* and the terrain, the facilities of GIS for mapping on screen, and the participation of *ejidatarios*. All these make it possible to produce a procedure that integrates the data available and to produce a map of land tenure from the different sources and produce a method for mapping the land tenure for the municipality.

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[11]The boundaries of the *ejidos* and small properties were transferred to a map at scale of 1:50,000 from archives of the SRA and the public register of the property by INEGI personnel for the 1990 census. This was the map, which was available from PROCEDE at municipality level.

[12] The number of *ejidos* is 33 and comprises 71 polygons, one *ejido* could have land in different places and each area is mapped as an ejidal polygon. For example SMN has two polygons and only one was provided, the other has problem of boundaries with the neighbouring *ejidos*.

[13] In 1997 PROCEDE reports that at national level only 50% of the *ejidos* had asked for the certification of lands (PROCEDE, 1997). In 1999 the total amount of land certificate at national level was 50 million of hectares (V informe de Gobierno, 1999). This means that around 50 % of the total areas in possession of the *ejidos* have been are certificated. As the program is voluntary asked for certification and others not. This could produce gaps in availability of data to produce maps at regional level such as municipalities.

Figure 4.7 Ejidos certificated by PROCEDE and types of land tenure within the ejidos in the municipality of Texcoco
(Compiled from the digital maps of PROCEDE 1994-1998)

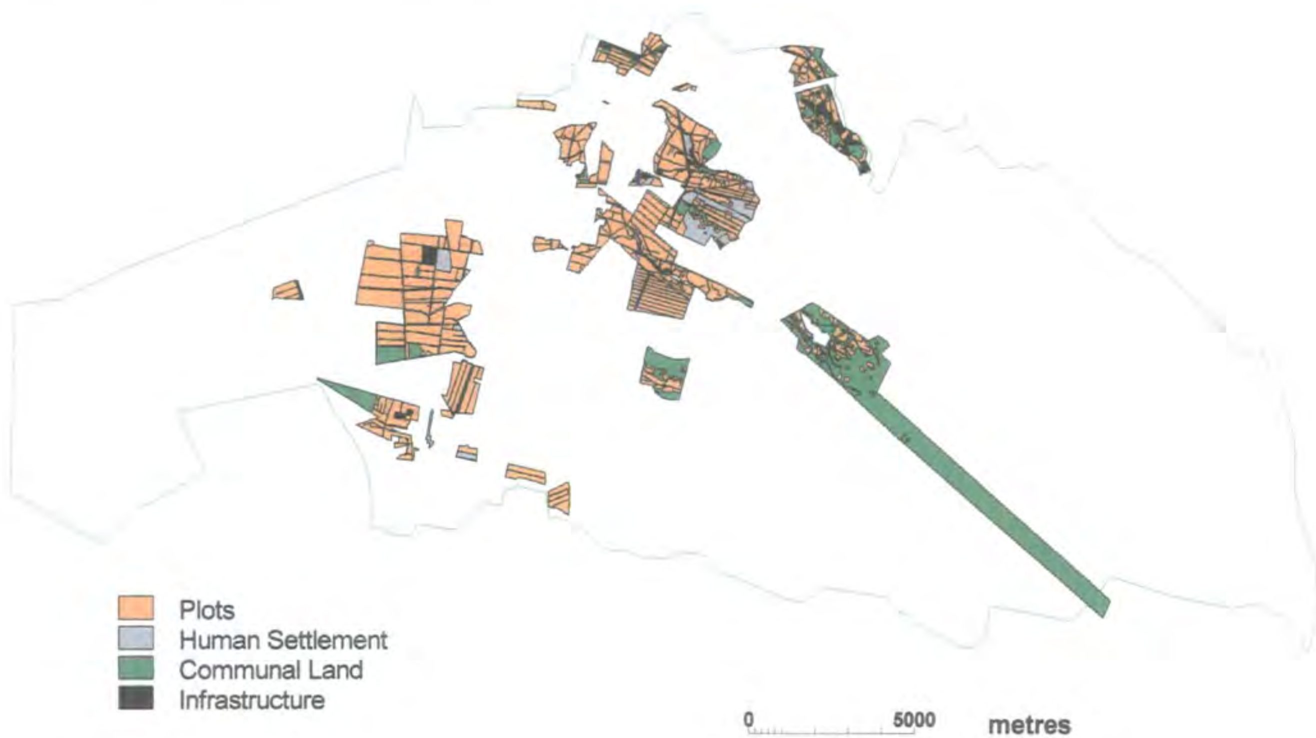
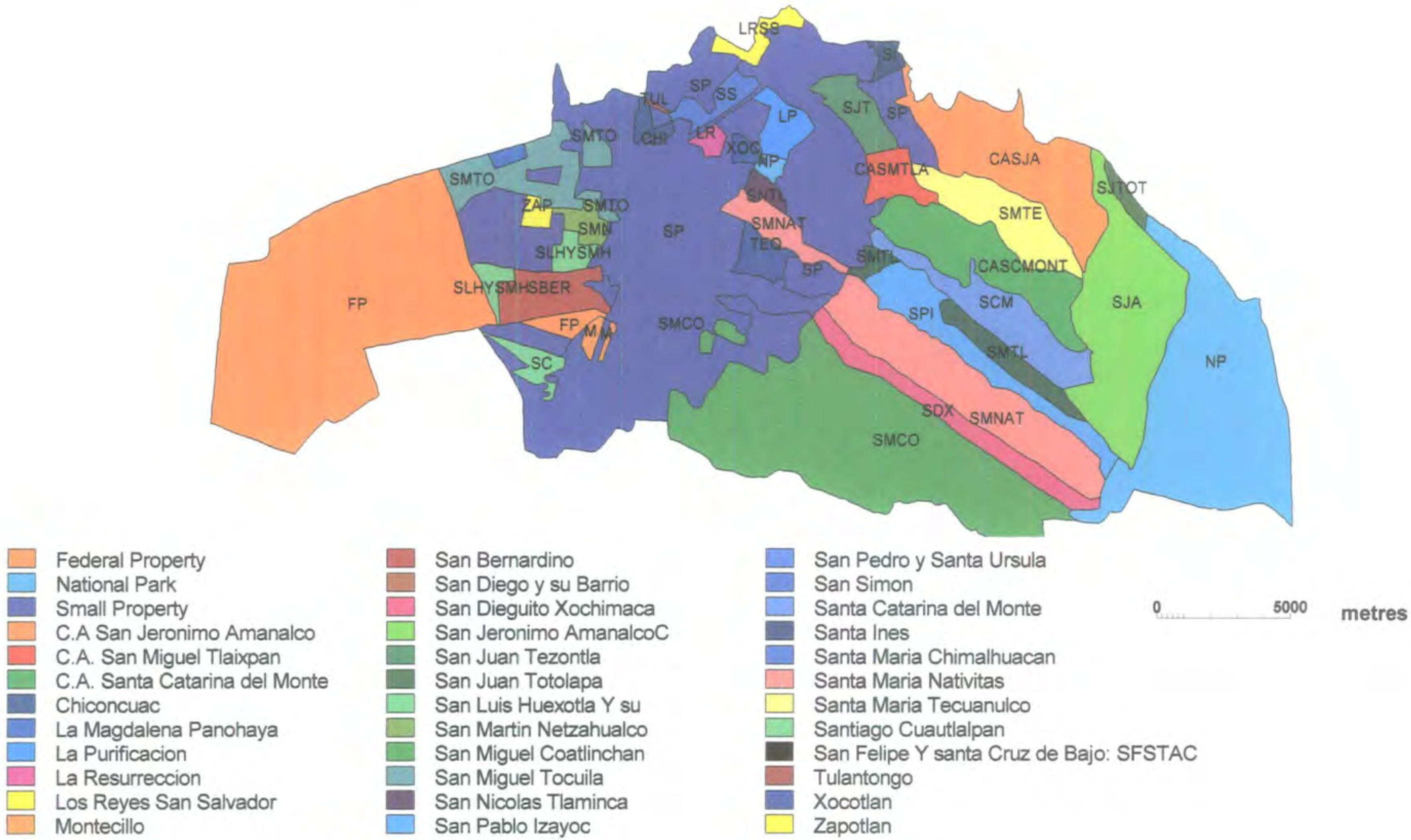


Figure 4.8 Ejidos in the municipality of Texcoco digitized from 1:50,000 map of INEGI, Censo Agropecuario,1990)



Note:The names are represented by their first letters in the map.

As the maps of PROCEDE were already in GIS format and this operation would save a lot of time and effort in the location of boundaries, the first step was the overlay of the segment maps over the satellite image. However, when the maps were overlaid the boundaries of the map of PROCEDE were displaced over their location in the image. The problem of overlay between the two coverages was by the co-ordinate system used for the georeference in the image and the maps of PROCEDE. INEGI in the cartography at a scale of 1:50,000 used as co-ordinate system UTM with ellipsoid Clark 1866 and Horizontal datum North America Datum (NAD) 1927. For the maps[14] of PROCEDE the specification said only georeference UTM and in small letters **modified by INEGI**. The specifications of the co-ordinate system were requested to the INEGI agency and they were UTM ellipsoid (WRS), 94 and datum NAD 94. As ellipsoid and datum were not available in ILWIS 2.2 the overlay of maps and image was not possible.

This situation raised the issue of standardisation of data and transfer procedures, especially in the geographical projections; this lack of standardisation or des-information of users, makes the use of one of the most powerful tools of GIS overlay of maps impossible. It is the responsibility of agencies like INEGI, with coverage at national level, to have at least the same standards for the cartography produced by them.

The scale selected for transfer of boundaries was 1:20,000, as most of the *ejidos* have an area of more than 100 ha, and 1 cm^2 of map represent 4 ha which was considered an adequate scale. The boundaries of the *ejidos* were transferred to 8 mosaics of aerial photographs covering the entire municipality, with the following procedure:

a) Transfer of the boundaries of the maps of individual *ejidos* of PROCEDE on the mosaics and b) transfer of the boundaries that were the same in the map 1:50,000 and 1:100,000, most of the *ejidos* in the plain and hilly area. For the transfer of boundaries a key for interpretation of the *ejidos* in the mosaics was produced using

[14] The paper maps were available at the end of fieldwork in April 1998; the digitising was in June-July 1997.

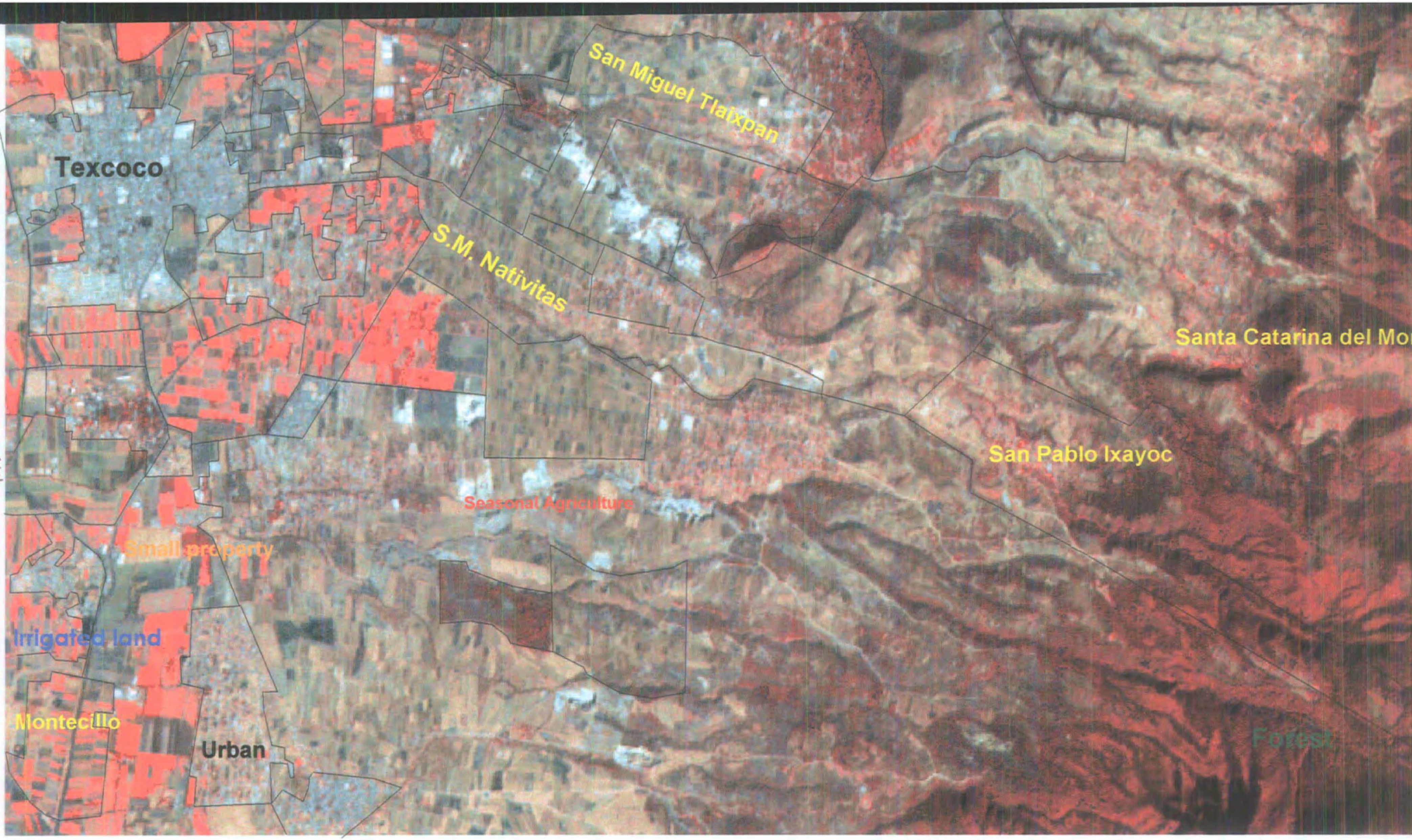
location and shape as criteria. The delineation of boundaries of *ejidos* in the area cultivated was based on location, shape and size of the *ejido* polygons. Also the principle of convergent evidence was used, for example, for the identification of boundaries among small properties and *ejidos* location and size of plots: The small property was concentrated in the plain areas and the *ejidal* land was distributed near the shore of the Ex-Lago of Texcoco and in the areas with gentle slopes and in the sierra. The areas with bigger plots (more than 4 ha) were identified in the mosaic and the boundary drawn when a compact area of small plots characteristic of the *ejidos* was found. Also the boundaries run along roads, rivers or ravines identifiable in the mosaics of aerial photographs.

In the forest only the boundary of one *ejido* was transferred in the forest area, as the boundaries of the *ejido* were straight lines, the co-ordinates of the vertices were obtained from the map of PROCEDE and transferred to the mosaics.

The boundaries identified in the mosaics were digitised on-screen over the 1989 SPOT satellite image using the criteria of location, shape and colour. The colour allows the identification of areas under irrigation, and urban areas, and more precise delimitation of *ejidos* in the irrigated area by the size of parcels (Figure 4.9)

4.7.5.1 Ground truthing of ejidal boundaries

The boundaries of the *ejidos* in the forest for the municipality were checked with the agent of the Procuraduria Agraria that is in charge of the certification of ejidal rights in the municipality of Texcoco, and the boundaries which follow streams or the edge of the mountains related with features visible in the mosaics were transferred following these features. During transects high vantage points with extensive views of the *ejidos* were selected to check the boundaries with the ejidatarios, and the agent of the Procuraduria Agraria. Also I was involved in the process of certification of the forest of the three *ejidos,* and the maps were consulted in the *ejidal* office and the boundaries checked in the field with an agent of the P*rocuraduria Agraria,* and the *ejidal* authorities. Detailed information about this process is discussed in chapter VII. Once the boundaries of the *ejidos* in the municipality were checked in the field


San Miguel Tlaixpan
Texcoco
S.M. Nativitas
Santa Catarina del Mon
San Pablo Ixayoc
Seasonal Agriculture
Small property
Irrigated land
Montecillo
Urban
Forest

the missing boundaries were digitised on screen in the satellite image. The final map is shown in Figure 4.10.

4.7.6 Historical maps

The historical map of the changes in land was for the *ejido* of Santa Maria Nativitas. The map was produced by using the information of time lines in land use, photo interpretation of aerial photographs of different dates, (1966, 1989) to identify the areas with erosion in 1966, and the changes introduced in 1989 by the building of terraces also; information about changes on land use was elicited from time lines and the spatial location by interviews with the comisario ejidal who also checked the final map.

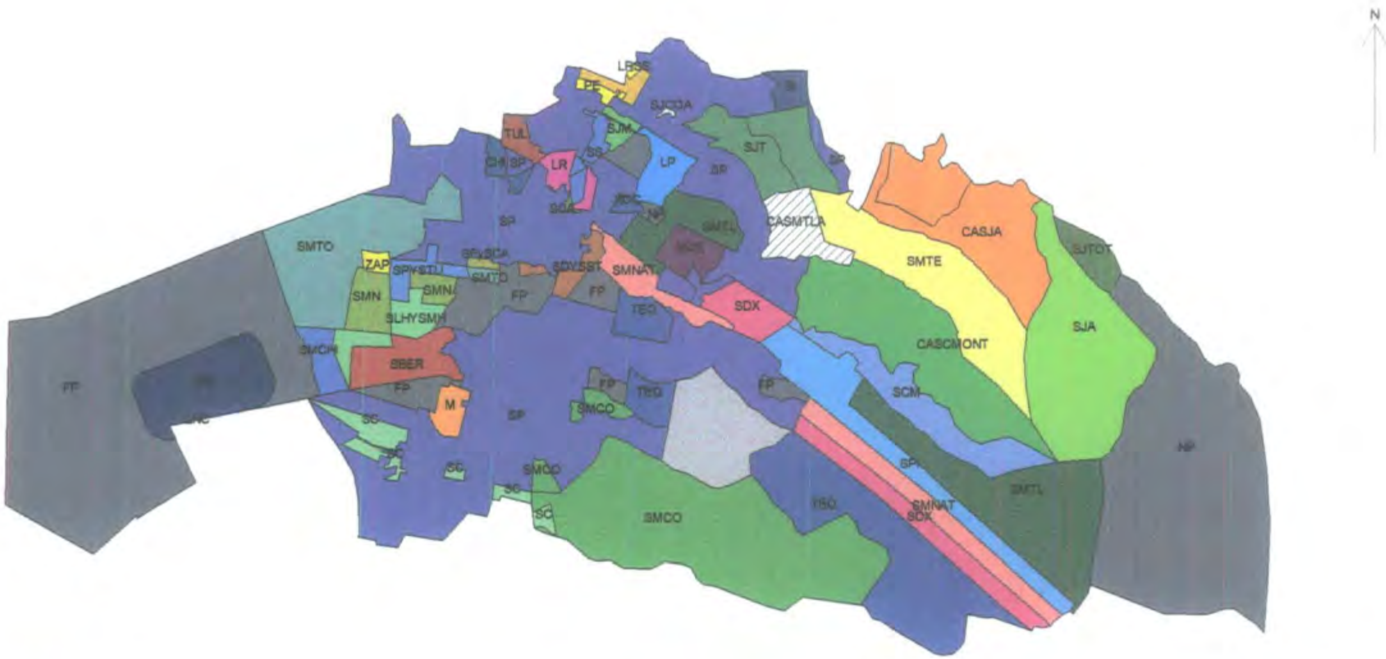
4.7.7 Views of *ejidatarios* and government agents about GIS

The municipality agents were agronomists with a background in photo interpretation, and some basic knowledge about GIS. The *ejidatarios* had been exposed recently to GIS technology and production of maps during the certification of parcels by PROCEDE. A group of ejidatarios was involved directly in the surveys of PROCEDE and all the *ejidatarios* have to locate their parcels on an aerial photograph as first step in the mapping of parcels.

The *ejidal* authorities of Nativitas and Tequesquinahuac expressed interest in having more knowledge about the reading and production of maps. The ejidal comisariado of Nativitas said that the government agents are using modern equipment and aerial photographs for the location of boundaries but he expressed his doubt about the maps produced

> 'How I am going to know if the map produced by the government is correct and represent my parcel. In PROCEDE they use a lot of equipment but we do not know how the map is produced and if its right or wrong. Now we have the map, but somebody in the *ejido* has to learn how to read the map. In the map there are a lot of numbers (co-ordinates) and we do no know the meaning. The *ejido* is covered for 4 maps; in the corner of each map there are a small area of the *ejido*. We need the map of all the *ejido* not in small pieces, as it is useless. Now with the problem of boundaries in the forest, we have the

Figure 4.10 Map of location of ejidos and small property in the municipality of Texcoco.
Source: Compiled by the author from SRA,1989; PROCEDE,1997; Fieldwork observations and mosaics of aerial photographs).



- Small Property
- Federal Property
- National Park
- Lake Nabor Carrillo
- C.A. Santa Catarina del Monte
- C.A. San Miguel Tlaixpan
- C.A San Jeronimo Amanalco
- Chiconcuac
- La Purificacion
- La Resurreccion
- Los Reyes San Salvador
- Montecillo
- Pentecoste
- San Bernardino
- Santa Catarina del Monte
- Santiago Cuautlalpan
- Santa Cruz de Arriba
- San Diego y su Barrio La Trinida
- San Dieguito Xochimaca
- San Felipe y Santa Cruz de Aba
- Santa Ines
- San Jeronimo Amanalco
- San Joaquin Coapango
- San Jose Mecatillo
- San Juan Tezontla
- San Juan Totolapa
- San Luis Huexotla y su Barrio
- San Nicolas Tlaminca
- San Martin Netzahualcoyotl
- San Miguel Coatlinchan
- San Miguel Tlaixpan.
- San Miguel Tocuila
- Santa Maria Chimalhuacan
- Santa Maria Nativitas
- Santa Maria Tecuanulco
- San Pablo Izayoc
- San Simon
- San Pedro y Santa Ursula
- Tequesquinahuac
- Tulantongo
- Zapotlan
- Xocotlan
- land under litigate

0 5000 metres

Note: the names are represented in the map by their first letters.

> same situation, we have the original map of 1937, but we can locate the boundaries with the information included in the map' (*Comisariado ejidal* 68 years).

The *ejidal comisariado* of Tequesquinahuac went further and he said that

> 'I do not have any knowledge about the reading of maps and aerial photographs; however I studied the first year of a Degree for engineer. I am an old man but not a fool I would like to learn how to produce and use maps. I think that this could be a help to know what we are doing in the *ejido* to co-ordinate efforts to do the thing better. With the new well we are going to irrigate the *ejido* and with the map in your computer we can control the distribution of water (*Comisario ejidal* of Tequesquinahauac, 65 years).

The government agents of the rural development district also showed their interest in the use of GIS, for the production of maps and some of them have a training in GIS. However the software and hardware are not accessible to them and the view of one agent expressed the importance of the hierarchical structure of power and their view of GIS as a tool

> 'With this high technology for your work You can make a good impression on the bosses' ("*uno puede apantallar a los jefes*")(Government agents 45 years).

In general the people were very impressed by the technology of GIS and its facilities of mapping directly in the screen, to expedite the production of maps. Both government agents and ejidatarios see this technology as a tool that could help them to solve some of their problems, the agents to reduce the work, by the efficiency in the management of data, and to present the results of their work. The ejidatarios can make sure that the government are doing the right thing in the mapping of their land and control over the use of water.

4.8 Input and manipulation of data into the GIS

4.8.1 Importing data into the GIS

As digital data were provided by different agencies a number of obstacles first needed to be overcome in terms of data transfer. The Rural district development (DDR03) used PKZIP (version 2.40 PKWARE Co) and data were captured in Lotus 123 and Dbase, the National Agricultural Census office used LZH (version 2.13 ©Haruyasu Yoshizaki) and data captured in Dbase, PROCEDE used UNIX as a platform and MIME2CIS (version 3.0 ©Murray Freeman) and data captured in .E00 format (ARC/INFO ver 7.02) for UNIX. For the present research these required the use of different compression formats and platforms for decompression of data, and conversion of data from UNIX to a PC platform compatible with ILWIS 2.2 (see appendix 2). The retrieval of information in these various formats and their conversion to a format compatible with ILWIS 2.2 proved to be very time consuming both for organisational reasons (agencies not making available the decompression software) and for technical (software reasons) because the import module for import of .E00 coverage from ARC/INFO into ILWIS 2.2 does not work properly. These problems raise wider issues related to standardisation of data relating to procedures for data transfer, by the agencies producing data at national level among different software systems.

4.8.2 Input of data to ILWIS2.2

The collection of relevant spatial data from different agencies yielded a heterogeneous mix of data in diverse formats, software, scales and themes (Table 4.5).

The 'import' module of ILWIS 2.2 was used to import coverages from Arc/Info, spreadsheets from Dbase, raster data Tag Image file format (.TIF) (the scanning of aerial photographs was carried out using a Hewlett Packard Scan Jet 4c scanner in .TIF format with a resolution of 300 x 300 dpi), and the General Raster Data for satellite images and the digital terrain model.

Table 4.6 Spatial databases collected from agencies

Agency	Format	Scale and No of Maps	Themes
INEGI	Analogue	1:50,000 (6)	Soils, land use, geology, Hydrology
INEGI/PROCEDE	Analogue	1:50,000 (1)	*Ejido* Boundaries
SRA/ PROCEDE	Digital ARC/INFO	1:5000 (32)	Communal, parcel, infrastructure, Settlement.
RAN/PROCEDE	Analogue and ARC/INFO	1:5000(4)	*Ejido* Parcels and database of names
DDR /PROCAMPO	Tables		Names of beneficiaries, crops and areas sown.
Three *ejidos*	Analogue	1:5000	Map of tenure at parcel level.
INEGI	Analogue	1:50,000	Boundaries of *ejidos*
INEGI	digital		Digital terrain model,
INEGI, IGEECEM	Analogue	1:20,000 and 1:75,000	Panchromatic aerial photograph, georeference mosaics of aerial photograph
Colegio Postg raduados	Digital		SPOT satellite images
Colegio Postgraduados	Analogue	1: 40,000	Land systems
Colegio Postgraduados	Analogue	1:20,000	Soil series

Analogue data from paper maps were input through the process of digitising, using a Calcomp 2000 digitising table (22”x 36”) and ILWIS2.2.

Prior to digitising, however, since the municipality and *ejidos* were covered by several map sheets, issues related with subsequent manipulation, and the potential errors introduced have to be considered.

The municipality is covered by six INEGI map sheets[15] at scale of 1:50,000, and several sets of maps of resources had to be digitised (land use, soils, geology, land tenure, hydrology, settlements and infrastructure) these involving a total of 36 maps that have to be joint to cover the whole municipality. In addition the *ejidos* of Santa Maria Nativitas and Santa Catarina del Monte were covered by several map sheets[16] at scale of 1:5000 (4 and 6 maps). There were two alternatives: a) to digitise each map individually, and at the end of the process, joined each set of maps using the operation GLUE in ILWIS; this is probably the most accurate procedure, but a very time consuming process b) The wrapping of the six maps manually, and afterwards the digitising as one single map in the digitising board.

[15] The cartography is presented in map sheets of 20 minutes of longitude and 15 minutes of latitude covering each an area of 1000 km² on scale 1.50,000.

[16]The cartography is presented in map sheets of 1 minute of latitude and 1 minute of longitude covering each an area of 1000 ha on scale 1:5000.

In the case of the municipality, two of the six maps cover almost 90% of the area, it was decided, that that the best alternative was to wrap the maps manually, to cause minimal displacement in the location of features and measurements introduced by the join of the maps. For the maps of the *ejidos* as they were photocopies of the original maps, that were stored in the ejidal archives, they had been manipulated and exposed to changes in humidity and temperature causing them stretch or wrinkle with consequent changes in scale. Errors introduced by these problems and in the process of digitising are recognised, such that any subsequent analysis would need to be treated with caution. In the present research the maps were used with the objective of comparing for example, distribution and estimated areas of vegetation, access to land, spatial distribution of parcels, and estimated areas in the *ejidos*. Despite the fact that the maps are available on digital format in PROCEDE they are not accessible to either researchers or ejidatarios. Then to make available these data to users, the maps available in the 'ground' have to be used as sources of information acknowledging of their inherent errors in location and measurements.

The projection used in the maps is the Universal Transverse Mercator (UTM) with the following characteristics: Datum: North America (1927). Datum Area: Mexico. Ellipsoid: Clark, 1866. Northern Hemisphere, Zone 14. For the purposes of digitising the following control points were used:

X: minimum= 496,000 maximum= 538,000;
Y: Minimum= 2,139,950 maximums= 2,164,050.

All the digitising was achieved with a transformation sigma value of less than 1.

The SPOT satellite images were input as raster maps and a scene comprised from 1994 (3404 rows x 3668 columns) and a sub-scene of an image 1989 (2500 rows x 2400 columns). As the satellite images cover an area of around 3000 km^2 a sub-scene of each image of 1024x1024 pixels covering the municipality was produced using the operation *Raster operation / sub map of raster map.* As remote sensed data in their raw format contain no reference to the location of the data and in order to integrate these data with other data in GIS, it was necessary to correct and adapt them geometrically, in a way that they give comparable resolution and projection to the other data sets. ILWIS 2,2 has two different procedures for georeference of raster data *georeference corners* and *tie point.* As information about the georeference of corners was available for the 1994 SPOT image and the digital terrain model (DTM), and the data of the image of 1989 and the aerial photographs were raw data the two methods were used as follows:

a) In the *georeference corners* procedure the x and y values of the corners of the satellite image and the DTM were inputted into the GIS and the co-ordinates of each pixels were calculated automatically in the GIS.

b) In the georeference *tie points* for a number of points that can be clearly identified, both in the image on a topographic map at scale of 1:50,000 and georeferenced mosaics at scale of 1:10,000, the co-ordinates were determined. The reference points correspond to location of objects in the mosaics or in the map were crossroad intersections, fixed river crossings, railways crossings. For the computation of sigma eleven points identifiable in both the map (X, Y) and image (row and column) were selected and located accurately in either materials. The accuracy of the transformation is calculated by the average of the errors in the reference points as the Root Mean Square Error (Sigma value) and should be, less than one as recommended by ITC (ILWIS, 1997) .The number of points used to compute the transformation, the sigma value obtained, type of transformation and size of the pixel are shown in Table 4.7.

Table 4.7 Image georeference

Source/Date	Number of points	Sigma Values	Transformation	Size of pixel
Satellite imagery			Third order	20mx20m
1989	11	0.369		
1994	11	0.252		
Aerial photograph			First order	4.1mx4.1m
1989	15	0.954		
1994	18	0.927		

A false Colour Composite (FCC) was created for the satellite images to enhance the appearance of the image, for optimum visual interpretation. The colours assigned in a FCC for vegetation are red to the infrared band (band 3), blue for the red visible (band 2) and blue colour for the green visible band (band 1). The green vegetation will appears reddish, the water bluish and the soil in shades of brown and grey (ILWIS, 1997; Mc Cloy, 1995). The FCC for the two images were produced by the standard method of ILWIS based in the Heckbart algorithm with the function linear stretching and range of intensity between 0 and 255 with the operations *Image processing/ standard/ linear stretching.*

INEGI produce Digital Terrain Model (DTM) based on the topographic maps scale 1:50,000 with elevations every 50 meters; these are in raster format with pixel size 20 x 20m. Two DTMs covering 90% of the municipality were available. The two DTMs were joined digitally in the GIS, and afterwards a sub-map covering the area of the municipality obtained. The DTM was used to produce three-dimensional models and was overlaid with the satellite images and aerial photographs. Other information produced from the DTM included hill shadow maps, height maps and slope maps by percentage of slope.

In ILWIS 2.2, the DTM is processed from format raster with each pixel in the raster map containing the altitude of the centre of the pixel. Maps of slope percentage and altitude could be produced from the raster maps. The slope percentage is calculated from the raster map in X and Y directions using a DTM, gradient filters (*Dfdx* and *Dfdy)* and a map calculation formula for the calculating of the slope percentage. The maps of slope percentage were produced by the following procedure (ILWIS 2.2, 1997, p 389-390):

First using the functions gradient filters *Dfdx* and *Dfdy*, the horizontal and vertical gradients are calculated for each pixel. Second the percentage of slope was calculated with the following formulae:

Slopeper =((HYP (Dx,Dy))/ pixelsize(dem))*100

Slopeper= slope in percentage

HYP = is an internal map *Calc/tabCalc* function to calculate the positive root of the sum of square Dx plus square Dy (*Pythagoras rule*)

Dx = the horizontal gradient map

Dy = the vertical gradient map

In this formula the numerator is divided by the pixel size using the internal function *pixelsize* (DTM), since the gradient is expressed in meters difference per pixel and the result should be in meters. The value 100 in the formula gives the slope in percentage.

The maps of altitude could be classified in different height zones using the operation *map slicing*. Through this operation a range of values of the input map are grouped together into one of more output classes (for example altitude 1000 to 1500m). In order to produce the map of altitude a *group domain class* with the intervals of heights is produced and afterwards the map is produced using an internal function to classify values according to an specific domain group (CLFY); the expression has the following structure:

OUTMAP = CLFY (InputMapName,Domain group)

Where CLFY is the function to classify domain groups;
InputMapName is the name of the input map;
Domain group is the name of the domain group.

The digital elevation model are visualised in three dimensions in the module georeference in 3D. The programme produces as output a line grid, and it is possible to superimpose satellite images or thematic maps with the same co-ordinate system on the perspective view. The view parameters could be specified (altitude, rotation, distance, vertical exaggeration), in order to help to create the best view.

4.8.3 Accuracy of the data

In the input of data into the GIS it is important to consider the issue of propagation of error introduced by the data and also propagation of errors after the data have been input. There are two types of errors: Inherent associated with the source of data and its radiometric and geometric manipulation and the operational associated with the processing techniques by the imprecision of manual digitising or warping on paper maps (Konotes et al. 1993; Burrough and Mc Donnel, 1998).

The satellite data used were of processing level 1B (radio metrically normalised and geometrically corrected for systematic deformations). These images have good geometry relating to the extremely small geometric distortion in the along-track direction, and positional errors inherent in the satellite image are not considerable (Boissin and Gardelle, 1986). The operational errors (RMS errors) introduced during the image registration process are 0.369 and 0.252 for the satellite image of 1989 and 1994, respectively. Then the inherent errors should be small.

The aerial photographs have inherent spatial errors arising from the resolution of the source data and positional errors by differences in height on the terrain. The cell size is less than 0.0069 mm (0.138 m at scale 1:20,000 and 0.51 m at scale of 1: 75,000). According to Valenzuela and Baumgarden (1991) if the pixel size is less than 0.5 mm the expected error in estimation of area should be less than 0.3%.

The aerial photographs however, are affected to some degree in the location of position, produced by the differences in heights in terrain that make them spatially inaccurate. However the introduction of these displacements in position can be ignored, because either the terrain is flat or the position of the points is not displaced by differences in height or when a single photograph is used as map base (Mc Cloy, 1995). In this research the terrain in the *ejidos* of San Pedro y Santa Ursula and Santa Maria Nativitas the terrain is almost flat less than 4 %, and hence the positional errors could be negligible in these two *ejidos*. However in Santa Catrina the topography landscape is mountainous with differences in a gradient of altitude between 2700 and 4000m and in some areas slopes of more than 100 %. ILWIS 2.2 does not have a module for the corrections of these errors and hence is not possible to improve the positional errors in areas with high variability in altitude and slope.

The operational errors are related with errors introduced during the digitising process by the imprecision of manual digitising or when more than one map is warping on paper maps. Digitisation was always done carefully, but in the case of maps of tenure because of the small size of parcels, some as small as 500 m^2 and an average of 5000 m^2, and sinuosity of boundaries distribution, digitising was particularly difficult and operator error was unavoidable.

The standard procedure for verification[17] of the geometry of the images and aerial photographs was the overlaying of maps digitised from the topographic maps, and for the measurement of areas comparison of area measurement in the GIS with areas surveyed in field (See Hinton, 1996). Error measuring of areas in the *ejido* maps was estimated by the comparison of the maps *ejido*, parcels and, communal area produced by PROCEDE, against the areas measured in ILWIS 2.2 The error of estimation in area for the ejidal polygons is less than 2.1 % (Table 4.8).

Table 4.8 Estimation of error for the ejidal maps between the digital map of PROCEDE (1998) and the digitised map of ILWIS 2.2

Ejido	San Pedro Y Santa Ursula								
	Total	Parcel	Com.	Total	Parcel	Com	Tot al	Parcel	Com
PROCEDE	166.9	156.9	2.0	284.0	247	9.2	824.6	160.9	656.8
ILWIS 2.2	166.5	156.5	2.0	283.9	241.7	10.0	828.3	159.5	659.1
% Error	-0.3	-0.3	0	-0.003	-2.1	+0.8	+1.0	-0.008	+0.003

Com = communal

The estimation of error at parcel level was not possible, by lack of information of areas from PROCEDE, specially in SMN and SCM where the size of parcels were from 500 m² to 5000 m², with 481 and 300 parcels respectively, and where the shape of the parcels was irregular following stream or topographic features. The estimation of parcel areas in these *ejidos* should therefore be treated with caution. Moreover, each ejidatarios has an official estimation of the area issued by the National Agrarian Register. As the purpose of the measurement of parcels in these research is comparative and not cadastral, hence the error introduced during digitising should be acknowledged.

The other method used to digitise maps was on screen digitising of vectors from the SPOT satellite images and the aerial photographs. This method used during the fieldwork, when a digitising board was not available, and allowed the production of maps interactively with research participants. The maps produced on screen were the

[17] Displacement between the image and the segment maps of INEGI were found by the use of different ellipsoid and datum see section 4.2.7.2.

map of land tenure for the municipality, the map of agro-ecological zones, and maps of land uses in the *ejidos*. The main disadvantage of this method is the loss of precision in the location of boundaries and estimation of areas. However as the objective was to produce maps of resource base based on local knowledge and the aim was to gain an understanding of the processes rather than using the maps in a cadastral sense this method was felt to be appropriate.

In this research then the maps are produced by the people' on the ground, and the map is the representation of their perception of their reality and associated problems. The map potentially acts as a tool that could help to empower people to present their ideas and propose actions to improve their actual conditions either to their fellow *ejidatarios* or to the government.

4.8.4 Operations for the production of maps

The digitised boundaries have to be converted to thematic maps, and this implies the association of attributes to each area (polygon). For example: in order to produce the map of vegetation, a point map, which identifies the attribute by its co-ordinates, is produced for each polygon (type of vegetation, soil). Once each polygon has an associated attribute the segment map is polygonized using the operation *polygonise segment/label map.*

Chapter 5 Agrarian structure in Mexico

5.1 Introduction

The evolution of the agrarian system in Mexico has been derived from the fusion of two different arrangements. The first was established by the native indigenous people (Aztecs), and reflects their social organisation, based in communal land property. While the second system brought by the European Invaders (Spanish), involved private land holding and was both imposed on and adapted from the original Aztec system of the native population had influenced the land tenure patterns through all Mexican history and some of their features have been incorporated into the agrarian code of the most recent land reform.

These two systems of tenure private and communal have co-evolved together over the last 500 years, creating a complex system of access to land. This chapter describes the process of land reform and the policies of the government that have produced a polarisation in the agriculture sector; on one side are a small group of highly capitalised farms on the best land and having opportunity to be successfully integrated into the new economy of free market and in the other the 'social' sector an impoverished sector with land of low quality and with few resources for investment and with limited options of production for self and/or consumption or local markets.

5.2 The Prehispanic system of land tenure

At the time of arrival of the Spanish in 1519 on the shores of lake Texcoco an empire, the federation of three city-states (Tenochtitlan, Texcoco and Tlacopan, Figure 5.1) with a population of 1,500,000 inhabitants controlled a large portion of the central Mexican Region (Gibson, 1964). The Aztec society was a state level society, socially stratified and with centralised power. They had state level institutions such as laws, taxes, and a complex administrative organisation. The society was stratified into several levels; the top level was composed of the *pipiltin*, or nobles, the majority of the population however composed the *macehualtin* or commoners, who were organised into *Calpulli*, territorial landholding groups with some kinship features; the

Figure 5.1 Indigenous settlements in the shore of lake Texcoco in 1521.

mayaque, serfs bound to the land in large estates represented the lowest level of the hierarchy (Ortiz de M, 1990).

The land tenure system elaborated by the Aztec society was a village type land-holding. It was developed with a democratic character, in which each *macehualtin* had rights to land. Also the rights of possession were clearly identified and well enforced (Tannenbaum,1968).

The *Calpulli* was the basic unit for the organisation for agriculture. Each *Calpulli* was composed up to twenty different clans. Components of the clan were families whose heads participated in decision-making meetings. The land was free commonly held, and distributed among the families based on their needs (Simpson, 1937). The *Calpulli* held two different types of land the *altepetlalli* and the *tiatmilli*: The *altepetlalli*[1] (literally 'land of the town') was further divided into two types, the area of individual cultivable plots and a communal area with diverse resources such as hunting grounds, timber lands, rock quarries and so forth; the *tiatmilli* was the land divided into cultivable plots, distributed among the various family heads for the production of food for the subsistence of the family, and worked independently. The land was passed by inheritance from father to son[2]. The size of the plots varied according to the availability of land for distribution, the number of persons among whom it had to be apportioned, together with characteristics related to soil, rainfall and the supply of water for irrigation were considered. McCutchen Mc Bride (1923) estimates the size of plots typically to be between 2 and 3 ha. The most distinctive characteristic of the system was that neither the public land nor the 'parcel' assigned to individuals could be transferred to other people in any circumstance. There were no written titles to the individual lots, and the families owned only by the usufruct, which was also transferable from father to son. The families however lose the privilege to the land if: a) they did not cultivate the land for two consecutive years or b) moved away from the village or died out (Mc Cutchen Mc Bride, 1923).

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[1] The *altepetlalli* would seem to correspond to *ejido* created later by the Spanish on the foundation of Indian towns during the Colonial period.

[2] The *tiatmilli* plots were assigned annually, since during the years plots might be vacated due to death, of the owner, the removal of the occupant, whilst an increase in the number of households would require distribution of land.

The social organisation was based on agriculture, and the system of production was adapted to the conditions of the area for example by the building of *chinampas* in the shore of the lake and terraces for irrigation in the areas of steep land[3].

5.3 The Colonial Period

5.3.1 Grant of land in the Colonial period

In early colonial times the Spanish Crown established legislation to ensure that the Indians retained sufficient land to support themselves. In spite of the regulations, designed to protect the village land holding, other forms of land tenure were developed to the detriment of the community. As a result of land given as rewards by the Spanish Crown to the colonisers new land tenure system developed the three main forms were *Hacienda*s, *rancho*s, and landholding *pueblo*s. The tendency during this period was the accumulation of land in few hands

5.3.2 The *Hacienda.*

The *Hacienda* grew by both legal acquisition of land and sometimes by the misappropriation of land from Indian land holding *pueblo*s and there became the most important force in the government and in the organisation of agricultural production (Mc Cutchen Mc Bride; 1923; Gibson, 1964).

By the end of the Colonial period in 1810 the number of big estates in Mexico was quantified as follows: 4944 large farms, 3749 *Haciendas* and 1195 *estancias* for cattle. The ownership of these lands was in the hands of 10,000 people of Spanish extraction. The main impact of the growth of these big estates was that Indians were left landless. After they were deprived their lands the Indians passed from the status

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[3] More detailed information about the Pre-Hispanic systems of irrigation and their importance in the development of the cultures in central Mexico can be found in Palerm, 1980a, 1980b, 1980c, 1980d; Palerm and Wolf, 1955a, 1955b, 1972; Armillas, 1949; Armillas, Palerm and Wolf, 1956; Sanders, 1953; Millon, 1957) cited by Palerm, 1980) and in: McAffe and Barlow (1946) and Dibble (1943) cited by Rodriguez, 1995)

of free communal landholders, to that of serfs bound more or less strictly to the *Hacienda* upon which they lived.

5.3.3 The Ranchos.

Many of the *ranchos*[4] in Mexico owe their origin to the grants made by the Spanish government as *peonias* and *caballerias* and to the grants for the colonisation of uninhabited lands. At the end of the colonial period it is said that there were 6684 *ranchos* in Mexico, 71 of them in the state of Mexico (Navarro Y Noriega, 1795 cited by Mc Cutchen Mc Bride, 1923).

5.3.4 Landholding *Pueblos*.

The Spanish colonial legislation attempted to protect the Indians by grant of land as landholding *pueblos* and as a result many of these native groups succeeded in preserving their land and freedom. Land also was allocated to the new settlements created for colonisation of the territory of the *Nueva España* (New Spain).

The Spanish Crown respected the communal holding of the Indian *pueblos* (calpulli), recognised this collective Indian type of tenure through the expedition of land title to the calpullies, through the so called *Mercedes Reales* and modified the system of tenure slightly to make it conform to the Castilian[5] institutions, and gave it legal status by the enactment of the appropriate legislation. For new Indian settlement to ensure its survival land was allocated as follows: an area for construction of dwellings (*Fundo legal*) which was to be measured at least 600 varas (around 500m) in each direction from the door of the church; one square league[6] of *ejido* land including agricultural parcels, the communal forest and pasture land for each settlement. The local Indian governing body was recognised by the Spanish authorities, and their

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[4] In central Mexico the term is used in general to designate smallholdings as contrasted with the large haciendas. The most common usage of the word is that which signifies a small rural property, worked by the owner himself, with the aid of the immediate family

[5] The similarities of the Spanish system for the foundation of towns based in the Castilian system and the Indian *Calpulli* produced this category of land tenure. In both systems the land is inalienable and non- agriculture land is held as a pool of communal land

[6] A Spanish league is approximately 3 miles.

members represented the inhabitants in any dealings with the government. The lands were not alienable[7] and were to be administered by the town council. (Mc Cutchen McBride, 1923; Gibson 1964). Thus the communal Indian system was carried forward into the colonial period and protected by the laws.

During the sixteenth century there was a drastic reduction[8] of the Indian population as a result of epidemics of European diseases such as chicken pox. The Hacienda claimed the vacant land and the surviving Indian population was regrouped in new towns called *congregaciones* (Rosenweigz, 1989). This result in the decline of the indigenous social system reflected in many places by the destruction of the traditional irrigation systems. At the same time irrigation on the Hacienda increases (Gibson, 1964; Palerm and Wolf 1972).

The Colonial period impacted on the area in two ways-ecological and social. The first as suggested by Gibson (1964) was the result of the exploitation of both natural and human resources to the detriment of the environment. Gibson (1964) summarised the changes involved in the environment deterioration of the Valley of Mexico as follows:

> 'with the Spanish conquest the equilibrium of the population changed abruptly. The conquerors cut down huge quantities of timber for building materials and fuel. Their ploughs cut more deeply into the earth than had the Indian digging sticks, and their cattle and sheep cropped the land bare. New irrigation system and gristmills concentrated or redistributed the water flows. Not of the new developments was disastrous in itself, but the combined effect over the years was an accelerated depletion of agricultural land. In the rainy season, topsoil was washed to the valley bottom, erosion produced gullies, and slopes that had once been capable of cultivation became barren" (Gibson 1964, p5.).

The social impact of the colonial system is represented by the collapse of the Aztec Empire which was fragmented into individual communities as landholding *pueblo*s as is signalled by Gibson

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[7] In law inalienable means not able to be transferred to other ownership

[8] From a population of 325,000 inhabitants in 1570 the population dropped to 70,000 in the Seventeenth century (Gibson, 1964).

'the community during this period proved to be the largest Indian social unit capable of survival, and it survived in spite of manifold and severe stress. To support it the cofradia, the fiesta and the communal system of land tenure were enlisted' (Gibson, 1964 p.409).

The increasingly unequal distribution of land eventually triggered the War of Independence in Mexico that last from 1810 to 1821(Tannenbaum, 1968).

5.4 Mexican Independence (1821-1910)

The newly independent government set about regulating the access to land by enactment of new laws. The new laws focused on the need to break up the large estates created during the Colonial period. It led to a) abolition of the legal inferiority of Indians[9]; b) abolition of entailed large holdings; c) ultimate confiscation of the church lands, which was completed by the end of the called " War of Reform" by 1857.

The evolution of the land tenure in the 19th century can be divided in three periods:
The First between 1821 and 1853, a period in which the most important change was the transfer of land from Spanish to native-born Mexicans. The second began in 1853[10] with the enactment of further legislation (the so called Reform laws) and implemented after the war of Reform supported by the Indians and landless. The third period, the dictatorship of Porfirio Diaz 1876-1911, saw a change in emphasis towards rapid industrialisation of the country by developing railways, public utilities and stimulating the mining industry. These changes increased the flow of foreign investment and as a consequence led to rapid rise in land value and land speculation

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[9] During the colonial period the Indians were under the protection of the King of Spain as 'child-minors' (Mc Cutchen McBride, 1923)

[10] In the late eighteenth century the official circles in Spain believed in the economic virtues of the proprietary farm, with the consequent condemnation of any monopoly of land ownership, Jovellos (1793) a minister of the Spanish Crown in his writings attacked the church and the estates of the aristocracy as the chief obstacles to the development of agriculture. He advocated that common land of pueblos and villages should be distributed on an individual basis. With a free market in land, the elimination of government regulations in trade would open the way for an unrestricted increase in production and prosperity, based in the diffusion of ownership. The policies advocated by Jovellos governed all future discussions of the agrarian problem and with the Reform Laws in 1853 the property of the church was nationalised and sold and some lands of the Indian landholding *pueblos* were divided into individual plots (Braiding , 1978).

also. From here on, the Mexican government developed a policy that was deleterious for the country (Tannenbaum, 1968). The attempt to destroy the feudal character of the Mexican land system was also halted by Diaz and by 1910 most of the lands of the country were concentrated in few hands as *Haciendas* or land of private corporations. In addition, to land issues, the Diaz administration played down the racial problems existing in Mexico, indeed it showed almost an aversion towards the Indian population and their institutions. The Diaz government viewed the destruction of the Indian institutions as essential to the Mexican economy and it supported the replacement of the Indian population with foreign immigration (Tannenbaum, 1968).

5.4.1 Enlargement of the *Haciendas*

At the end of the war of Independence form Spain in 1821 new legislation was enacted for the protection of private property. The laws promoted the transfer of the Haciendas without substantial changes in size. The main change was in the proprietorship of the Haciendas that was transferred from Spanish to native-born Mexicans. The transfer was made by confiscation, grants or by sale, under the direction of the new authorities. The land of the nobles (entailed estates) was abolished and some of these properties were divided into smaller haciendas or Ranchos. However, the main holder of land the church remained in possession of land until the middle of the century. It wasn't until 1857 after the war of Reform that the land of the church was nationalised and later put up for sale among individuals. However during this process there were no attempts to partition most of the confiscated haciendas into smallholdings. In most of the cases the sale of the land only was a change in ownership from the church to individuals. These transfers only increased the number of landholders by thousands (Mc Cutchen McBride, 1923).

The enlargement of the Haciendas was promoted also from 1883 when laws were issued to recover for the nation the so-called of *Demasias*[11] and, *Excedencias*[12] lands and to encourage the denouncement of lands irregularly occupied. These laws allowed

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[11]Demasias was lands held by individuals within the established boundaries of their respective properties, but which were in excess of the amount specified in the deeds.
[12] Excedencias was land held by individuals for at least twenty years or more, bordering on the owner's lawfully held property but not included within the bounds specified in the deeds.

the *Hacendados* the opportunity for clearing all imperfect titles, whilst at the same time legalising the lands that they had taken from the neighbouring Indian communities. By these means the *Haciendas* legalised their landholdings in excess of lands acquired during previous centuries from the landholding *pueblos* and ranchos. These processes ensured that by 1910, the number of *Haciendas* in Mexico remained almost the same as that at the end of the Colonial period (8245). In the state of Mexico there were 95 *Haciendas* 64 with an area of between 1000 and 5000 ha, 27 between 5000 and 25000 ha and 4 between 25,000 and 50,000 ha (1910 census cited by Mc Cutchen Mc Bride 1923). Thus the land reforms begun after the war of independence in 1810, and retaken after the war of reform in 1853 had achieved few of their targets.

5.4.2 Indian land holding *pueblo*

After the War of Independence the change in the situation of the Indians with the advent of the Republic was that the Indians secured legal equality with the whites, and acquired a new status as citizens, that gave them great liberty in contracting their services. They continued in possession of their communal lands and remained as the main source of labour for the *Haciendas* either on a permanent or temporary basis. It was until the middle of the century after the 'War of Reform' that this situation changed (Mc Cutchen Mc Bride (1923)

In 1856 an attempt to break up communal land and convert it to individual property was initiated by the law of *desamortizacion.* This stated that no civil nor ecclesiastical body should acquire or administer any property other than the buildings devoted exclusively to the purposes for which that body exists. All communal property was to be granted in severalty to the individuals holding the respective plots. This included the communal lands of the landholding *pueblos* called *ejidos*. The number of *pueblos* throughout Mexico in 1857 was stated as 5021[13]. These pueblos were "agricultural *pueblos*" with their ejidos containing the communal lands and cultivated plots assigned to individuals probably. They averaged no more than 2300 ha each, making an approximate area of land held of 75,000 km². It was these communal holdings that the government proposed to break up, by transferring them to individual proprietors, the hope being to counterbalance the large landholders by creating a middle class composed of small farmers. The division of communal land was implemented readily in *pueblos* of the *mestizos*. In the Indian landholding *pueblos* in central Mexico however, were in general opposed to the individual distribution of land and they made every effort to oppose or evade the execution of the law. When the division was made in these towns the Indians lost their holdings as soon as they received them either selling them or as a result of the corruption of public officers who claimed and obtained Indian land not registered. As a result of the reform, the landholding *pueblos* greatly decreased in number and many of them were left only with the land occupied by their houses. However, the communal land holding survived in the areas of the country where Indian influence remained strong such as the valley of Mexico (Mc Cutchen Mc Bride, 1923).

Between 1877 and 1893 348,242 ha of communal land were allocated to individuals. Most of the divisions of communal lands were located in the north of the country with an average size of 30 ha. The size however varied with the individual States and for example in Durango it was 199 ha or in the humid areas in Tabasco 33 ha. By 1906 19,906 plots had been distributed to individual holders from the landholding *pueblos* (Mc Cutchen Mc Bride, 1923).

5.4.3 The Ranchos[14].

In 1857 with the laws of Reform, the government promoted the formation of more ranchos, and in 1863 a law was passed for the allocation of public land to farmers similar to the scheme of homesteads of the North Americans. Most of the Ranchos in this period were established in the north of Mexico and very few in the regions with strong Indian influence, for example in the state of Mexico there was only 460 Ranchos (Mc Cutchen Mc Bride, 1923).

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[13] Twenty five percent of the pueblos, 1196 were in the state of Mexico. Mc Bride, 1923)

[14] In the nineteenth century the term "rancho" had different senses. In the northern plains and in the grassland areas is applied to large stock farm with sometimes hundred or thousands of hectares. In central Mexico it was least a property with 1000 has. However the most common usage of the word is that which signifies a small rural property worked by the owner himself, with the aid of his immediate family. (Mc Cutchen Mc Bride 1923). The last meaning is the used here.

This policy of promoting private property in small land holdings resulted in the number of Ranchos growing from 8,400 in 1810, to 15, 805 in 1854 and to 47, 939 in 1910. They contributed greatly to the supply of food of the country and Mc Cutchen Mc Bride (1923) suggested that the Ranchero formed the 'middle class' in the Agriculture sector and hence had become the conservator of law and order.

5.4.4 Monopoly of public lands.

From 1883 to 1910 industrial and commercial activities increased in Mexico as a direct result of foreign investment in the exploitation of natural resources. In 1883 legislation was enacted by which public lands might be acquired in large amounts. The main beneficiaries of these laws were the surveying companies employed in the delimitation and measurement of *baldios*[15] in the ten years 1883 to 1893 some 50,000,000 ha were surveyed and of which the companies were given over 16,000,000 ha, much of this land was held in immense tracts for speculative purposes (Mc Cutchen Mc Bride, 1923)

By this processes a great amount of public land was transferred to the private sector, so much that by 1912 there was no public land remaining in twelve states of Mexico, eight had less than 500,000 ha and only nine with more than one million. The total of public land remaining in the hands of the government in 1912 was 22,821,678 ha (Secretaria de Fomento, 1912, cited by Mc Cutchen Mc Bride, 1923)

By 1910 12 million people obtaining their living form agriculture[16]. The land ownership was as follows: access to land was as follows 8000 *Haciendas* occupied 113 m hectares with 4500 managers, 300,000 tenants, and 3 m peons (labourers) and sharecroppers. There were 50,000 ranchos occupying 10 m hectares and 110,000 small owners with 1.4 m hectares. Around 150,000 indigenous communal landholders occupied 6 m hectares (12 m hectares less than in 1810) and together with their

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[15] *Baldios* were defined as lands which have never been lawfully alienated by the nation or legally destined to public use. As recompense for the services the government gave to the companies a third of the land that they might surveyed (Mc Cutchen McBride, 1923).

[16] The total population was 15 million.

families, totalled one million people (50% of the total indigenous population in the country). Half of the population lived in 57,000 towns directly controlled by the *Haciendas* and ranchos, while the other half lived in 13,000 "free *pueblos*" suffering from several forms of exploitation. Less than 1 % of the population owned 90 % of the land, and over 90 % lacked access to it (Esteva, 1987). This inequality in distribution of land that was magnified during this period during the post Independence war was one of the direct causes of the Mexican revolution of 1910 and the subsequent Agrarian Reforms (Esteva, 1987, Mc Cutchen Mc Bride, 1923; Tannenbaum, 1968).

5.5 The Mexican revolution and the land Reform

The policy of the Diaz regime had brought rapid economic growth to the country and pronounced concentration of wealth in the hands of few individuals. However as a counter effect, the landholding *pueblo* lost more of their land, while inflation exceeded the increase in agricultural wages, and the standards of living for the majority of the Mexicans was lowered. These elements combined, with other economical and industrial factors weakened the central power creating the basis for the Mexican revolution (Tannenbaum, 1968).

In the Mexican revolution peasant[17] armies became the dominant forces (Womack, 1986, Wolf 1969 Cited by Esteva, 1987). The conflict ended seven years later with the enactment of a new Constitution for the Republic in 1917. The basic demands of the peasants for the restitution of the communal lands usurped by the *Haciendas from the pueblos*, were enacted in the article 27 of the constitution of 1917. Based on this article the state was the entity that was in charge of the redistribution of land through the Legislation and expedition of the Mexican Agrarian law.

[17]The peasantry raised arms in 1911 in the State of Morelos against the unremitting encroachment of neighbouring land owners on communal lands and made desperate by the rapid decline in standards of living which occurred in the areas of greatest modernisation of the agriculture. Here the basic ideas of the agrarian reform were declared under the leadership of Emiliano Zapata. The principles of his leadership were "land and liberty" (Tierra y Libertad).). The meaning of liberty in this context meant autonomy, the right to conduct community affairs without outside interference. The possibility to reinforce the foundations of a peasant order badly shaken by the foundations of the capitalist society (Hewitt de Alcantara, 1980).

After the revolution the government had two key tasks, the reorganisation of the social structure and the modernisation of the country. Land distribution was viewed as a policy of modernisation with the objective of removing constraints preventing the development of capitalism and strengthening the domestic market. (Gordillo de Anda, 1996.

De Janvrey et al. (1998) in an historical overview of land reform in Mexico divided the process of post Revolution land reform into three phases:

a) The first phase between 1915 to 1992 with focus on re-distribution of land and support of the state for rural development;

b) The second from 1992 promoted market forces through a land tenure reform based on security in land tenure and promoting privatisation of ejidal land, and join ventures between private and ejidal sector and the reduction of the intervention of the state in the provision of services;

c) The third phase that is in progress will be achieved by the increase of the competitiveness of the beneficiaries of the second phase by the implementation of effective programmes of rural development based on grassroots initiatives and the reconstruction of rural institutions.

5.5.1 First Phase of land reform 1917-1992 redistribution of land

The re-distribution of land proceeded throughout Mexico on the basis of the Constitutional principles established in the article 27 of the constitution. The regulations for the Land Reform were passed in 1920 and established the basis for the process of land re-distribution in Mexico. The landowner from whom land was expropriated did not receive any compensation for the dispossession, and the beneficiary was not required to pay for the land granted (Eckstein, 1978).

The Agrarian law of 1924 created of the Comison Nacional Agraria[18] (CNA, National Agrarian Commission) that carried out the donation of land to the villages.

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[18] For a detailed account of the activities of the CNA see Fernandez, 1975. For more detailed information about the process of land reform see Sanderson (1984) Chapter 3.

The CNA was composed by nine members and acted as a final decision maker in the process of turning lands over the villages. The CNA received the records from the local agrarian commissions and could approve or disapprove the decision taken by state authorities. Its final judgment was then passed back to the local authorities for its execution. From 1934 the CNA was dissolved and the final decision passed to the President of the Republic, who takes the decision to approve or disapprove the grant of land (Fernandez, 1975)[19].

The land was granted to the beneficiaries in three forms *Restitucion, dotacion* and *ampliacion. Restitution* was prescribed to the *Comunidades* (Land holding *pueblos*) if they could prove through the original titles (generally of colonial origin) that they had been illegally deprived of them. The land granted by restoration was generically called *Comunidades Agrarias* (Agrarian communities)[20] The *Comunidad Agraria* then continued with the system organisation for internal allocation of land, and organisation in the management of their resources based in the uses and customs of each community.

For the *ejido* the land expropriated was granted as corporate patrimony of the beneficiaries and was no alienable. The Agrarian Law stipulated that the land was to be granted by *dotacion* (outright grant) as *ejido* for the already existent nuclei of population (*pueblos*) with right to claim land in a 7 km radius or from 1940s as new centre of population (Agriculture settlement) when the land was granted for colonisation a settlement was founded with this purpose. If more land was required for the production of food of the people living in the nuclei of population the *ejido* would request an *ampliacion* (enlargement) of land when land to be expropriated was available.

The structure of the *ejido* is similar to that of the landholding *pueblos* in the sense that the land was granted as 'corporate patrimony' to each community and was non alienable (sellable). The land of the ejido could be worked either individually or

[19] The allocation of land was approved by the President of the Republic himself as is known colloquially as sign of Presidential resolution.
[20] *Comunidad Agraria* is the term generically used in Mexico to call this type of grant. The members of the *Comunidad Agraria* are called *comuneros*.

collectively as the *ejidal* assembly preferred[21]. According to the Agrarian code 1934 the *ejido* has to be administered by a six-man committee elected every three years.[22] The *ejidatarios* could pass their *ejidal* rights to parcel and communal land to their heirs; it was however forbidden to rent, sell or mortgage the plot. Any land not used by an *ejidatario* for two years reverted back to the group for redistribution.

5.5.1.1 Comunidades Agrarias

All communal land taken from landholding *pueblos* by the Hacienda after the reforms of 1856 was returned to them providing that the original titles (generally of colonial origin) showed that they had been illegally deprived of the land. Most of the C*omunidades Agrarias* were Indian communities (or communities with Indians and *mestizos)* granted with land during the colonial period as landholding *pueblos*. Within the C*omunidades Agrarias* parcels of land for cultivation are allocated to the members of the pueblo, and together with the management of the communal land are regulated by the communal assembly and decisions are ruled by the customs and traditions of each nuclei of population. The number of *Comunidades Agrarias* in Mexico is 2572 with around 803,890 *comuneros* and in possession of 18,138,543 ha (INEGI; 1991).

The main post Revolution support for these communities has been through the co-ordination of the *Instituto Nacional Indigenista* (National Institute for the Indigenous).This has been also very limited, concentrating on the promotion of artisans and crafts, with not efforts to improve agriculture production (Hewitt de Alcantara, 1984; Bassols, 1990). These indigenous households are among the poorest in Mexico, with the fewest opportunities for vertical mobility (Deere and Leon, 1997 cited by de Janvry et al, 1998).

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[21] The type of organisation for production as individual or collective changed through time: from 1923-1927: individual plot and communal or collective; 1923 to 1927 private with full property rights; 1934-1940 Collective; 1940-1992 Individual plot and communal (Sanderson, 1984)

[22] This arrangement made the *ejido* something more than a type of land tenure. It became and instrument of local government with new bases of co-operation, involving new patterns of authority different to that found in these communities. The traditional system of cargos in the communities assigned prestige on the basis of length and degree of devotion to the public service, and therefore gave devotion to age. It was a participatory system and not based on parliamentary rules (Hewitt de Alcantara, 1980).

5.5.1.2 The ejidos

The distribution of land to the *ejidos* was driven by the enforced limitation in the quantity of land that any person could held as private property (*Pequeña propiedad,* small property[23]); the amount of land that one person could hold varied according to the type of land irrigated, seasonal and forest and grassland. Thus the maximum area of an individual small property having irrigated land was 150 ha; seasonal agriculture 200 ha; and no more than 500 hectares of other classes of land[24] (Agrarian Code, 1920 cited by Sanderson, 1984). Land Areas in excess of these were subject to expropriation

The ceiling[25] in the amount of land allocated by *ejidatario* within an *ejido* changes through time, however until 1972 after which larger grants were made; the maximum amount of land granted by *ejidatario* was less than 10 ha of cultivated land. The grassland and forestland areas were allocated as communal land (Agrarian code, 1923 cited by Fernandez, 1975)

During the 75 years of this phase 27,399 ejidos where created throughout Mexico. The number of *ejidatarios* is around 2,718,580 which are in possession of 85,148,116 ha (INEGI, 1991). A further 2168 *ejidos* are in the process of registering by the SRA (SRA, 1998)

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[23]The term *pequeña propiedad* is used in Mexico to contrast the size of the Haciendas with the ceiling of 150 ha established to the private property by the agrarian law.

[24] The limit of the small property varies as follows: 1922 -1934 150 ha of irrigated land, 250 ha of seasonal lands, 400 ha of other types of land 1934 –1942. 150 have of irrigated land or their equivalent in other types of land. If there is an agricultural nucleated claiming land in a radio of 7 km the limit was reduced to 1/3 (50 ha); 1942-1992 100 ha of irrigated land or their equivalent in other types of land. Plantation of henequen, cotton, bananas, rubber and others 300 ha. Land for stock and cattle ranches: 1923-1937 not specified; 1937-1942 Limits for stock and cattle ranches were establish according to quantity of land to grass 500 heads of cattle. The limit range from 300 has of good land and a maximum of 5,000 ha of poorest quality land in the desert (Stavenghagen, 1970, Sanderson, 1984)

[25] The limit of the amount of land to the individual ejidatario varies as follows: 1917-1942 No specified; 1942- 1946 4 to 6 ha of seasonal land and 2 to 4 ha of irrigated land; 1946-1972 10 hectares of irrigated land or their equivalent on other lands; 1972 20 has of irrigated land or their equivalent in other type of land Sanderson, 1984).

5.5.1.3 Colonisation of lands (Agricultural Settlement)

The redistribution of land during the Land Reform was not only by expropriation; the Country had also reserves of public land in the uninhabited areas of the deserts in the North and in the Tropical forest of the South. This land was used by the government for its modernisation project through colonisation by individuals and to create ejidos and new population centres when the pressure of land increased in central Mexico[26]. The policy adopted is summarised by a quotation from President Avila Camacho in 1941:

> 'fortunately for the future of the Republic there are areas along the coast with prodigious potential waiting only the creative power of men of action' (cited by Revel Mouroz, 1980).

The law of colonisation of 1946 permits private colonisation of national lands; the private colonist can cultivate up 300 ha of tropical plantations or can create ranches of between 500 and 2500 ha. However the law restricts access rights of the ejidatarios to parcels smaller than 20 ha. From 1942 to 1962 new settlements (*Colonias*) were created for private landholders covering 6.5 m ha to involving 76,000 private landholdings. In contrast ejidal colonisation covered 3.5 m ha for 71,565 *ejidatarios* (Revel Mouroz, 1980).

During the 75 years of this phase 781 agriculture settlements where created throughout Mexico. The number of beneficiaries is around 51,607 in possession of 9, 906,634 ha (SRA, 1999).

Gordillo de Anda (1997) pointed out that in many situations, *ejidatarios* received bad quality and marginal lands that had been decapitalized in the process of expropriation. Once in place the *ejidatarios* were as rule forgotten by the policy makers more concerned about catering to the commercial sector of agriculture and the urban import substitution and industrialisation than the productivity of the reformed sector. *Ejidatarios* were left without sufficient access to credit, technical assistance, modern

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[26] For example in Texcoco during the research it was found that the each *ejidatario* of San Joaquin Copango was granted 20 ha of land in the state of Chiapas.

inputs, or education that were necessary to enable them to keep up with the private sector. An exception of this was a successful initial phase of expansion in the reform sector achieved in large-scale public irrigation projects in the north. This was not however sustained. This was due to a combination of severe government control over the *ejidatarios* decision-making and public authorities that were more interested in monopolising rural votes than in promoting production. This stifled individual innovations and prevented adaptation to local circumstances.

During this initial phase the government supported the *ejidos* mainly by centralised management of access to market and supportive organisations. Public services were placed under the control of the state and specialised state agencies to manage production. Even this was restricted, occurring mainly in the *ejidos* with the most productive land, and similar support was rarely offered to *ejidos* with small parcels or marginal lands (de Janvry, 1998).

5.5.1.4 The Private property (Pequeña Propiedad)

Parallel to the distribution of land to the ejidos the government promoted a contra reform by protecting the privately owned land. Until 1930 the expropriation of land proceeded slowly and was concentrated where peasants were most rebellious. Between 1930 to 1940, when the creation of ejidos increased, the numbers of privately owned land units doubled from 600,000 to 1.2 millions, this occurred because the land owners feared expropriation divided in small lots (de Janvry et al, 1998).

After 1940 a small group of agriculture entrepreneurs (the new agrarian bourgeoisie) operating with modern technology and mechanisation, contributed the greater part of the Mexican agricultural production, and started to monopolise the most productive regions. This land grabbing was possible through false titles that granted neo-latifundio[27], whose sizes and resources exceeded the best ejido parcels area (Rello,

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[27] Neo-latifundio land was when owners evaded the land holding regulations by dividing up this land and registering it under different names, belonging to the same family members or friends of the owner (Stavenghagen, 1970).

1986). In 1942 the agrarian law was modified to allow private landowners to apply for a judicial writ of injunction against executive action by the government in expropriating land. Thus could give security to the owner to avoid the expropriation. (Stavenghagen, 1974).

From 1940 to 1960 the number of private owners increased only by 100,000. This increase in numbers was concentrated in units of less than 5 ha. By 1960 two thirds of private land was in units of less than 5 ha in size occupying only 1.3 % of the private land. At the other extreme, the 34 % of the farm units over 5 ha occupied 98 percent of all private land. The private land under 5 ha apart from those with irrigation and near the markets, private farms under 5 ha are associated with poor subsistence farming (mainly maize) based on insufficient economic resources and backward technology. Although the hacienda disappeared, the large landholdings that monopolise the land, water and other resources still exist; land owners evaded the land holding regulations by dividing up this land and registering it under different names, belonging to the same family members or friends of the owner (Stavenghagen, 1970).

The pressure on land increased in the period from 1960 to 1992 as a result of the deleterious economic conditions, growth in population and Presidential resolutions[28] by 49 million of hectares were appointed to the *ejidos* in this period (*Informes presidenciales*, 1960-1998). In 1999 SRA reports the national agrarian structure as follows:

Type of land	Number of holders	Area (ha)	Benefited
Public land	27,460	84,098,365	3,024,400
Communities	2,400	16,474,573	503,705
Agriculture settlements	781	9,906,634	51,067
Private Property	1,593,935	73, 596,341	1,593,935
Other type of property	0	12,642,423	0
Total	1,624,576	196,716,300	5,173,107

[28] The process of grant land has two steps: the sign of the resolution by the President of the republic that authorises the expropriation of the land and grant it as ejido. And the official deliver of the land by the Agrarian Reform.

This 'social land' in Mexico covers an area of 101m ha, and private land 73 m ha. If we consider the data of 1940 of 80 million hectares in haciendas (Esteva, 1987) only 7 m ha of private land were expropriated between 1940 and 1998. Despite this reduction of area in private land, the number of units of production increased from 1,217,428 to 1,593,935, indicating a process of fragmentation to smaller units. This fragmentation of land also occurred in the 'social sector' where the maximum amount of land allocated by *ejidatario* was 20 ha.

Thus 75 years of land reform in Mexico have deeply transformed the rural sector, but not the agrarian structure that has existed in Mexico since the colonial period; this remains divided into communal and private ownership. In both the 'social' and private sector land has gradually been divided as a result of both population pressure and inheritance.

5.5.2 Second phase of the Land Reform of 1992

The second phase of Land Reform began in Mexico in 1992. The policy emphasis focused on the promotion of market forces and reduction in the role of the state, a key element of the policies being to replace communal lands in the plots to individual tenure. The new Agrarian Law made it possible to sell, lease and mortgage the individual plots within the *ejidos*; the renting of communal land to private investors was also permitted, and Courts were established to solve land disputes. Cornelious and Myhre (1998) pointed out that the designers of the reforms signal the objective of the reforms as

> ' it is in everyone's interest to bring all the clandestine rental contracts and other forms of facto privatisation out into the sunlight; give adequate legal protection to private investors, protect *ejidatarios* from exploitation by private firms, and reduce the leverage of local power brokers- the comisarios ejidales, who have often been the local *caciques* or front man for them- in determining who gets access to land in the *ejido* communities'.

Thus the government policy changed from one that promoted the communal exploitation of forest and grassland and banned the rent or sale of ejido land to a policy

> 'the thrust of which is to permit and even encourage (but not compel) the privatisation of the ejido land' (Cornelius and Myhre, 1998.p 1).

The changes in the law operate to alter the agrarian structure, by the certification of the parcels to the individual *ejidatario*, giving them the sale or rent and also to permit the *ejido* to rent its communal land to private investors creating a land market. In order to do this the *ejido* has to form a 'legal association'. The idea behind the reform was to create a class of independent landholders with the ultimate aim allowing better farmers to replace older or less skilled farmers, inducing a slow process of social differentiation. This process would gradually concentrate the land toward the most competitive farm sizes and the better farms[29] (De Janvry et al, 1998).

This is a transitional phase of change in tenancy arrangements, that consists in the certification of *ejidal* rights over cultivated parcels, and communal rights as shares to allow the privatisation of cultivated parcels in the ejido, or if the land continued under ejidal tenure its sale to other *ejidatarios* or their rent to private investors. Communal land could be also rented to private investors.

The change in Agrarian Law also brought to an end the post Revolution land reforms. Thus those who had never gained access to land during first phase of land reform would now have to do so by other means such as renting, land purchases, or illegal squatting (Cornelius and Myhre, 1998).

The government expectation is that the association among *ejidatarios* and private investors would become the major conduit of private capital investment to the agriculture. It was also hoped that increased private-sector involvement through production associations might increase the flow of World Bank and Inter-American Development Bank credit to Mexican Agriculture. Finally, it was also expected that the export potential of the agriculture and forestry sectors in the areas of the country where Mexico has comparative advantages against USA and Canada would improve (Cornelius and Myhre, 1998).

The changes in legislation had a direct impact on the pattern of land use and decision-

[29] The amount of land that one individual *ejidatario* can hold under the regimen of ejidal rights is limited to a maximum of five percent of the *ejidal* land, or an area equivalent to that states for small Property art 47 Agrarian law (1993).

making in the 27,410 ejidos and 2330 *Comunidades Agrarias* (PROCEDE, 1998) that occupy more than half of the Mexican lands devoted to agriculture, livestock and forest lands (1.01 m km^2). Gordillo de Anda et al (1996) perceived these changes as an opportunity to rebuild the *ejidos* in Mexico and called these changes as the 'third Mexican Land Reform'. He identified these as an

> ''opportunity' to transform the *ejido* from mere instrument of political control into a vehicle of autonomous expression of peasant's needs and democratic participation, freeing the *ejidatario* from overwhelming government bureaucracies'' (Gordillo de Anda et al 1998, p8).

Other agricultural analysts who believe that the Government policy is leading to the right direction support this view. They are of the opinion that the *ejidos* need and are able to make their own decisions, regarding land matters. The problem is that the *ejidos* did not have the technology and the financial power to support the necessary programmes (Johnson, 1995).

This second phase of Land Reform ended the reform by distribution of land, and could be seen as a tenancy reform, which effects improvements in tenancy contracts among the *ejido* and private investors, to sell or rent land. Also the association of private proprietors and *ejidos* to create trading companies with ceilings of land up to 25 times the ceiling of land imposed to individual ownership. Under the new legislation the structure of land tenure In Mexico has 5 types of tenure:

Ejidal: The lands granted by the government to any nucleated population, three types of lands are recognised: Land for human settlement; land for communal use and parcel lands (Agrarian law, 1993. p.16*)*.

Comunidad Agraria: restitution of land for communities stripped away from their land. The administration of land is according to the terms that the statute established by the communal assembly and the custom.

Individual Pequeña propiedad agricola (small agriculture property) is the area of irrigated land or equivalent, the permitted area varies with land use (figures for irrigated land):

100 hectares when they are devoted to crops other than category II and III crops.
150 hectares when they are devoted to cotton (group II crops).
300 hectares when they are devoted group III crops such as banana, sugar cane, coffee, rubber, grapes, or other fruits.
These figures are revised for non-irrigated land as follows: 1 ha irrigated = 2 ha seasonal agriculture = 4 ha of grassland of good quality = 8 ha of grassland in arid climate.

Propiedad de sociedades [30](Societies properties) Mercantile or civil societies that held property over agriculture, livestock or forest land, cannot hold a land area bigger than 25 times the limits of the individual "*pequeña propiedad*" (for example: 2500 ha. of irrigated land; 7500 ha planted with coffee or fruit trees.(Agrarian Law, 1993 p.42).

Terrenos Nacionales (National lands) this is land that has not been outside the dominion of the nation by legal entitlement and the boundaries have not been delimited or measured (Agrarian law, 1993 p. 50).

Calva (1993) argues that the new laws promote the reconstruction of the haciendas, as the basic objective of the new Agrarian law is to reverse the fragmentation of land, and to encourage the investment and capitalization of the unit of rural production in the *ejidal* sector. The reversal of land fragmentation induces the concentration of land, in production units of bigger size. The new legislation opens the possibility 10,933[31] Trading Companies could hold the land of all Mexico.

5.5.2.1 Paths of development after the second land reform

The changes that occurred in the land reform as envisaged in this chapter are represented in figure 5.2. There three phases of the land reform the first from 1917 to

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[30] This form of tenure was incorporated in the new legislation.
[31] The maximum area held by a trading company is 25 times the maximum amount of land under private property. This means that a company would held by the association of 25 private proprietors: 2500 ha of irrigated land, 7500 ha of fruit trees, 20,000 ha of forest and until 500,000 ha of grassland in the arid area of Northern Mexico (Calva, 1993).

1992 that followed a policy of redistribution of land and government investment in infrastructure, a second that is a tenancy reform that is a transitional phase, which consists of certification of *ejidal* and communal rights to create the conditions for privatisation, rent or sale of land in the *ejidos*, and a third phase that consists in the promotion of rural development through new rural institutions to support the growth of the sector. The strategy is through co-investment of government and lands owners in infrastructure to increase productivity in agriculture, also the sale and rent of parcels or communal land in the *ejidos* may produce investment in the private sector with concentration of land and economies of scale to produce competitive trading companies in international markets (see section 5.4.4).

The changes in both individual and communal tenure had as an objective the enabling of *ejidatarios* to become competitive in the context of liberalised markets and a sharply reduced role of the state. De Janvrey (1998) believes that this could be achieved by one of three paths:

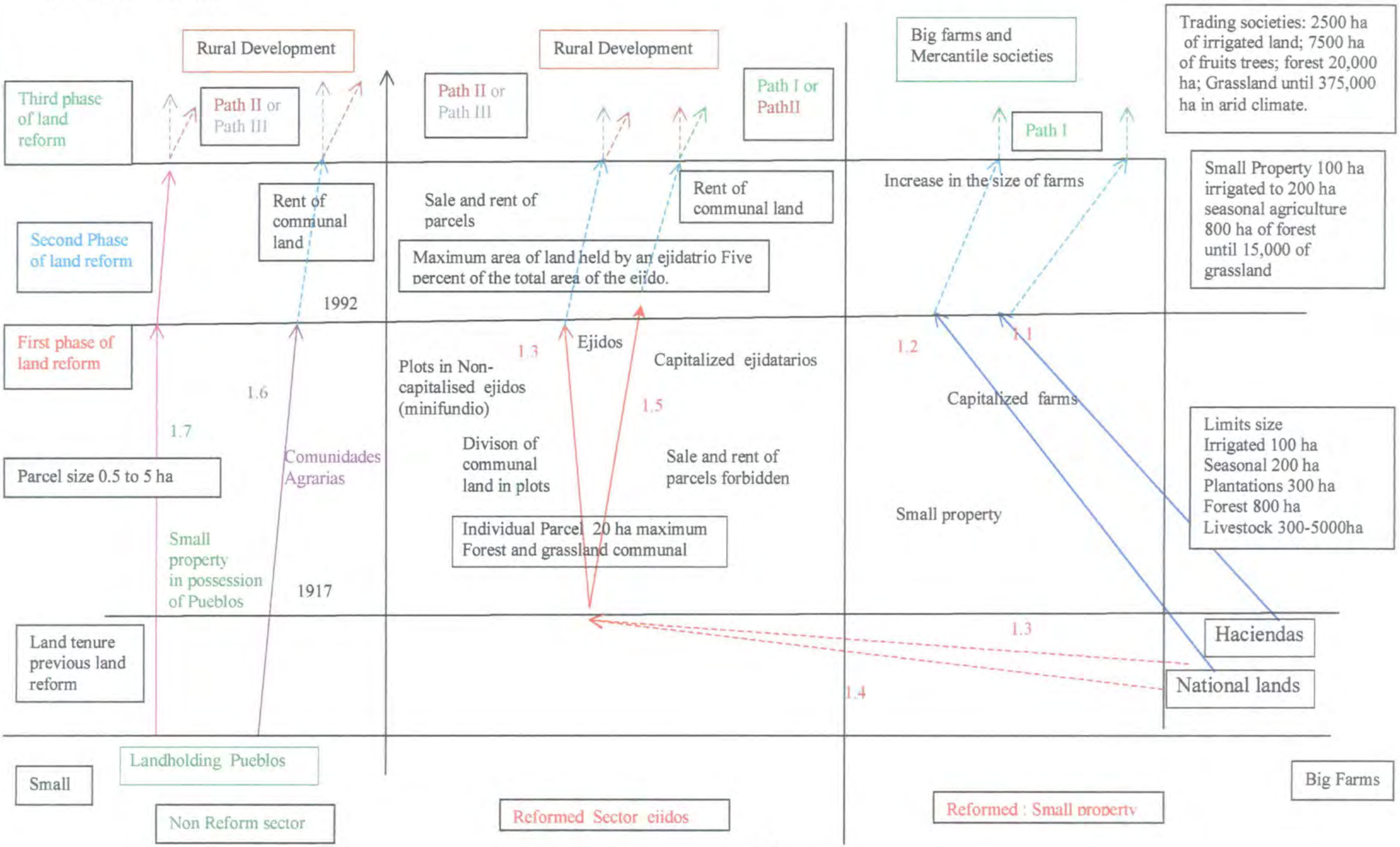
Path 1 . Failure to be competitive, land is sold leading to land concentration, with the *ejidatarios* being forced to seek alternative sources of income and possible migration.

Path 2 Development into largely self-sufficient peasant farming operations, complemented with seasonal participation in labour markets and migration.

Path 3 Successful, stable, capitalised and modernised smallholders.

He added that given the heterogeneity of the land reform beneficiaries, these paths coexist within the reform sector but with different weights. For instance *ejidos* in Mexico have widely divergent resource endowments, some with high potential for modernisation and production for global markets, allowing them to follow path 3, others with little other than subsistence production confining them to path 2, and yet others with good resource endowments but no ability to compete with other farm entrepreneurs, throwing them to path 1.

Figure 5.2 Evolution of Land tenure types and sizes of holdings in Mexico and the possible paths of development after the reforms of 1992 (Based on De Janvry, et al, 1998 p5 and adapted to Mexico by the author)



First phase

In this first phase there were two sectors, the non-reformed sector and the reformed sector.

The lands under the ceiling of 100 ha constitute the non-reformed sector of irrigated land (or its equivalent in other types of land) imposed to private tenure by the land reform. The land holding belonging mainly to people living in the pueblos with land holdings of variable size but most between 0.5 ha. The land of these people was the former communal land of the pueblos subdivided into parcels after the land reform of 1857. This group of landholders followed path 1.7. The pueblos that were able to keep land in sufficient amount for their subsistence (*Fundo legal* and *ejido*) since the colonial period were recognised with the rights over these lands as *Comunidades Agrarias* following the path 1.6.

The haciendas and the *pueblos* that were granted with *ejido* constitute the reformed sector. The first were expropriated reduce their size to the ceiling of ownership established in the legislation; this created landholdings called small proprieties (path 1.1). The *Haciendas* expropriated of land where allowed to kept the infrastructure, and to choose the land that they would kept in this way they kept the land of best quality and remained in production as capitalised farms. Also in some cases to avoid expropriation, land was divided in lots under the allowed limits of ownership, producing a sector of capitalised farms.

The *ejidos* were allocated with land expropriated from *Haciendas* with small amounts of cultivable land; in most cases the land was decapitalised during the process of expropriation (except from 1934-1940, when land of first quality and infrastructure were allocated as collective *ejidos*, and in 1974). Also from 1940s land was allocated in amounts of up to 10 ha in areas with low density of population with purposes of colonisation.

The land was allocated to landless residents on pueblos until 1934, and from this date groups of 20 or more people could claim land to create new centres of population. The amount of land allocated to each *ejido* was variable in the amount allocated to each *ejido* as cultivated (individual parcels up to 10 ha until 1974 and from 1974 20 ha) or communal land, and in different types of lands (irrigated, seasonal, forest and grassland). In each region the amount depended on the number of pueblos or people claiming land, amount for expropriation, types of resources. The *ejidos* in the north located in the irrigation districts received land of best quality, and were provided with infrastructure for irrigation, mainly in the states of the North of the country. In the non-populated areas of the south the amount of land allocated by ejido was considerable (path 1.3). In the centre and areas with high density of rural population in the south, in mountainous topography where cultivable land was scarce, in plains and valleys, and the best land was kept as small property; in consequence the size of parcels in these *ejidos* frequently was small. Also in most of the north of the country the land was semi-desert, or desert with small areas for cultivation. Most of the land allocated to this *ejidos* were forest, grassland or under other uses (path 1.4).

Thus by design in this first step of the land reform the *ejidos* were allocated land of poor quality, without infrastructure, and during the land reform it was provided in limited amount. Most of the *ejidatarios* received small parcels of land in populated areas and some up to 10 ha.

Second phase

The second phase of certification of land is a transitional phase of changes in tenancy arrangements, that consist in the certification of *ejidal* rights over cultivated parcels, and communal rights as shares to allow the privatisation of cultivated parcels in the *ejido*, or if the land continued under *ejidal* tenure its sale to other *ejidatarios* or their rent to private investors. Communal land could be also rented to private investors.

The result of the certification was not privatisation of ejido land since 0.28% (54) of the 18,621 ejidos certificate in 1999, changed their regimen from *ejidal* to *Dominio pleno*. Hence the impact was only in a new rules for organisation in the *ejido* such as: a) an empowered *ejidal* assembly, deciding the destiny of their resources b) opening of the market of land for sale among *ejidatarios* and *avecindados* of the same nuclei of population c) legalisation of the already existent practice of rent of *ejidal* parcels and d) rent of communal land to private investors. Rent of land both parcels or communal is limited to periods up to 30 years renewable, and afterwards the land has to be returned to the original owner d) increase of area of ownership by one *ejidatario* limited to either a ceiling of up to 5 % of the cultivated land in the *ejido* or to the ceiling established for small property holders.

In the private sector the already existent capitalised farms over the ceiling of 100 ha located mainly in the irrigation areas, were legalised as trading companies, and the ceiling in ownership increased to make them competitive in international markets.

Third phase

The transition to the third phase of land reform occurred in Mexico in the context of serious agricultural profitability crises coupled with the de-institutionalisation of state support services to the *ejido* sector. However early responses in 1994 showed that the majority of *ejidatarios* lost access to credit, technical assistance, modern inputs and crop insurance. In response to the greater freedom to define individual strategies, the low profitability of new investment, and the withdrawal of state support, many *ejidatarios* reverted to traditional peasant farming systems. Use of manual and animal traction was replaced mechanical power, inter-cropping expanded, extraction of common resources increased, and migration accelerated. With the land titles however, not yet fully marketable, land rentals accelerated. Responses were uneven due to the heterogeneity of the *ejido* population. The *ejidatarios* with better finance were successful in modernising and diversifying their crops initiating a process of differentiation across the *ejido*. Other factors involved in determining the success were greater ability of family labour, higher educational levels, better access to credit and technical assistance, and membership of producer organisations (De Janvery et al., 1995)

In the third phase of the land reform the beneficiaries of the reforms of 1992 (De Janvrey et al. 1998 would follows three paths I = production oriented to international market; II= production oriented to subsistence farming and local market; III = sale of land and abandonment of agriculture activities.

The land types 1.1 and 1.2 are private property that had their origin in the break-up of the haciendas, the grant of land for colonisation to private proprietors by the government and in the purchase of land by landowners (including purchase of land of the *ejidal* sector); this tenure was consolidated by the actual legislation as trading societies. These are mid-capitalised farms that by design of government policies since 1945, have been the main beneficiaries of the Land Reform in access to infrastructure and government support. In the third phase of land reform with security on tenancy rights is expected that the estates of this sector will grow by the transfer of land of the *ejidos* to increase the areas or number of the already existing trading companies, and that they would became the engines for the rural development creating employment, and revenue from an agricultural sector more competitive in the international markets. Most of the farms in this group would successfully became the stable, capitalised and modernised landowners exporting and produced revenue for the country form international markets. The path followed by this sector could be path I.

In the social sector by design, the creation of big agricultural estates has been limited, by law; during the land reform the ceiling of land for each individual *ejidatario* was up to 20 ha, the ceiling was increased after 1992 for the individual *ejidatario* up to 5 % of the cultivated land of the *ejido* of which the *ejidatario* is member. Hence only the *ejidos* with big extension of cultivated land could be productive farms with sizes competitive in international markets. The most probable process of increased of area cultivated will be probably through rent of parcels. Also income in *ejidos* with communal land could be achieved by the rent of communal land (forest and grassland).

The mid-capitalised *ejidatarios* (path 1.5) are those with land in district of irrigation mainly in the north of the country with *ejidal* landholdings of 20 ha or bigger, for those *ejidatarios* that acquired *ejidal* land by the purchase and consolidated ownership with the certification of parcels after 1992. The ultimate achievement of the land reform policy in this case will as stated by De Janvry et al 1998 would allow better farmers to replace older or less skilled farmers, inducing a slow process of social differentiation. This process would gradually concentrate the land toward the most 'competitive' farm sizes and the better farmers. In this *ejidos* the opening of market of land, and rent and sales between *ejidatarios*, the actual landholdings could be increased for the creation of bigger farms following paths II or III.

The non-capitalised ejidos (path 1.3) have small parcels of land; most of these *ejidos* are under seasonal agriculture and have limited access to irrigation, and diversity of resources forest and grassland, sand mines. In these *ejidos* agriculture production is oriented for self consumption and by the quality of resources the market of land in most cases will be restricted to *ejidatarios* and people of the same nuclei of population limited by the poor resource base and lack of capital and infrastructure. The paths that could be followed are II or III

The options for capitalisation in these *ejidos* will be in the exploitation of their communal resources by creating of trading companies by association of several *ejidos*, or with their association with private investors. However also by design of the government policy this option is not open to most of the *ejidos* as argued by Pare and Madrid (1997) the policies of the government towards the *ejido* in fact are discouraging by the low budget allocated to *ejidos*, also relative to association of private sector with *ejidos*; the experts advice[32] considers ethnicity as an important factor in the evaluation for forest exploitation this exclude most of the *ejidos*.

All this pointed out that most of the *ejidos* of path 1.3 will follow path II development into largely self-sufficient peasant farming operations, complemented with seasonal participation in labour markets and migration, leading to semi-proletarisation (income depending on wage labour and agricultural production for self consumption)

Finally the paths 1.6 and 1.7 identified in this research are the non-reformed sector during the first phases the Agrarian communities, and the pueblos with agriculture land. The Agrarian communities during the third phase have the option to rent the communal and parcel land; however this has been made by the agreement of the assembly of *comuneros* and after certification of communal rights by PROCEDE, also

[32] (See assessing the opportunity for project development in Mexico *ejido* land, North and South Trade & Investment Inc. SA of CV. 1997, p. 16)

in the evaluation of the Secretariat of Environment, the investors of the private area not advised as option for join ventures with *comuneros*, by the fact that most of the *Agrarian communities* frequently prefer to exploit the forest for socially oriented purposes.

In this research the paths found in the municipality of Texcoco were 1.1, 1.3, 1.6 and 1.7; the following chapter will be oriented to the description of the process of access to land through the land reform and the support of the policies followed by the government for the modernisation of the agricultural sector.

Chapter 6 Contemporary land reform and access to resources by the ejidos of the municipality of Texcoco

As discussed in section 5.4 after, the Revolution, the government had two key tasks: the reorganisation of the social structure by the redistribution of land to reduce inequalities in access and the modernisation of the agricultural sector. The first was to be achieved through land reform and the second through provision of infrastructure. In this chapter the process of land reform, distribution of land as *ejido* and the government programmes in the municipality of Texcoco are discussed.

6.1 First Phase of land reform 1917-1992: Redistribution of land from the *Haciendas* as *ejidos* and restitution of land to the Indian communities.

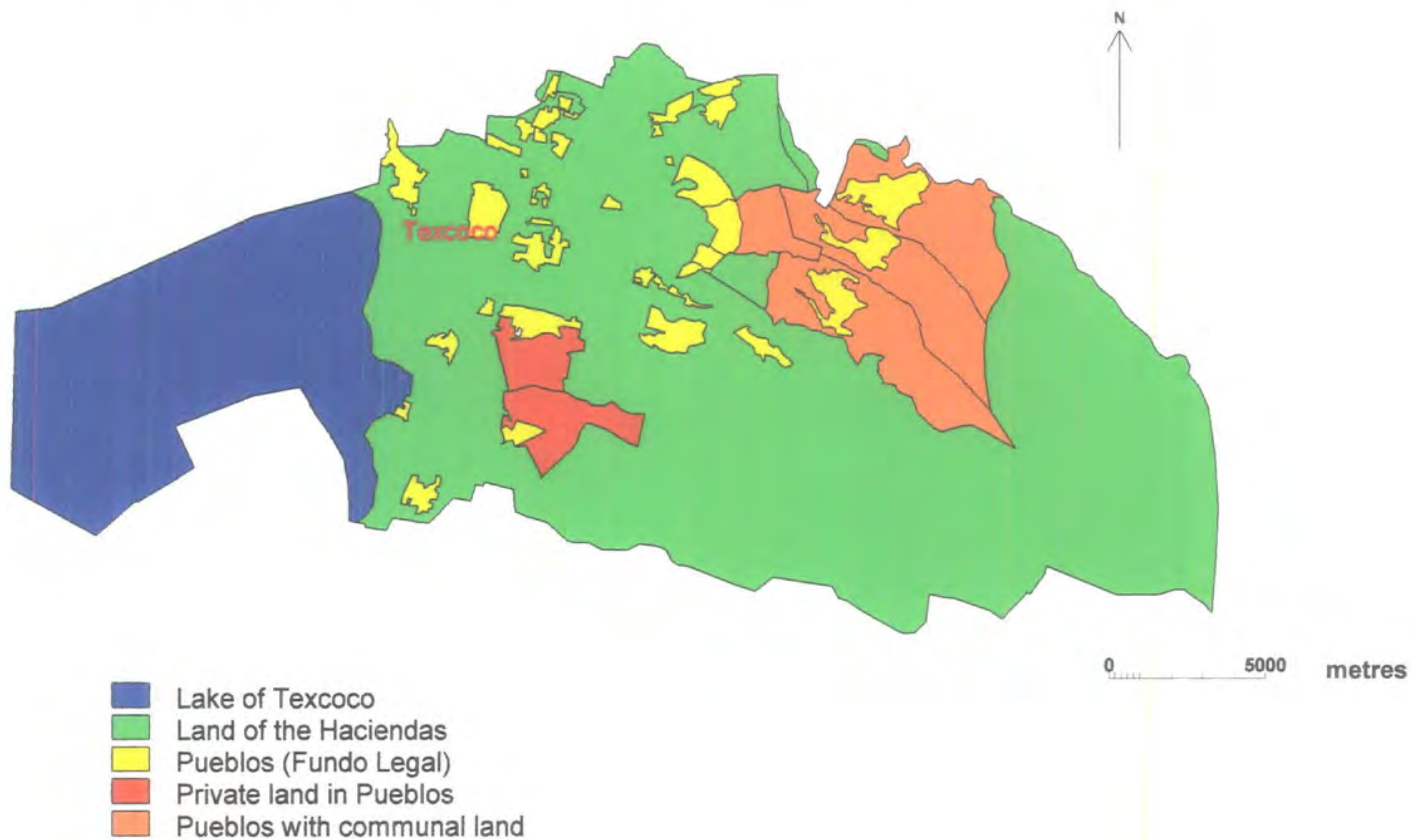
In Texcoco the land tenure system based in land held as communal was carried out after independence in the pueblos of the municipality in which indigenous populations dominate. For a detailed description of the process of access to land from the Prehispanic period to 1915 see appendix 3. The 1915 structure of land tenure in the municipality was: ten *Haciendas* owning 25,211 ha; four *pueblos* with around 5,500 ha of communal land; twenty-two *Pueblos* with the area of the *fundo legal*[1] of, 2,611 ha; 1,556 ha of small parcels in private tenure belonging to people of two pueblos, and 8,085 ha of the municipality in the Texcoco in the former lake basin (Figure 6.1).

6.1.1 Expropriation of land from the *Haciendas*

Under the Land Reform of 1915, 18,551 ha were expropriated form the *Haciendas* and converted into small properties (area depending on land use). The expropriated land comprises 10,254 ha from haciendas, 4,842 ha from landlords and 2,428 ha of mortgaged *Haciendas* owned by banks (Table A6.1 Appendix 4). The expropriated land comprises: 353 ha (1.8%) of irrigated land, 7457 ha (40.1%) seasonal agriculture, 3,604 ha (19%) grasslands, 7,345 ha (40.3% high mountain and 192 ha (1%) of badlands (Table A6.2 in Appendix 4). The quality of the land seized depended on the previous management of the land. Where the *Haciendas* had been managed under

[1] The area of land of the *fundo legal* of the *pueblos*, was estimated as the land surrounding the *pueblos* that is not *ejidal* based on the map of tenure of 1998 produced in the research.

Figure 6.1 Map of Land Tenure in the Municipality of Texcoco prior to the land reform of 1915.
(Compiled by the author from: Map of the hacienda de Chapingo (1883);
Maps of ejidos(1923-1997 INEGI, PROCEDE); Maps of ejidos of the municipality of Texcoco(Fabela, 1959);
Boundaries of the Lake(Gibson, 1964) and photointerpretation of saline soils)



modern production techniques quality was good, but mortgaged *Haciendas* land usually were overexploited. For example the land of the Hacienda of Chapingo was in good condition (See: Gonzalez M, 1993). Whilst that of the *Hacienda* of *Tierra Blanca* was overexploited (Gonzalez, R 1996; Aldana, 1994).

6.1.2 Distribution of land as *ejido*

In the municipality the *pueblos* made claims both for *restitucion (*restitution*) of* land as *Indian* communities or as *dotacion (*outright grant*)* of *ejidal* land as pueblos[2] since 1917. However, land grants only began in 1923. By 1930, only 22 *ejidos* had been created plus extensions to 8 of the original 22. A census of the *pueblos* was made before allocation of land as *ejido*; it was found that many of the *pueblos* had privately owned (*Fundo Legal)* parcels amounting of 4480 ha, and in consequence land was allocated to landless residents in the towns. Allocation of land was a slow process, the Agrarian Commission having to make a recommendation, to the state Governor for approval. In some cases where the request for land was rejected[3] appeal was made to the President of the Republic, who had the power to reverse the decision of the Governor. The final part of the process of allocation involved a survey and classification of land type (cultivable, forest, grassland and other lands), all cultivable land was divided equally amongst the beneficiaries (*ejidatarios*)[4]. Any non-cultivated land was given as communal land. Most of the *ejidatarios* received less than 2 ha of cultivable land; only in six *ejidos* did they receive more to a maximum of 6 ha. At the end of the land reform 33 *ejidos* were created and 3300 *ejidatarios* were granted 17,689 ha (Detailed data about the number of beneficiaries, amount of land by *ejido* are shown in Table A6.3 Appendix 4).

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[2] From 1917 to 1933 the allocation of land was to communities that had the legal status of *pueblos*.

[3] For more detail see the case of Nativitas that requested land in 1917 and received it only in 1923. See also Gomez, 1974, Historia de la Comision Nacional Agraria. Also only 14 of the ejidos created in Texcoco have the approval of the state Governor (see table A6.3 appendix 3 chapter 6)

[4] The amount of land to be allocated to beneficiaries was not specified in the Agrarian Law; the Law Stated that the cultivable land had to be divided among the beneficiaries and forest, grassland and other types of land have to be communal.

The land granted to the *ejidos* varied in area and quality, ranging from 8 ha[5] to 2695 ha. The *pueblos* granted most land were either those located near the Lake Texcoco or in the hills and near the mountains where extra land was available within 7 km of the *pueblo* (figures ranges from 250 ha to 2695 ha). In the area surrounding Texcoco, with higher density of *pueblos*, only 250 ha were granted per *pueblo* although this was either irrigated or seasonal land of good quality. Thus the allocation of land produced two types of *ejidos:* those that had access to small amounts of agricultural land of good quality located in the plain area and those with diverse types of land relatively poor land in the hilly areas. In addition to this some 16 ejidos had land allocated to them far away from the *pueblos* (Figure 6.2).

From information coming form interviews and field transects, it seems that these varied conditions in soils, climate, infrastructure and land use were considered during the processes of allocation parcels inside each *ejido*. This ensured that the *ejidatarios* usually received more than one parcel according to the quality of lands available. For example in the *ejido* of Tocuila, each *ejidatario* has three separate parcels comprising: 0.5 ha of irrigated land, 1 ha on seasonal land, and 0.25 ha on which to built a house. This *ejido* had also been in conflict over 25 ha of good land with a neighbouring *ejido*. Thus the government using land suitability made the division initially, how this was distributed was left to the *ejidatarios,* who adopted an egalitarian policy of distribution. This process involved the division of land according to its quality, then the delimitation of parcels, and at the end a draw for the allocation of parcels.

Although grant of land as *ejido* reduced the inequality in land ownership between the private proprietors and those in the *pueblos,* the *ejidatarios* rarely received more than 2 ha of cultivable land. In the *ejidos* with access to forest and grassland, income activities were oriented to the combined use of the resources, the parcels for production of subsistence crops and the grassland for the raising of livestock and the forest for extraction of wood and firewood and other products for self-consumption

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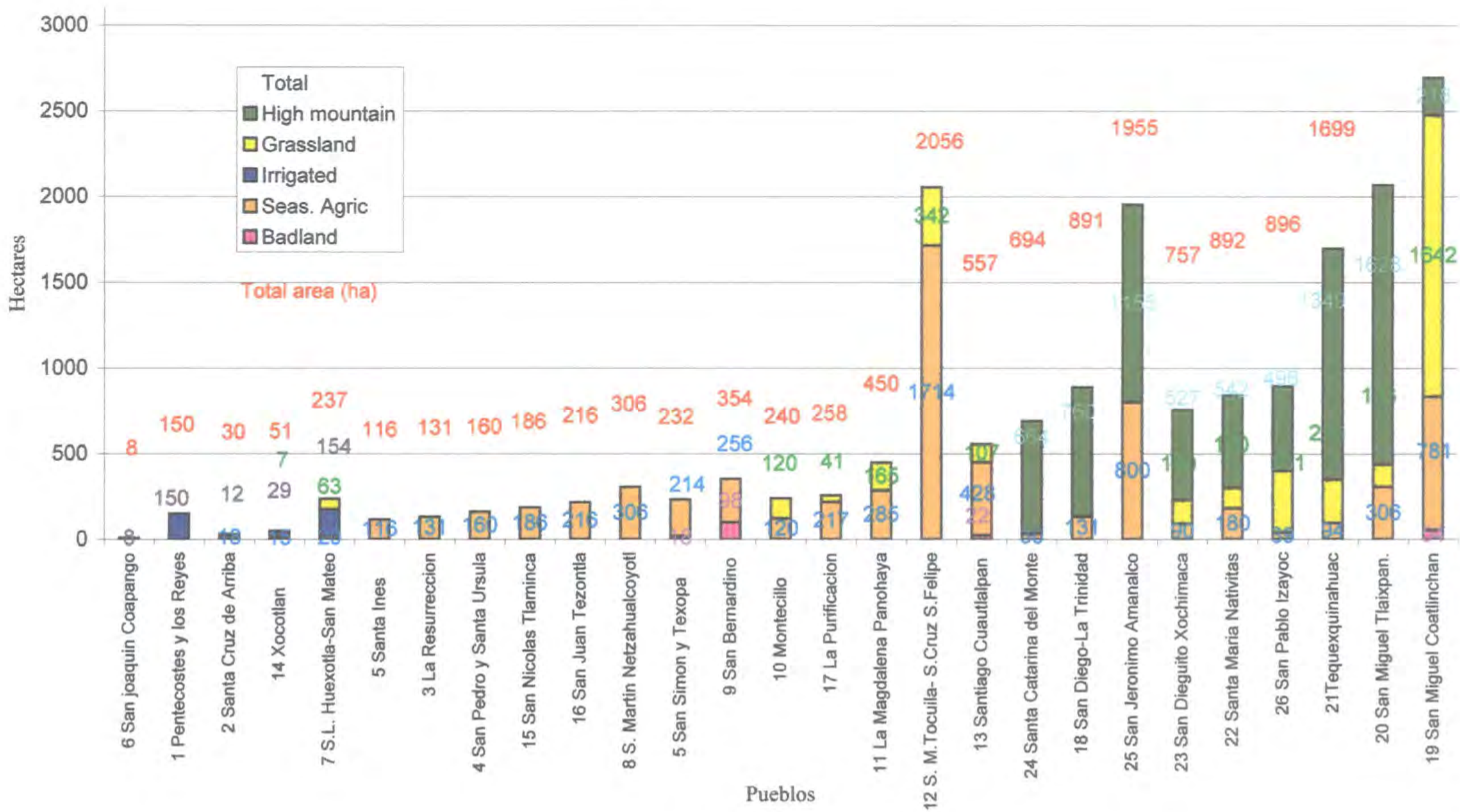
[5] The *ejidatarios* of San Joaquin were granted an additional 20 hectares of land by person in the State of Chiapas in south Mexico (some 900 km away); some of the *ejidatarios* moved to Chiapas, but after some years they came back to Texcoco. They were not used to the tropical climate of Chiapas (Municipality agent SRA).

Figure 6.2 Land granted during the land reform to the pueblos of the Municipality of Texcocco by land type (Compiled by the author from Fabela; 1959).



and market. Those *ejidos* that received only agriculture seasonal land had to supplemented income by work outside the ejido.

6.1.3 Restitution of land as Comunidad Agraria

In the 1920s seven *pueblos* in Texcoco requested the *restitucion* of their lands granted under titles issued in the Colonial period[6] as *Comunidades Agrarias* according to the Agrarian Law. With the exception of the *pueblo* of San Luis Huexotla this was not approved, and the request for land was reverted to *dotacion ejidal.* The refusal to grant such claims was, according to documentation and informants, due to the fact that claims often involved lands of neighbouring *pueblos*. However after 1947 a further 4 *pueblos* were granted land restitution as *Comunidades Agrarias* (see Table 6.1)

Table 6.1 *Comunidades Agrarias*, number of comuneros, and area of communal land.

Comunidad Agraria	No of Comuneros	RAN (1997)	Presidential resolution©	Official Diary ©
San Miguel Tlaixpan (SMT)	69	579	1984	1985
Santa Maria Tecuanulco (SMTE)	150	1736	1946	1947
Santa Catarina del Monte (SCM)	254	1475	1966	1966
San Jeronimo Amanalco (SJA)	n.a	1737	n.a	n.a
Total		5527		

Sources:Municipio de Texcoco(1998)©Promotoria Agraria, 1997.Unpublished

The organisation of the management of the land resources of the *Comunidades Agrarias* retained the features of the Prehispanic organisation, as Article 57 of the 1923 Agrarian Law stated that decisions about allocation of land and use of resources are according to customs and traditions of the Indians in communal assemblies without government intervention.

6.1.4 Small properties[7]

During the process of re-distribution of land some of the land of the *Haciendas* was subdivided according to the ceiling of 100 ha of irrigated land or its equivalent in other types of land. From information from the DDR 03 (1989) and from that

[6] The agrarian communities are indigenous communities already in possession of land and/or communities that recovered the lands, which they had lost to *Haciendas*.

[7] Land under private ownership is limited to 100 ha of irrigated land or equivalent and is called *pequeña propiedad* (small properties). In Mexico there are further division between land holdings above 5 ha and > 5 ha. Ranchos are a special version of this as they are given areas to commercial production. Properties > 5 ha are known as *unidades de produccion rural.*

collected during fieldwork for the present research, there are 55 *Ranchos* in the municipality, most of them with good quality soils in the plain and are used for dairy farming or commercial cropping (Table 6.2). Though more recently many near Texcoco are being given to housing.

Table 6.2 *Ranchos* and types of land use in Texcoco (DDR03, Texcoco, 1989).

Ranchos(ha)	Number of *ranchos*	Total area (ha)	Irrigated (ha)	Dairy Farms	Agriculture	Building of Real states
5-20	20	222	198	3	11	6
20-50	23	731	668	13	7	3
50-100	10	240	634	5	3	2
10-165	2	301	240	1	1	
Total	55	2079	1835	22	22	11

Source: Archives DDR03, 1989, fieldwork observations, 1998.

Including both the commercial ranchos and the *unidades de produccion rurales* > 5ha occupy some 3,389. The area of small property < 5 ha is estimated as 2368 ha[8], if the parcels allocated for housing in the *pueblos* are included (most of them have a house with back yard production) then small properties are < 5 ha increase to 3,522 ha.

6.1.5 Public property

Public land in Texcoco is held by institutions such as the Universidad Autonoma Chapingo, Colegio de Postgraduados, Instituto Nacional de Investigaciones Agricolas y Forestales (CAEVAMEX) and Centro Internacional Para el Mejoramiento de Maiz y Trigo (CIMMyT). Some of the forestland of the Haciendas was expropriated for the creation the Zoquipan y Anexas National park and belongs to the Nation. Finally when the lake of Texcoco was drained in the sixties the land became property of the Nation and is administered by the Plan Lago de Texcoco. The total area of land in possession of the Nation in the municipality is 9,554 ha (Table 6.3). After the *ejidos* the government is the largest owner of land in the municipality.

[8] Most of the area of private property under 5 ha was the *fundo legal* of the Indian towns or communal land of their *ejidos* subdivided after 1857 and allocated as private property.

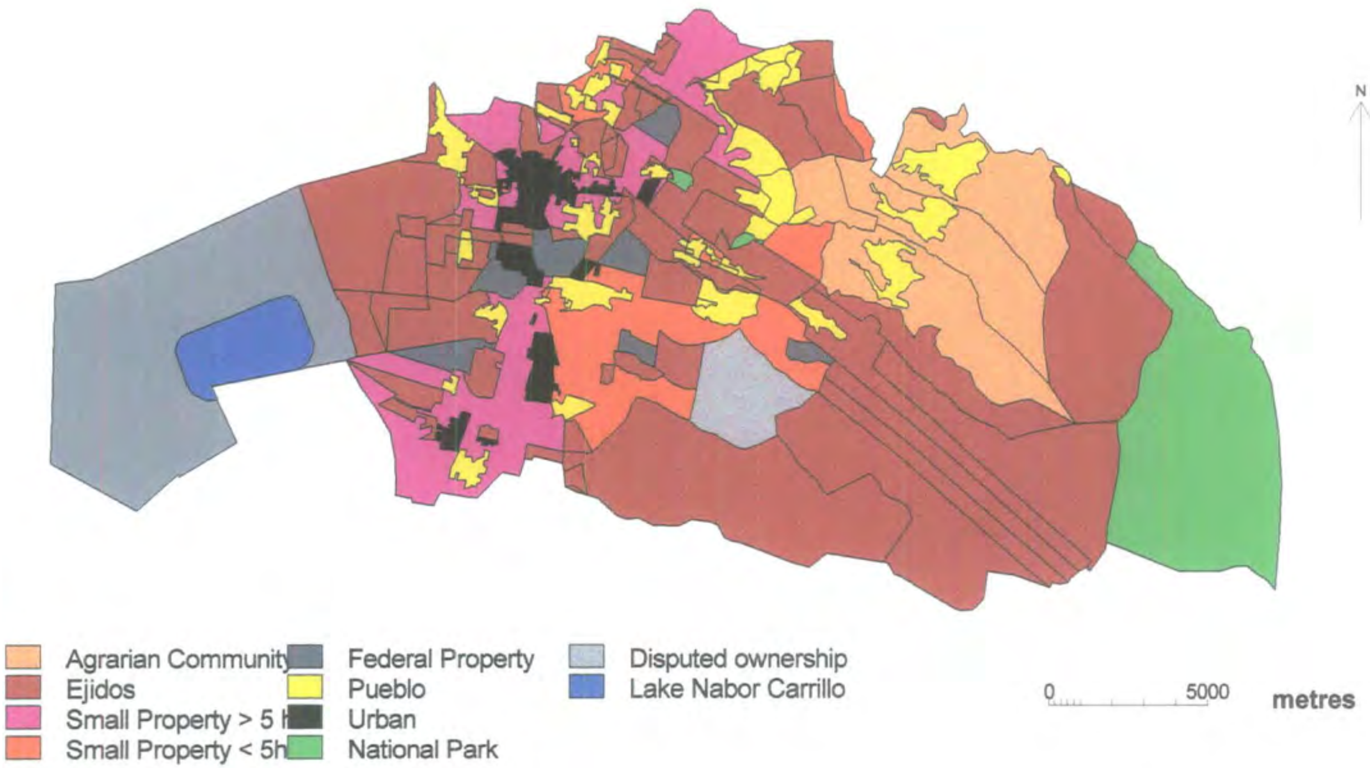
Table 6.3 Agriculture and forest land in possession of Government and institutions in the municipality of Texcoco (Muro and Bulbara, 1994).

Government	Ha©	Irrigated	Seasonal	Badlands	buildings	Gardens	Forest
Colegio de postgraduados	186	57		83	26	19	
Research centre CAEVAMEX	40	36			4		
CIMMYT	77	54			18	4	
Universidad de Chapingo	662	296	182		105		69
Terrenos nacionales							2045
Lago de Texcoco				5591			
	965	443	182	5674	153	23	2114
Total	9554						
Source:©Muro and Bulbara, 1994; *DDR03, 1989;							
** The PLT introduced grassland resistant to high salinity in the basin of the lake, built a lake of 917 ha, and infrastructure for management of sewage water from Mexico city and the Texcoco Municipality (Muro and Bulbara, 1994).							

In summary the actual access by tenure in the municipality is as follows: *Ejidos* 42 %, *Comunidades agrarias* 9.8 %, private property less than 5 Ha 5.6 % Private land more than 5 ha 7.9 %, government 26.3 %, *pueblos* 6.3 % and urban cities 2.1 %. The distribution of this land is shown in Figure 6.3.

Figure 6.4 is a diagrammatic representation of the distribution of land use. The *Ranchos* of more than 20 ha tend to be in the area with best soils; adjacent to these there are a group of private proprietors with areas of less than 5 ha based in the *pueblos*. Most of these lands are located in the hilly area with shallow soils. The *ejidos* and *Comunidades Agrarias* can be divided into two groups: those with access only to agriculture land in amount of less than 250 ha, located in the areas with best soils and irrigation; and the *ejidos* of more than 250 ha located on the shore of the ex-lake of Texcoco, the hilly and mountainous land, with access to diverse agriculture resources. Finally the government land is in the drained basin of Lake Texcoco, the flat areas and in the forestland. The figure emphasises the complex spatial array of patterns of tenure, fragmentation of agriculture land in small parcels, access to land by an increased number of individuals, and the allocation of grassland and forest as communal land. This complex array in available resources is reflected in the process of decision-making in land use for either the individual or the *ejido* on the use of communal resources.

Figure 6.3 Land tenure in the municipality of Texcoco in 1997 (Compiled by author from map of DRA,1989; INEGI, 1990; PROCEDE,1997 and Fieldwork observations)



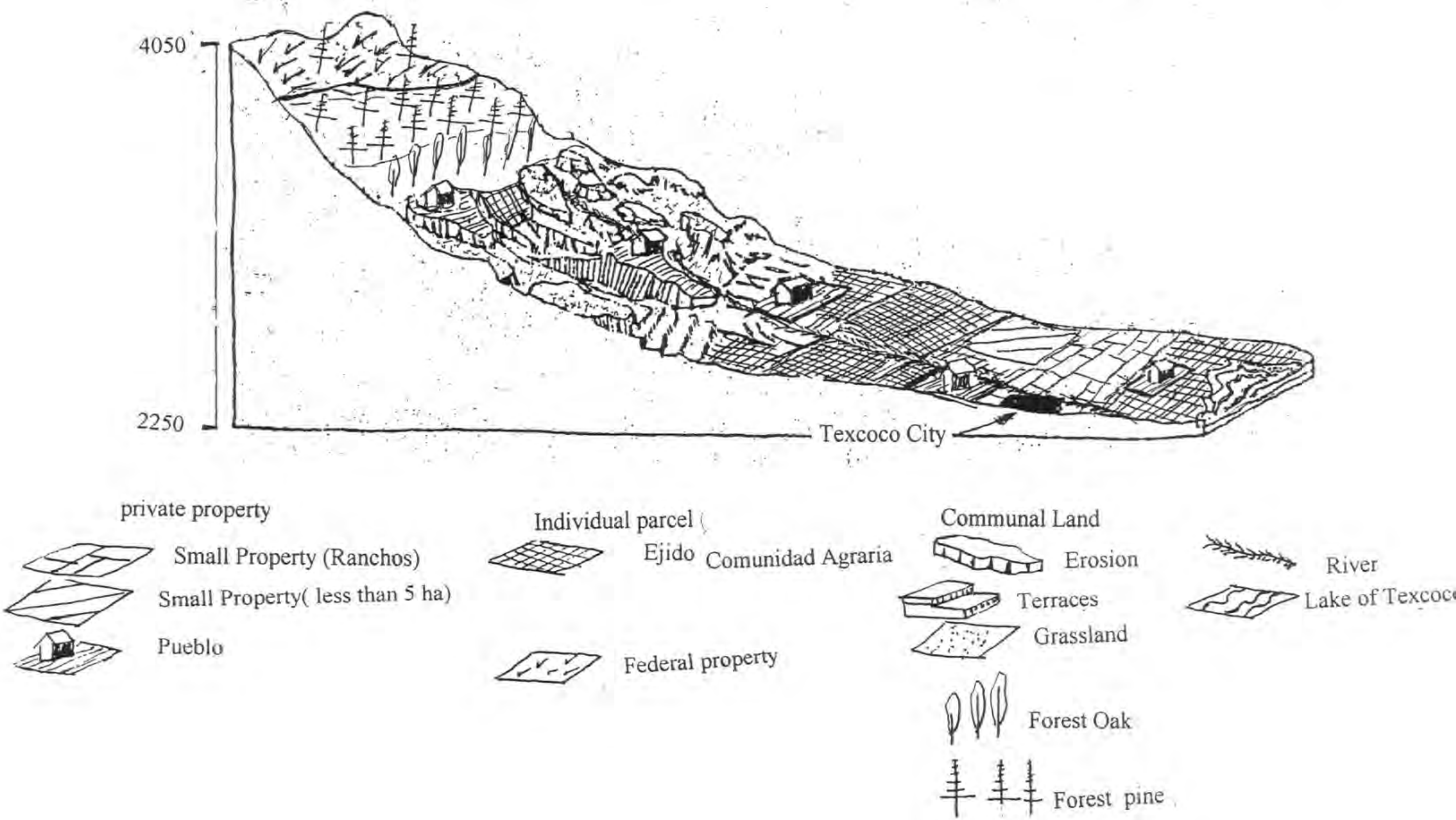


Figure 6.4 Diagrammatic representation of land tenure and erosion after Land Reform period (1910 to 1975) in the municipality of Texcoco (Author 1998; information about erosion based on Fabela, 1959; Ortiz, M.L, 1986)

6.2 Use of redistributed resources under the first phase

6.2.1 Access to sources of water from springs

Of the 7410 ha of agriculture land originally allocated to the *ejidos* some 353 were irrigated (this area has progressively increased). The seasonal land is used mainly for the production of subsistence crops such as maize, wheat, beans, oats and broad beans

The initial irrigated areas were within the settlement areas of the pueblos and used water from springs to produce flowers, fruits and herbs. In the 1970s the commercial production of flowers in greenhouses was introduced, and in several *ejidos* this activity is an important source of income. In the late 1970s the government promoted irrigation throughout the municipality through the creation of small irrigation units using ground water as a source. More recently untreated sewage water has been used for irrigation in some *ejidos*.

6.2.1.1 Management of the irrigation system

The system for distribution of spring water was built since the Prehispanic period, and is little changed. Organised as a "constellation", water is collected from several springs stored in tanks and distributed to the *pueblos* along streams. The principal channel is often up to 15 km long and supplies a smaller network of distribution channels with secondary tanks for the storage and distribution of water. The rights to water and the amount for each town were formally established by agreement in 1926. Two systems are still in use with some modifications (Palerm ,1993; Sokolosky, 1995; Rodriguez, 1995): the central system and the Southern system.

The Central system is the largest and has its source in San Francisco spring in lands belonging to San Jeronimo Amanalco; this has two branches: a) The Rio Coaxcacuaco which flows South-East to irrigate the lands of the *pueblos* San Jeronimo Amanalco, Santa Maria Tecuanulco, San Miguel Tlaixpan, La Purificacion Hacienda del Batan, Xocotlan, *ejido* of La Resurreccion, and the *pequeña propiedad* of La Resurrecion and the Rancho el Xolache; and b) the Rio Papalotla with a North Easterly flow irrigating land of the pueblos of San Juan Tezontla, Santa Ines, San Joaquin, Papalotla, San andres Chiautla and San Miguel Chiconcuac. The second or Southern system has its source in the springs belonging to several ejidos Santa Catarina del Monte, San Pablo Ixayoc and Tequesquinahuac and irrigates the lands of the pueblos San Pablo Ixayoc, San Nicolas Tlaminca San Dieguito, Santa Maria Nativitas, San Diego y Tequexquinahuac.

The administration of the water system is by a Water Council formed by the users under supervision of the National Water Commission (Comision Nacional del Agua). The Council is elected every three years and is in charge of the supervision of the distribution of water to *pueblos* and of the maintenance (Rodriguez 1995). The amounts and access to water by the users is based in the system of *tandas* (each of the users have the right to take water from the channel for determined periods of time) (Figure 6.5).

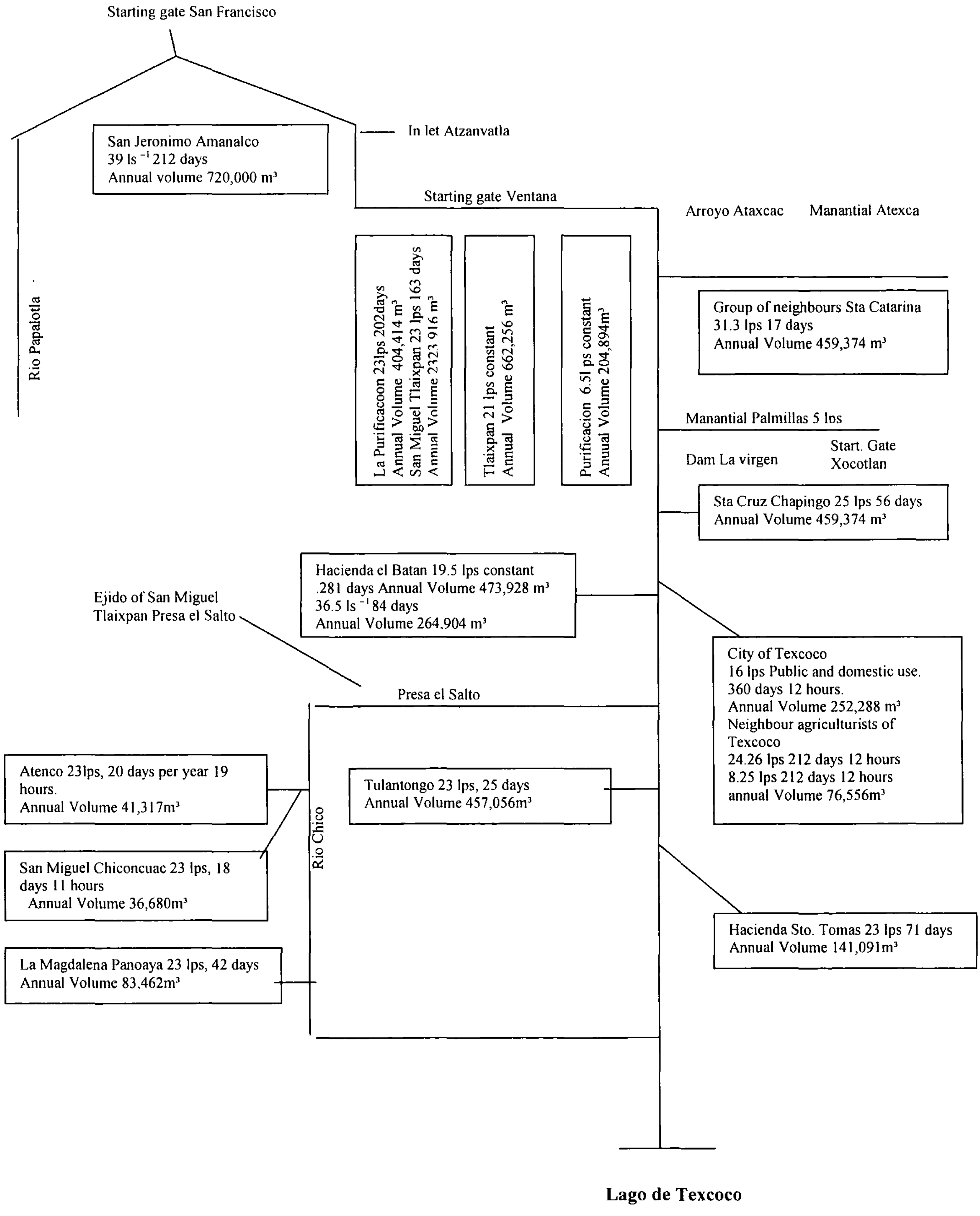
During the fieldwork it was found that 13 *pueblos* and *ejidos* are using water for irrigation from spring sources. The *pueblos* in the plain area only have access to the water from seasonal streams. Rodriguez (1993) notes that in the 1970s when water wells were built for the supply of drinkable water and the irrigation units created, the *pueblos* with access to groundwater gave up their rights to water from the springs and only retained their rights to stream river water.

6.2.2 Irrigation water from the temporal streams

The use of the water of seasonal streams for irrigation is used by nine *ejidos*. Five are located in the hilly area and water tanks called *jagueyes* were built for the storage of the water (size varies from 3000m² to 1 ha and depth of 2 to 4 m). The number of *jagueyes* in each *pueblo* varies from one to three. (Table A6.4 Appendix 4).

During the fieldwork it was observed that the sewage system in the *pueblos* upper reaches of streams discharges into the streams. Thus the four *ejidos* in the plain with rights of use of water from these streams in the plain area are effectively irrigating with untreated sewage water.

Figure 6.5 Schema of the distribution of the channel from the San Francisco gate to the Lake of Texcoco in 1926 (source Gomez,1993)



6.2.3 Irrigation with groundwater (units of irrigation)

In the period from 1978-1983, 31 irrigation units were created with government support in 19 *ejidos* and covering 1910 ha with 1696 ejidatarios as beneficiaries. The size of the irrigation units varies between 40 and 120 ha, between 1 and three units per *ejido* and numbers of *ejidatarios* varies from 14 to 119 (Table A6.5 Appendix 4).

The difference in number of units between *ejidos* depends on the area of land and the capacity of investment of the *ejidatarios.* The Government funded 50 % of the cost with the remainder coming from the *ejidatarios*. Thus only the *ejidos* with the best land and most money could afford the units (Municipality Agent, 59 years). The units are managed by a 3-man board of directors elected every three years by the "*socios*[9]" of the well. The Board supervises the allocation of water and maintenance of the infrastructure. Figure 6.6 shows the number and area of irrigation units in the *ejidos*, all of which have first class soils. Five ejidos on the hill area have recently drilled 7 wells without the authorisation of the government, and are currently seeking of permission to incorporate areas of seasonal agriculture into production.

Figure 6.7 shows the *ejidos* by sources of water; 12 *ejidos* have obtained water only from wells; 2 from wells and spring; 5 wells and streams; 3 wells and untreated sewage water; 5 from springs, and 2 from springs and streams. The access to different sources of water relates to different levels of investment and different organisation and infrastructure management of the systems.

The principal difference however is that in those settlements with wells the rights are transferable amongst individuals, whilst in the older systems using spring and streams such transfer is not permitted.

[9] The term 'socio' is used in the *ejidos* to refer to the people that invested in the building of the well. For example the unit of irrigation of Candelaria have 44 '*socios*' the socios can sell their rights to the water.

Figure 6.6 Ejidos with irrigation units in the municpality of Texcoco(DDR03,1998)

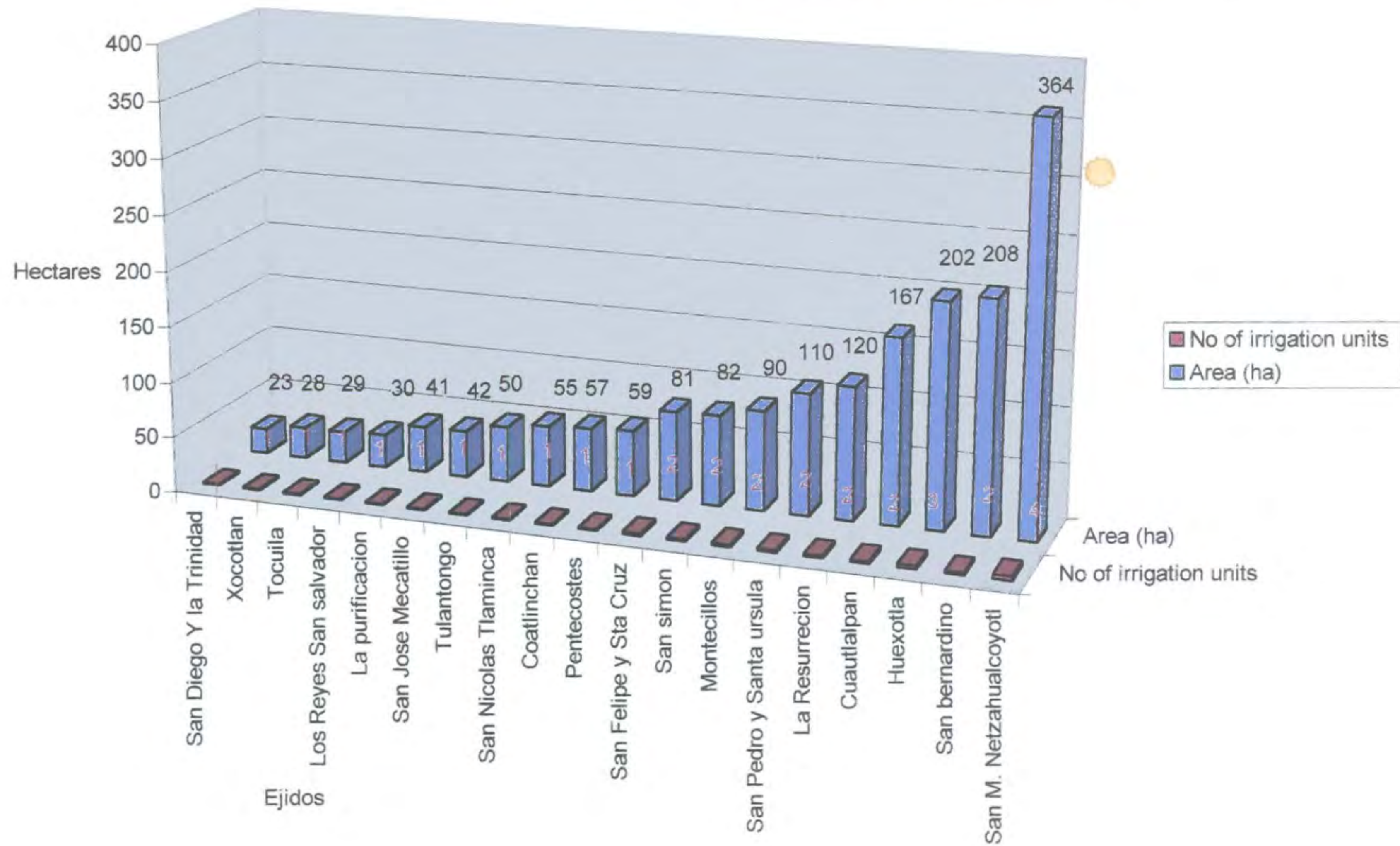
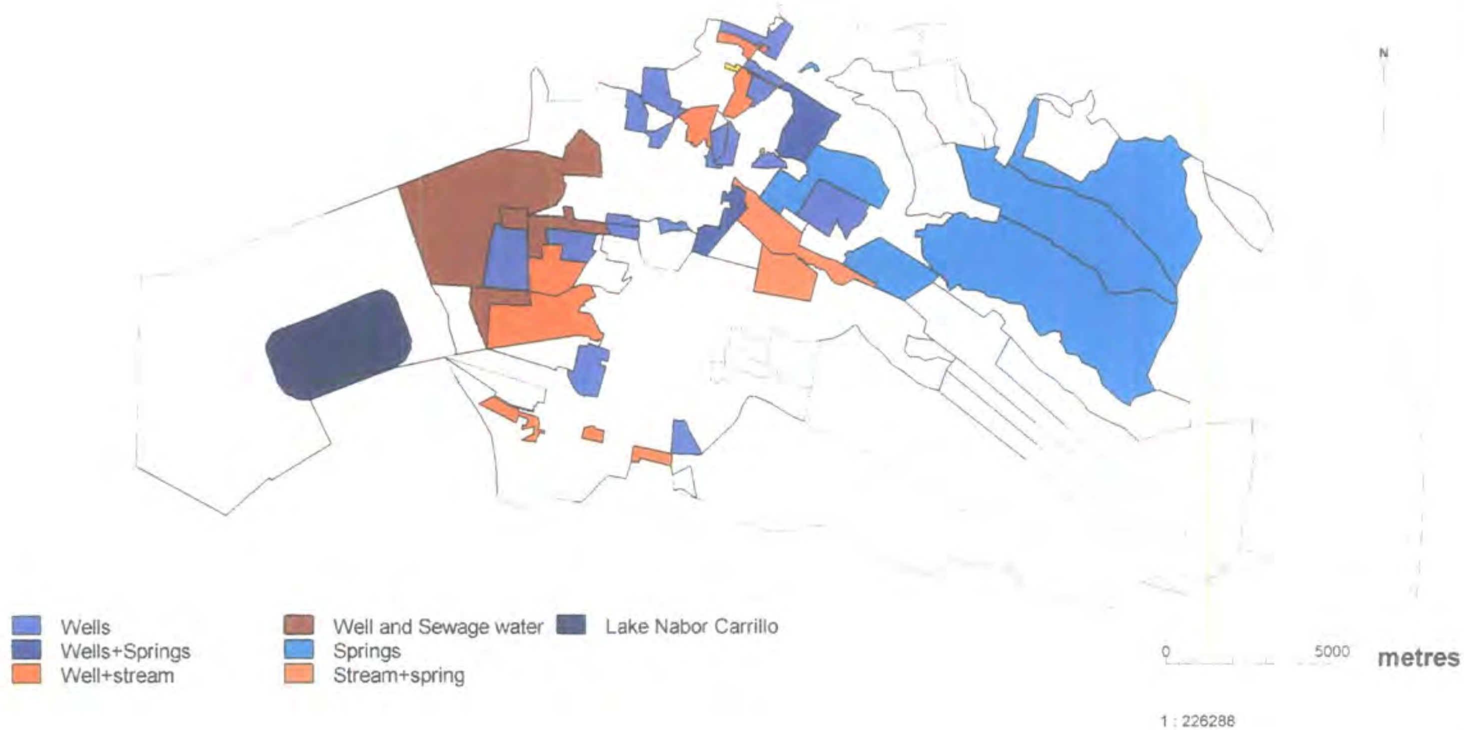


Figure 6.7 Sources of water for irrigation for the ejidos in the municipality of Texcoco (DDR.03, 1998, Fieldwork, 1998)



Note: The area irrigated in each ejido is below 250 ha.The map to which sources of water each ejido have access.

6.3 Forest and grassland of the *ejidos* and *Comunidades Agrarias*

The municipality has around 13,556 ha of forest, which is some 33% of the area of the municipality. The forest and grassland have been important sources of income for the people of the *Comunidades agrarias*, since the colonial period. During the land reform several *ejidos* received communal forest and grassland amounting to 7,345 ha of forest and 3,604 ha of grassland. The exploitation of both these resources by the communities has been largely for self-consumption with some marketing of forest products. The importance of the forest as a source of income has changed in particular since the land reform; these changes reflect modifications in government policy as they affect the access to the forest by *ejidatarios*. For example in recent years the rate of exploitation reported for 1996 by Ayuntamiento de Texcoco was 1000 m^3 but in 1999 the authorised volume of wood has increased to 11,000 m^3.

6.3.1 Use of the forest by the *ejido*

The forest has been exploited as a source of income generation for the *pueblos* near the sierra since Colonial times. According to Palerm V (1984) the sale of firewood and charcoal has been an important source of income since the sixteenth century. After the revolution and until the middle 1940s the forest was the provider for building of houses, for heating and the main sources of subsistence of the communities with access to these resources (Aldana, 1994; Sokolsoky, 1995; Gonzalez R, 1996). In 1945 the exploitation of the forest declined rapidly due to: a) a government imposed ban on the extraction of wood by the *ejidatarios*, instead extraction rights were given to San Rafael and Anexas Company; this was an attempt of the government to reduce overexploitation and erosion (Aldana, 1994 and informants, 1998) b) the introduction of kerosene in the 1940s and afterwards gas displaced the use of firewood as a main source of energy and the market declined c) despite the government ban, illegal extraction of wood continued, with the *ejidatarios* willing to risk fines or jail in order to increase their income.

The communal or *ejidal* authority however in some *ejidos* regulates the extraction of wood and firewood by the *ejidatarios* internally by the extension of internal permits (Palma, 1996). Firewood until now is still the cheapest source of energy for the poorest people of the *ejidos* with forest, and has a market to cook some traditional dishes such as sheep, bread, or for the production of ceramic handcrafts, and in traditional Indian baths called *"temascal"*. The provision of wood is by order with a network of commercialisation among woodcutters and clients. The sale of wood and firewood and collection of mushrooms and other products of the forest is a source of income for the poorest people of the *ejidos* in the sierra (Informants, 1998).

6.3.2 Proposal of exploitation of the Forest in Texcoco by the government

During the period 1926 to 1942 i.e. immediately following the establishment of ejidos the forest was threatened by the overexploitation caused mainly by the lack of alternate economic resources by which the *ejidatarios* could obtain alternative income. This also reflected the lack of any management in terms of promotion of reforestation, control against fire risk, diseases and uncontrolled illegal extraction (San Rafael, 1945, Aldana, 1994, Sokolosky, 1995).

In 1942 the Forest Law was issued with the objective of " the protection, promotion of conservation, restoration, propagation and exploitation of the forest and its derived products". In 1945 the government granted the San Rafael and Anexas Company (Unidad Industrial de Explotacion Forestal San Rafael y Anexas S.A de C.V) a 25 years lease to exploit 141,917 ha of the Sierra Nevada forest. As part of the agreement the company had to ensure reforestation and controlled extraction of wood. All the *ejido* forest was included in this agreement and thus the *ejidatarios* were banned from using their communal forestland. In fact the company did not exploit the forest since detailed surveys in 1948 revealed that the forest could not sustain the economic rate of exploitation. Additionally identifying ownership of the forest was difficult. In 1965 a new programme of management was launched by the company for the forest in Texcoco, with an extractable annual volume of wood 18,304 m^3 (see Table A6.6 Appendix 2 Chapter 4). However the price paid for the wood was low and the participation was only of some *ejidos* during few years Thus between 1948 and 1994 there was little other activity than illegal exploitation of the forest.

6.3.3 Conflicts in the exploitation of the Forest

Conflicts within the forest lands were detected in the fieldwork, and these centred on demarcation of boundaries, disagreements about practices, these latter involving *ejidatarios* and Government adviser and usually centred on the livestock activities in the forest.

An example of the conflicts is a disagreement in the delimitation of limits between the communities of Santa Maria Nativitas, San Dieguito Xochimacan and Tequexquinahuac which began in 1936 and has not yet been resolved.

Discussion with Government Agents identified other management problems. These relate to the practice of grazing cattle in the forest. Firstly, control of grazing is often very poor resulting in cattle entering in reforested areas and destroying the newly planted trees. When possible such areas are fenced, but cost often prevents this. Secondly, and more damaging, is the annual burning of the grassland beneath the forest canopy during the dry season which inevitably has a damaging effect on the trees, especially young ones. The burning is carried out by the graziers in the belief that the re-growth of grass will be stronger.

As a consequence of these activities many of the reforestation programmes fail and regeneration is very slow. Where the burning gets out of hand destruction is severe e.g. a fire 26th May 1998 destroyed 103 ha of Forest by lack of care when shepherds or farmers burn the grassland and wheat residues in the winter in the agriculture areas or grassland in the mountains (PROBOSQUEa 1998).

The conflicts with the government have been caused mainly by the illegal extraction of wood by the *ejidos*. Two conflicts reported in the community of San Jeronimo by the informants from the government and ejido illustrate the extreme situations that have been reached in Texcoco. The first in 1960s where 5 forest agents that had extorted the woodcutters in San Jeronimo for several years were killed in the town of San Jeronimo Amanalco. It is said that they were invited to the main fiesta in the town and killed during the meals. The other in 1997 when a group of people from San Jeronimo transporting wood without legal permit from the forest of San Jeronimo, were arrested by a group of agents armed with heavy weapons. When the convoy passed through the town the people realised that, stopped, confronted and disarmed the agents and retained them in the town. A strong police force was mobilised by the state, but after negotiations between the town authorities and the state authorities the agents were released (informants, 1998). A month later the a permit for extraction of wood by the *ejido* of San Jeronimo was issued by the Government

6.3.4 Grazing of livestock

Grazing of livestock was an important activity in the *ejidos* with grassland until the 1970s. Overgrazing however has resulted in the degradation and erosion of the grassland, during the 1970s Government supported efforts to reclaim the eroded areas often by terracing and these were then used for either reforestation or cultivation. Grazing is now largely restricted to the *pueblos* near the forest, or along the sides of ravines and rivers. Livestock numbers are reduced and usually comprise small mixed flocks of sheep, goats, donkey and mules and one or two cows; small herds of cows are sometimes grazed in the forest during the rainy season where they are left to feed for themselves. During the dry season the cattle graze the residues of crops after harvest in the cultivated fields and in winter are housed. The number of head kept depends on the availability of straw for winter-feed. The number of *ejidatarios* with herds of more than 10 animals has fallen e.g. in Santa Catarina only two ejidatarios have herds of more than 10. Informants at Santa Catarina explained how there was often co-operation between grazers and woodcutters, in this case between people of different *ejidos*. A family of the *ejido* of Rio Frio have a large herd of cattle that they grazed in the sierra forest erasing boundaries between *ejidos*. These people co-operate with the woodcutters telling them where they could find timber or dying trees and in return the woodcutters tell them where the best grazing is. More importantly however the herdsman acts as a forest guards reporting illegal felling which is a common problem specially where surveillance is poor e.g. Santa Maria Nativitas.

6.3.5 Programme for reclamation of the watershed of Texcoco

During this first phase of the Land Reform the most important government programme was the Plan Lago de Texcoco (PLT) that in 1972 started the reclamation

Plate 6.1 Grassing of livestock in maize fields after harvest

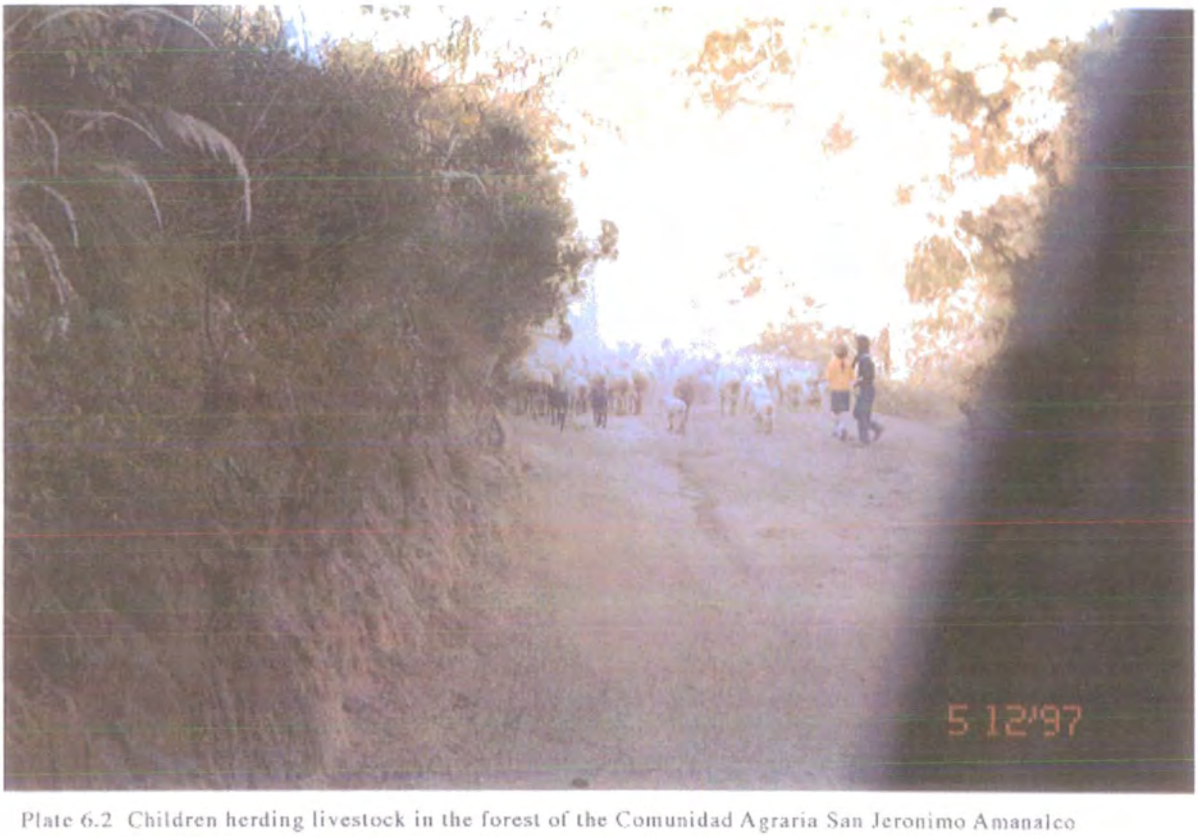


Plate 6.2 Children herding livestock in the forest of the Comunidad Agraria San Jeronimo Amanalco

of the degraded lands for the ex-lake Texcoco watershed. The approach followed for the reclamation of land was based on conservation works, reforestation and the building of gabion dams for retention of sediment up streams. Figueroa (1975) showed that the annual production of sediments in the facets of the land system Ixayoc was 11,695 to 20,461 ton/ha, and in the facets TE-1 5362 ton/ha; he concluded that the problem of erosion was the cultivation of the land without the adequate practices of soil conservation. Ortiz (1977) evaluates the capability of soils according their land capability and recommends a change of use from agriculture to forest or grassland in the areas with risk of erosion. However in 1978 when the works started in San Pablo Ixayoc, the *ejidatarios* were worried about what would happen with the *ejidal* land after the reforestation. As consequence they did not allow the building of terraces until the Government authorities make clear that point. The agreement reached was that the terraces could be incorporated into cultivation, if the *ejido* and the *ejidatarios* that take possession of the land cultivate them to avoid the erosion again. The *ejidatarios* agreed and the land reclaimed from tepetate was allocated to *ejidatarios* with less amount of land and to other land less of the town. Similar situations happened in the other ejidos. The works of reclamation of tepetate were done in the shared fashion, the government participate with the machinery and the *ejidatarios* with the petrol and wages of the operator (Aldana,1994)

The programme involved construction of terraces and breaking up of *tepetate* and their use for reforestation or agriculture. Gabion[10] dams were also constructed along the streams to reduce the sedimentation in the basin area. The area with the worst erosion problems was identified in the East zone of the watershed. This area comprises the hills and mountains of the municipality of Texcoco (Comision del Lago de Texcoco, 1985 cited by Adame, 1991). Following reductions budgets in the 1980s all PLT activities in the uplands were reduced and by 1994 have stopped and works restricted to the reclamation of in the former ex-lake area (Personal communication director of the PLT). Up to 1994 8651 ha had been reclaimed for forest (5121 ha) and agriculture (3530 ha) and some 1212 dams built (Adame,1991).

[10] The gabion dam is a dam built by piling up 1 m³ metallic boxes containing broken stone. This allows the flow of water and retains the sediments

The reforestation has not been very successful in terms of percentage survival of trees planted per hectare. The percentage of tree survival differs from sources: Sierra et al (1975) quote 55.3 %; Pedraza et al (1987) 59.6% and Adame (1991) 23.1 %. As these reports represent time series, the information may show progressive failure of the schemes. The failures of the scheme have been attributed to problems for the survival of the trees attributed to several causes: a) low quality of the substrate; b) pests that attack the trees and c) uncontrolled livestock grazing and the practice of burning during the dry season by the shepherds (Adame, 1991). Additionally the species planted are not always the most appropriate; much of the reforestation was with pine, which does not grow well below 3000 m, often the trees were planted at the wrong time i.e. at the end of the rainy season, thus many died of drought (Pers. Comm. Technician, *ejidatario*).

Although PLT had to pull out reforestation this is still taking place under the auspices of other agencies. In 1996 there were six agencies involved in reforestation (Comite Estatal de Reforestacion del Estado de Mexico, 1996). This is aimed to encourage *ejidos* to become involved in tree planting as an important income source for the *ejidatarios* during the rainy season.

6.4 Second phase of the land reform modifications to tenancy arrangements and rural programmes

6.4.1 Certification of *ejidal* rights PROCEDE 1992- 1998

In 1992 the *Programa de Certificacion de Derechos Ejidales y Titulacion de Parcelas Urbanas* (PROCEDE)(Programme of Certification of *Ejidal* Rights and Entitlement of Urban plots) started in Texcoco. The procedure for the certification of rights is complex incorporating 10 stages including Government Agencies, ejidal programmes and finally the formalisation of the agreements of the *ejidal* assembly about tenancy rights with the Secretaria de la Reforma Agraria (SRA) and in the Registro Agrario Nacional (RAN, National Agrarian Register). For detailed information of the process see Appendix 5. In the final stage of the processes of certification the *ejidatarios* assembly have to decide the regime of tenure as: continuation of the tenure as *ejido* or the adoption of *dominio pleno* over the parcel by the individual *ejidatarios*. The

Plate 6.3 Breaking up of tepetate for the building of a terrace in Santa Maria Nativitas

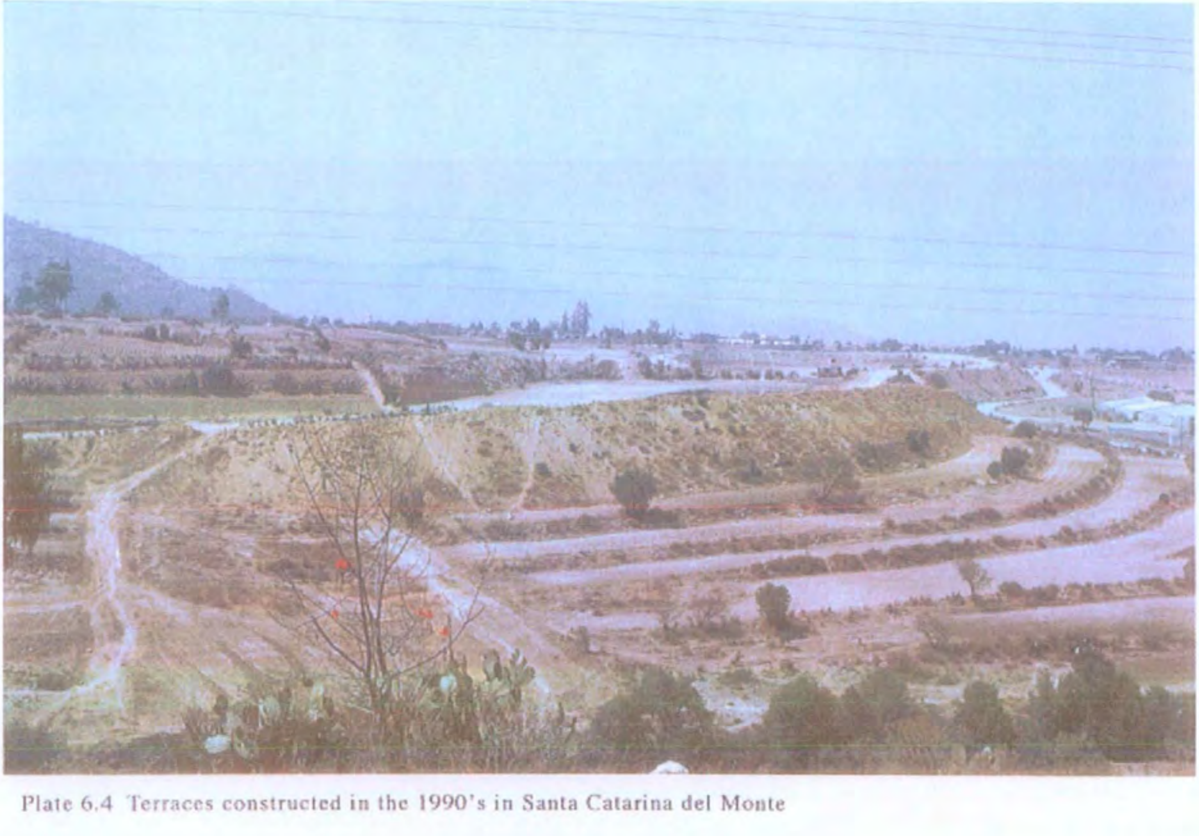


Plate 6.4 Terraces constructed in the 1990's in Santa Catarina del Monte

Plate 6.5 Area reforested in the 1970's by the Plan Lago de Texcoco

Plate 6.6 Reforestation in the forest land of Santa Catarina del Monte in 1998 by the programme of Ecological reforestation 1997

land under forest, grassland or other uses has to be allocated as communal and the right of the individual ejidatarios to communal land is recognised by the issue of a certificate of communal rights.

The three first stages of registration were accomplished in the municipality by 1993, by which 31 *ejidos* and 4 *Comunidades Agrarias* were located in the municipality of Texcoco. The *ejido* land is distributed in 72 *ejidal* polygons[11] (31 granted as outright grant *(dotacion)* and 39 as enlargement *(ampliacion)*. In 1997 26 *ejidos* finished the process of certification of the area with parcels, and of these 25 decided to continue under the *ejidal* regimen, and 1 adopted the *dominio pleno* of the parcels in 1998 (Table 6.4). The area certificated for the 26 *ejidos* is 7569.34 ha comprising 3554.61 ha parcels, 3413.38 ha communal land, 440.9 ha infrastructure and "*Asentamiento humano*" (human settlement[12]) 139.5 ha, 45.44 ha of river and streams and 73.45 ha as collective land (Table A6.7 Appendix 4, shows the information for the individual *ejidos*).

Figure 6.8 shows the distribution of the area certificated by PROCEDE in 1998. Most of the parcel areas have been certificated, however the all C*omunidades agrarias* did not agree to participate in the PROCEDE programme, and some *ejidos* have boundary demarcation problems[13]. An official commented that he thought that several disagreements began during the original land allocation in the 1920s and that it would be very difficult to resolve now.

Thus 43 % of the *ejidal* land most of them parcels was certificated by 1998, amounting to 32% of the total area of the municipality that could be certificated; however if we consider the area of land of the C*omunidades agrarias*, the amount of land certificate in the municipality is only 32% of the total amount of land entitled for certification.

[11]An *ejidal* polygon is the boundaries and areas that correspond to each Agrarian action or group of Agrarian actions through which the *ejido* was granted with land (INEGI a, 1997).

[12] Human Settlement (*Asentamientos humanos*): According to the Article 63 in the *Ley Agraria* is defined as "area of land required for the development of the community life in the *ejido*, which is constituted by the lands where the urbanization is located and its *Fundo legal*. *Fundo legal* is the extension of lands allocated to the *pueblos* for its foundation and edification (RAN, 1996).

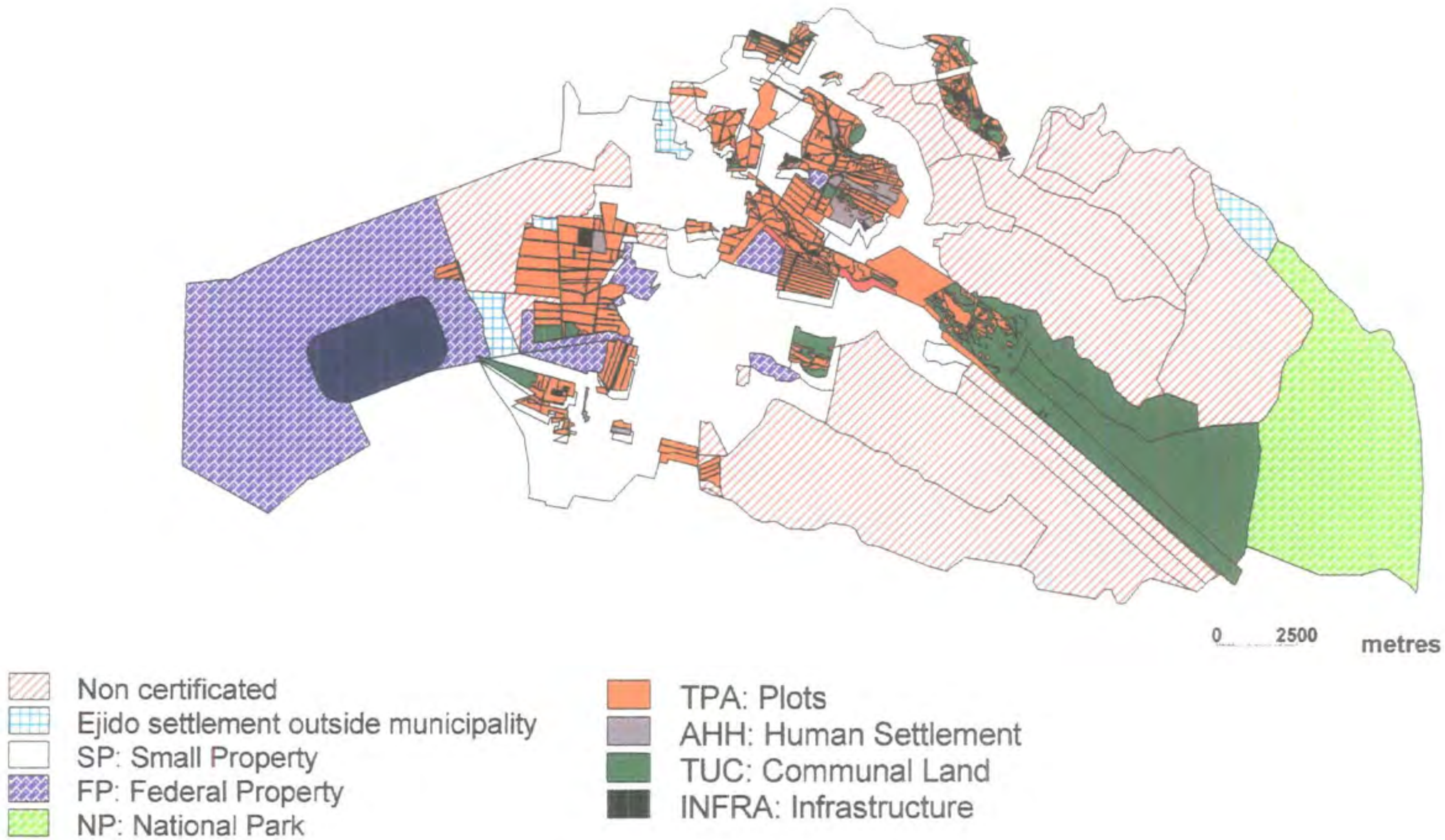
[13] The five *ejidos* left: La M.Panoaya, San M.Coatlinchan, San M. Tocuila, San Felipe y Santa Cruz y San J.Amanalco are in phase II step 5 by problems in agreement on limits with neighbors and limits of parcels inside the *ejido* (personal communication, Director of PA, Texcoco, 1998).

Table 6.4 Information on the programme PROCEDE in Texcoco (Sources (PROCEDE; 1997, Fieldwork interviews)

Ejido	No of ejido.	No of Ha	No of polygons (PROCEDE, 1997)			Year of
	(Prom.Agr.1998)	(RAN (1997)	Dotacion	Ampliacion	Total	Cert/ Tenure
La Magdalena Panoaya	410	439.36	1	2	3	Phase II
La Purificacion	158	250.64	1		1	1994/*ejido*
La Resurreccion	69	136.09	1	2	3	1993/*ejido*
Los Reyes San Salvador	42	51.63	1		1	1993/*ejido*
Montecillos	50	129.42	1		1	1993/*ejido*
Pentecostes	87	184.28	1		1	1994/*ejido*
San Bernardino	129	399.20	1		2	1995/*ejido*
San Diego y La Trinidad	116	140.98	1		2	1994/*ejido*
San Dieguito Xochimacan	110	757.43	1	2	3	1997/*ejido*
S.Felipe y S.Cruz de Abajo	340	863.73	1	1	2	Phase II
San Jeronimo Amanalco	33	1995.00	1		1	Phase II
San Joaquin Coapango	37	10.56	1		1	1994/*ejido*
San Jose Mecatillo	51	87.72	1		1	1993/*ejido*
San Juan Tezontla	55	228.23	1	6	7	1994/*ejido*
S. L.Huexotla y San Mateo	196	251.33	1	1	2	1995/*ejido*
San Martin Netzahualcoyotl	75	328.50	1	1	2	1993/*ejido*
San Miguel Tlaixpan	348	1959.64	1	5	6	1996/*ejido*
San Miguel Tocuila	310	972.36	1	3	4	Phase II
San Nicolas Tlaminca	62	203.77	1		1	1993/*ejido*
San Pablo Ixayoc	124	976.77	1	1	2	1994/*ejido*
San Pedro y Santa Ursula	52	166.93	1		1	1993/*ejido*; 1998 D.P
San Simon and Texopa	83	144.33	1		1	1994/*ejido*
Santa Catarina del Monte	132	694.00	1		1	1997/*ejido*
Santa Cruz de Arriba	26	19.39	1		1	1994/*ejido*
Santa Ines	32	110.17	1		1	1993/*ejido*
Santa Maria Nativitas	126	842.94	1	2	3	1995/*ejido*
Santiago Cuautlalpan	214	868.38	1	4	5	Phase II
San Miguel Coatlinchan	353	2477.24	1	6	7	Phase II
Tequesquinahuac	161	1693.15	1	2	3	1995/*ejido*
Tulantongo	66	94.22	1	1	2	1994/*ejido*
Xocotlan	22	53.26	1		1	1994/*ejido*
Total	4069	17530.68	31	39	72	
Agrarian Communities						
C.A San Miguel Tlaixpan	69	579.62	1		1	*n.c*
C.A San Jeronimo Amanalco	33	1736.04	1	2	3	*n.c*
C.A Sta Maria Tecuanulco	150	1474.80	1		1	*n.c*
C.A Santa Cartarina del Monte	254	1736.96	1		1	*n.c*
Total	506	5527.42				

n.c: Not included in the programme of PROCEDE.

Figure 6.8 Ejidos certificated by PROCEDE in the municipality of Texcoco in 1998.(Digital maps of PROCEDE and map of tenure by the author)



Most of the certificates over communal land are delayed by problems of boundaries among *ejidos*. The decision of the *ejidal* assemblies about land tenure were to remain as *ejidos*, thus some 93.7 % of the land continues with tenure as *ejido* only and 0.7 % was transfer to *dominio pleno* and possible privatisation.

The continuation of the tenure as *ejido* in the municipality meant that PROCEDE extends a "*Certificado of derechos ejidales*" (certificate of ejidal rights). The certificate, however is not a full private property title in that it contains several limits and 'safeguards' that prevent the *ejidatario* from selling land to non-*ejidatarios*, the sale of land is limited to other *ejidatarios* or *avecindado*s of the same nuclei of population (art 80, Ley Agrarian, 1992). It also prevents the subdivision of the parcels (Art. 18 Ley Agraria, 1992).

The certificate allows the *ejidatario* to rent the parcel (Art 46, Ley Agraria, 1992) or to bestow the usufruct of the parcel as guarantee to a credit institution or to persons with whom the *ejidatario* has commercial relations. But it limits the guarantee to a temporary usufruct of the land for an agreed period of time for a maximum of 30 years; when the period of time agreed finishes the *ejidatario* gets back the usufruct of the parcel (art 46 Ley Agraria, 1992). These are rights that they formerly did not have.

The rights over the parcels by the *posesionarios* also are restricted. The Agrarian law of 1992 stated that the assignment of parcels to non-ejidatarios (*posesionarios*) is by the *ejido* assembly and the title confers on the *posesionario* the rights of usufruct and enjoyment of the land. This implies that when a *posesionario* sells the land to other non-ejidatarios, the ejido assembly must approve the assignment of land to the new owner and the assignment of land could be charged with a fee, destined to works for the benefit of the *ejido* (art 57, Ley Agraria, 1992).

6.4.2 Data about the *ejidos* produced by PROCEDE

The data produced by PROCEDE on the 26 *ejidos* certificated in 1998, show the internal complexity of access to land in the *ejidos*. The data provides information on types of land; land use, access to different types of tenure by the *ejidatarios* and the income activities of each *ejidatario*.

The land with parcels devoted to agriculture is 3,804 ha (51% of the area certificated) of this 97.9% is under agriculture and 2.1% are under other uses (infrastructure, livestock, badlands). The land in the parcels is classified according to its suitability[14]: 30% irrigated, 68% are seasonal agriculture and 2% other uses. Communal land accounts for 3,520 ha, of which 33.9% are seasonal agriculture, 22% livestock and agriculture, 14.7% reforestation and 29.4% under other uses (natural forest, infrastructure, badlands, and rivers). The 22% (1643 ha) of communal land under cultivation indicates a gradual encroachment of cultivation into previously areas of grassland or forest (a strictly illegal process). Table 6.5 and 6.6 show areas under different land uses and land use types.

Table 6.5 Parcel and communal areas of the *ejidos* by land uses (INEGI, 1998)

Number of *ejidos* (26)	Total	Agriculture		Livestock[15]		Agriculture and Livestock		Forest		Other uses	
		ha	%	ha	%	ha	%	ha	%	ha	%
Parcel	3804.5	3724.6	97.9	3.8	0.1	15.2	0.4	-	-	60.8	1.6
Communal	3520.8	1193.5	33.9	517.5	14.7	257	7.3	517.5	14.7	1035.1	29.4
Total	7325.3	4918.1		521.3		272.2		517.5		1095.5	

The percentage is as declared by the informant and was not verified during the survey by PROCEDE.

Table 6.6 Parcel and communal areas of the *ejidos* type of land use (INEGI, 1998)

Type Of Land	Municipality		Agriculture				Forest/grassland				Infrastructure	
	Total		Irrigated or first class		Seasonal Agriculture		Grassland		Monte[16] and/or grassland		Infrastructure and others	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Parcel	3804	51	1145	30	2602	68					57	2
Communal	3520	49	63	1	1580	44	292	8	1147	32	436	12
Total (ha)	7325	100	1208	16	4183	57	292	3	1147	15	493	6

The percentage is as declared by the informant and was not verified during the survey by PROCEDE.

The picture that emerges from this data is that there are several complex elements interwoven which complicate the productive launching of the *ejido*. First the differential access to land resources as individual parcels and communal land that gives diverse options to land use to each *ejido* and for the individuals themselves. Second the diversity in resources, agriculture, forest and grassland make available also several options for land use. Also the decisions in use of communal land for their

[14] PROCEDE collect this information in interviews with *ejidal comisariado*, and the land suitability classes were the land classification used for allocation of land by the SRA during the allocation of land, the information was not corroborated with field survey by PROCEDE.
[15] Lands used for the grassing of livestock (INEGI, 1998)
[16] Land with vegetation of forest or bushes, growing natural or introduced by reforestation (INEGI, 1998).

exploitation in association or by the *ejidatarios* themselves have to be decided by the *ejidal* assembly. This complexity of options makes necessary the elaboration of a plan of action based in the actual availability of resources, and the alternatives opened to each *ejido* and ejidatario under the new options for rural development opened since 1992.

6.4.3 Social data

The *ejido* is seen by the *ejidatarios* as an important organisational, economic cultural and politic resource (Goldering, 1998; Zendejas and Mummert 1998). This view however varies for different groups of *ejidatarios* and is related with factors such as gender, generation, sense of shared history, and access to capital, wealth, and status. For example the original and older *ejidatarios* have identities that are strongly bound with the history of the land struggle, but this could be less important for the younger generation and for *ejidatarios* who see land as a source of income or a quasi-commodity. The government also considers that the advanced age of most of the title holders is a disadvantage for increased productivity, and thus the Government encourages their replacement by younger or more skilful and entrepreneurial[17] *ejidatarios* (PROCEDE, 1999).

Under the new legislation the rights to transfer for inheritance remains but is not specifically compulsory to the son or wife, and of course it can be sold. The possibility of sale of land by the *ejidatario* puts the women and the children as the most vulnerable groups by the loss of their rights of inheritance, in the communities. As most of the *ejidatarios* are over 30 years (78 %), 18.7% are woman, and 95.2% are natives of Texcoco (tables 6 and 7). This could mean that they have a strong identity and shared history of struggles additionally 73% are married (Table 6.8). As Goldering (1998) notes sale of land will be unlikely by *ejidatarios* with strong identities, such has those born in the communities and with families. De Janvery et al (1995) note one of the usual strategies followed by landholders with families is to produce maize for self-consumption as an insurance against lack of income from other sources. Thus sales of land will be difficult.

[17] *Ejidatarios* with entrepreneurial character are those that produce for the market and use credit, technology and take risk investing infrastructure improvement.

Table 6.7 Possible individual with parcel rights by sex and age group

Group of age	Total	Men	%	Women	% *ejidatarios*
Under 18 years	3	3	0.001	0	
18 to 30	88	77	3.28	11	0.20
30 to 45	561	496	21.25	65	12.08
45 to 60	996	839	35.77	157	29.18
60 to 75	850	642	27.37	208	38.66
More than 75	385	288	12.28	97	18.02
Total Municipality	2883	2345	81.34	538	18.7

Table 6.8 Number of individuals with parcel rights in the municipality by marital status and place of birth. (INEGI; 1998)

Individuals with rights to land	Marital status				Place of birth		
	Single	Married	Free union	Other	Texcoco Municipality	Other municipality	Other State
2974	329	2188	53	300	2856	29	109

In the 26 *ejidos* there are 3233 individuals with *ejidal* rights[18]. An individual could have access to a single or several forms of tenure land e.g. a parcel or and/or communal land and/or a '*solar*' for the building of a house. The Texcoco *ejidatarios* rights over ownership of land are broken down as follows: 1676 individuals have both rights over individual parcel and communal, 1295 have only over parcels; 206 have only communal land; 53 have both '*solar*' and communal land; and 3 over individual parcel, communal and *solar* (INEGI, 1998).

This variable access to land greatly influences the opportunities of income generation. *Ejidatarios* with both parcels and communal land have the chance to gain from the sale and rent of their parcels and also from receiving a share of the rent on exploitation of communal land. Those with only parcels benefit have only the possibility to rent or sale their parcels.

Location of the *ejido* or parcels is also crucial, as the land of the *ejidos* surrounding Texcoco City and near larger towns alongside main roads, has highly value, probably for building. As migration to Texcoco increases these *ejidos* will benefit further.

The data produced about sources of income show that 62.1% of the *ejidatarios* depends on activities related to agriculture and use of resources available within the

[18] PROCEDE call the ejidatrios possible individuals with rights; because, PROCEDE is in charge to produce the maps only. The certification as ejidatario is done by the SRA by the deliver of the individual certificate.

ejido e.g. subsistence farming, cattle rising, extraction of forest products, some 21.1% of the holders of parcels have activities outside agriculture, with 5.9% in the industrial sector, 15.2 % in activities related with the provision of services and 16.8 % unemployed. The most vulnerable group in the *ejido* are those unemployed mainly older people and women (Table 6.9).

Table 6.9 Number of individuals by occupation[19] (INEGI, 1998)

Individuals with rights to parcel	Agriculture	Industry	Drivers	Shopkeeper	Offices	Teachers, technicians, graduates	Inactive or unemployed
2883	1791	169	82	112	227	18	484
%	62.1	5.9	2.8	3.9	7.9	0.6	16.8

Palerm (1993) and Sokolosky (1994) found that *ejidatarios* are engaged in activities outside the *ejido* and hence they argue that *ejidatarios* are in a process of semi-proletarisation combining production for self-consumption with wage labour.

6.5 Government Programmes

6.5.1 Programme for Ecological Restoration (SEDAGRO)

This was a one-year programme run in 1997 by the SEDAGRO. The programme approach was innovative in the sense that participating *ejidatarios* constituted a committee, which was not directly under supervision of the *ejidal* authority. This committee was in charge of the works and participated in selection of sites for reforestation and buildings of dams in co-operation with the government agents. The group was co-ordinated by a president, secretary and treasurer. The government agents were in charge of the technical supervision and the provision of materials (trees, materials for building the dams, tools) and committee members were in charge of the works. The programme focussed on: soil conservation works, reforestation, fencing of the reforested areas and building of gabion dams in the streams. The total investment by the government in the municipality was £234,273. Eight *ejidos* participated in 25 projects that are listed in table 6.10(see also table A6.8 appendix 4 chapter 6), 77.4% of the budget was invested in five *ejidos* an important objective of the programme was the provision of temporary work for the *ejidatarios* and 49.3 % of the money was spent in this.

[19] For detailed description of the occupations see page 39 (INEGI, 1998)

Table 6.10 Budget, in Sterling pounds (£) of projects in the programme of Ecological restoration in the municipality of Texcoco (Archives SEDAGRO, 1998)

Ejidos	Ditches	Reforestation	Gabion dams	Fences	Labour	Total	% By *ejido*
S.M Tlaixpan		4504			741	4504	1.9
La Purificacion		9007		1817	1818	10824	4.6
S.M Nativitas		2252	13040		9550	15292	6.5
S.M Coatlinchan	6775*	13511		2019	8983	22305	9.5
S.C del Monte		16889	9780	2221	10074	28890	12.3
S.J Amanalco		22518	9780		10588	32299	13.8
S.P Ixayoc	20324	18015	13040	3129	31302	51379	21.9
Tequesquinahuac	17389	15763	32600	3028	42494	68780	29.4
Total	44488	102459	78240	12214	115550	234273	100.0

6.5.2 Programme *Alianza para el Campo.*

In Texcoco some 350 farmers participated in 40 programmes. The programmes included purchase of machinery, subsidies for the buying of seeds and fertilisers; building of irrigation infrastructure such as surfacing of channels; introduction of better breeds of livestock; sowing of improved grassland; building of silos for storage of feed; better milk storage; better access to artificial insemination; provision of milking equipment and grains mills. Cheap credit provided to individuals for the support of production projects such as development of greenhouses, introduction of sheep, and development of cheese making. As well as financing the above activities another key focus was the development of training for farmers, covering such things as cheese making, development of floriculture and the use of high yield varieties of maize and wheat. (See table A6.9 appendix 4 for full details)

In the programmes the role of the technicians are as salesman offering products with substantial discounts to the farmers, as expressed by one of them

> 'I had to promote the installation of three milk stores in the municipality. I only could sell one. I started from scratch, first looking for dairy farmers then organising meetings to explain the project, and attempting to convince them, the main advantage was a 66% of subsidy. I convinced them to buy the store, however when it was installed most of the *ejidatarios* people that participated in the purchase did not use it!. They prefer to sell their milk door by door. The people of this group also bought milking equipment and mills. It was seems that they are going to sell the stockpile to a group or private farmers or to a rancho' (Pers. comm. municipality Agent 40 years). A similar situation happened with the sale of tractor wheels, 22 pairs were bought by farmers in Coatlinchan, where one of the farmers said that it was a good buy as they

saved 50% on the market price, and could sell them at a good profit or use them on their own tractor (Ejidatario 72 years).

The total investment in the programmes for modernisation of agriculture in the municipality was £205,644 and of this, £98,873 was Government subsidies (Table 6.11, see also tables 6.9 and 6.10 appendix 4).

Table 6.11 shows that 91% of the investment occurred in two settlements including 78 farmers all of whom were already involved in some commercial farming. 21 farmers invested the remaining 9% in 10 *pueblos*. It was discovered that some of the participants were friends of the municipality agents and in many cases had purchased equipment at subsidised prices to sell on at a profit.

Table 6.11 Total investment, in Sterling pounds (£) in the municipality of Texcoco by government and farmers
(Archives. DDR03, Texcoco, 1997)

Pueblos	Government	Farmers	Total	Participants	% investment
Tocuila	76	38	114	1	0.11
S.diego	206	206	412	1	0.41
S.Jeronimo	233	205	438	2	0.44
Tezontla	223	223	446	1	0.44
Montecillo	296	167	463	1	0.46
Huexotla	398	311	709	3	0.71
Santa Cruz	318	691	1,009	2	1.02
Texopa	650	391	1,041	3	1.01
La Resurreccion	837	440	1,277	3	1.27
Cuautlalpan	1,223	1,655	2,878	4	2.69
Coatlinchan	22,608	14,642	37,250	59	37.09
Texcoco	16,069	38,421	54,490	19	54.25
Total	43,136	57,390	100,526	99	100

Although the scheme was successful in increasing the investment in agriculture assets, the group of farmers benefiting were not those intended. Instead of subsistence farmers it was the farmers interested in mechanisation of agriculture, those already involved in dairy farming, or the entrepreneurs who saw the subsidy as an opportunity to increase their capital.

Where *ejidatarios* were involved they only participated in programmes that were sensible for them and required a minimum investment. These included programmes to increase production of local maize seeds, provide chickens and line irrigation channels. Why the *ejidatarios* participated only in these schemes was expressed very plainly by one *ejidatario*

> 'The seeds were selected and produced by people of the *ejido* and had been used for years, they are adapted to the region, and never fail to give a crop (*ejidatario,* 56 years).

The lots of chickens were seen also as an opportunity

> 'currently our wives have some chickens at home, and this is a good opportunity to increase its number with a minimum investment of money'. Moreover, if you take care of the chicken in two months you could have eggs, or meat for the next Fiesta'

In the case of lining irrigation channels;

> 'the government paid 80 % of the materials and the *ejidatarios* put in the work, currently you need to clean the channels from weeds, and repair the channels when they are broken, with masonry channels a lot of time, water, and work is saved' (*ejidatario,* 72 years).

Interviews in several *ejidos* with *ejidal* authorities, *ejidatarios* and Municipality Agents raised the conflicts between the support required by the *ejidos* and that offered by the Government. In the *ejidos* with irrigation by wells the support is required for: a) refurbishment of wells b) re-introduction of electricity subsidies c) surfacing of channels. Apart from lining channels no support has been forthcoming and four ejidos were illegally drilling new wells. In the *ejidos* with seasonal agriculture the support required is for: a) drilling of wells for irrigation b) building and maintenance of water tanks and dams for irrigation c) credit for the purchase of mules and implements d) access to equipment to build terraces and tanks. As well specific requirements frequently arose in discussion: a) more support for the management of the *ejido* such as accounting procedures and help on the establishment of mercantile societies b) the support for the construction of buildings for the *ejido* offices c) installation of electricity, sewage and drinking water schemes. None of these requirements are covered by the scheme.

Plate 6.7 Gabion Dam constructed in a ravine in San Jeronimo Amanancla in the programme of Ecological restoration 1997

Plate 6.8 Infrastructure for irrigation in the ejido of Santa Maria Nativitas, (programme Alianza para el Campo, 1997)

6.5.3 Programme for the subsidy of crops PROCAMPO

In 1997 the farmers of the Municipality received a crop subsidy of £35.25 per hectare, with a total amount of £ 155,805, covering an area of 4,420 ha. Ojeda (1993) reported that the area sown with maize, wheat, beans and sorghum in 1993, eligible for subsidy was 8810 ha, meaning that the area registered and receiving subsidy from PROCAMPO is 50 % of the eligible area. Table 6.12 lists the distribution of subsidy; this shows that ejidos received most of the subsidy.

Table 6.12 Subsidy of PROCAMPO by type of tenant in the municipality of Texcoco (archives PROCAMPO, DDR03, Texcoco, 1997)

Ejido	No beneficiaries	Area (ha)	Subsidy (£)	Average subsidy £ per farmer/area (ha)	% area
Ejidatarios	2,021	3,319	117,008	30.1/1.64	75.1
Private Property	129	861	30,352	51.5/1.46	19.5
Comuneros	164	240	8,473	227.5/6.67	5.4
Total	2,314	4,420	155,833		100.0

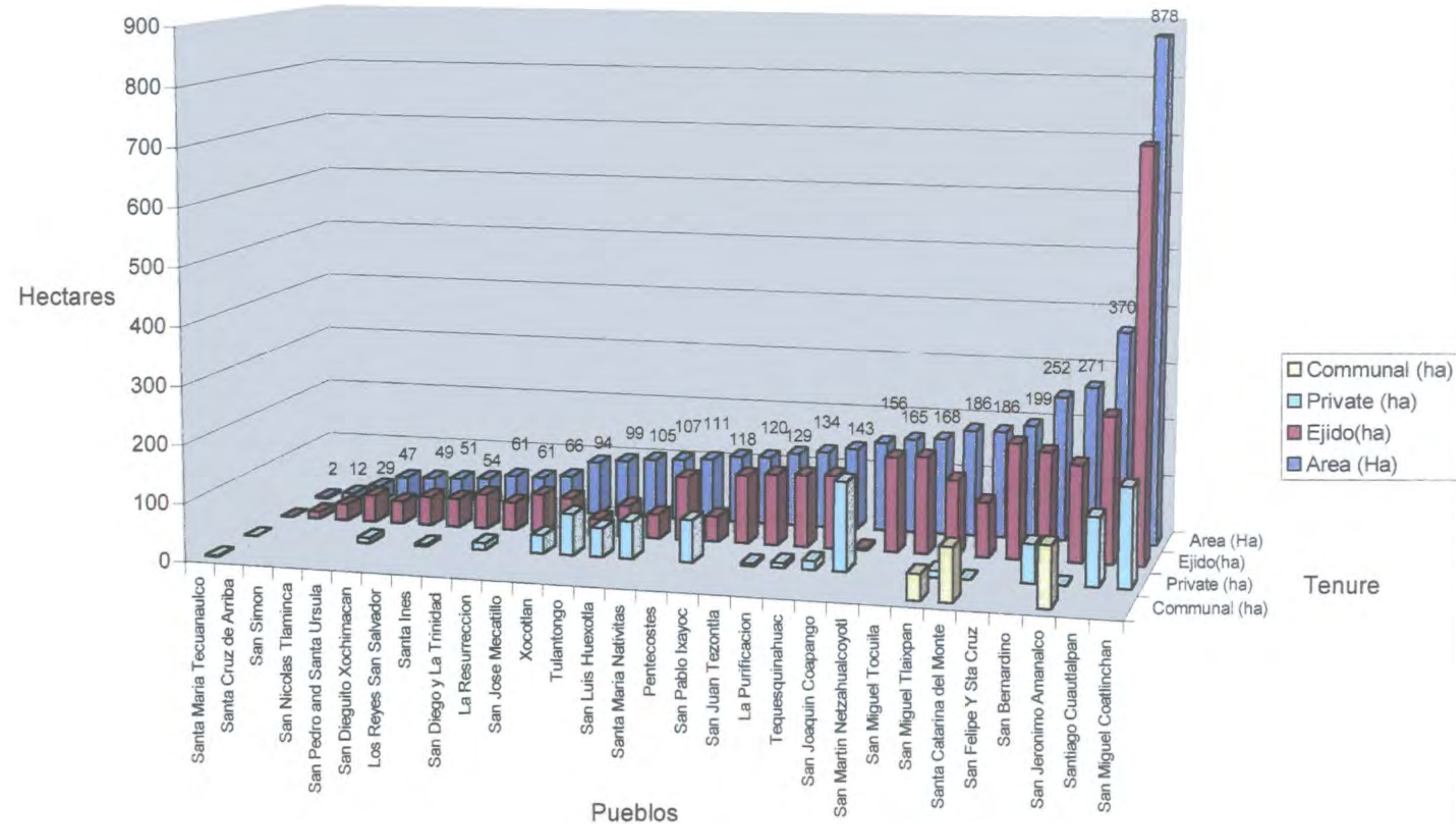
Land eligible for subsidy, which comprises land sown to crops eligible in the period 1990-1992 was registered in PROCAMPO in 1993-94. In figure 6.9 the data on subsidy are aggregated by *pueblo*; it shows that of the 30 *pueblos*, only in six did farmers register more than 250 ha and one *pueblo* received 19.9 % of the total subsidy award (Table A6.11 appendix 4 gives full details).

During the interviews farmers complained that the registration was a time consuming and bureaucratic process and *ejidatarios* with less than one hectare of land considered the registration of their parcels pointless. Other *ejidatarios* had not updated their rights after they inherited their parcels and as the land titling by PROCEDE was underway, they were waiting for new titles and were not able to register the parcels.

For these reasons the number of farmers registered in PROCAMPO vary in the pueblos from 2 to 277 farmers.

Altogether in 1997 PROCAMPO subsidised 4420 ha of crops involving 9 for self-consumption, 3 for animal fodder, 27 vegetable crops and 13 different flower and fruit crops, figure 6.9 (see table 6.12 appendix 4 for more details). The vegetable, flowers and fruit crops reflect a change towards a more commercial output by some *ejidatarios*. In general, however, the great diversity of crop grown reflects the land

Figure 6.9 Subsidies by town and tenure in the municpality of Texcoco(Archives PROCAMPO,DDR 03, Texcoco, 1997)



available, its quality and also the attitude of the *ejidatarios*. The majority of crops grown were oriented for self-consumption by the *ejidatarios* , and the objective to change the pattern of use to crops with competitive prices in the market was partially achieved by a switch to vegetables and alfalfa.

6.5.4 Commercial exploitation of the forest by the *ejidos*

In 1995 the exploitation ban of the forest was lifted and the commercial forest extraction started in several *ejidos;* this required a Government permit. Initially a permit was granted for the extraction of diseased timber only then later for any timber for fixed rates per year per set number of years e.g. *ejido* of San Jeronimo Amanalco was granted a permit per extraction of 5381 m^3 a^{-1} for ten years. Interestingly in some cases the area granted for extraction was grater than that identified as suitable by the San Rafael y Anexas Company e.g. Santa Maria Nativitas were granted licence to extract 1036 m^3 a^{-1} whilst the San Rafael y Anexas company set the rate at 552 m^3 a^{-1} Permission for extraction is however not granted if neighbouring *ejidos* are in conflict about ownership and delimitation of boundaries e.g. San Dieguito Xochimacan and Tequesquinahuac. The permission to exploit the timber was welcomed by both the *ejidatarios* and government agents, the later saying that previously all their time had been given over to policing the forest whereas now they could focus on management (Personal com. Municipality Agent).

The *ejidatarios* are responsible for the exploitation of the forest and in this way they have control over extraction processing. The success of their enterprise however, will depend on the price of wood. Currently the *ejidos* sell unprocessed wood at prices £ 22 m^3, which is 50 % below the prices in the market. The *ejidatarios* from several *ejidos* are in the process to forming a trading Society for the commercialisation of timber sales. Within the *ejidos* any profit is invested in *ejido* infrastructure e.g. building a bridge and are now looking to build a saw mill in Santa Maria Nativitas.

6.6 Summary

The two phases of land reform that have taken place since 1915 have seen the effective dismantling of the *Haciendas.* A proportion of the land was redistributed, as *ejido* land amongst the *pueblos;* however some 20 % remained as private land, here a key factor is size. Areas of < 5 ha are *unidades de produccion rurales* and those between 5 ha and 100 ha (or their irrigated equivalent) as *Ranchos.*

Despite the aim of Land Reform the *Ranchos* have retained the best land and have most of the irrigated land. Given their size and tenure *Ranchos* are commercial farms, whereas the '*unidades de produccion rurales*' and the *ejidos* are very much subsistence based, with a high proportion of the people being engaged in non-farming activities as an important income source. Even the *ejidos* with a variable resources base are even more complex by the latest land reforms that permit the sale of an individual *ejidatario* allocation of land. The *ejidos* on the plain are smaller, and they have irrigation and several are geared to dairying to supply the city. Also being near the city their land is on demand for housing. *Ejidos* in the hill and sierras are very large with more diverse land-forest and grassland as well as 'arable', the lands however is of poorer quality and subsistence farming remains as the main activity (figure 6.10).

Despite various Government attempts to persuade *ejidatarios* to adopt a more commercial cutback including the latest reform permitting sale and rent of land, this has so far been a failure. Few *ejidatarios* have taken up the full range of subsidies offered by PROCAMPO, and when they have done this it is often to sell on the subsidised products with a small profit. PROCAMPO has only succeeded in reaching under 50% of those eligible. The limited participation in the government programmes by the very farmers, which the schemes were aimed at, clearly demonstrates a problem with the programmes. Government Agents seem to blame the fragmentation of land as a drawback to the commercialisation of farms. Close examination of the situation however reveals a more complex scenario: Firstly, the *ejidatarios* especially the older ones have a close affinity for their land that has been won through 'struggle'. Secondly the very notion of *ejido* farming means that they do not have the necessary capital to engage in many PROCAMPO schemes. Thirdly, as the majority of the *ejidos* are involved in subsistence farming this must be seen as a critical social activity, by keeping their farms the *ejidatarios* have something to full back on if off farm work became unavailable.

Land reform on the last 85 years have achieved some redistribution of land but has largely not resulted in the hoped for agricultural development. Even the most recent reforms reflect a government thinking that shows little understanding of the farming communities attitudes and aspirations. These problems will be explored in more detail using specific examples in the next chapter.

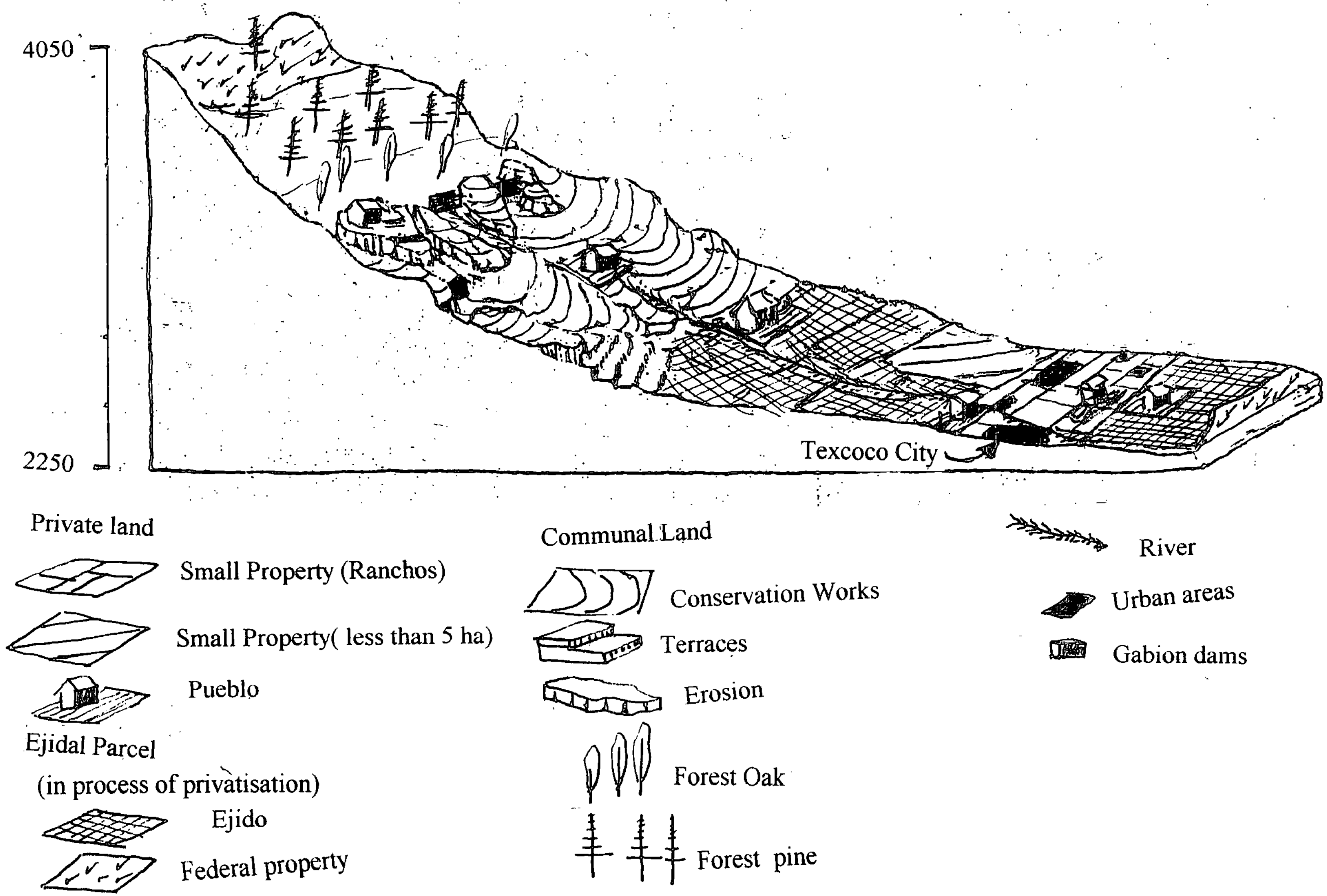


Figure 6.10 Diagrammatic representation of land tenure, erosion and conservation works (1975 to 1998) in the municipality of Texcoco (Author; fieldwork observations , 1998).

Chapter VII Resource base and land uses in the three *ejidos*

7.1 Biophysical and socio-economic characteristics of the three towns

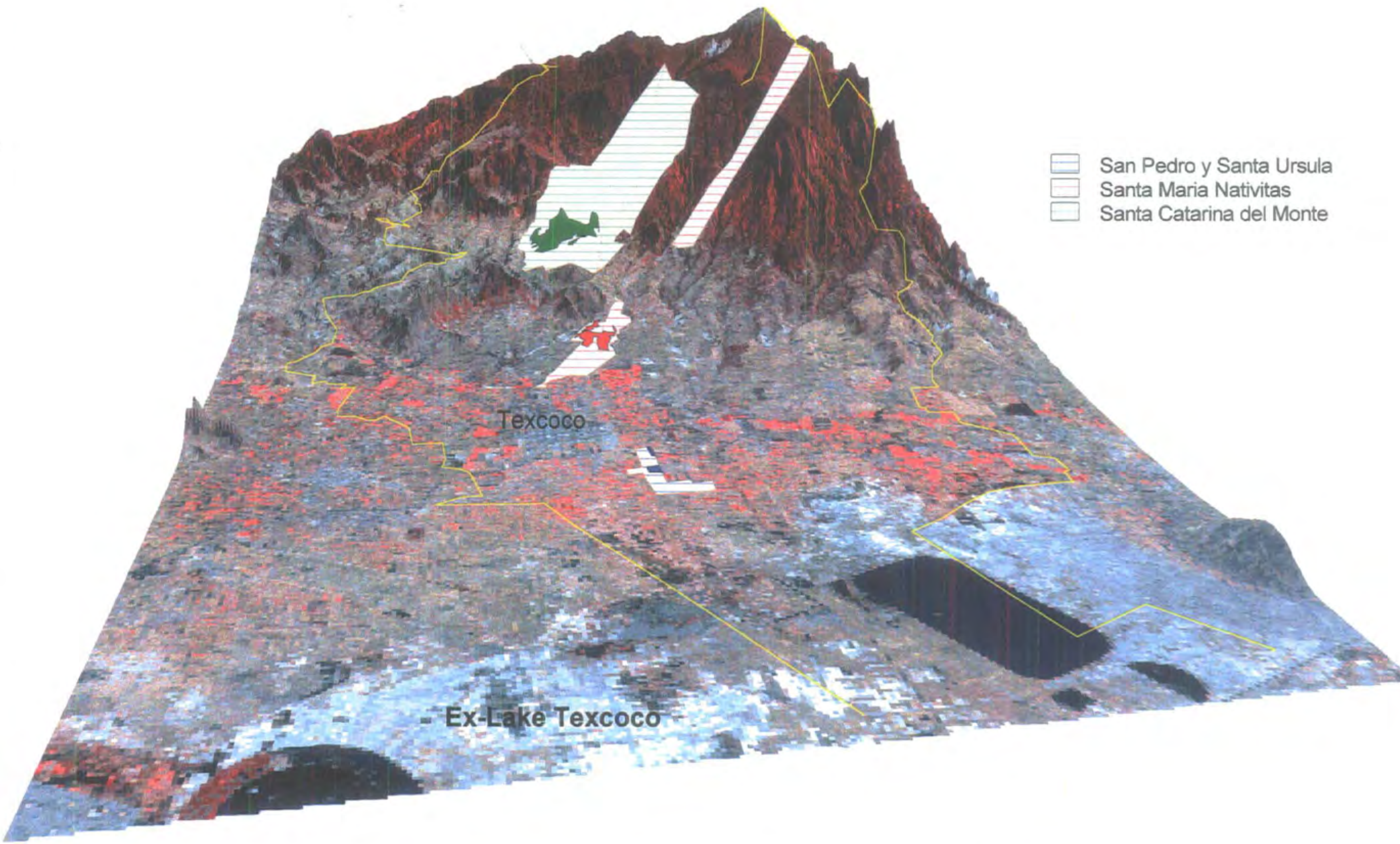
7.1.1 Biophysical Characteristics

The three settlements selected for the study although lying in the watershed of Mexico and only 17 km apart, vary in their biophysical characteristics. San Pedro y Santa Ursula (Pedro) is in the bottom of the valley, with agriculture land of 166 ha. Santa Maria Nativitas (Nativitas) and Santa Catarina del Monte (Catarina) are located in the hilly area and with some land in the mountains. The first with 360 ha of agriculture land surrounding the settlement and an area of land in the mountains under forest vegetation of 542 ha 15km far away from the settlement. The former with 2,392 ha located in the hilly area and sierra surrounding the town.

San Pedro and Santa Ursula are in a flat valley bottom with slopes of less than 3%, with deep soils, the height is 2,442m with semiarid climate, an annual rainfall of 600 mm, with summer rain. In Santa Maria Nativitas and Santa Catarina there are two types of climate: The sub-humid between 2,300 to 2,600m height that has an annual rainfall of 700 mm, with rains in summer starting in May or June and frost from October to March. The land in the mountains above 2,600m with forest vegetation and climate temperate sub-humid, annual rainfall between 800 and 1,200 mm, the rainy season starting in March and first frost in September. Hence the difference in height produces sharp variations in the climate, vegetation, soils and land use in the three *ejido* (Figure 7.1).

This diversity in environment and soils produces different types of agriculture with irrigated lands and commercial crops in the plain areas, with maize, vegetables and fodder crops in the piedmont of the mountains and with subsistence crops of maize and beans combined with small scale commercial crops and exploitation of communal resources in grassland and forest. In the mountains with cold and more humid climate,

Figure 7.1 Location of the three ejidos in the municipality of Texcoco (Overlay of DTM, INEGI, 1998, SPOT Image, 1989 and map of ejidos, Author, 1998)



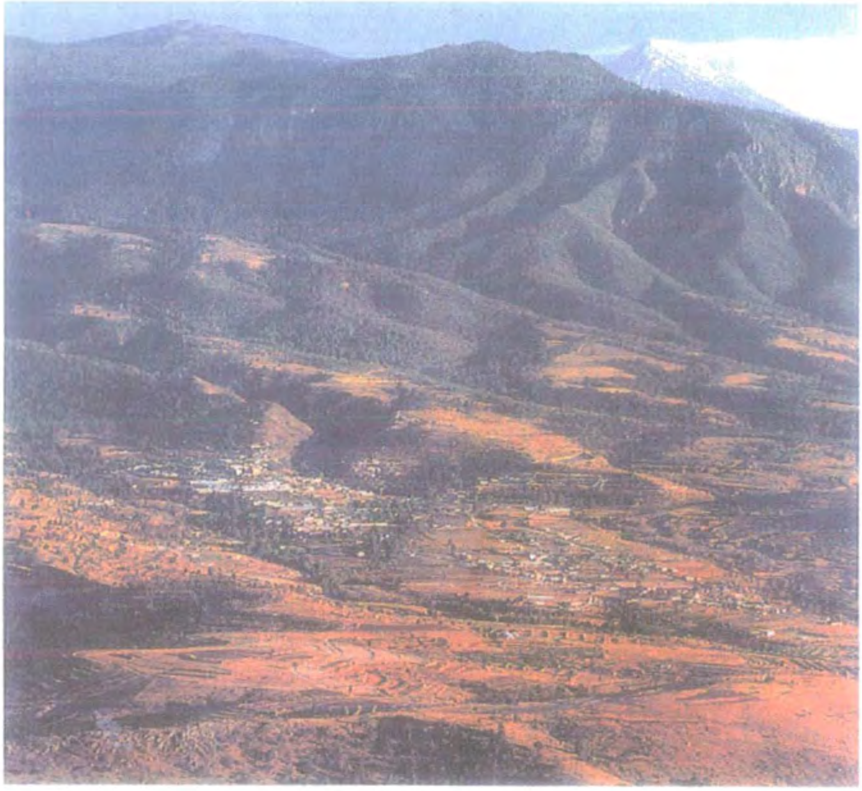


Plate 7.1 Terraced and forest area in the mountains and municipality of Texcoco

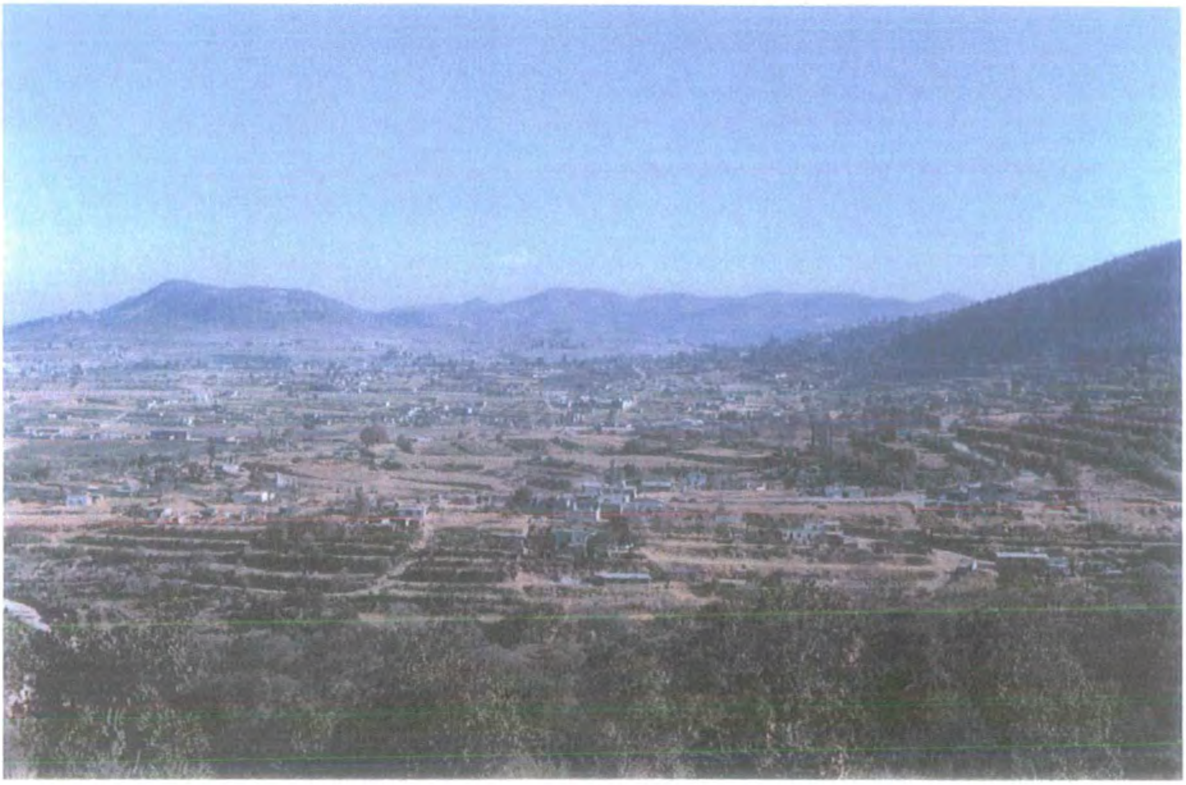


Plate 7.2 Overview of the peublo of Santa Catarina in the edge of the sierra

crops resistant to cold such as wheat, barley, oats, broad beans and potatoes are sown. Through time different combinations and varieties of crops have been adapted to the variable climatic conditions.

7.1.2 Socio-economic characteristics

San Pedro y Santa Ursula are two barrios[1](neighbourhood) founded in the Colonial period in the city of Texcoco. Nativitas originally was settled in the east side of Texcoco, in a place called "*Las palmillas*". The pueblo appears in the actual location in a map of 1790 (Gibson, 1964 p88-89). Santa Catarina del Monte was founded in 1418 when several settlements were established on the edge of the Sierra (Coy, undated cited by Gonzalez R, 1993). Catarina is the only town in which some 10% of the population still speaking Nahutal the native Aztec language (INEGI, 1990). Gonzalez R (1993) reports that most of the Nahuatl speakers are elderly people, and currently the primary education in the School of the town is bilingual in an effort to preserve the language.

Census data from 1900-1995 (Table 7.1) shows that the increase in population has been from the 1960s with an annual growth rate above 3%. The two *pueblos* and the *ejido* of Pedro are still agricultural communities with small rural populations.

Table 7.1 Population in Nativitas and Catarina from 1900 to 1995 (Direccion General de Estadistica Census, 1910-1960; INEGI Census 1970-1995).

Year	1900	1910	1921	1930	1940	1950	1960	1970	1980	1990*	1995
No of inhabitants	n.a	255	282	340	408	502	620	835	1305	3332	3902
Difference			27	58	68	94	98	215	470		570
Rate of annual growth			1.05	2.05	2.00	2.03	1.95	3.46	5.62	n.a	3.42
Catarina											
No of Inhabitants	496	583	720	940	982	1258	1372	1736	2383	3428	4163
Difference		87	224	220	42	318	114	364	647	1045	735
Rate of annual growth		1.75	2.25	3.05	0.44	1.69	0.90	2.65	3.7	4.38	4.28
Pedro											490* *

*The census of 1990 and 1995 comprises the towns of Nativitas and San Dieguito all together. n.a No available

** No information was available from census for the *ejido* of Pedro (communication personal ejidal comisiario of Pedro).

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[1] The cities in central Mexico were divided in barrios since Colonial time. Each Barrio had their political representation in the municipality.

The configuration of the settlement, houses with agriculture parcels and backyard production of crops and rising of livestock reflect this. The density of houses per ha in the area of settlement[2] in Pedro is 2.5, in Nativitas 5.4 houses and in Catarina 4.5 houses per ha. The increase in the number of houses per year from 1980-1995 also indicates the low increase of urbanisation in Pedro 1.28 houses per year, in Nativitas seven house per year with the higher increase in Catarina with 25 houses per year.

The marginalisation of the pueblos is also reflected in the provision of public services surfacing of roads and streets, potable water, network of sewage water and building of public facilities provided by the municipality that do not cover all the settlement area. The roads to Nativitas are surfaced but had a minimum maintenance work. The network of potable water by pipes covers 30% of houses in Pedro, and 93.5% of houses in Catarina. There are no sewage water network in Pedro, in Nativitas 40% of the houses are connected to the network, and in Catarina 56.7% of the houses are connected to the network. Also the sewage network is discharging into the natural streams producing contamination.

The provision of most of the services is done in a bipartite way, with the government providing mainly the materials or machinery for the works and the people the labour. For example for the surfacing of a street the government provides the materials, cement and machinery and the people the labour. The request for public services to the municipality government is the main issue of the municipality delegations. However it is a slow process as was explained by the ex-delegate municipal of Nativitas:

> ‘ If you want the things done you have to go lobbying with the municipality authority in charge of the programme in which you are interested, for example for the surfacing of the channel we were the first to fulfil the invoice and we were every week to ask for the resolution, also we invite the agent to a meal in the town and drink, that is the best way to get the things done, you have to work hard, and spent a lot of time. This is a competition with the other delegations to get the resources that are scarce. Sometimes you are lucky for example, the last municipality government (1994-1997), one of the sub-Delegados of Santa Catarina worked in the office municipality of public

[2] The area of the settlement of the pueblos was estimated in aerial photographs, and the data on population and number of houses form census.

lightning and the main streets of Santa Catarina got public lights. The participation of the people also is important, they are willing to participate, however when the participation is in cash, the problem that, they agree to put the money, when you need the money they invent excuses, for example with the road we are still collecting the fees from some people that are reluctant to pay, or with the sewage network, it was finished in 1995, but only 40% is connected to the network, the other people do not want to pay. This make things difficult because, if the delegation not do as agreed the next year the municipality do not run any programme in the town. It's hard work, without any pay, but one year you can get one street surfaced, or with public light and I hope that one day we will have a 'decent' town with all the public services it is in our benefit'.(*Delegado Municipal*, Nativitas 57 years).

7.1.2.1 Economic activities

The agriculture activities have declined in the *pueblos* and any increases of the occupational activities are in industry, and there is less provision in the sector of services (Table 7.2). During the interviews the *ejidatarios* said that recently to find a paid job is hard, including for their children that had technical training or are graduates from Universities. Most of the work that they can find is temporary in agriculture as carriers in the markets, gardeners, mason helpers. Information on the census carried out in the year 2000 is still not published. However from data of this research in Nativitas a considerable number of *ejidatarios* have activities in the sector as traders[3], and most of the *ejidatario*s have as main occupation agriculture activities. The inactive people (mainly women and under 18 years old) decreased in Santa Maria Nativitas in 85 (10.8%) and increased in Santa Catarina in 85 (11.5%) and during interviews the people said that more of the youngest people specially men are unemployed. The difference on decrease of unemployment among the two towns is maybe because currently woman can get part time job as maids or when they have technical training as secretaries, helpers in shops; this situation is common in Nativitas. However in Santa Catarina the view about the role of woman is more traditional as was said in an interview:

[3] Most of the traders are in the informal sector, such as sold of bread alongside roads, sale of food outside the door house, rent of horses to tourist in the national park, etc. As these works are in the informal sector of the economy and declare it as an activity with remuneration could cause trouble, because they are not paying taxes over this income.

'the married woman have to be at home with the children, and the single woman will go out from her home to the altar in the church to be married' (*Comunero* SCM, 52 years).

Table 7.2 Population and economic activities in 1980 and 1990 (INEGI, 1980,1990)

Year	People with employment.	Primary sector	Secondary sector	Tertiary sector	Inactive[4]
1980	717	356	78	283	872
1990	737	241	211	286	787
Change	2.7 (+)	32.3(-)	170.5(+)	1 (+)	10.8(-)
CATARINA					
Year of census	People with employment	Primary sector	Secondary sector	Tertiary sector	Inactive
1980	754	380	11	363	735
1990	775	312	92	371	820
Change (%)	2.7 (+)	20.5 (-)	73.6 (+)	2.2(+)	11.5(+)

7.1.3 Government map for planning land use in the municipality

The government for planning land use and management has produced diverse maps. In 1927 land suitability studies were carried on for the allocation of land to the *ejidos* according to their suitability. In the 1970s INEGI produced disciplinary maps of land resources, soils, topography, land uses and geology at scale of 1:50,000 to support government planning. The soils in this period were also surveyed at the level of soil series (Cachon et al, 1974) to produce recommendations of management according the land capability (Kliengebel and Montgomery, 1975) and suitability for irrigation (USBR, 1959). A survey using the land system approach (Christian and Stewart, 1959) was carried out for the recommendation of land uses with soil conservation purposes according land suitability (Kliengebel and Montgomery, 1975) for the whole municipality (Ortiz, 1977). Also a map of land uses 1:10,000 was produced for the identification of land use type for the municipality (Ojeda, 1993). These maps were produced using GIS in the present research for the three *ejido*s. From 1992 with certification of *ejidal* rights, maps of tenure at scale of 1:5000 are available for the three *ejido*s. The maps at *ejido* level and data about land resources produced from

[4] Inactive: People that in the week of the census do not work for a salary (Students, housewives, pensioners, handicap people, etc). Tot. with employment: People more than 12 years old with working for a salary: Primary sector: in activities related with Agriculture, forestry or livestock. Secondary sector: In activities related with industry(manufacturing, water or electricity) and construction. Tertiary: In activities related with trade, transportation, communications and services.

these maps will be discussed against the participatory maps to compare the understanding of land uses in the three *ejido*s.

7.2 *Ejido* of the barrios San Pedro y Santa Ursula

The *ejido* was allocated in 1933 with seasonal land of second class to 49 people. The actual number of people with parcels in the *ejido*s is 50 and four *posesionarios*[5]. The total area of the *ejido* is 167 ha, from this 154.59 are in parcels, 2.9 ha are communal and 10.28 ha are in infrastructure (Figure 7.2). The number of parcels is 94 accesses of parcels by four *posesionarios*. The actual distribution of parcels is: 16 *ejidatarios* with one parcel, 29 with two parcels, four with three parcels and four *posesionarios* with one parcel each (Table A7.1 Appendix 6).

7.2.1 Soil maps

The government soil map shows the distribution of the mapping units in the *ejido*, grouped according to the morphological characteristics of the soil, in soil units or soil series. The 1:50,000 INEGI map has cartographic units representing associations of soils. There are two associations identified: 63 ha of chromic vertisol + pelic vertisol with fine texture (clay) and 100 ha of haplic Phaeozems with fine texture (Figure 7.3). The main limitation for use of this map in a planning context is the cartographic generalisation of the soil units since within the *ejido* either soil pelic or chromic vertisol could be found.

The 1:25,000 soil map after Cachon et al (1974) recorded three soils series: Chapingo Horno and Boyeros (Figure 7.4). The map provides recommendations for

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[5] The tenure as posesionario is included in the Agrarian law of 1992 to certificate the rights over parcels in possession of non-ejidatarios, the non-ejidatarios that have possession of parcel of land in 1994, were recognised in the ejidal assembly and PROCEDE provided a certificate of the possession. They have the rights of usufruct of the land, but not transfer of this right to third persons, neither the right to participate in the ejidal assembly.

Figure 7.2 Map of land tenure in Santa Pedro y Santa Ursula (Author, based on the map of PROCEDE,1994)

Figure 7.3 Soil Units in the ejido of San Pedro y Santa Ursula(INEGI, 1982)

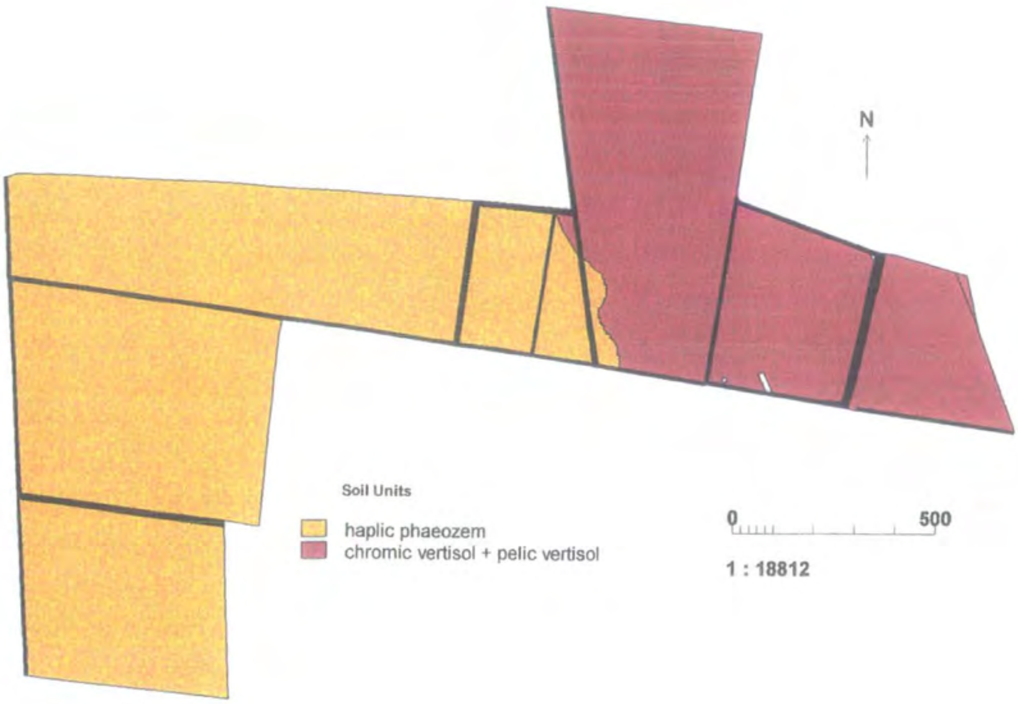
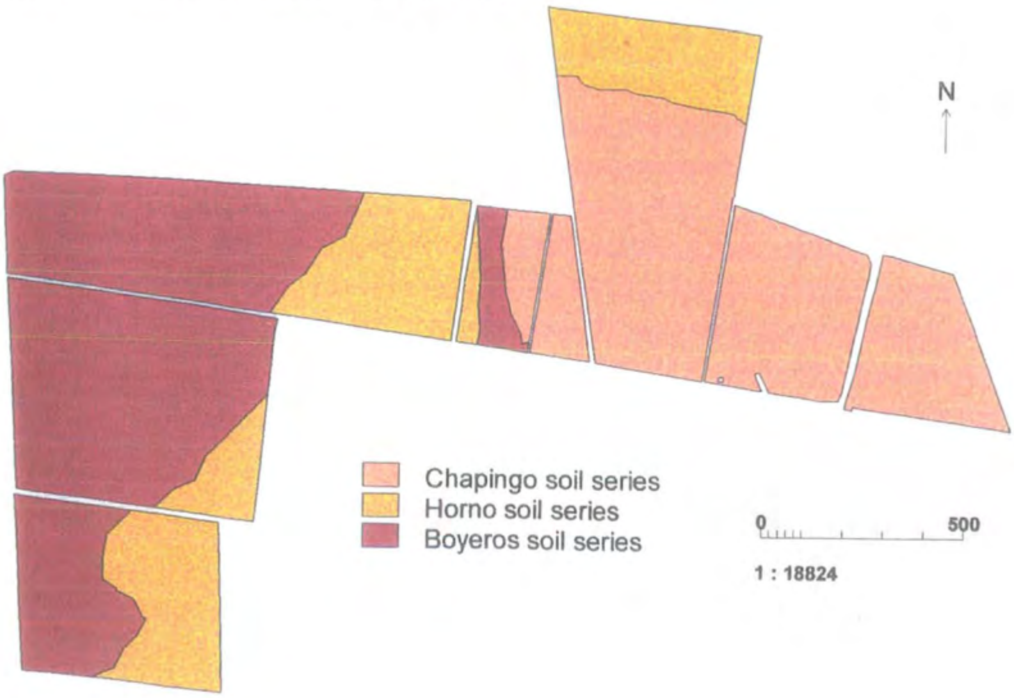


Figure 7.4 Soil series In San Pedro y Santa Ursula (Cachon et al, 1974).



management of the soil series for its use in irrigation as follows: Chapingo and Horno Series are class I and do not have any restrictions for irrigation; the Boyeros series is class III-h, and the limitation for the crop growth is the presence of a horizon saturated with water at the depth of 115 cm. For irrigation the recommended management is careful control of the irrigation system to avoid rise in the water level in the sub-soil.

During the fieldwork *ejidatarios* revealed that they differentiate *ejidal* land first by seasonal and irrigated areas, and recently they differentiate the soils irrigated with sewage water. They then identified the soils by the specific management that the owner gives to the parcel (incorporation of organic matter, amount of fertiliser applied) or the crop sown, for example a parcel with alfalfa, after four years is good for growing vegetables, or a parcel under a mono crop of corn is not adequate for growing vegetables. They take into account the characteristics of the soil using management and production as an indicator of its quality.

Their perception of the different areas of soils was not the same when all the *ejidal* land was under seasonal agriculture. The oldest *ejidatario* of the group (68 years) commented

> 'the differences in the soil of the west and east of the *ejido* were evident, when the land was under seasonal agriculture. The soils in the east had better and more consistent yields; the soils of the west of the *ejido* produced variable yields in the rainy season in very wet seasons, the maize became yellow in some areas because, the soil '*no chupa*' (do not suck the water). When we have irrigation, the people started to improve the land by the incorporation of organic matter. This improved the soil and the yields. Also in the past the rain was very heavy and lasted several hours or sometimes days, now the rains are very short and light. Currently you can see spots of yellow maize in parcels that have not been improved with organic matter. The people that sow vegetables know their land well and how many times they have to irrigate the parcel, in some tracts you put more water, in others less, depending where the soil '*no chupa*' the water'.

The boundary of the east area of soils identified by the *ejidatarios* coincides in general terms with that of the Boyeros soil series of Cachon et al (1976). In some parcels some saline spots are observed in the east area of the *ejido* lands.

7.2.2 Land use maps

The 1982 1.50,000 INEGI map represents land use and type of vegetation, and in cultivated areas the dominant crops are specified for each land use. In the *ejido*, the land use is irrigated land and the main crops are alfalfa and maize. The main limitation of this land use map for planning is the scale since the *ejido* is only 160 ha in size. In several cases non-irrigated land surrounded by irrigated land is erroneously mapped as irrigated. Furthermore, cartographic unit aggregates crops, and the diversity of crops is not represented (Figure 7.5).

In the 1994 1:10,000 map of land use for the Municipality of Texcoco (Ojeda, 1993), the *ejidal* lands are included as part of a composite cartographic unit with five crops: alfalfa, grain maize, maize forage, carrots and courgette. Even this diversity fails to convey the diversity of crops in the irrigated and seasonal area found in the *ejido.*

The participatory mapping produced two maps: one of main land use and the other of crops by parcel. The former identified six land uses: land irrigated by wells, land irrigated with sewage water, seasonal agriculture, forest nursery, communal land, and land with houses (Figure 7.6). Three land uses not included in the available maps were identified by the *ejidatario*s: irrigation with sewage water, forest nursery and communal grassland.

The second map of land at parcel level identifies the crops by parcel. The crops sown in the *ejido* are maize (88 ha), alfalfa (48 ha) vegetables (29 ha). The map shows the complex pattern of crops, 16 different crops, and some parcels with two or more crops (Figure 7.7) The map produced by the *ejidatario*s show the diversity of crops and indirectly the strategies of production. Most people with alfalfa and maize as a main crop have agriculture as a secondary activity and most of them work outside agriculture; some *ejidatario*s with alfalfa have dairy cows (four) the *ejidatario*s that have agriculture as their main activity sown commercial crops such as vegetables.

The differences between the participatory land use map and the other two maps (INEGI, 1982 and Ojeda, 1993) are produced by the difference in scale 1.50,000 and 1:10,000, which of necessity requires the aggregation of crops within a mapping unit.

Figure 7.5 Land uses in the ejido of San Pedro y Santa Ursula(INEGI, 1982)

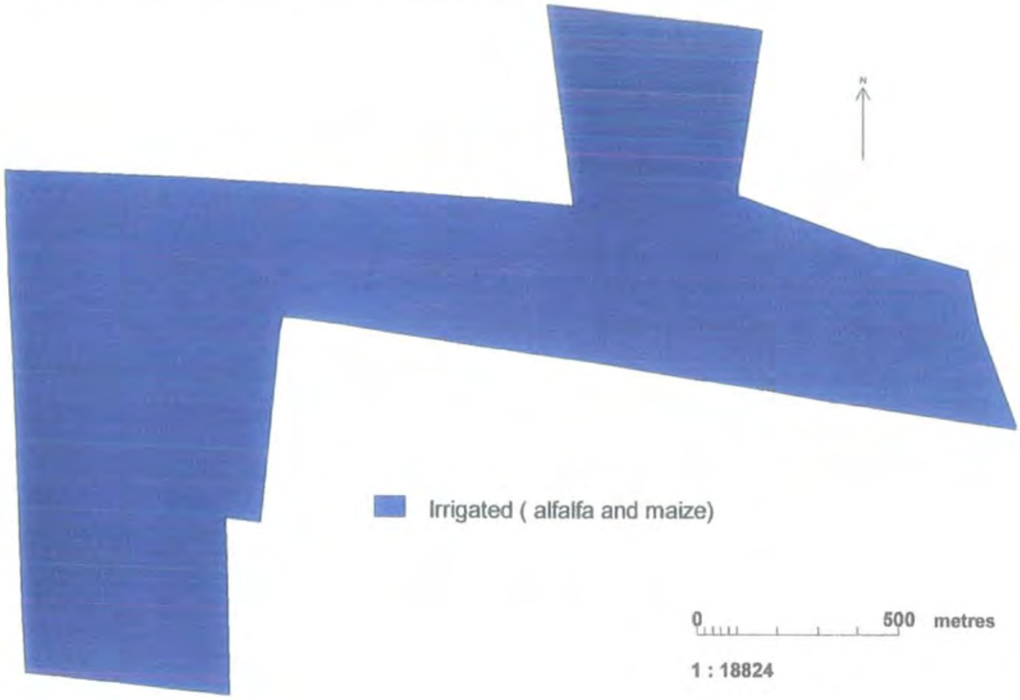


Figure 7.6 Main land use map produced by the ejidatarios of San Pedro y Santa Ursula (Fieldwork, 1998)

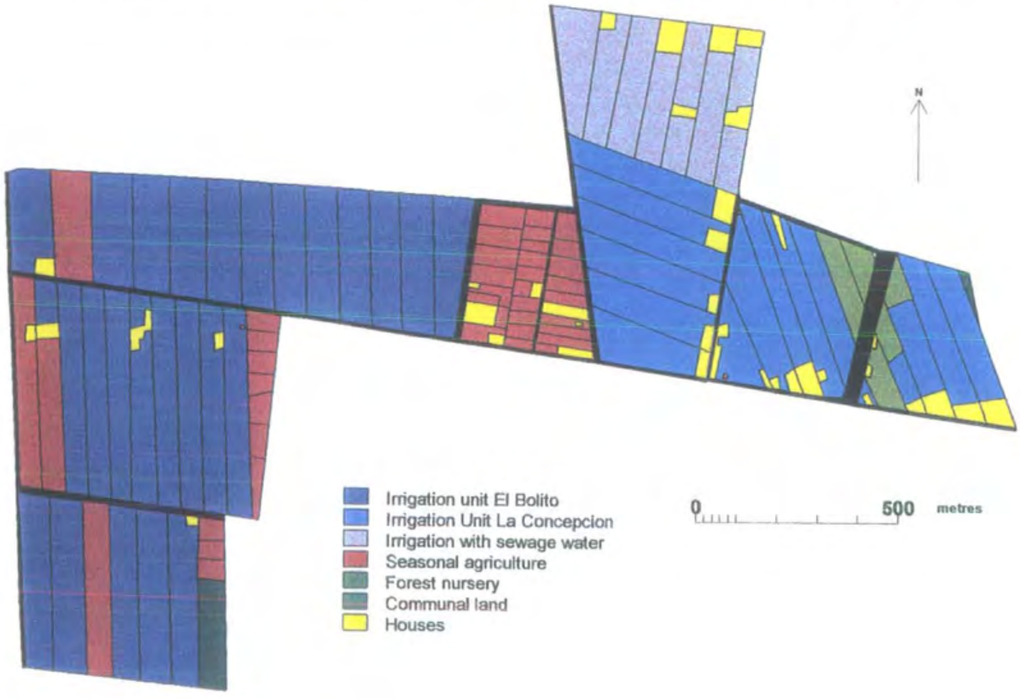
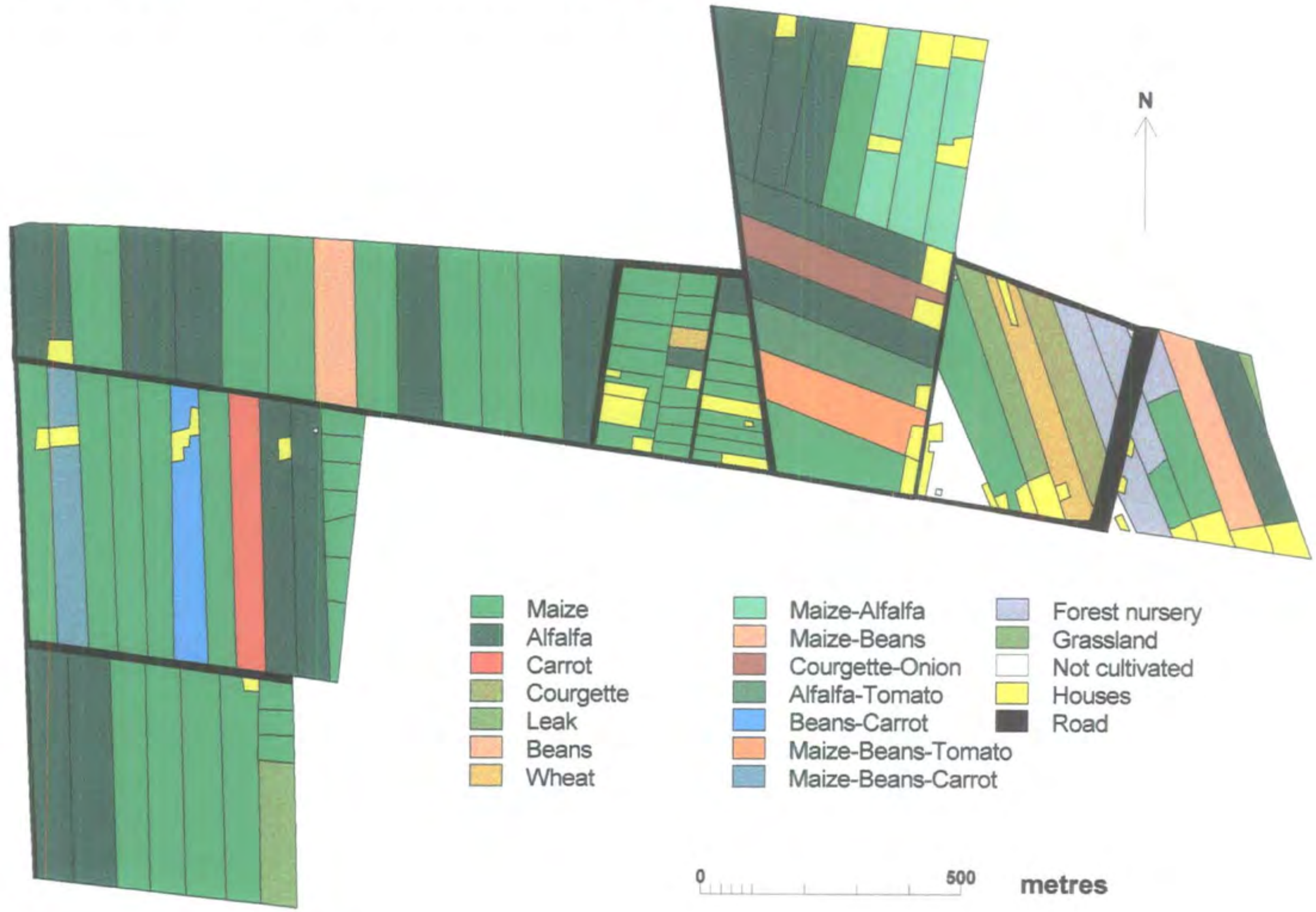


Figure 7.7 Inventory of crops in the ejido of San Pedro y Santa Ursula (Fieldwork, 1998)



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7.2.3 Irrigated agriculture

The irrigation system consists of two wells drilled in 1975 together with a concession granted in 1994 for the use of 157,683 m³ of water from the San Lorenzo River. The irrigation system are organised as "*Unidades de Riego para el Desarrollo Rural*" Irrigation units for Rural Development) and the amount of water used for irrigation is supervised by technicians of the DDR03 Texcoco. There are two irrigation units: "La Concepcion" constituted with 16 users and 47 ha under irrigation and "El Bolito" with 21 users and 63 ha under irrigation (Fig 7.6).

The irrigation system is used as supplementary providing one or two irrigations at the beginning of the agriculture cycle to allow the crop to establish prior to the onset of the regular summer rains. Additional irrigation is used when there is a period of drought during the rainy season. The alfalfa is a semi-perennial crop that lasts four years and receives nine irrigations per year. The vegetables are sown in March and have five irrigations per year.

Administration of the irrigation units is by a board of directors (Mesa *directiva*) that is elected every three years by the '*socios*'[6] of the well. The Board are in charge of the distribution of water and the maintenance of the equipment and channels. The annual irrigation cycle begins in March with the supply of water to vegetables sown before the rainy season. The distribution of water in the 'La Concepcion' unit is as follows: Alfalfa is irrigated all year and has its last irrigation in February. March is the month for the sowing of vegetables. April and May are the critical months for irrigation because this is the period for sowing maize and other crops and all 47 hectares will be under irrigation. The assignment of water in April and May is by lot and each *ejidatario* has the right to an 8-hour "block" of water for irrigation every 27 days. The well operates from 5 am to 9 pm daily during this period. The assignment of water operates as follows: The '*socio*' first in the draw irrigates their parcel on April 1st from Five am to one pm, the second in the draw from 1 pm to 9 pm and the others successively over the following days. Irrigation of the 47 ha takes 26 days. In the 27th

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[6] The government and *ejidatarios* and the ownership of the well rest in the group shared the expenses for the drilling and equipment of the wells. The users call themselves '*socios*' of the well.

of April, the first '*socio*' has water again for another eight hours. This is a period of intense negotiation among the '*socios*' especially those that have drawn late in the allocation and who have alfalfa, or March sown vegetables. As a result of negotiations more complex arrangements about irrigation times are the norm, for example, a '*socio*' that needs the water obtains four hours from his *compadre.* On rare occasions water allocation is actually sold, but normally it is by exchange involving a 'couple of beers' and the implicit promise 'I owe you one' (*ejidatario*, 38 years).

Actually the problem of the irrigation system is the collapse of the well *La Concepcion* in 1998, and to this reason the drilling of a new well is necessary. The cost of drilling of a new well is around £40,000, which means around £2,500 to each '*socio*' a sum they imply that they do not have. They are seeking government support but negotiations have failed, and it is very unlikely that the irrigation system will restart its operations.

Also the fees charged for irrigation, which in 1995 was £10 per water 'block' of eight hours, increased. However the subsidies for electricity for the irrigation units were cut in 1995 and since then the bills have increased by 40%, with the water charges also increased by 40%. Several of the '*socios*' commented that the rise in cost of water makes the cultivation of irrigated maize unprofitable; vegetables however are still profitable but as the market is very risky few '*socios*' grow vegetables.

> ' I used to sow vegetables and maize, one hectare of vegetables and two of maize. However in the last year I have sown carrots, I have any profit because the prices were low. Actually to repair the well of the *ejido*, broke down last year or to sown vegetables, I need money that I do not have. I am going to sown maize the next two years, but as all the products prices increase (fertilisers, seeds, herbicides), and now with the increase in cost of water and maize prices declining. I have to think very careful about it. Maybe is better to follow the advice of my compadre 'sell half or one hectare of your land and you will be not worried for money'. (*Ejidatario* 40 years)

7.2.3.1 Irrigation with sewage water

The concession to get water from San Lorenzo River was granted in 1994. The river is used to discharge the sewage water from the urban areas upstream, and the water used for irrigation is non-treated sewage water. The water is taken directly from the stream and is conducted by channels to the parcels. Administration of the sewage water is organised by the *Comisariado Ejidal*. However, as few parcels are irrigated, the users take the water when necessary.

Sewage water is used in the irrigation of maize and alfalfa on seven parcels adjacent to the river occupying 20 ha (Figure 7.6). After the collapse of the well of *La Concepcion*, one of the options proposed by a group of *ejidatario*s was the building of a tank for the storage of the sewage water to enable them to have enough water to irrigate the parcels of the unit. The proposition was dismissed by the '*socios*' because they grow vegetables, and the government prohibits the use of sewage water for irrigation of these crops. The '*socios*' also argued that this is the area with houses, and the use of sewage water could cause diseases, and produce bad odours.

7.2.4 Seasonal Agriculture

Seasonal agriculture occupies 22 ha and is carried out by those with no access to the system of irrigation, for which maize is the main crop, and the seasonal land comprises 35 plots of less than one hectare and six plots of more than two ha. Cultivation is mechanised and the crop grown is improved maize supported by use of fertilisers and herbicides. The yield of maize is around 1.5 to two ton ha^{-1}.

7.2.4.1 Crops and management

In the inventory of crops during the fieldwork it was found that the crops sown are grain crops, fodder crops and vegetables. Also the *ejidatarios* sow one or several crops in their parcels (Figure 7.7, Table 7.3). Maize (forage or grain) is the main crop sown covering an area of 65 ha in 54 parcels. Labour is mechanised, and fertilisers and herbicides are used as current practice. The average yield of maize for grain is 3-4 t ha^{-1} and forage maize 60-80 t per ha^{-1}. Production of both grain and forage maize is oriented to market and is sold to the neighbouring *ejido*s with dairy farming. Land is worked with rented machinery, and contracts of sharecropping or rent of parcels by those owning machinery or with dairy farming is common.

Alfalfa is sown in an area of 42 ha. Alfalfa is sown in winter, requires levelling of land and is fertilised with 200 kg ha^{-1} 17-17-17 NPK and with additional annual dressing of 100 kg ha^{-1} of the same formula. Alfalfa production is sold 'in the parcel' to the larger dairy farming producers in the region. Within the *ejido* there are few *ejidatario*s involved with dairy cattle and these are in small herds of less than 10 cows. Alfalfa is the preferred crop for several reasons. First it is a profitable crop in the long term and there are low risks of low prices at market as with vegetables. Second the cost of planting is high but intensive labour is not required, with 9 irrigations and one application of fertiliser per year. Third the demand for alfalfa is very high in winter and a well-managed parcel can achieve good prices. Arrangements for the sale of alfalfa centred on periods of time, parcels are rented by one harvest period, 5-6 months or a year, and as the price is negotiated each time, the price can be adjusted according to the demand. There are two types of arrangements: a) the parcel is rented to sown alfalfa for one cycle (4 years) the tenant is responsible for planting the crop and paying the cost of irrigation. The rent is agreed annually. This arrangement is among *ejidatario*s with long-term relations, relatives, *compadres*, or people of the same *ejido*. b) The *ejidatario* sows the alfalfa and pays for water and fertilisation. The alfalfa is then sold by area and periods of time, for example a tract of 2000 m^2 of alfalfa is sold for the period December to March; the people that rent can harvest the alfalfa during that period. This system has the advantage that the *ejidatario* can adjust prices through the year in response to demand.

Vegetables are sown by 11 *ejidatario*s in 17 parcels, covering an area of 28.2 ha. The crops sown are green beans, pumpkin, carrots, leek, onion, green tomato and maize. There is no standard practice of planting vegetables; sometimes they are grown individually and sometimes as mixtures in the same parcel (see table 7.2)

Table 7.3 Inventory of crops in the *ejido* of San Pedro y Santa Ursula (Fieldwork, 1998)

Crop	No parcels	*Ejidatarios*	Area (ha)
Grain			
Maize	54	18	65
Fodder crops			
Alfalfa	17	15	42
Maize-alfalfa	5	5	6.51
Wheat	2	1	2.66
Vegetables			
Green beans	1	1	2.43
Pumpkin	1	1	2.19
Carrots	1	1	3.20
Pore	1	1	2.04
Combined crops in plots			
Maize[7]-green beans		1	4.30
Pumpkin-onion	1	1	2.65
Green beans-carrot	2	2	2.80
Alfalfa-tomato	1	1	2.87
Maize-green beans-tomato	1	1	2.79
Maize-green beans-carrot	1	1	2.85
No crop	1	1	1.64

(See figure 7.7)

The growing of vegetables started in the 1980s when a 'middle' man from Mexico City rented land from an *ejidatario* to grow carrots. The *ejidatario* decided after two years to change to sharecropping, although, in 1985 the *ejidatario* decided to plant by himself as he knew people in the market of Mexico City. Other vegetables were introduced under technical advice from the neighbouring agriculture University, and advice from farmers from the neighbouring *ejidos*. Cultivation of vegetables is very expensive owing to the cost of seeds and other inputs, and high amounts of fertiliser required (up to 150 kg ha^{-1} of nitrogen). Pesticides are also very expensive. The growing period varies from 90 days for cucumber to 180 for carrots. Crops are sown from March to June with up to five irrigations. Harvesting is also expensive, as it usually involves scarce hired labour.

As the marketing of vegetables is very variable and the cost of production is high, in order to cope with the risk, several strategies are followed. Renting land to a

[7] The maize cobs are sold before their reach maturity.

middleman or another *ejidatario*, the tenant pays a fixed amount of money, around £350 per hectare, and takes the risk.

In sharecropping with a middleman, the latter contributes seed, fertilisers and pesticides and handles the sale of the crop, whilst the *ejidatario* contributes land, management of the crop and labour. The profit is shared after expenses are deducted.

The *ejidatario* grows and harvest the vegetables himself and then sells them. It has two options to sell the crop directly in the market or from the parcel to the middleman.

When the *ejidatario* sows the crop by himself, two strategies for sale are available: Direct sale in the market is carried out when the *ejidatario* owns or has access to transport and sale to a middleman with a price negotiated according to the current price in the markets. For crops such as tomatoes, green beans and pumpkin, which are harvested over a period of four to six weeks, the price, which fluctuates over a short period of time, is negotiated weekly.

The decision to sow vegetables is made each year. One *ejidatario* explained:

> 'It's a lottery, one year you can make a lot of money, and the next you can lose all your investment' (*ejidatario*, 40 years).

The *ejidatario*s of Pedro have an advantage over other areas because of the short distance to the market of Mexico City. The decision-making processes by the *ejidatario*s require the acceptance of risk taking but at the same time trying to minimise the risk. Where a single crop of carrots or onions is involved there is some leeway in that the harvest can be delayed in the hope of better prices, so regularly checking of prices is important. On some occasions prices have been known to change from £1.50 to £8 for a 20 kg box of carrots within one day. An alternative is to grow two or three crops in the parcel. Where maize or beans are grown both can be sold as 'grain' rather than the vegetables if the price is higher. The experience of the *ejidatarios* is that when the price of one crop is high in the market one year, the next year the area sown with this crop increases and the price inevitably falls.

New opportunities for selling vegetables have arisen including direct selling in the markets of the region. To aid this *ejidatario* producers from several *ejidos* (San Bernardino, Tocuila, San Diego and San Pedro y Santa Ursula) have combined to create a marketing organisation. In 1994 the organisation pressured the Municipality government to help with their marketing. This permitted them to sell vegetables directly to the people outside the local market every day from 6 am to 8 am prior to the opening of the local market. The Municipality currently has a scheme for the construction of a retailing centre of vegetables in the municipality, just half a kilometre from San Pedro y Santa Ursula.

7.2.5 Dairy farming and cattle

Five *ejidatarios* have small dairy farming enterprises of five to 15 cows. Cattle are fed with alfalfa, forage maize and straw of maize produced in the *ejido*. Milk is sold directly to the consumer, and to the cheese factory in Texcoco.

In the 1990s farmers of the municipality started to buy cattle for meat production from tropical areas of Mexico (Chiapas, Veracruz, Puebla, Tabasco, Michoacan). Cattle are fattened for a period of up to six months and are then sold direct to butchers or slaughterhouses. Recently one *ejidatario* that owned a meat shop, bought 20 cows, fed with grains produced in his own parcel. This included maize, wheat, and straw, plus vegetable wastes. The introduction of this new activity was on advice of his '*compadre*' (*ejidatario* of San Diego) who taught him how to manage the cattle, and to mix food.

There is also intensive production of pigs by some *ejidatarios*, for marketing in backyard production in herds of 10 to 20 pigs. These animals are fed with grains and vegetable wastes produced in the *ejido*.

7.2.5 Second step of the land reform

7.2.6.1 Programme of certification of *ejidal* rights (PROCEDE)

At the end of the certification of *ejidal* rights in 1994 the *ejidal* assembly had to decide which system of tenure to have to adopt: *ejidal* tenure or the '*Dominio Pleno*'. This decision resulted in a conflict among the *ejidatarios*; those favouring the *ejidal* system won and the land remained as *ejidal*. However in 1998 the assembly reversed the decision and decided to have '*Dominio Pleno*' over the parcels. As this decision changed the arrangement of access to land, the implications of this change are discussed in the following paragraphs.

Following the 1994 decision to remain as *ejido* and to keep agriculture as the main land use, the *Comisariado Ejidal* requested the inclusion of *ejidal* lands as 'protected agricultural lands' to the Municipality Committee for the prevention and control of the urban growth in Texcoco. In November 1996 however the group in favour of the change to *'Dominio Pleno'* called an *ejidal* assembly asking for a change of the *ejidal* authority members. The proposition was voted on and the *ejidal* authorities were dismissed by a majority of one vote. The new *ejidal* authority submitted a new request to the Municipality authorities asking for a change from "protected agricultural land" to "urban land of low density". At the end of 1996 the lands of the *ejido* were changed to this category. The *ejidal* assembly in September 1998 decided to acquire the '*Dominio pleno'* (Acts of Assemblies, 1994, 1996, 1998, Archives *Procuraduria Agraria* Texcoco), it becoming the first *ejido* to ask for the 'D*ominio Pleno*' in Texcoco. The request was submitted to the offices of the *Procuraduria Agraria* for its approval, although by the end of 1999 approval has not still been granted, apparently because the requested environmental impact assessment had still to be carried out (Pers. comm. agent of the *Procuraduria Agraria* Texcoco, May 2000).

The *ejido* of Pedro located only five minutes from Texcoco and some 30 minutes from Mexico City is a rural settlement with houses built in the parcels and along side the roads, and with commercial agriculture as the main activity. By its location it is an attractive place for housing and building of real estates. During the interviews the people complained about the provision of services by the municipal authorities, these involved lack of a sewage system, electricity, and water, inadequate support from the government for the commercialisation of vegetables, and general subsidy for agriculture. People also expressed concerns about the possibility of becoming part of the urban area of Texcoco and with the consequent change in their way of life

> 'I built my house in the *ejido* in 1975, there was no electricity, no sewage or and the road was a dirty track. We have the water form the wells, however there was no electricity or sewage system. Actually only the houses along the main road have electricity, but there is not sewage system. Also with the collapse of one of the wells problems of provision of drinkable water are frequent. When I get my pension, I sow vegetables, however, the commercialisation of the crops is problematic. Recently with the building of the real estate neighbour to the *ejido* lands, during the night the vegetables are stolen by people living there'.

Currently 30 parcels have houses and around 100 families of *ejidatario*s and their relatives have their residence in the *ejido*. The reason for moving their houses to the *ejido*, were explained as: a) crops under irrigation require more attention, and theft of crops was becoming common, especially maize in cob and vegetables, b) potable water and better communications made it sensible to move house. In fact the first to move were the *ejidatario*s with work in the neighbouring University. Recently, with increases in the value of land, (with prices per square meter adjacent to the *ejido* at £8 to £13 (Comisariado *ejidal*, 1998), the value of one hectare of land in the *ejido* could be around £80,000 to £130,000. The high value of the land and the decision in 1998 to have the "*dominio pleno*"[8] transforms the view of the land from a place of residence of the family into a commodity. The future of the *ejido* is seen by one group as an agriculture unit and by another as an opportunity to make profit. One *ejidatario* expressed his view as follows

> ' Yes, you can sell the land and go out of poverty (*salir de pobre*), but what happens when you have spent the money, you have nothing; but cultivating your parcel is hard work and with vegetables risky, some years you lose

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[8] Under the new Agrarian law in ejidal tenure the ejidatario can sell the parcels to other *ejidatarios* or *avecindados* (individuals over 18 years old living in the ejido and recognised as avecindados by the ejidal assembly) or rent it to non-*ejidatarios*. Under '*Dominio pleno*' the individual *ejidatario* can decide the change of the ejidal tenure to private property, the ejidatario that want to change to private property his parcel have to request the deletion of the certificate from the databases of the *Registro Agrario Nacional* (National Agrarian Register) as *ejidal* land, and afterwards he can register the parcel as Private property land in the databases of the Registro Publico de la Propiedad.

Plate 7.3 Parcels with houses and alfalfa field in San Pedro y Santa Ursula

Plate 7.4 Parcel sown with vegetables in San Pedro y Santa Ursula

money, but review your balances (*hacer cuentas*) in the long term. When you are old, your parcel will give you money to eat, and to send your children to school, at the end you have the two things, money and land. It is a foolish thing to sell the parcels' (68 year old *ejidatario*).

7.2.6.2 Participation in Alianza para el Campo Programme

The *ejidatarios* of San Pedro y Santa Ursula participated in only one programme. This involved the lining of two km of irrigation channel. The lack of participation in other programmes is because the *ejidatarios* found that the Alianza Para el Campo programmes did not address the problems of the *ejido*. These problems are seen by the *ejidatarios* to be: support for the drilling of a new well in the irrigation unit, subsidies for electricity costs of the well pumps, support for the commercialisation of vegetables, advice for planning of the "urbanisation" in the *ejido* and the provision of services to houses namely secure electricity, a sewage system and drinkable water.

The actual government policy encourages the use of improved maize seeds that require high inputs of fertiliser and pesticides. Any *ejidatario* can participate in this programme as one *ejidatario* said

> 'The government offer requires you to take everything, credit, seeds, fertilisers and pesticides and do the things the advisor says. As most farmers have some livestock and there are also 5 dairy farms, manure is abundant and is free, whereas the fertiliser and herbicides are expensive. It is also cheapest to use the tractor, which does not poison the land. Furthermore if the rain fails, the yield will be low, and if you have adopted the government advice, you will have a large debt' (*ejidatario*, 70 years old).

7.2.6.3 Programme of subsidy of crops (PROCAMPO)

Under the requirements of the PROCAMPO programme the registration of parcels was carried out in the summer periods 1994 and 1995. To be entitled to the subsidy a parcel has to be sown with one of the basic crops: corn, beans, soybean, sorghum, cotton or safflower supported by the programme in at least the previous two summers. In 1997 the total subsidy for the *ejido* was £1,465 given to 17 *ejidatarios* (varying from £44.81 to £110.7 per *ejidatario*, Table 7.4).

Table 7.4 Subsidies, crops and area supported by PROCAMPO, by Tenure in the ejido of San Pedro y Santa Ursula (Archives PROCAMPO, DDR0Texcoco, 1998)

Ejidatario	Area (ha)	No of parcels	Crop	Subsidy
1	1.25	1	Courgette	44.81
2	1.45	1	Pore	51.99
3	1.50	1	Alfalfa, Tomato	53.78
4	1.50	1	Green beans, carrot	53.78
5	2.00	1	Green beans	71.70
6	2.00	1	green beans	71.70
7	2.50	1	Alfalfa	89.63
8	2.50	1	Maize, Beans, courgette, tomato	89.63
9	2.68	1	Maize, beans	96.08
10	2.82	2	Wheat	101.10
11	2.83	1	Maize	101.46
12	2.93	1	Maize	105.05
13	2.93	1	Courgette	105.05
14	2.95	2	Maize	105.76
15	2.96	1	Beans	106.12
16	3.00	1	Green beans	107.56
17	3.07	1	Alfalfa	110.07
	40.87	19		1465.26

The *ejidatarios* without subsidy have been requesting the registration of their parcels since 1996, but the agents have so far refused maintaining that the register was closed in 1995.

The reduced participation of *ejidatarios* is explained by a number of factors: a) the parcels sown with alfalfa, forage maize and vegetables were not eligible b) the certification of parcel rights finished at the end of 1994, and some *ejidatarios* thought that under the new tenure arrangements receiving money from the government could be a threat to their ownership, as they believed that the government might be able to confiscate their parcels c) the *ejidatarios* thought that receiving the subsidy implied that they had to sow the same crop every year, and hence restrict their selection of crops. d) procedures to received subsidy have to be done annually and are very bureaucratic.

One *ejidatario* considered that the subsidy was government charity, saying:

> 'the subsidy is a '*Limosna*' (charity), the government do not really help the people, we need help for the drilling of the collapsed well. With the water we could produce, with '*pinches*' (bloody) five hundred pesos (£37) per year each, we can do nothing'

7.2.7 Other income generating activities

Most of the *ejidatario*s in Pedro have been involved in non-agricultural activities since the creation of the *ejido*. They are employed in the neighbouring University of Chapingo, other institutions, and as shopkeepers, and for most agriculture were for a long time, a secondary source of income. Since the investment in wells for irrigation, however a number of *ejidatario*s have returned to farming as their main source of income. This has been aided by increased job losses, the parcel of land being seen as a source of financial security. This applies especially to the older *ejidatario*s, 42%, of whom are over 60 years old, and who see their land as a future source of income either from central income or outright sale. Nevertheless the majority of *ejidatario*s still gain their main income from outside the *ejido*. Of the total of 50 *ejidatario*s, 16 have agriculture as their main source of income, with production of vegetables (11) and dairy farming (five). Twelve are housewives, with husbands or sons working the parcel at the weekend and their main income coming from activities outside agriculture. Employees and pensioners (nine) Shopkeepers (11) have their main income related to agriculture, as they are involved in selling vegetables, as bakers and butchers. For this group with financial resources, activities such as the production of vegetables, feeding of cattle, are additional options open to them.

7.3 Santa Maria Nativitas

7.3.1 Private and *ejido* land in Nativitas

Private land is 60 ha, the parcels of sizes of around 0.5 ha with provision of water for irrigation to each parcel. The *ejidal* lands are 842 ha of which 300 ha were granted in 1927, and the *ejido* was enlarged in 1938 by further 542 ha located seven km away from the settlement (Figure 7.1).

The maps of land tenure available for the research were maps by parcels of 1927 (Archives Nativitas) and 1995 produced by PROCEDE. Comparison of the maps shows changes in land access, encroachment into communal land by *ejidatario*s and also the number of parcels and amount of land held by individual *ejidatario.*

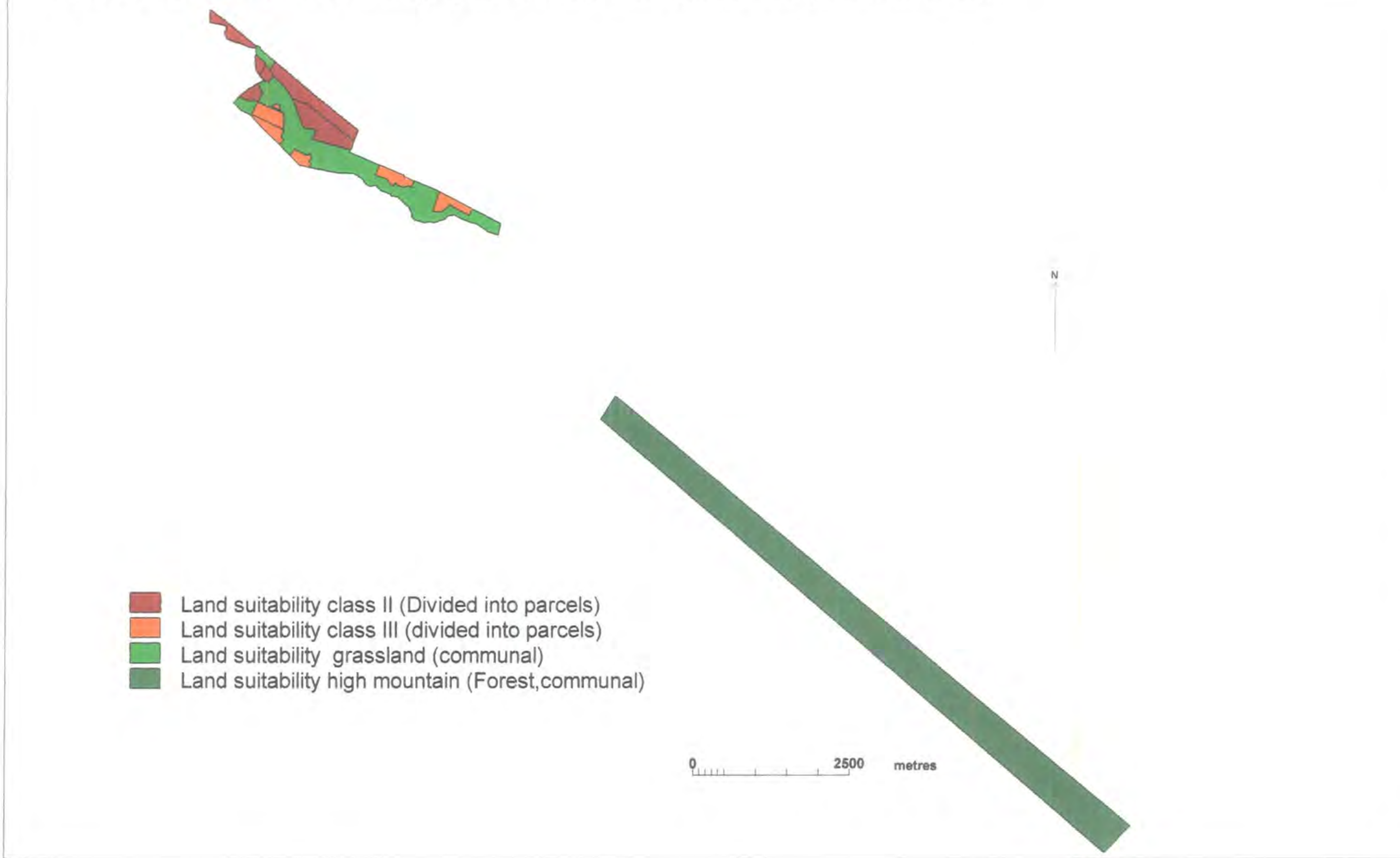
In 1927 300 ha were granted to 91 *ejidatarios*, and 110 ha were suitable for agriculture. These were subdivided into 182 parcels, with each *ejidatario* receiving 1.2 ha as two parcels of 0.6 ha each. The 190 ha remaining were grassland and were granted to the *ejidatarios* as communal land (Figure 7.8). The changes in land use of communal land to individual parcels were documented from field observation, interviews and interpretation of aerial photographs of different dates. In the aerial photographs for 1966 most of the land under grassland was eroded, and areas adjacent to the settlement were incorporated into agriculture by the building of terraces. Aerial photographs of 1980 and 1989 show that terraces were built in this period and the eroded land was reclaimed. Also between 1980 and 1989 new infrastructure for irrigation was built and two tanks for the storage of water from the stream of Texcoco River and the spring were built in the east area of the *ejido* lands.

Figure 7.9 shows settlement land held as private property in 1927 as seasonal agriculture, and the changes in land use brought about by the incorporation of grassland into cultivation, by the building of terraces between 1927 and 1980 and by reclaiming soil by breaking up *tepetate*. Cleared forest areas are also shown.

Comparing the map of 1927 with the map of 1995 it is observed that the communal land of 190 ha allocated in 1927 was reduced to 9.15 ha in 1995. The grassland was subdivided in parcels of variable size to increase the number of parcels from 182 to 481. There are four types of land tenure in the *ejido*: in the parcel area parcels held by *ejidatario*s, *posesionarios* and by the *ejido* and communal land. In 1995 the area of *ejido* is 284 ha; from this 247.42 ha are subdivided in 481 parcels, 9.15 ha are communal land, and 27.42 are infrastructure such as roads, and the stream of the river.

An area of 232.5 ha was allocated to 236 beneficiaries as parcels, 157. 03 ha were

Figure 7.8 Land suitability classes according to government map of 1927 (Archives of the ejido of Nativitas,1998)



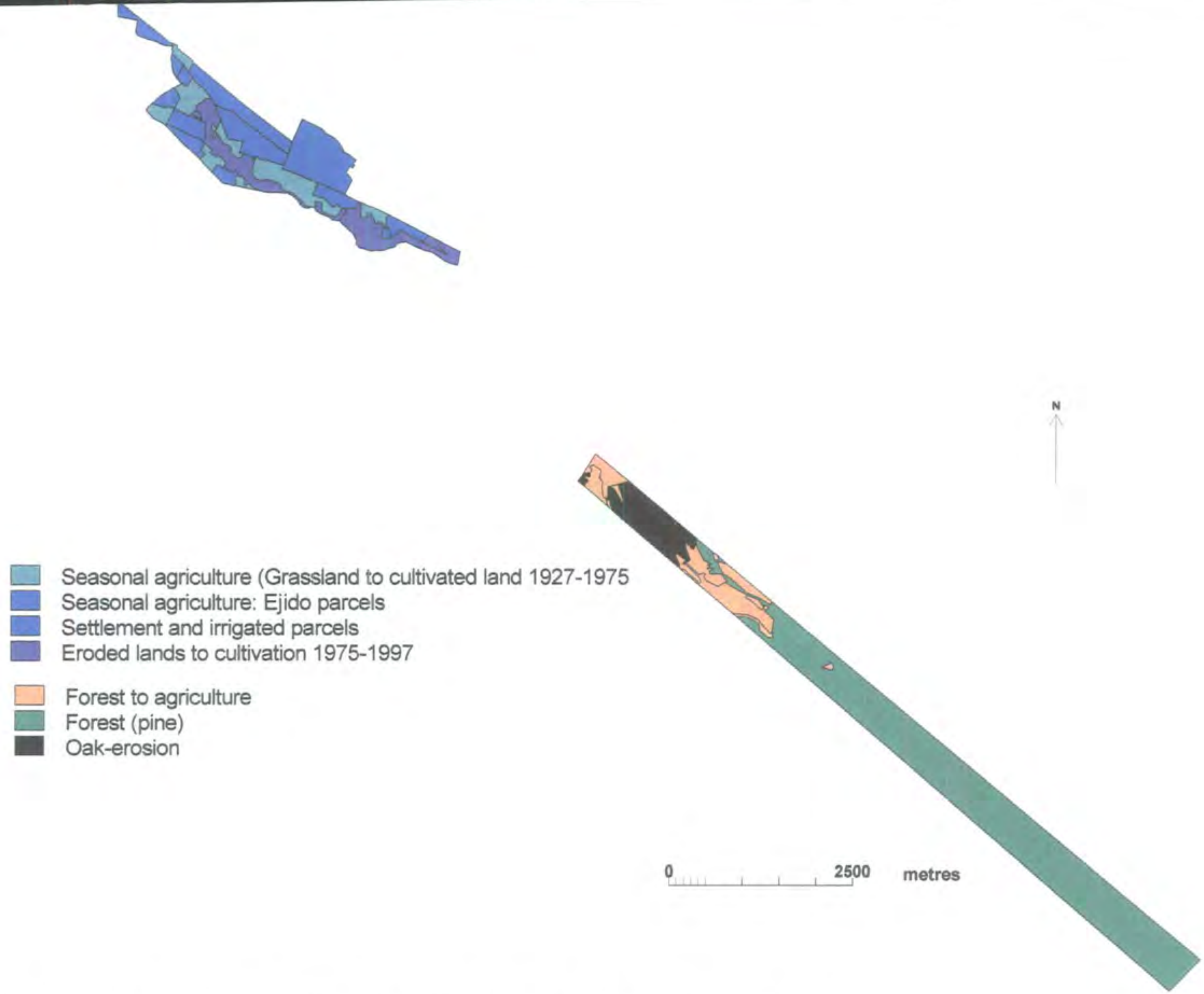


Figure 7.9 Changes in land use from 1927 to 1997 in the ejido of Santa Maria Nativitas (Author)

certificated to 111 *ejidatarios* that hold 269 parcels and to 125 *posesionarios*[9] with an area of 75.2 ha with 200 plots. Eleven plots are for public use such as school, health centre, recreation area, for young people parcel (two parcels) and three parcels without any use (Figure 7.10). The communal rights over the 542 ha in the forest were granted to *ejidatario*s and *posesionario*s, however the map of PROCEDE has not been produced because since 1938 are in conflict with neighbour *ejido*s by disagreement in location of limits that has been not solved

7.3.2 Government and participatory maps

7.3.2.1 Soil maps of INEGI

The INEGI soil map (Figure 7.11) shows the soil units for the *ejido* on agricultural land. There are three soil units: haplic phaeozem, pelic vertisol and a composite unit comprising eutric cambisol, humic cambisol and lithosol. In the forest area the dominant soil units are cambisol (dystric, eutric and humic), with molic andosol and haplic phaeozem to a lesser extent. The map is useful as an inventory for location of different soil types, giving information to soil experts about soil characteristics and insights into management issues. For example, phaeozem and cambisol in general are suitable for crop production, while shallow lithosol overlying bedrock or hardpan and andosol can be associated with problems of nutrition in crops due to fixation of phosphorus. However in composite cartographic units the individual soil unit cannot be located specifically, and this limits the utility of the map for land use planning at *ejido* level. Table 7.5 shows the areas of the cartographic units found in the *ejido*.

Table 7.5. Soil units (INEGI) in Santa Maria Nativitas (Compiled from soil map of INEGI, 1978)

Ejido	Land use	Area Hectares								
		Vp	Hh	Bd	Bh	Hh+Be	Bh+Tm	Be+I+Bh	Tm +Hh	I+Hh
	Agriculture	17	220			52		108		
SMN	Forest			130	21		115	180	82	12

Abbr: Vp: Pelic Vertisol, Hh: Haplic Phaeozem; Bd Dystric Cambisol; Be: Eutric Cambisol; Bh: Humic Cambisol; Tm: Mollic Andosol; I Lithosol.

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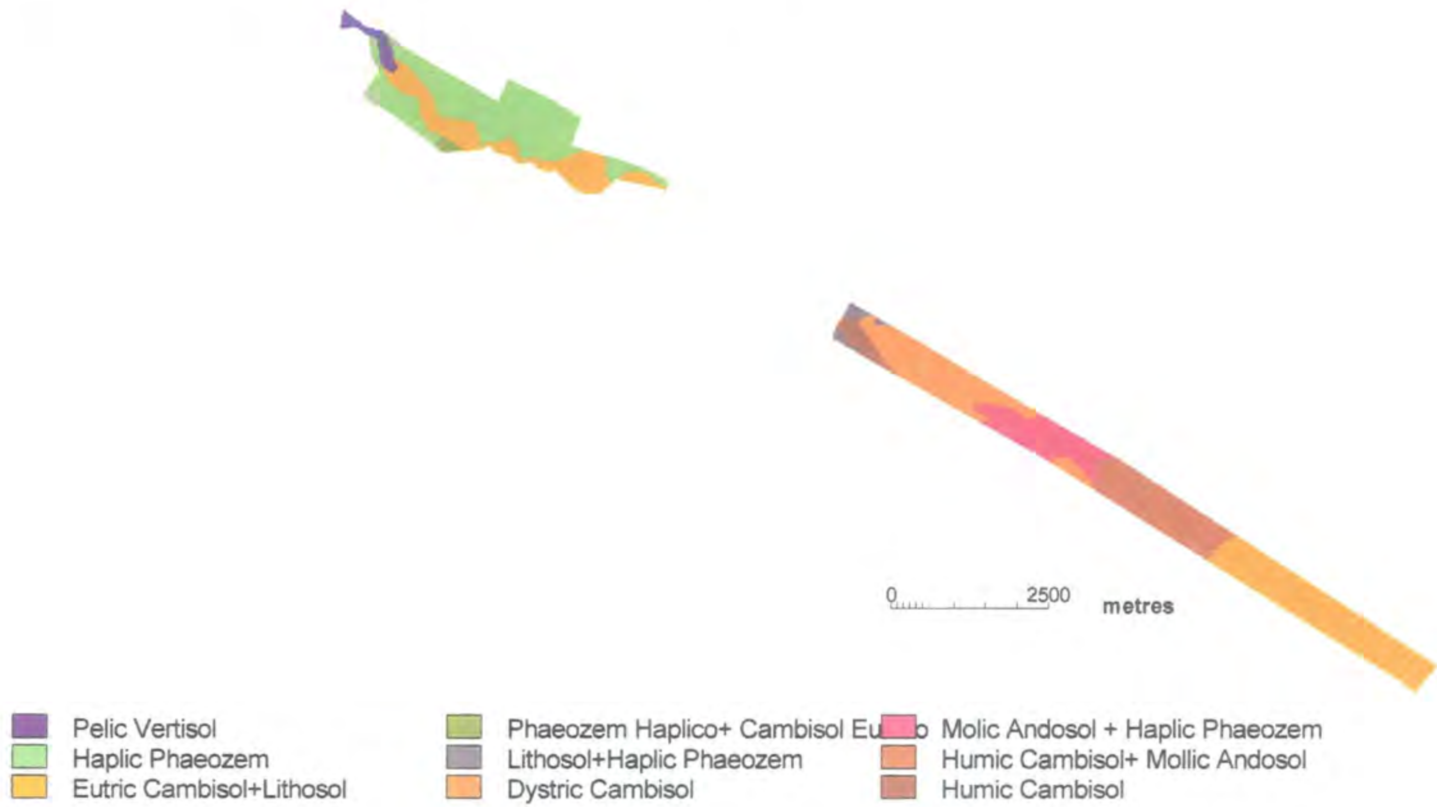
9 The "*posesionario*" is a new category of land tenant establish in the Agrarian law of 1993. These are people that have the usufruct of the land, but not the category of ejidatario.

Figure 7.10 Types of land tenure in the ejido of Nativitas(PROCEDE,1995)

Figure 7.11 Soil types in Nativitas (Compiled from INEGI soil map, 1978)



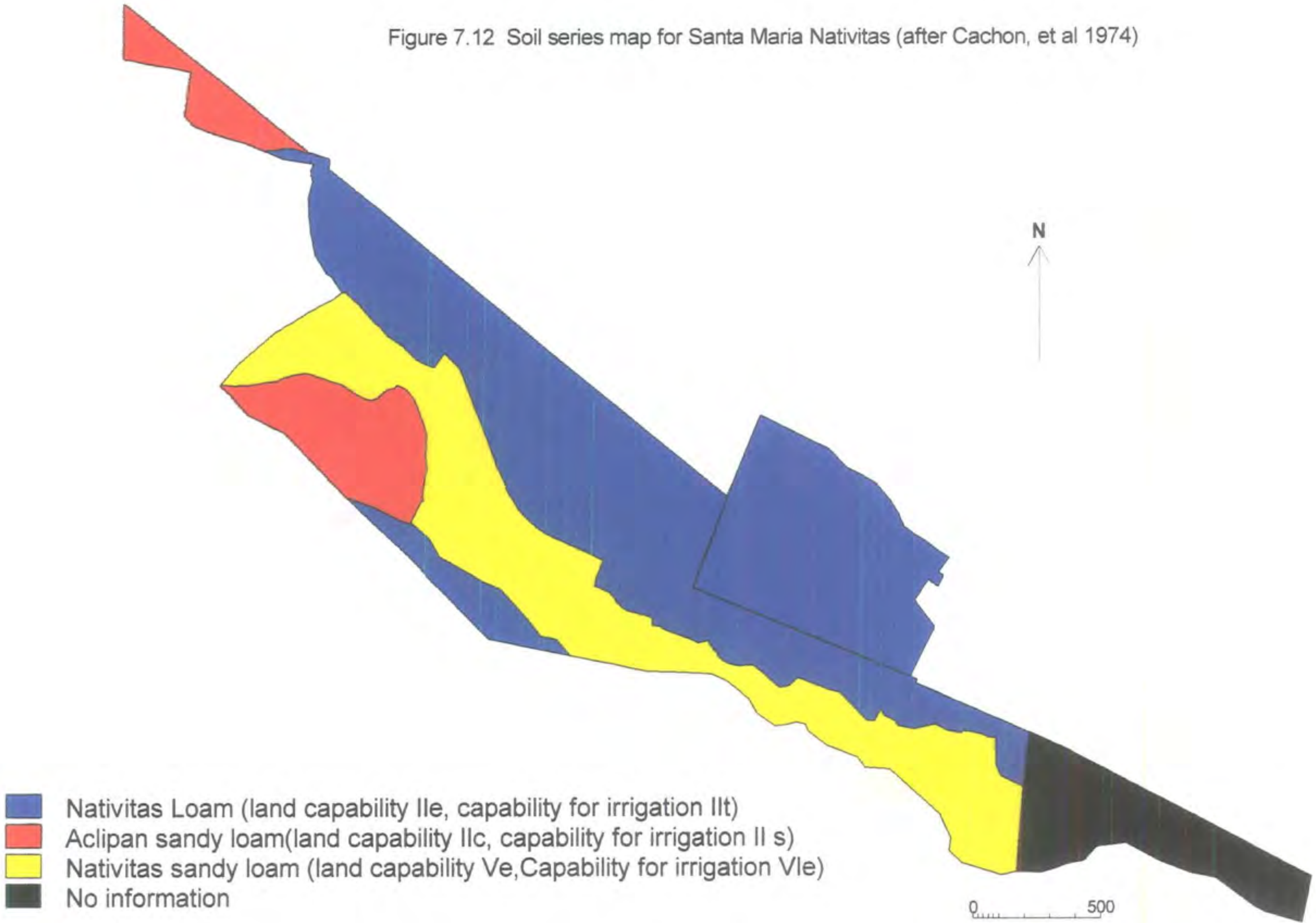
7.3.2.2 Soil survey maps

Cachon et al. (1974) identify three soil series: Nativitas loam (185ha), Aclipan sandy loam (36ha) and Nativitas sandy loam (93ha). The series are classified according to suitability for irrigation (USBR, 1959) and land suitability (Klingebiel and Montgomery 1962) (Figure 7.12, Table A7.1 appendix 7). Land is classified by its suitability as cultivable class II c with limitations in the storage of water by its sandy texture, which limits the range of crops to those resistant to drought; for class II e limitations due to erosion as a result of its slope of 2-4%, its loamy texture, and depth of less than 70 cm, hence practices of soil conservation such as contour ploughing are required; soils of class V e are unsuitable for cultivation due to a slope greater than 10 to 15%, texture ranging from sandy to loam, depth 10 to 15 cm, and outcrops of *tepetate* in some areas, hence the recommended use is grassland or reforestation; currently this area has been reclaimed by terracing and is under cultivation.

Suitability for irrigation is classified as: II-t for soil series Nativitas loam, IV-es for the soil series Aclipan sandy loam and VI-e for the series Nativitas sandy loam. The soils of class II-t are restricted by a slope of 2-4% that requires levelling of soils, and the presence of a layer of permeable materials at a depth of 70 cm, which requires careful management of irrigation schedules. The soils of class IV-es have sandy texture and the retention of water is low and the soil is highly permeable. Finally soils of class VI-e are not suitable for irrigation due to erosion, outcrops of *tepetate*, depth of less than 15 cm, and the slope, which ranges from 10 to 15%. Land of the series Nativitas loam is currently under seasonal agriculture, although the *ejidatarios* are promoting irrigation by using sewage water.

It appears that for the sustainable use of soil under agriculture investment in conservation practices is required. For its incorporation into irrigation careful planning of the irrigation schedules is required and investment in levelling of land.

Figure 7.12 Soil series map for Santa Maria Nativitas (after Cachon, et al 1974)



7.3.2.2 Land system map

Ortiz and Cuanalo (1977) carried out the survey of land facets in the municipality, and evaluated the land suitability by facet according to Kliengebel and Montgomery (1962). The land of the *ejido* of Nativitas comprises ten facets. Figure 7.13 shows the location of facets in the *ejido* and Table 7.6 the suitability and areas (For details see table A7.2 Appendix 7). The major limitations for agricultural use are erosion, depth of soil and climatic restrictions. The recommended land use practices in Texcoco-4, Tlaixpan-3, and Coatlinchan-1 facets covering and area of 194ha were contour lines plough lines and terracing in areas of steep slopes. The land use proposed for the other seven land facets covering an area of 647ha was grassland or forest as these facets were classified as classes V to VII with restrictions of steep slopes, and risk of erosion. The land facets, Coatlinchan-4, Ixayoc-1, 2 and Tecuanulco-2 in which the recommended use is grassland or forest, are currently under cultivation in some areas by the introduction of terraces by the Government in the 1970s, but in other areas operate without any conservation.

Table 7.6 Land suitability by Facet in the *ejido* of Nativitas (Compiled from Ortiz and Cuanalo, 1977)

Ejidos	TEX-4	CO-1	CO-4	TL-3	IX-1	IX-2	TE-2	TE3a	SN-1	TL-2
Land suitability	II-c	III-es	V-es	IV-es	VII-es	VII-e	VI-e	VII-e	VII-e	VI-e
Area (ha)	11	55	89	128	14	8	296	50	72	136

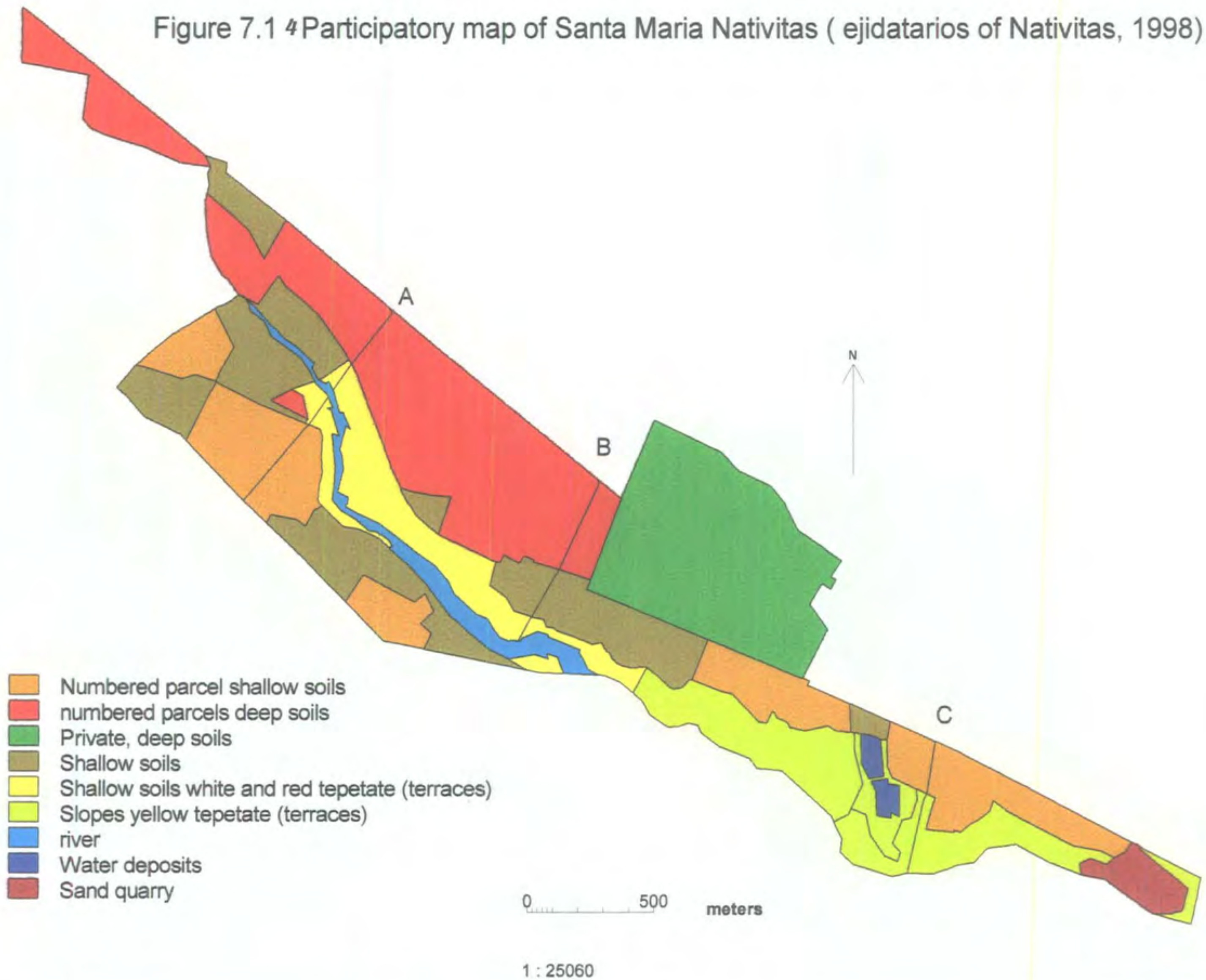
Abbr: c: climatic restriction; e: erosion; s depth of soil

7.3.2.4 Soil map constructed by the *ejidatarios*

Maps were constructed by the *ejidatarios* only for the cultivated land. Figure 7.14 shows the distribution of lands in the *ejido* as identified by the *ejidatarios*. Differences in the land production and opportunities for improvement of the land were described by the *ejidatarios* for each type of land (See transects 4a, 4b, 4c. Annex 3). Opportunities to improve the land are related to the incorporation of organic matter and more efficient use of fertilisers; reclamation of soils by terracing;

Figure 7.13 Land systems and facets in the ejido of Nativitas (Compiled from Ortiz, 1977)

Figure 7.1 4 Participatory map of Santa Maria Nativitas (ejidatarios of Nativitas, 1998)



breaking up of tepetate; sowing of maize as alternatives for the reclamation of eroded lands.

Table 7.7 shows that six different types of land were identified by the *ejidatarios* taking into consideration properties of the soil and landscape. However they also included other factors such as tenure, differences in management, access to infrastructure and yield of maize. For example the fact that those with private property have access to water, organic matter is incorporated regularly, and as the house is in the parcel the family spends more time working the parcel.

Table 7.7 Types of soils mapped by the *ejidatarios* of Nativitas (1998)

Land type	Slope	Soil (depth, texture, tepetate)	Yield maize (kg)	Area (ha)
Numbered parcels	Gentle	Deep, sandy and loamy	1000-2000	58
Numbered parcels	Gentle	Shallow, sandy	500-1500	82
Parcels	Gently	Shallow sandy soil	500-1500	44
Reclaimed soils with terraces	Steep	White and red tepetate, shallow soil, sandy	250 –750	53
Reclaimed soils with terraces	Steep	Yellow tepetate, shallow, sandy	250 –500	41
Private land	Gentle	Deep, loam	More than 2000	60

In the *ejido* the criteria for differentiation were the quality of land, the parcels allocated in 1927 (called numbered parcels) were those with deep soils, in contrast the parcels incorporated into cultivation from grassland have shallow soils and are located in steeper slopes. The areas of reclaimed tepetate have sandy texture and the soil is in process of formation by cultivation of maize and incorporation of organic matter and has lower yields. These areas are differentiated by the type of *tepetate* according to its hardness (yellow and red *tepetate* that is soft and easy to break, and white that is very hard to break up). They considered it also important to include in this map the areas of water deposits, and the sand quarry.

7.3.2.5 Land use maps of INEGI and map of the *ejidatarios*

The official map of land use (INEGI, 1980) (Figure 7.15) shows eight different categories of land use and vegetation for Nativitas. In the land use map produced by the *ejidatarios* (Figure 7.16) thirteen land use categories were identified.

Figure 7.15 Map of land use and vegetation in Santa Maria Nativitas (INEGI, 1980, compiled by the author)

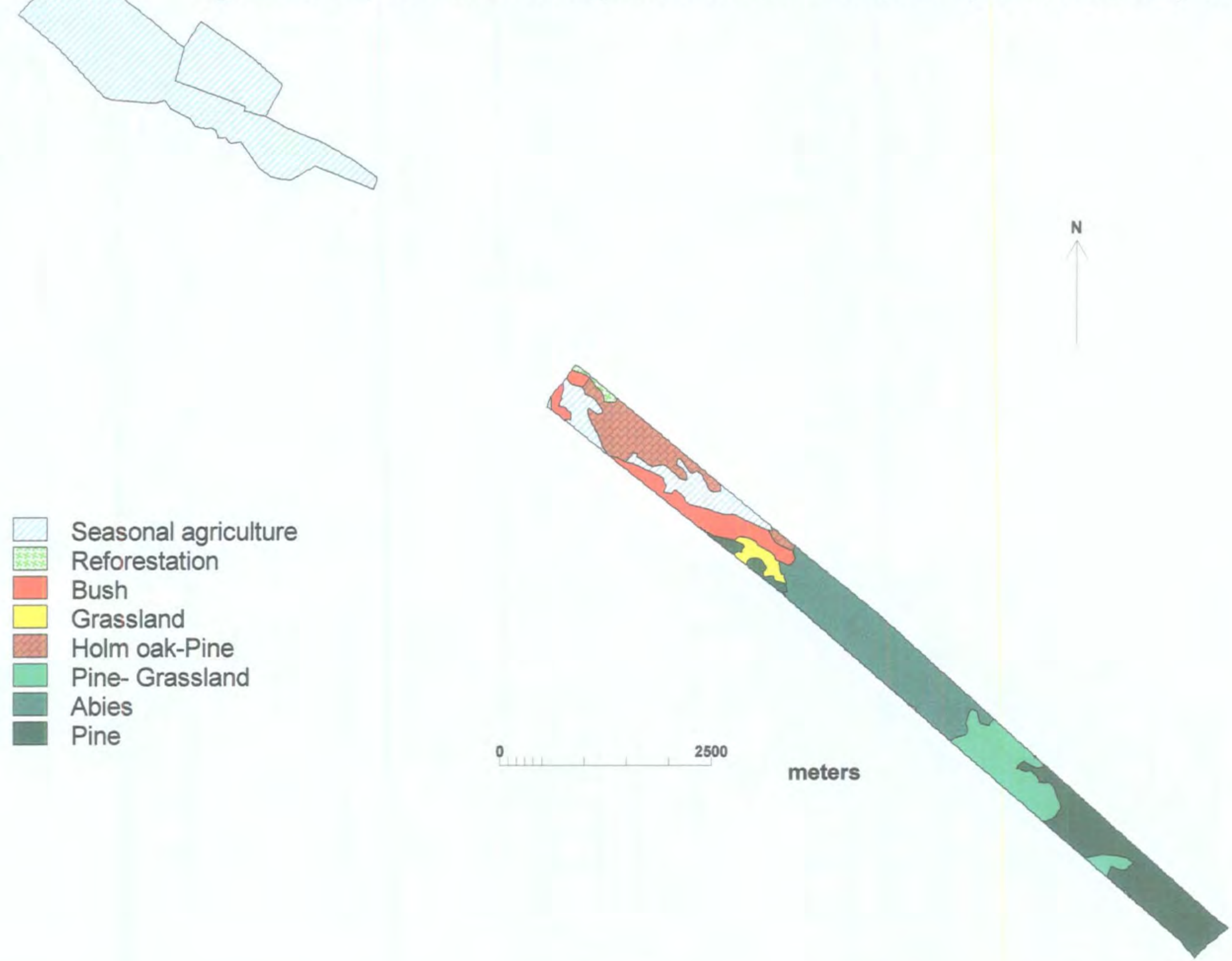
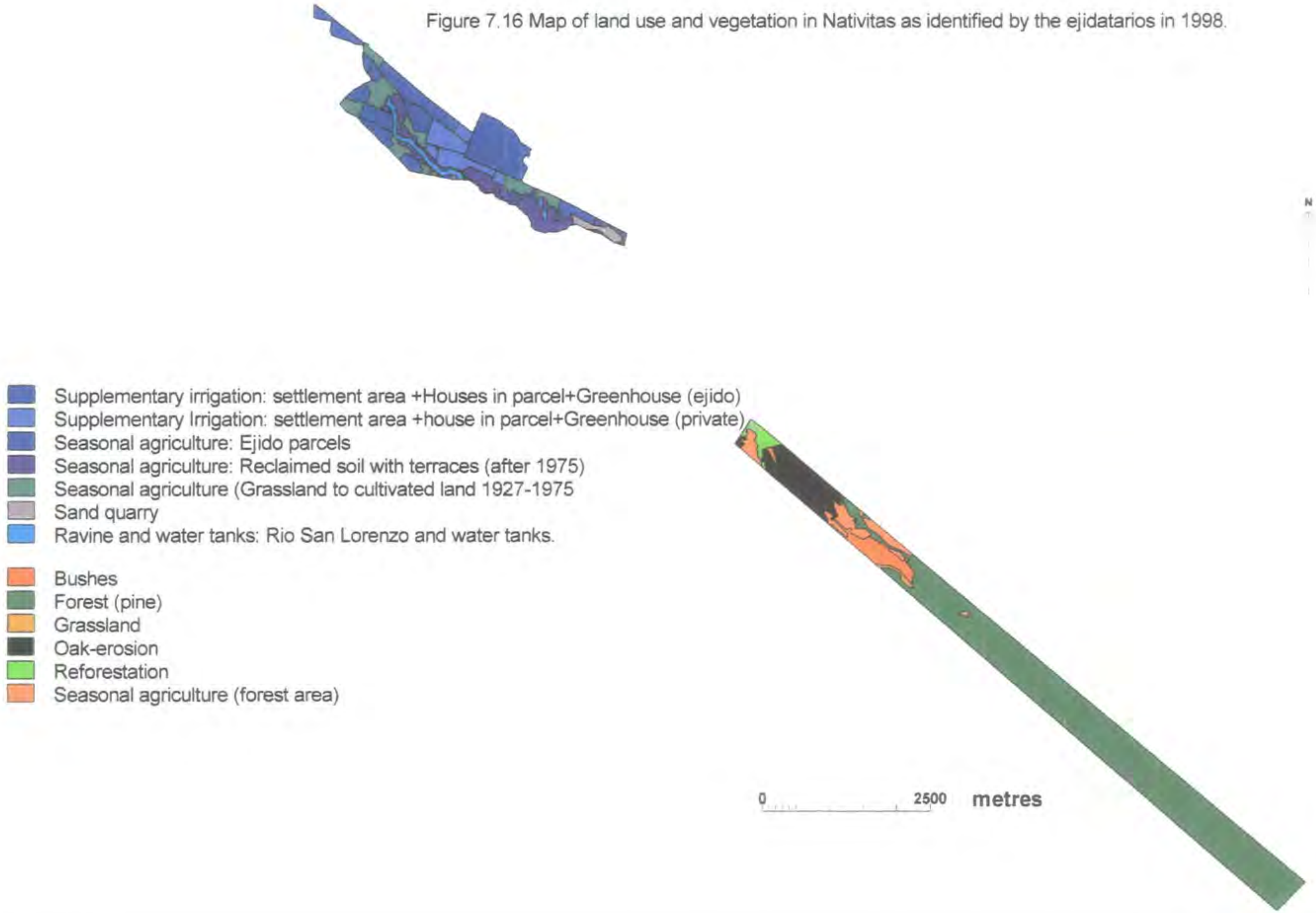


Figure 7.16 Map of land use and vegetation in Nativitas as identified by the ejidatarios in 1998.



Apart from the number of cartographic units identified, there are also differences in the criteria used for land use classification. For example, for agriculture, INEGI identified one type of land use, seasonal agriculture and the *ejidatarios* seven. In the forest lands the types of vegetation are the same on the two maps but the areas covered in the two maps are different. The area under seasonal agriculture is smallest the map of the *ejidatarios*. The number of vegetation types identified by INEGI as Abies, pine, and pine-grassland are aggregated in one cartographic unit as 'forest' in the map produced by the *ejidatario*s.

The differences between the two maps could be the result of three possible causes:

First land use mapped by INEGI is based on aerial photographs of 1970 and has not been updated since then. This is reflected in the forest area where in the present research land use was mapped in aerial photographs of 1989 and 1994. The area under seasonal agriculture in the 1970s was not cultivated afterwards or reforested and this reduced the area under seasonal agriculture in the forest area.

Second, map scale is important. The INEGI map shows only one mapping unit as seasonal agriculture, while the *ejidatario*s for the same area identified the area under cultivation and the area of reclaimed land along the stream of Texcoco. The ravine in which the Texcoco River flows which should be represented on the 1:50,000, map of INEGI. But the unit was not mapped or was generalised and included as seasonal agriculture. In comparison areas of grassland with a width of five mm are mapped. It is supposed then that the ravine area was simply not drawn.

Finally classification of the map of INEGI considers dominant land use and vegetation as appropriate criteria for classification. Mapping was carried out first by criteria on the basis of types of land use (agriculture and forest) and subsequently with forest subdivided. Thus INEGI identified four types of forest vegetation (pine, Abies pine-grassland and holm oak-pine). The criteria for classification were decided at the outset and the cartography and sample sites in the fieldwork were directed to the identification of the dominant types of vegetation in each cartographic unit. In contrast the process of mapping followed by the *ejidatario*s is based on the information available for mapping, by combination of the aerial photographs and their knowledge of the land use and vegetation. For example the first criterion for identification of land uses was the mapping of the two main land uses (cultivated and non-cultivated). Then during the transects other characteristics were identified, some identifiable in the photographs such as the presence of terraces or houses in the parcels, and others not evident in the photographs but important for land use such as land tenure as private or *ejidal*, and access to water for irrigation.

All the forest types were aggregated into two cartographic units. Abies, pine and pine grassland were aggregated as forest, because for the *ejidatario*s the product obtained (wood) is the same for the two types of trees. Oak was identified as different because charcoal could be produced from oak and in addition, the area was also eroded.

The perception of the forest as a source of income by the *ejidatario*s has changed through time as result of a combination of government regulations affecting forest exploitation and the reduction in the markets for forest products.

Changes in forest exploitation by the *ejidatarios* were described by the *ejidal Comisariado* who was a woodcutter as follows. From 1937 to 1945 exploitation was intense, most people used firewood as fuel and there were markets for firewood in Texcoco and in the towns of the plain. There were no control over the extraction of wood and by 1945 the forest was overexploited. The government then gave a concession to exploit to industry in San Rafael, and limited the extraction of wood by the *ejidatarios* to dead trees. Despite the prohibition, the forest was still exploited by the *ejidatario*s for firewood for both domestic and commercial use. The firewood was sold in Texcoco, but government agents were waiting in the roads, and they confiscated the wood. The extraction of firewood and mushrooms eventually was abandoned, as was also the grazing of cattle in the forest and by the 1960s only a few people continued with the extraction of firewood for sale. With this abandonment of forest exploitation came the loss of knowledge of the forest trees, such that the youngest generation are no longer able to identify the variety of forest and edible mushrooms species. This changed the perception of the forest as a source of income to an area of recreation (picnics, hunting and camping).

In 1989 the concession of exploitation of the forest by San Rafael expired, but the government decreed a ban on exploitation for preservation of the forest in the state of Mexico that lasted until 1995. In 1995 new agrarian legislation promoted exploitation of the forest as a source of income for the *ejidatarios*. Permission to exploit is issued to *ejidos* on the presentation of a programme of management. In 1998 the *ejido* created a civil society for forest management and the programme proposed the extraction of 12,000m^3 of wood in the next ten years with an average annual extraction of 1,200m^3 (Chavez, 1998). The perception of the value of the forest was therefore changed again to become a source of income. Agrarian law states that income obtained from the exploitation of communal land must be divided among the people with communal rights, meaning that each of the 236 people with communal rights will receive £170 per year.

The land use map produced by the *ejidatario*s reflects current land use, change in land use, which is the result of changes occurring over a period of 74 years, and the constraints and opportunities in the use of the lands in the *ejido*. The period of non-controlled extraction of firewood from 1937 to 1945 resulted in overexploitation, degradation and erosion of the communal lands. Degradation slowed and then ceased during the period 1945-1995. Regeneration occurred and was increased as a result of government policies encouraging regeneration of lands in the 1970s, a process continued voluntarily to the present time by the *ejidatarios*. Some degradation was however continued in areas under oak. New legislation permitting exploitation could result in the re-appearance of degradation, as exploitation is not adequately controlled.

7.3.3 Agriculture

7.3.3.1 Irrigated agriculture

The system of irrigation consists in two tanks with capacity of storage of 40,000 m^3; water is distributed from the tanks by a network of channels that connects parcels with houses. Water is provided on a rota basis to insure that each parcel receives water. The amount of water is fixed in three hours with a supply of 36 litres per second (around 388m^3). Registration as a member of the group implies participation in

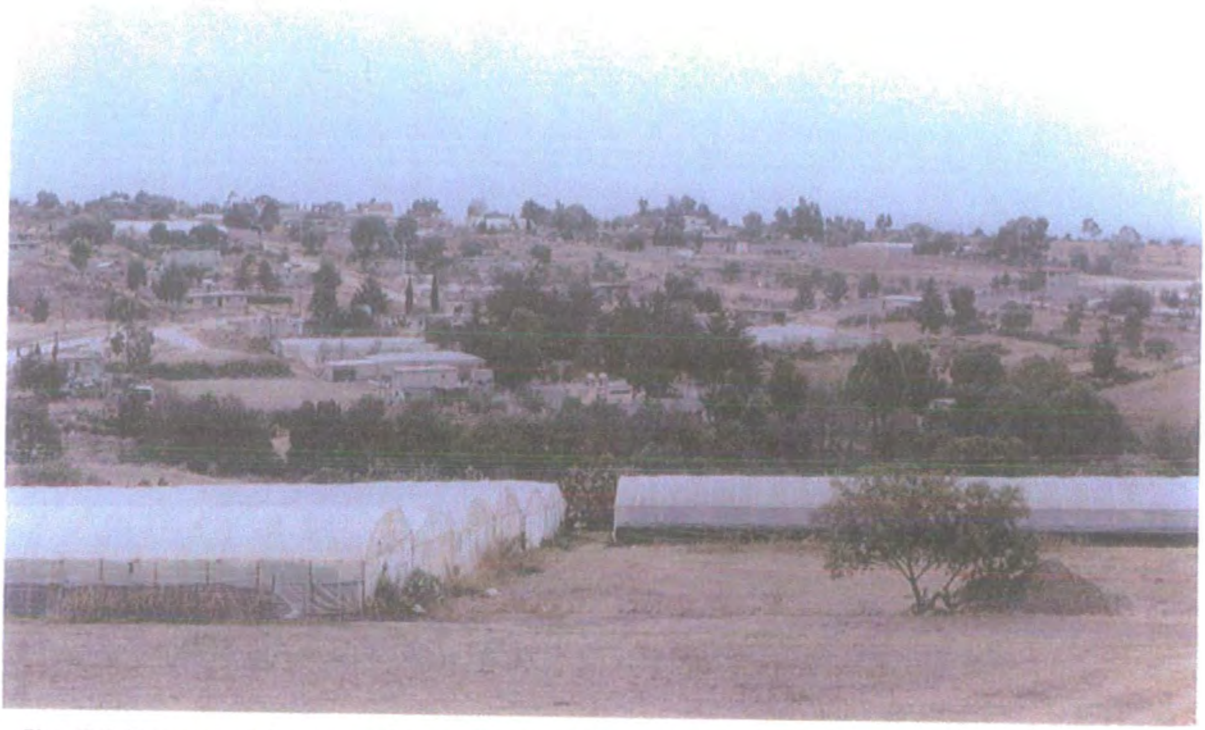


Plate 7.5 Overview of the pueblo of Santa Maria Nativitas, in recent years the number of greenhouses are increasing

Plate 7.6 Overview of parcels sown with maize in Santa Maria Nativitas

community work for maintenance of the system, and payment of annual fees for administration expenses. Water rights are not transferable to third parties.

Administration of the irrigation system is by the regulations established by the assemblies of users and a board of three persons elected by the assemblies. The board are in charge of the maintenance of the system and distribution of water and are elected every three years.

Figure 7.17 shows the enlargement of the network for irrigation. The system has been enlarged in 1950, 1975 and 1994, to supply water to new houses built in the town. The original system was supplied with water from springs and covered private land in the settlement. In the 1950s houses were built in *ejidal* land and the system was enlarged. In 1975 the number of houses in *ejidal* land increased together with the requirement for water for irrigation of flowers in greenhouses and a tank was built to collect and store water during the rainy season from the Texcoco River. In 1990 demand for water increased in houses and greenhouses and a second tank was built in 1994. However during 1994-1997 period there were water shortages for irrigation of greenhouses, and as a result, people used potable water, extracted from groundwater. People with greenhouse built bigger tanks in their parcels to increase storage of water. To solve the problem of shortages of water in 1997 a system for yielding water in an area of 10,000 m^2 with t*epetate* exposed was built with an expected yield of 5,000 m^3 of water per year, while another alternative solution to the water problem is the drilling of a well with the money that is expected to be raised from the exploitation of the forest.

7.3.2.2 Production of flowers in greenhouses

Flower production was introduced in 1972 by a native of the town who had worked for 20 years for a firm that grew flowers in the region for export. He promoted and encouraged the building of greenhouses by other people in the town. Most producers started with a small greenhouse of 144 m^2 and investment in heating, irrigation systems, fertilisers and pesticides increased gradually until they had a secure market, and hence reliable income stream.

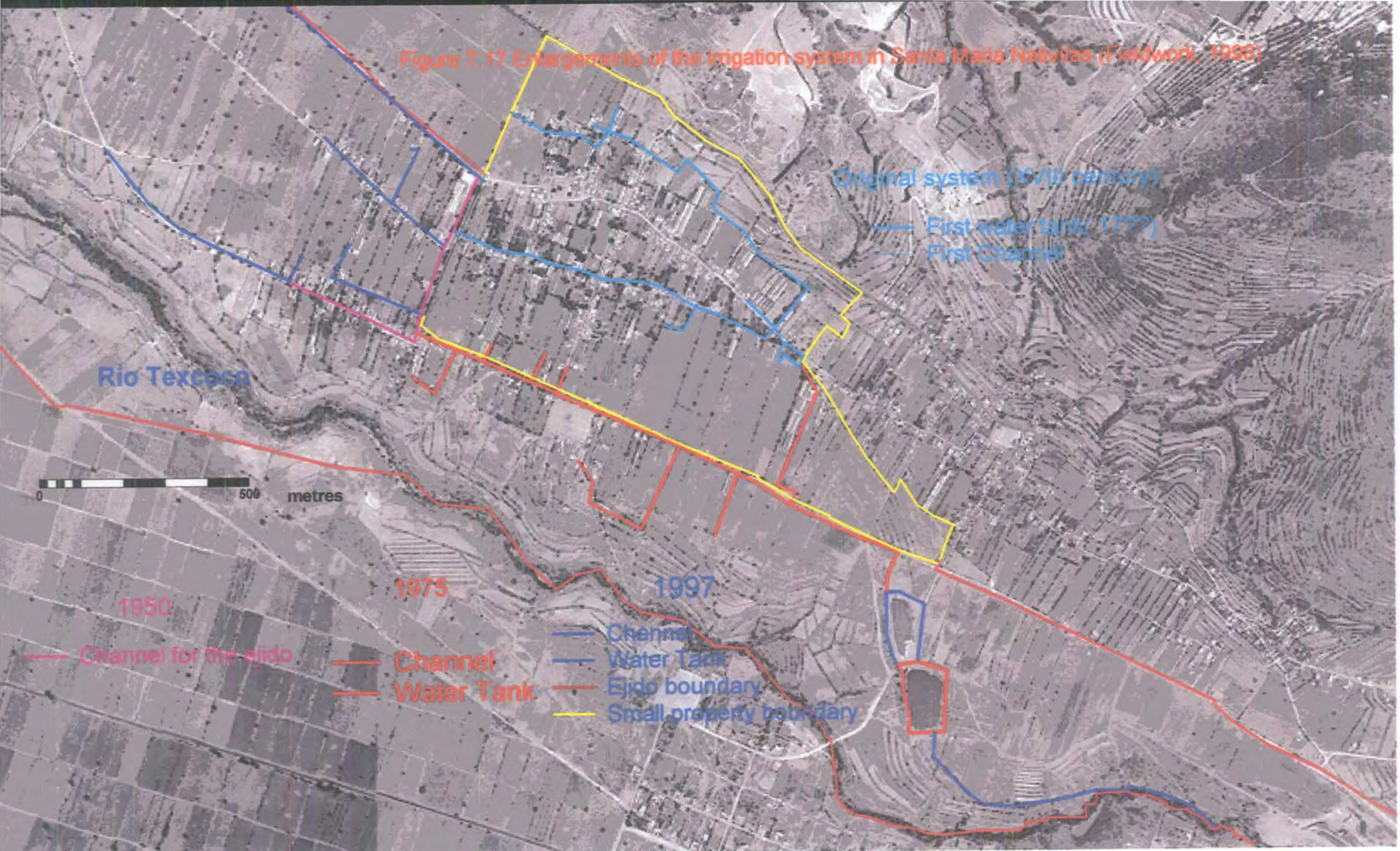


Figure 7.17 Enlargements of the irrigation system in Santa Maria Nativitas (Fieldwork, 1998)

Table 7.8 shows the areas of greenhouses by tenure of land; both *ejidatarios* and private owners carry out greenhouse flower production. The Rural District of Texcoco (Archives DDR 03, Texcoco, 1998) reports 65 people with greenhouses: *ejidatarios* (15), *posesionarios* (15) and private owners (28). The area occupied by greenhouses is 70,000 m², ranging from 140 m² up to 3,300m². The greenhouses owners can be stratified into three groups by the area under production: a) greenhouses under 500 m² with a production capacity of 1,000 to 15,000 flowers, with two harvests per year; b) greenhouses between 500 and 2,000 m², with a production capacity between 15,000 and 80,000 flowers and two harvest per year; and c) greenhouses between 2,000 and 3,300 m² with an annual production between 80,000 and 180,000 flowers with three harvests per year.

Table 7.8 Greenhouses in Nativitas by size and type of tenure (Field Survey, 1997)

Range of area (m²)	Private	*Ejidatario*	*posesionarios*
144-500	13	6	6
500-2000	14	8	7
2000 to 3300	1	1	2
Total	28	15	15

The producers are organised into a 'union for the commercialisation of flowers' that gives access to key flower markets in Mexico City, Central de Abastos and Jamaica. It is the largest producer who also has the means of transport to market in Texcoco and Mexico City, who controls the local network and hence prices.

7.3.2.3 Seasonal agriculture

Seasonal agriculture is carried out in 188 ha of land in the *ejido*, and in 35 ha in the forest. The start of the rainy season and the date of the first frost limit the length of the growing season to 90 days if the rain starts in July and to 150 if it starts in May. The decision to sow each crop is also dependent on the availability of labour and machinery (Table 7.9).

The yield is variable each year depending on the amount and distribution of precipitation, the quality of the soil and the opportunity of cultural practices. The yield per hectare varies for maize in parcels with terraces and shallow soil (20 to 50 cm of depth) the production of maize is around 250 kg in bad years to 750 in good

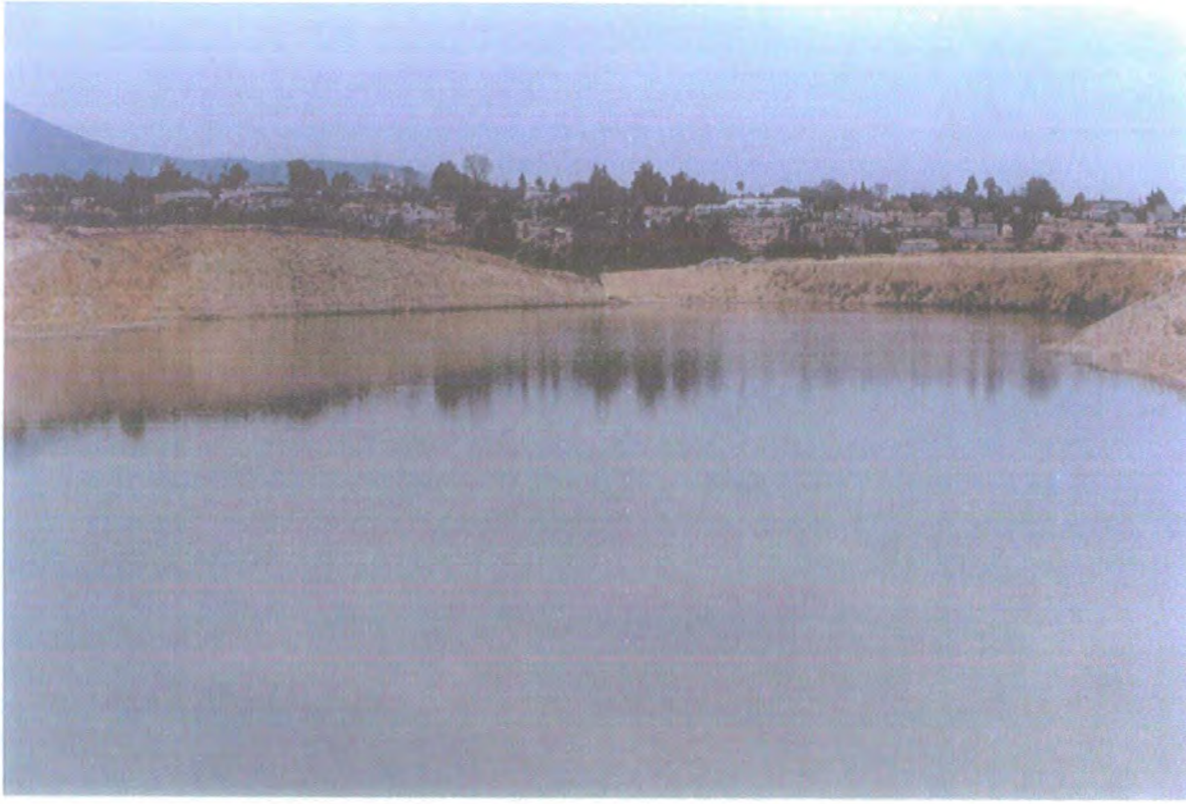


Plate 7.7 Water tank in Santa Maria Nativitas

Plate 7.8 eroded land in the forest Holm Oak in communal lands of Santa Maria Nativitas

Table 7.9 Criteria for the selection of crops to sow in relation with the starting of the rainy season and labour.

Starting of the Rainy season	Crops	Labour available	Access to yolk or tractor	Decision
May	Maize (long growth cycle.	Yes	Yolk	Sown
		No	Tractor	Sown
		No	Tractor	No
June	Maize, Beans or Broad beans (short cycle)	Yes	Yolk	Sown
		No	Tractor	Sown
		No	No	No
Before 15th of July	Wheat or Oat (short growth cycle)	Yes	Tractor	Sown
	Wheat or Oat (short growth cycle)	No	No	Not sown

years. For parcels with depth soils (more than 80 cm of depth) and good management is up to 2,000 kg of maize or 1,000 kg of beans in good years.

The *ejidatario*s that obtain the higher yield are those that own yolk and have family labour to sow the crop with the first rains, and those that hire machinery or yolk depending when the land could be sown.

Possible causes of changes in land use in the settlement area and the sowing of crops with a growing period of less than 150 days in seasonal agriculture land, were suggested by the *ejidatario*s to be changes in rainfall season, the amount and distribution of rainfall, and opportunities to work outside the *ejido*. Before 1970 the rainy season started in May to June; also in the past it was felt to be, well distributed during the period of crop growth, and there were no periods of drought in August. Also the incidence of pest and diseases in fruit tress was said to have increased after the 1970s and its production declined together with demand in local markets. Finally the increase in the number of people working outside the *ejido* has increased since 1970, the *ejidatario*s working outside the *ejido* usually working the parcels at the weekend. The traditional system of production with intensive labour such as inter-cropping, periodical addition of manure, and the use of yolk have been substituted by labour with machinery and use of pesticides and fertilisers that can damage the land

> ‘ the land became hard with the use of tractor, and fertilisers and herbicides poison the land’ (*Ejidatario*, Nativitas 70 years)

Three *ejidatarios* (Nativitas 65 years, Tequesuinahuac, 78 years and Coatlinchan 75 years) commented that the change in rainfall pattern is associated with two events: first the drainage of the lake Texcoco and second in the 1970s when the Aztec God of the rain, Tlaloc, was moved from the Pueblo of Coatlinchan to the Museo of Antropologia in Mexico City. The increase in diseases and pests in fruit trees is associated with the increase in area of the sand quarry adjacent to the settlement; by now the area of the quarry is around 10 has, and the sand is loose on the surface

> 'when the wind blows it causes dust storms form the sand quarry over the town of Nativitas specially during the period of blossom of trees' (*Ejidatario*, Nativitas 53 years old).

However the general view of the people interviewed was that the decline in the agriculture management system might be because the people do not like the hard work that the traditional system of production demanded

> 'Working the land is very hard, and in bad years you only harvest the straw of the maize, but this is our land and we must work it as our ancestors did to produce our food' (*Ejidatario*, Nativitas, 65 years old).

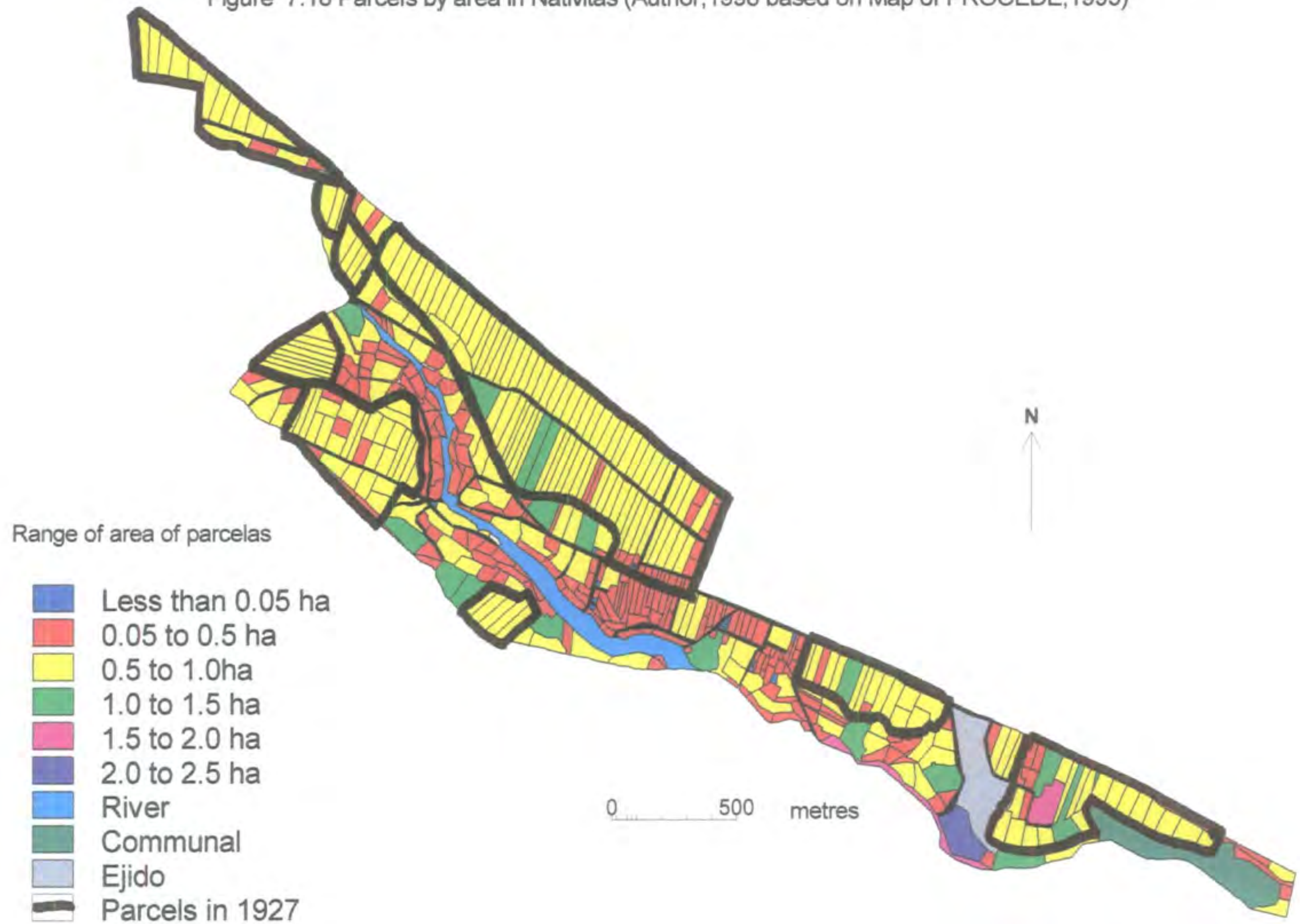
7.3.4 Second step of the land reform

7.3.4.1 Certification of *ejidal* rights by PROCEDE and access to *ejidal* land

The increase in area cultivated in the *ejido* land was illegal, through encroachment into communal land, converted to individual parcels. This illegal process of subdivision of communal land, and allocation of parcels by the *ejidal* assembly between 1927 and 1995 produced parcels in the *ejido* of different sizes, one individual having access to several parcels, regularly located throughout the *ejido*, and each individual having access to different amounts of land for cultivation.

Figure 7.18 shows that few of the parcels allocated in 1927 were subdivided or aggregated into big parcels, and only two parcels in the settlement area were divided into small parcels for housing (coloured pink in the map), and 7 parcels of more than 1 ha created by the aggregation of two neighbouring parcels (coloured

Figure 7.18 Parcels by area in Nativitas (Author,1998 based on Map of PROCEDE,1995)



green in the map). The source of land for subdivision into parcels thus was communal land; most parcels had sizes of less than 0.5 ha located in areas adjacent to the settlement or in areas adjacent to the river.

The *ejido* land was divided into 469 parcels with sizes that vary between 0.024 ha to 2.3 ha. Table 7.10 shows the number of parcels by area, tenure, and average size. From the communal land 200 parcels were allocated to *posesionario*s and some 87 to *ejidatario*s. The number of parcels of less than 0.5 ha is 222 and those of more than this amount are 247 parcels.

Table 7.10 Number of *ejidatarios* and *posesionarios* by area of parcel held in Nativitas (Source: land tenure map of the *ejido* of Nativitas, Areas calculated in ILWIS 2.2)

Area (ha)	No. of Parcels *Ejidatarios*	No. of parcels *posesionarios.*	Total No. of parcels	Total (ha)	Average size (ha)
<0.5	80	142	222	54.13	0.24
0.5-1.0	177	52	229	152.09	0.66
1.0-1.5	12	4	16	21.98	1.37
1.5-2.0		1	1	1.64	1.64
2.0-2.5		1	1	2.37	2.37
	269	200 -	469	232.13	0.49

Abbr: No: Number

The differences in size of parcels are because the subdivision of communal land has been the result of different circumstances, generally driven by the need for more land by the *ejidatario*s and *avecindados.* The first subdivision of land was in communal land with low slopes along the river in 1945, when *ejidatario*s started to incorporate these areas of grassland into cultivation. The second subdivision of land occurred in the late 1960s in the areas adjacent to the town, where communal land was divided into small parcels for houses. The last subdivision of land occurred in the 1980s by reclamation of eroded land by terracing and breaking of *tepetate*

The current number of parcels by holder varies from 1 to 6 parcels and the access by the number of parcels for *ejidatario* and *posesionario* is different. In Table 7.11 it is observed that 19 *ejidatarios* have one parcel, 47 two parcels and 45 have more than two parcels. In contrast most of the *posesionario*s (79) have 1 parcel, with some 48 holding two or more parcels.

Table 7.11 Number of *ejidatario*s and *posesionarios* by number of parcels held in Nativitas (Source: land tenure map of the *ejido* of Nativitas, Areas calculated in ILWIS 2.2)

No of plots	Number of *ejidatarios.*	Number of *Posesionarios.*	Number of Holders	Total (ha)	Average size (ha)
1	19	79	98	44.60	0.4551
2	47	27	74	82.84	1.1195
3	27	10	37	57.46	1.5531
4	14	9	23	38.43	1.6709
5	3		3	5.62	1.8760
6	1		1	3.27	3.2719
	111	125	236	232.13	0.9841

The differences in number of parcels held by individuals indicates an unequal access to parcels; this could be by the process of allocation of communal land, in which the *ejidatario*s take as much land as they could cultivate, or the *posesionario*s could take as many parcels as can incorporated into cultivation by terracing and breaking up of tepetate with the knowledge of the *ejidal* assembly, or a lack of control by *ejidal* authorities to supervise the access to land. However information to clarify this point was not available in the present research.

In Table 7.12 (for detailed information see Table A7.3 appendix 7) the area held by individuals is aggregated by intervals of 0.5 ha to highlight its distribution. The *ejidatario*s have most of the *ejidal* land, 157.03 ha; but the original allocation of land in 1927 of 1.2 ha by *ejidatario* as been reduced for 25 of them that have less than 1 ha of land. This is possible because they inherit only one parcel or they transfer one parcel to *posesionarios* or other *ejidatario*s. 47 *ejidatario*s kept the original allocation of land or increased the area held by encroachment into communal land. Communal land and parcels were transferred to *posesionarios* (sons of *ejidatario*s) for the building of houses or reclamation of land in amount of 75.2 ha. Half of the *posesionarios* have access to less than 0.5 ha; however the other half have access to more than half hectare; this meant an ongoing process of transfer of land from *ejidatarios* to *posesionarios* by sale or inheritance, as the allocation of land to non-*ejidatario*s was established at a maximum of 0.5 ha per *posesionario.*

Table 7.12 Number of *ejidatarios* and *posesionarios* by total area in Nativitas (Source: land tenure map of the *ejido* of Nativitas, Areas calculated in ILWIS 2.2)

Area (ha)	No of *ejidatarios*	Area (ha)	No of *Posesionarios*	Area (ha)	No of holders	Total (ha)	Avge size (ha)
<0.5	10	2.24	62	13.65	72	15.89	0.2189
0.5-1.0	15	10.48	39	27.35	54	37.83	0.7672
1.0-1.5	33	41.26	19	24.26	52	65.52	1.3101
1.5-2.0	39	67.02	3	5.50	42	72.52	1.7280
2.0-2.5	9	20.36	2	4.34	11	24.70	2.0581
2.5-3.9	5	15.67			5	15.67	2.3418
Total	111	157.03	125	75.1	236	232.13	0.9841

Table 7.13 shows the differences in numbers and size of parcels for sample of *ejidatarios* with number of parcels that varies from 2 to 5. The area held varies between 0.4 and 3.1 ha and size of parcels between 0.04 ha to 3.19 ha.

Table 7.13 Number and size of parcels for a sample of *Ejidatarios* in Santa Maria Nativitas

Ejidatario	No parcels	Size of parcels (ha)	Total area (ha)
Fabre Sanchez Cayetano	2	0.04, 0.36	0.40
Meraz Balcazar Felipe	2	0.70, 0.64	1.34
Carrillo Balcazar Elena	3	0.77, 0.61, 0.30	1.68
Ayala Meraz Franciso	4	0.89, 0.24, 0.26, 0.29,	0.88
Sanchez Rosas Basilio	4	0.59, 0.43, 0.20, 0.74	1.96
Meraz Solis Esteban	4	0.57, 0.67, 0.72, 0.74	2.70
Ayala Sanchez Aurelio	4	1.05, 0.23, 0.34, 0.68	2.30
Sanchez Carrillo Gumercindo	5	0.33, 0.37, 0.46, 0.58, 0.67	2.41
Flores Balcazar Aurelio	5	0.45, 0.52, 0.53, 0.73, 0.96	3.19

Figure 7.19 shows the location of parcels throughout the *ejido* for this sample of *ejidatarios*. The distance from one parcel to other is variable some are adjacent, however most of them are far away one of the other, the maximum distance between the parcels that belong to the same *ejidatario* is 3.5 km. This implies a lot of time spent in displacement, as only ploughing is made with machinery, and all the other labours with animal traction.

Figure 7.19 Location of parcels for a sample of ejidatarios in Santa Maria Nativitas (Author, based on PROCEDE map, 1995)

7.3.4.1.1 Sale of land after 1995

In 1995 at the end of the process of certification of *ejidal* rights by PROCEDE, the *ejidal* assembly decided not adopt the '*dominio pleno*' over the parcels and continue the tenure as an *ejido*. This allows the *ejidatarios* to rent parcels, and sale of land to *ejidatarios* and *avecindados* of Nativitas. In the interviews no information about rent or mortgage of parcels was obtained. However, since 1995 six parcels have been sold and only one parcel was sold to an outsider. The prices paid for the parcels are variable, for example the outsiders paid £1.7 per m^2 and the *ejidatarios* around £ 0.71. The difference in price was explained by a *posesionario* that helped the *ejidatario* to sell the land to the outsider. The *ejidatario* was 78 years old and did not have any children, and had three parcels in the *ejido*. The outsider was looking to invest his money in land as a better investment against saving the money in the bank. The parcel had good soil and location, and was situated alongside a paved road. In the second case the *ejidatarios* who were selling the parcels were facing economic problems, and they sold plots of reclaimed land. One man of the pueblo, working in production of flowers in greenhouses, has been bought three parcels of different sizes in the last two years; for him the purchase of land is an opportunity to invest his money. He said

> ' if somebody offers you a piece of land and you have the money, buy it. In land matters, the key to success is to buy land when somebody wants sell and sell it when somebody wants to buy. If you do not have the opportunity to sell the land at a good price, an inheritance for your sons is better than money' (*posesionario*, Santa Maria Nativitas, 62 years)

The *ejidal* authorities, who see the sale of land to outsiders as a future source of revenue for the *ejido*, are proposing that the fee for approbation of a sale to outsiders could be 10% of the transaction. To have the approval of the *ejidal* assembly, the law states that for the assignation of land to a *posesionario* the applicant must both lived in the *ejido* for one year or more and be recognised by the *ejido* assembly.

7.3.4.3 Alianza para el Campo programme

Thirty *ejidatarios* participate in the Alianza para el Campo technical assistance programme sowing 15 ha of maize and acquiring seeds and fertilisers, and 'following' technical advice. They explain their participation because the government agents do all the work of form filling and arrange transport of fertiliser; this is done at no cost to the *ejidatario*s. The fact that maize seeds come from local sources and are hence adapted to the local environment encourages the *ejidatario*s to use them. In addition, they are also engaged in a programme involving the surfacing of irrigation channels. The lining had two objectives: a) to build a bigger channel and to reduce loss of water through infiltration and b) to intercept water that runs off in an adjacent slope to conduct it to the water tank. The programme of assistance to marginal areas involving allocation of 10 units of poultry to farmers has attracted many more participants. One hundred and twenty participate because they see it as a good investment (90% of saving over the normal price).

7.3.4.3 Programme for subsidy of crops PROCAMPO

The subsidy of PROCAMPO at the time of the fieldwork was £35.25 per hectare and the area eligible for subsidy in Nativitas is around 360 ha owned by 300 people. However the area registered in the programme is just 30% of the total cultivated (111 ha) and the beneficiaries 81 people (27% of the landholders). Access by tenure is differential with 82.6% of the subsidies for the *ejidatarios*, 12.46% for *posesionarios* and 4.94% for private owners. The total subsidy for the *ejido* is £4004 (Table 7.14).

Table 7.14 Farmers of Nativitas receiving subsidy from PROCAMPO* in 1997(Archives DDR, 03 Texcoco)

Tenure	Number of beneficiary	Number of parcels	Area(ha)	Subsidy (£)	% Participation
Ejidatarios	61	135	92.27	3308	82.60
Posesionarios	15	22	13.92	499	12.46
Private	5	8	5.52	197	4.94
Total	81	165	111.71	4004	

* for detailed data see Table A7.3 appendix 11.

Most of the parcels registered are located in the areas with best soils and very few are in the areas with terraces with reclaimed tepetate (Figure 7.20). One *posesionario* with half hectare and a production of 250 to 500 kg of maize per year said

> 'You can do nothing with the subsidy. I got half a hectare, with £17 a year of

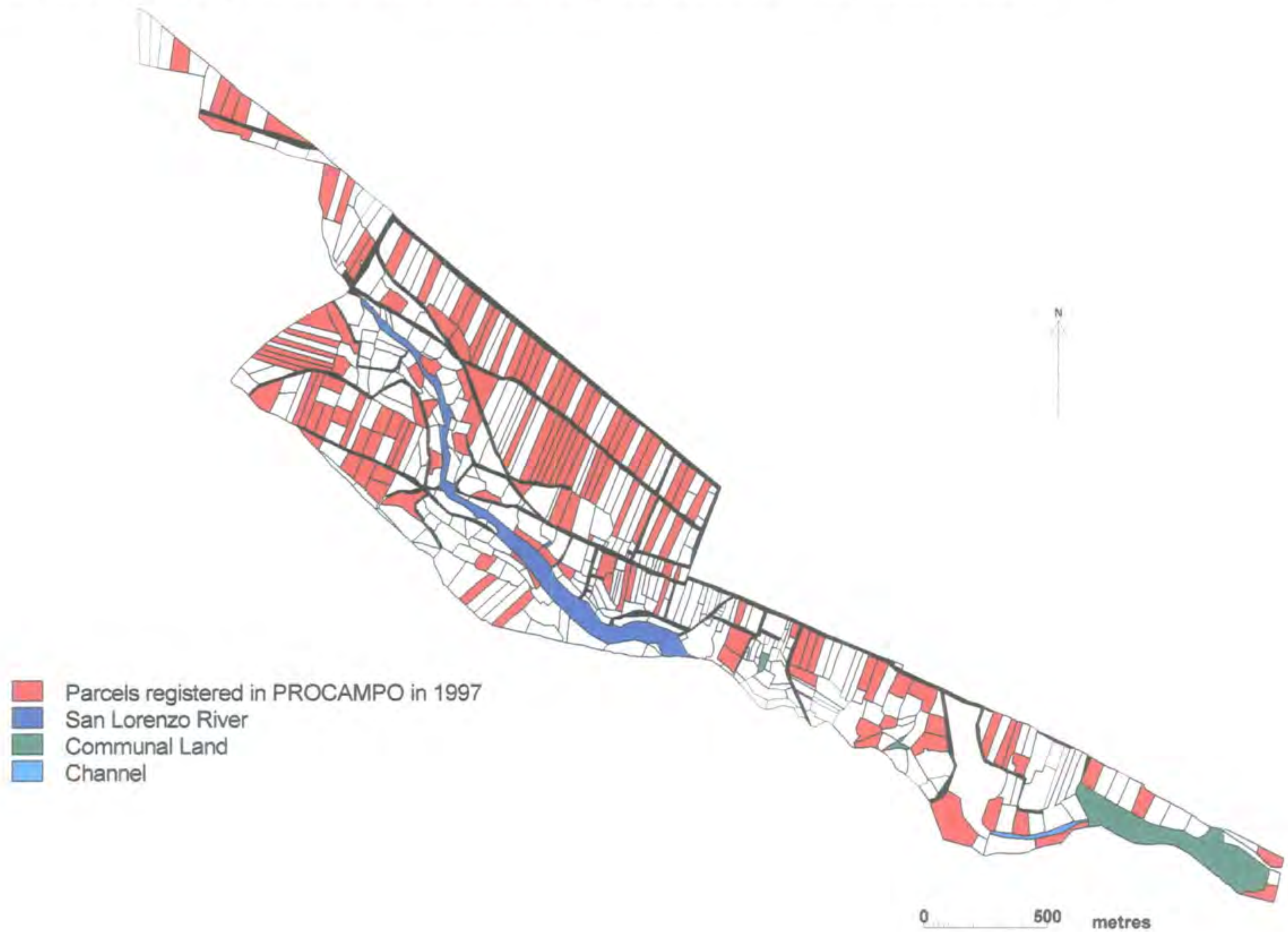


Figure 7.20 Parcels registered in PROCEDE programme in 1997 In Santa Maria Nativitas (Compiled by the author from Archives PROCEDE, DDR03, 1997)

> subsidy, what can I do to improve my land, you can do more productive things, that spent your time making queues in government offices asking for money' (*Posesionario*, 45 years old)

The objective of the subsidies is to change the actual pattern of crops to those with more competitive prices in the market. However this is not happening; the crops sown by the *ejidatario*s are the usual self consumption crops maize (79ha), beans (20ha), maize-beans intercrop (10ha), wheat (2ha), broad beans (2ha) and barley (0.5 ha)(for detailed data see appendix 11 Table A7.4 annex 7).

This pointed out that the production of the *ejido* would continue to be orientated to crops for self subsistence crops.

Low participation in PROCAMPO was attributed during the interviews to several factors but these are mainly related with mistrust of the government. Some *ejidatario*s and most of the *posesionarios* see subsidies as a threat. The programme requires parcels to be registered by presentation of the property title. However, the people with communal land divided illegally, have no property title, because the certification of ejidal rights finished in December 1995. Without land title, it was required that two neighbours testify the possession of the land; as this procedure was time consuming, few *posesionarios* were willing to follow the procedure and with less than 0.5 ha of land it is bothersome to receive 20 pounds per year.

The beneficiaries to be consider the programme good, because it provides cash that is handy, despite the fact that the money is provided after the date of sowing, and the bureaucracy involving the annual registration of parcels. One *ejidatario* commented

> 'several times over the years the 'Ingenieros'(agriculturist) have come to the *ejidos* to establish fertiliser trials and demonstration parcels. They also collected data about the *ejido* and the crops. However they never came back with the results or the promised programmes for increasing productivity of the crops. At least with this programme we received some money' (*Ejidatario*, 72 years old).

Participation of *ejidatario*s in government programmes is very poor, with only 81 *ejidatario*s in PROCAMPO and 30 in other programmes. During interviews with *ejidatarios* this was attributed to the fact that the government always has the same programmes, fertilisation, breeding seeds, organisation for production and crop protection. Each year government agents give the same presentation and this has discouraged participation. The *ejidal Comisario* comments that

> ‘ Every year is the same. They present the programmes, install demonstration parcels in the *ejido*, and at the end we have a field trip, where the bosses of the agents attend. We see the demonstration parcels, and they show their bosses that they can obtain high yields of maize with their technology. At the end of the trip there is a party and we all finish as friends. This year in the programmes they offer a lot of things such as tractors, spray pumps, razors for sheep, but you have to invest some money, at least 15%. People that do not have money to invest in those things said to me ‘why do I have to go, only to make the quorum. The technicians are very young, they cannot teach how to cultivate the land to somebody that has worked the land all his life’.

Government agents commented in contrast that participation of the *ejidatarios* is poor because they are narrow-minded and do not want to change the traditional systems of production, and there are only a few that want to participate in the programmes. For example the technician in charge of technical advice for the production of maize commented

> ‘ I have to give advice on 500 hectares to increase production of maize using the technological recommendation produced by the research institutions. People in the *ejidos* do not want to follow the advice, but I have to convince some of them. In Nativitas I gave advice this year to 30 *ejidatarios* that sowed 15 ha of maize. They did not follow the advice at all, because they do not want to apply herbicides, and they apply half of the amount of fertiliser. They are very attached to their systems of production and are very stubborn. The best thing for me to do is to work with private proprietors, with more than 20 hectares of land, they already are using the technology, thus I have to work with people that have more area of land and are more entrepreneurial to do my job efficiently’ (government agent, 50 years old)

7.3.9.3 Ecological Restoration Programme

The *ejidatarios* participated in the programme for reforestation and construction of permeable dams (*Presas de Gabiones)* from August to September 1997. The permeable dam is a structure for retention of river sediments and allows the flow of water. The dams consist of ‘gabions’ (wire mesh containers filled with pieces of rocks). Three criteria were adapted for selection of sites: a) areas with most erosion along the stream b) where the stream was narrower and c) where there were rocks available for construction. The government provided the gabion cages and the *ejidatario*s had to break the rocks, put them into the gabions and pile them up to build the dam. Three dams were built in 54 days: two of 150 m^3 and one of 100 m^3 *Ejidatario*s were paid daily wages of £11.9, eight times the minimum wage.

The committees for the works were formed in July 1997 and 16 *ejidatario*s participated for reforestation and 16 for the construction of dams. The sites selected for reforestation were areas in which reforestation had failed in past years. Reforestation work takes twelve days, each participant receiving dairy salary of £1.90. The *ejidatarios* and the technicians commented that they knew that reforestation would fail, because the plantation of trees was carried out in August, the driest month of the rainy season, and with one month of rain left most of the plants would die. The reforestation was visited during the fieldwork in February 1998 with agents, and it was estimated that 70% of the trees had died. The technician said

> 'this is a temporary job and we ought to do the things as the boss said'(Technician 45 years old).

The *ejidal comisario* of Nativitas commented that every year there are programmes of reforestation by the government in the eroded areas with hardpan (*tepetate*) exposed, and reforestation failed because the plantation is carried out to late. The *ejidal comisario* suggested that the problem of erosion in these terraces could be solved by the incorporation of the terraces into cultivation

> 'but at the end of the day, it is government money, and we can earn some money each year'.

Support provided by the government for agricultural programmes is very low £4004 (varying from £18 to £144 by *ejidatario*). Programme *Alianza para el Campo*, which is targeting individual resources for investment, is not providing the support required for rural development in Nativitas, nor a programme to provide temporary jobs such as reforestation or construction of infrastructure. In discussion with the members of the *ejido*, they expressed the view that none of the government schemes was providing what they really wanted. What they required was:

1. Help with improving the strength of the *ejido*s organisation and its financial management.
2. Development of irrigation either by the construction of a well or by treating sewage water and using the treated water.

7.3.10 Occupational activities

The people of Nativitas have had access to 902 ha of agriculture, grassland and forest. As explained in previous sections agriculture, livestock rising and exploitation of forest resources have been oriented to self-sufficiency, and marketing of any surplus. Also occupational activities in the *ejido* has been complemented with activities outside the *ejido* but the importance of these has varied through time and has been dependent on the national policies in the use of the resources and the opportunities to work outside agriculture in the region. Four different phases of income generating activities can be identified:

a) From 1923 to 1945 with low population and land access increased from 60 ha to 902 ha by the distribution of land by the Government the occupational activities centred on the use of available resources. Agriculture was essentially focused on subsistence with any surplus going to the market and irrigated land was used to produce maize, flowers and fruits in family gardens for market. Some people complemented income with the extraction of forest products. A small number of people also obtained additional income from seasonal employment outside agriculture.

b) From 1945 to 1970 there was the government ban on the exploitation of the forest by *ejidatario*s and the decline in markets for forest products; despite this the extraction of wood continued illegally, exploitation of forest resources was gradually declining and ceased in the middle sixties. Occupational income activities continued to be centred on agriculture, the arable base was increased by conversion of more land into agriculture from either areas of grassland or forest and similarly livestock numbers continued to increase. The expansion in the number of livestock and the reduction of the grazing area continued until the middle sixties when the remaining grassland became severely eroded as a result of overgrazing. Thus during this period the use of the resource base changed, use of forest as an income source was abandoned and reserved only for self-consumption. Seasonal agriculture continued on a subsistence basis but saw an increasing production of flowers, fruit and medicinal herbs for the local markets.

As well as changes in the use of the agricultural resource base new sources of employment were opened in the region as a result of the importation substitution policy adopted by the government. The area of Texcoco was identified as an area for the establishment of dairy farms (ranchos) and farms (granjas) for the production of chickens and pork aimed at supplying Mexico City. As activities in agriculture were dependent on manual labour the ranchos and granjas were a source of permanent or seasonal jobs for the *ejidatarios*.

c) From 1970 to 1995 much of the land passed to the hands of a new generation of *ejidatarios*, through inheritance as the original *ejidatarios* died. Most of the new generation had occupational activities outside agriculture. This new generation introduced several significant changes in the pattern of occupational activities involving agriculture; production of maize in seasonal lands became largely a secondary part-time activity. Whilst agriculture on irrigated land was transformed from family gardens into commercial flower production by the construction of greenhouses, the irrigation supply was also insured by the construction of storage tanks. Also agriculture techniques changed; where maize was grown cultivation was mechanised with tractors replacing mules. Livestock production was largely reduced to back yard production of pork and lamb. The resultant massive loss of organic manure required the use of bought inorganic fertiliser on the maize plots.

The *ejidatarios* negotiated the exploitation of the forest with the company and the forest was given in concession to the company, but the agreement lasted only one year because the price paid for the wood was very low. The *ejidatarios* also took over the exploitation of these reserves but always on a small scale. The sand quarry was leased as a concession to a private company for two years, but when the lease ended the *ejidatarios* increased the price of the concession and the company did not agree to the new price. The *ejidatarios* after a further year closed the mine. This was because the *ejidatarios* had to supervise the extraction of sand on a rotation basis and this proved to be very time consuming in relation to the small profit obtained.

The improvement of communications in the region by the surfacing of roads in this period increased tourism in the neighbouring National Park and some *ejidatarios* set up stalls for the sale of food. Some *ejidatarios* opened shops in Nativitas for the sale of groceries, building materials and a pharmacy and others rented stalls in the markets of the region. Other job opportunities were opened in government institutions, local factories and by the increase in general construction in the region.

Thus income activities outside the *ejido* were consolidated in this period and most of these *ejidatarios* obtained their main income from outside the *ejido* in paid work or self-employment as traders. Agricultural activities also changed; whilst maize production remained essentially subsistence and now mainly as a part time activity, livestock reverted to a subsistence activity. The irrigated lands on the other hand were exploited for commercial purposes, especially the production of flowers for sale in shops, in local and regional markets. The two attempts to commercialise communal activities both failed.

d) this period started in 1995 and continues today as the *ejidatarios* continued the cultivation of maize under seasonal agriculture for self-subsistence and raising livestock in backyards. The diversity of income activities however increased.

From information collected during fieldwork about income activities of 209 *ejidatarios* seventeen different activities were found. Only 11% have agriculture as main source of income. One hundred and eighty six *ejidatarios* have their main source of income outside agriculture; of these 56 have two income activities (Table 7.15).

The occupational activities are divided into three groups by their main activity a) agriculture as the main source of income b) permanent job outside agriculture c) self-employment as shopkeepers and traders.

The group depending on agricultural production can be further divided into two sub-groups by their main activity: either agriculture or production of flowers in greenhouses. In the first group there are 24 people, working in production of maize for self-subsistence, backyard livestock and working in temporary government programmes.

Table 7.15 *Ejidatarios* and *posesionarios* in Santa Maria Nativitas Aggregated by main occupation (fieldwork (1998)

Main occupation	Total			Baker		Greenhouse		Shopkeeper		Musician
	Total	Ejid.	Pos.	Ejid	Pos	Ejid.	Pos.	Ejid	Pos	Ejid
Shopkeeper	46	26	20	2		4	5			
Employee	24	14	10			2	3	1		
Greenhouse	22	15	7	2	1			3	2	
Farmer	21	12	9	2		1	2	2		1
Worker	21	8	13	1	2			2	1	
Baker	19	8	11			1	2	2		
Mason	17	5	12			1	1			
Housewife	10	2	8					2	3	
Driver	8	3	5	1						
Musician	8	2	6			1		1		
Blacksmith	5	2	3			2				
Day labourer	3	2	1							
Pensioner	2	2								
Florister	1		1							
Mechanic	1		1							
Plumber	1		1							
	209	101	108	8	3	13	13	12	6	1
Abr: Ejid=*Ejidatario*; Pos = *Posesionario*										

In the second group there are both *ejidatario*s and private landowners carrying out the production of greenhouse flowers. The Rural District (DDR03, Texcoco 1997) reports 65 people with greenhouses: *Ejidatario*s (15) *Posesionarios* (15) and private owners (35).

Members of the second group with permanent jobs outside agriculture, work as employees in government institutions or factories as clerks, cleaners, or specialised workers. Twelve of these have another source of income as bakers (3) in greenhouses (5) or shopkeepers (4). Many of these workers will rejoin the group of *ejidatario*s engaged in full-time agriculture when they retire. This was a frequently expressed aim of many of the interviewees for example one *ejidatario* said

> 'The pension paid by the government is very low. When I get my pension I will continue with the production of maize in my parcel. I am going have more time to improve my parcel or build a greenhouse, I will participate in the *ejido* assemblies and take advantage of the government programmes. When you are retired you need something to do. The only thing that I will have is that piece of land and my participation in the *ejidal* assemblies. My wife agrees, she said that it is good that I devote my time to something productive. She said that the people without any thing to do have bad thinking or become alcoholic. Then when I get my pension....' (*ejidatario*, Nativitas, 53 years)

The self-employed group could be considered the entrepreneurial *ejidatario*s mainly shopkeepers (46) and traders (26) since they have taken advantage of work opportunities outside agriculture and have hence earned higher incomes than the majority of the *ejidatario*s. Twenty-three have shops in the town, groceries (15), butchers (2), building materials (3), stationery stores (2) and drug store (1). Twenty-three have stalls in the Molino de las Flores National Park, 2 km from Nativitas and some in the markets of Texcoco or Mexico City. Thirteen of them have other sources of income, nine from greenhouses, two as bakers and two from agriculture. The bakers produce bread using traditional methods involving furnaces made with clay and using firewood as fuel. Bakery has been trade in Nativitas since Colonial period and recipes passed by generations. There are nineteen bakers, most with permanent stalls in markets or tourist places.

The traders provide services as skilled workers- masons (17), blacksmiths (5), plumbers (1), mechanics (1), florists (1) and eight in a musical band. Seven of them have other sources of income, five in greenhouse, one as a baker and one as a shopkeeper.

Women owning land in the *ejido* have their main activity as housewives (10) with five having as additional activity a shop in the front of the house. One of the main activities of the shopkeepers is the sale of food, cooked by the women. It seems though, that the women do not consider this as main activity because the stall or shop is in the name of the husband and this activity is carried out during the weekends.

The actual occupational activities of each individual *ejidatario* are the product of a strategic decision-making process. Whenever decisions are to be made regarding a new income activity outside agriculture, the income strategy is modified and revised according to the individual's resources and their perception economic conditions. If their perceptions are wrong, the strategy fails. In addition the strategy is often limited by the consequences of the individual's previous decisions. For instance the production of basic food (maize, beans and livestock) is a long-term strategy for self-sufficiency followed by all people that hold land. In the irrigated land however the strategy has been changed from production of fruit, flowers and medicinal herbs to production of commercial flowers in greenhouses when the technology and market were made available. The increase of population and tourism in the region increased the involvement in commercial activities and trade, and these have become the main source of income for the *ejidatarios*.

7.3 SANTA CATARINA DEL MONTE

7.4.1 Lands of the Comunidad Agraria and *ejido*

The pueblo of Santa Catarina had possession of land since Prehispanic times, recognised in 1609 by the Spanish Crown. In 1927 the government granted as *ejido*, 694 ha of land to people of the town. It was not until 1958 when the town claimed the restitution of the land as *Comunidad Agraria* land title issued in 1609. It was not until 1966 when 1743 ha were recognised to 238 people. In 1997 the *Ejido* of Santa Catarina requested the certification of *ejidal* rights in the PROCEDE programme.

The land tenure in Catarina takes two forms, Comunidad Agraria and *ejido*. Figure 7.1 shows the location of the lands of the *ejido* and *Comunidad Agraria.* The lands in possession of the *Ejido* currently are 869 ha from these: 694 ha are of communal land, and 159 ha as parcels. The current amount of land in possession of people of the town of Catarina is around 2612 ha (for details see table A7.1 Appendix 8).

7.4.2 Government and *ejidatario* maps

7.4.2.1 INEGI soil map

The government soil resource map of the *ejido* comprises a map of soil units (INEGI, 1982) and a map of land systems with the classification of facets according to land suitability (Ortiz y Cuanalo, 1977).

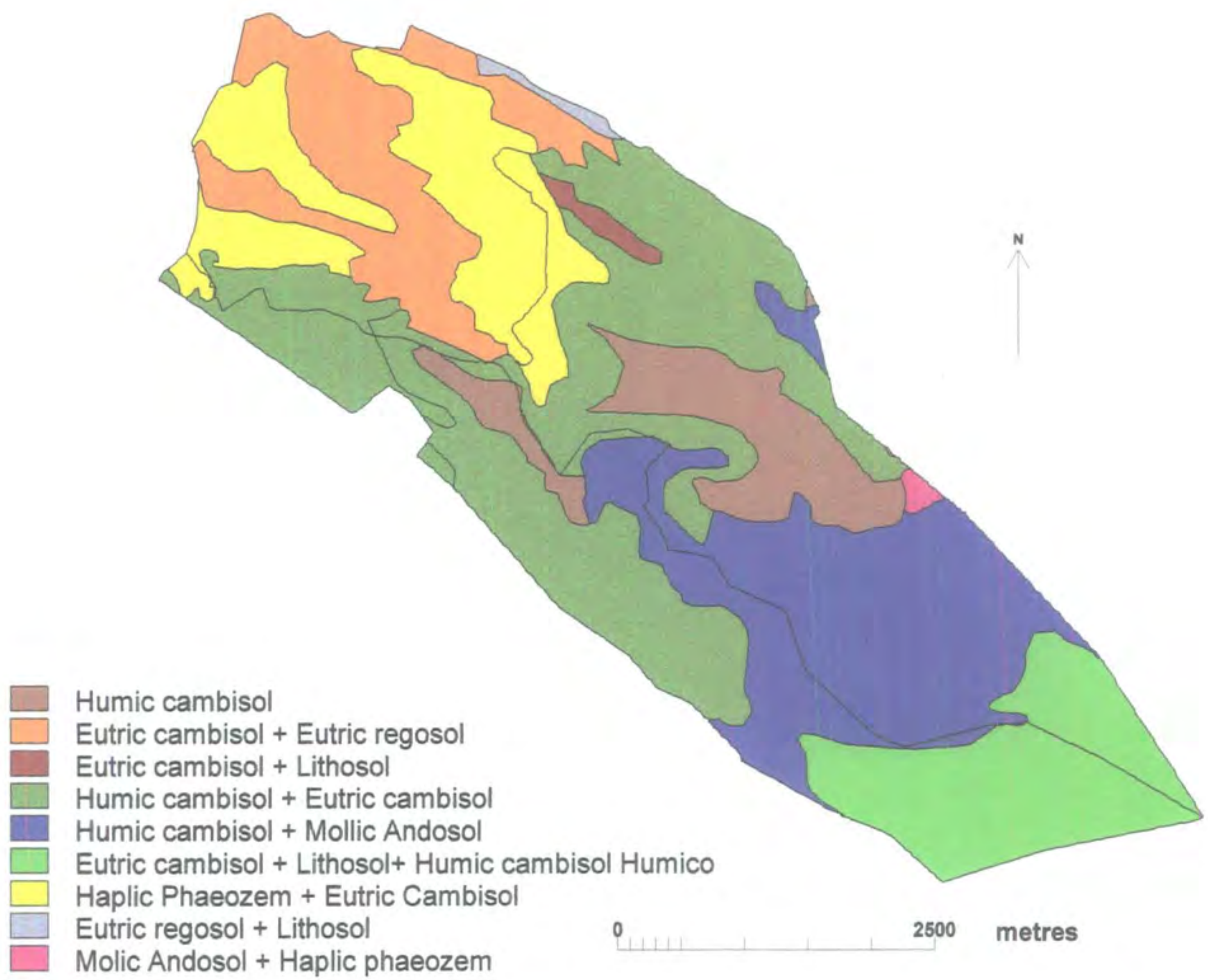
The map of soils of the *ejido* (Figure 7.21) shows the soil units according to the FAO classification. The dominant soil units in the agriculture area are Cambisols (subunit: Humic, Eutric and Dystric) and Phaeozems (subunit: Haplic). These are soils without significant problems for use in agriculture, although they overlay a hardpan that could limit the development of roots. The main restriction is slopes from 9-15% and steeper in the ravines. In the forest the dominant soil unit is Cambisol, and in the area that is actually under agriculture the dominant unit is Humic Cambisol with slopes of than 7 to 10% (Table 7.16). Composite cartographic units on the map occupy more than the area of the lands of Santa Catarina del Monte and the individual soil units cannot be located. This means that it is not known which of the soil units is present in the *ejido* lands and this limits the utility of the map for planning.

Table 7.16. Soil units in Santa Maria Nativitas (Author based in maps of INEGI, 1978)

Land use	Area Hectares								
	Bh	Be+Bh	Be+Re	Hh+Be	Be+I	Be+ I +Bh	Bh+Tm	Re+I	Th+Bh
Agriculture		119	273	326				11	
Agric. (Forest)	198								
Forest		582			16	301	506		7

Abbr: Bh: Humic Cambsiol; Be. Eutric Cambisol; Re. Eutric Regosol; Hh. Haplic Phaeozem; I. Lithosol ; Tm . Mollic Andosol; Th. Haplic Andosol.

Figure 7.21 Soil map of Santa Catarina Del Monte (FAO classification, INEGI,1982)



7.4.2.2 Land facets map

The land suitability map was produced using as a unit of classification land facets (Ortiz y Cuanalo, 1977). There are two land systems, Ixayoc and Tecuanulco, with differences in rainfall regime and landscape; the first highly eroded, and the second with high slopes above 40%. The five facets of the *ejido* by slope are classified as unsuitable for agriculture (class VI or VII); only sub-facet 3b is class II e (95 ha) is suitable for agriculture (Table 7.17. For a detailed description of the land system and facets see table A7.1 annex 8).

Table 7.17 Land facets by area in Santa Catarina del Monte (Compiled from Ortiz, 1977)

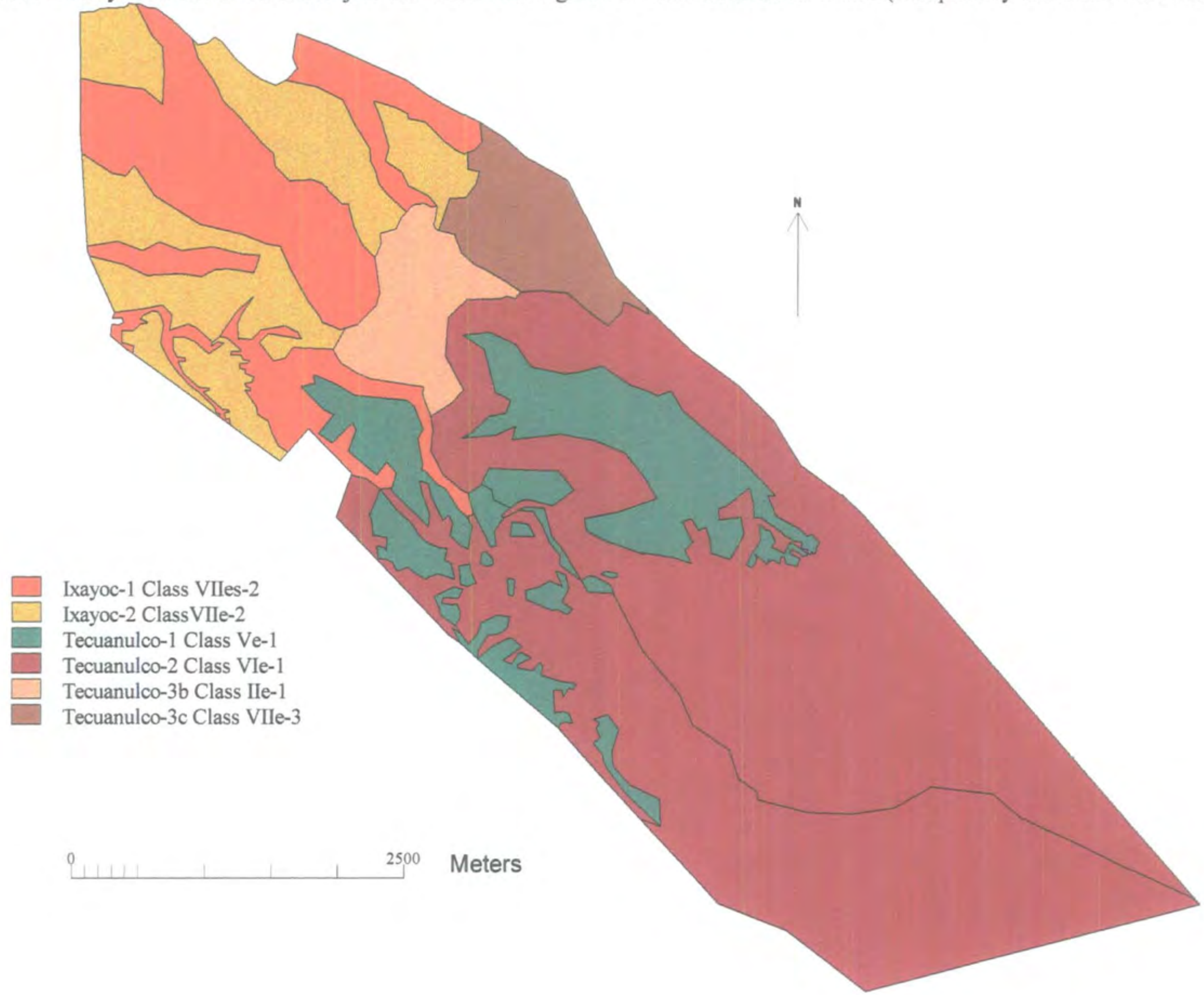
Land use	Land facets (ha)					
	IX-1	IX-2	TEC-1	TEC-2	TEC-SF 3b	TEC-SF 3c
Agriculture Suitability	348 VII e	306 VII e			95 II e	103 VII e
Agriculture in Forest land Suitability			296 V e			
Forest Suitability				1327 VI e		

Abbr: IX. Ixayoc; TEC:Tecuanulco, SF. Sub-facet

Figure 7.22 show the location and suitability of the land facets in Catarina, which are suitable for agriculture with conservation works, and only 95 ha are suitable for agriculture.

This survey concludes that the facets of the land system Ixayoc and Tecuanulco with exposed tepetate were the areas with the high rates of erosion. Facet IX-1 with *tepetate* exposed have a reported annual average of sediments from erosion of 11,695 to 20,461 ton/ha, and facet IX-2 with an annual average yield of sediments from erosion of 5362 ton/ha. These data were evidence of the necessity to reclaim soils. *Tepetate* was reclaimed by mechanically breaking it up and some terraces were reforested and others put under agriculture in the period between 1975 and 1985. The government supported this, and afterwards the *ejidatarios* continued with the reclamation of soils with their own resources.

Figure 7.22 Land systems and facets in the ejido and Comunidad Agraria of Santa Catarina del Monte (Compiled by the author from Ortiz,1977)



7.4.2.3 Types of soils identified with the *Ejidatarios*

The *ejidatarios*[10] identified types of lands and place names by their names in Nahuatl. Historical data suggest that the indigenous people of the region had their own classification system of land types and some are still used (Serrato, 1993). They identified three types of soils by their location, colour and workability in agriculture: *texoquilalli* as brown soils on the terraces of the settlement, very hard to work manually when dry, but very productive; *Costlatl* are 'Tierras amarillas' (yellow soils) under agriculture in the forest, very loose (*suelto*), and maize does not grow well; *Tlilticitlalic*: land of the mountain (*tierras del monte*) dark black colour soil, under forest vegetation, good for growing potatoes. The hardpan, classified generically as *tepetate* was also classified in three forms by its hardness and colour, from softer to harder, yellow, red and with related with the experiences of the *ejidatarios* for their reclamation. A soil maps was not produced by the *ejidatario*s due to constraints of time, because in the settlement area permission of individual owners to go into their parcels was required, and this proved be very time consuming.

7.4.2.4 INEGI map of land use and vegetation

INEGI map of land use and vegetation comprises one type of land use (seasonal agriculture) and five types of vegetation aggregated to eight cartographic units. Six cartographic units have one type of vegetation such as grassland, pine, Holm oak, bushes and Abies, and three are composite units with more than one type of vegetation. The types of vegetation in which there are associations of forest with grassland or bushes are evidence of the degradation of the forest by cut off of trees and growing of secondary vegetation such as bushes or introduction of grassland. The areas by land uses are showed in Table 7.18. There are four cartographic units with associations of two types of vegetation and 4 with one type and 1 land use is seasonal agriculture. Figure 7.23 shows the location of land uses and vegetation in the lands of Catarina.

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[10] The tenure in Santa Catarina is as *Ejido* and *Comunidad Agraria* and the people is referred by the type of tenure in the town, the people with ejidal rights is called *Ejidatario*, and the people with rights of land is called *Comunero;* in this section the term *Ejidatario* will be used generically for whether, except when the information is referred to an specific group.

Figure 7.23 Land use and vegetation of Santa Catarina del Monte
(Compiled by the author from map of land use INEGI; 1982)

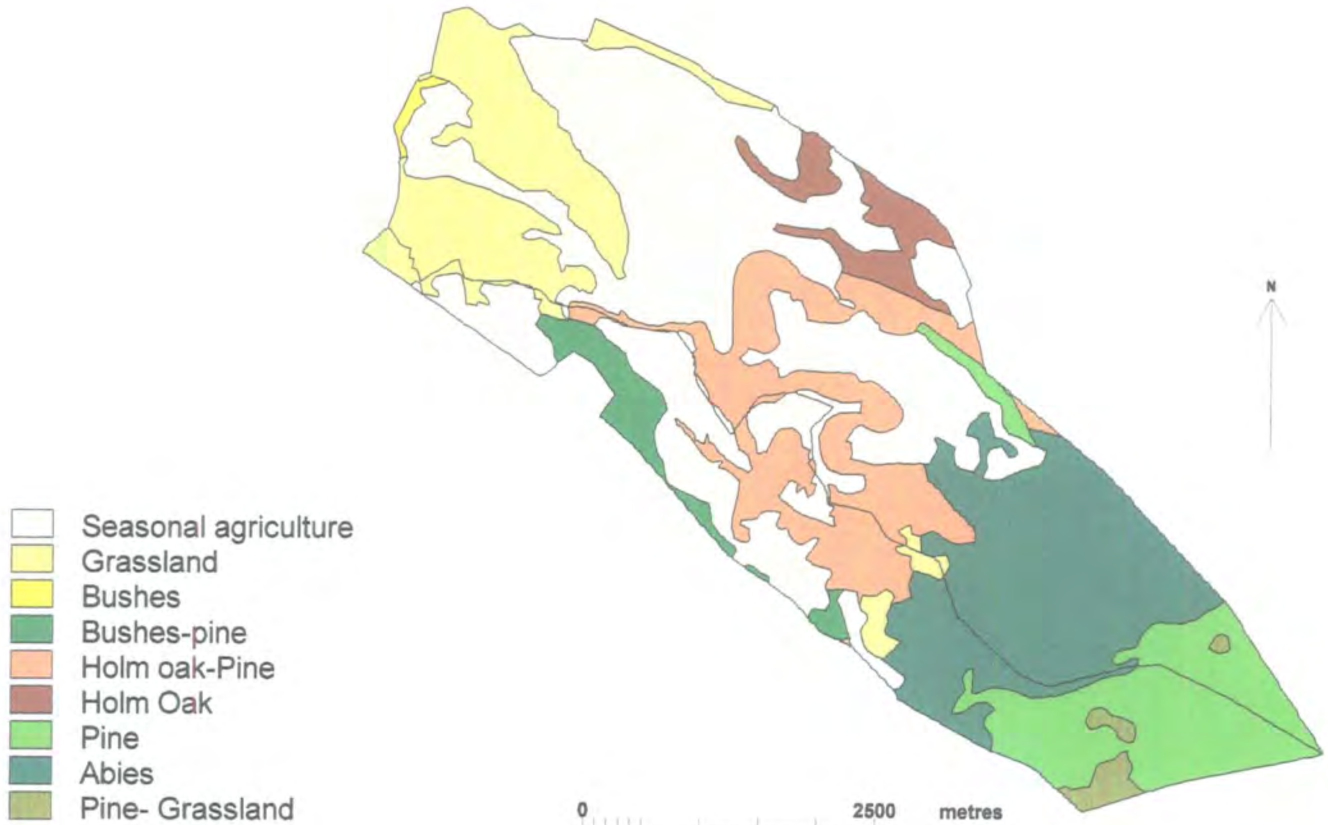


Table 7.18 Land use by area in Santa Catarina del Monte (Compiled by the author from INEGI, 1982)

Tenure	Land use and vegetation (ha)								
	Seasonal Agriculture	Grassland -bushes	Bushes - pine	Grassland	Holm-oak-pine	Holm oak	Abies	Pine	Pine-grass.
Ejido	210		63	40	101		94	181	24
Comunidad Agraria	646	7		272	205	73	323	85	
TOTAL	856	7	63	312	306	73	417	266	24

Abbr: Grass: Grassland

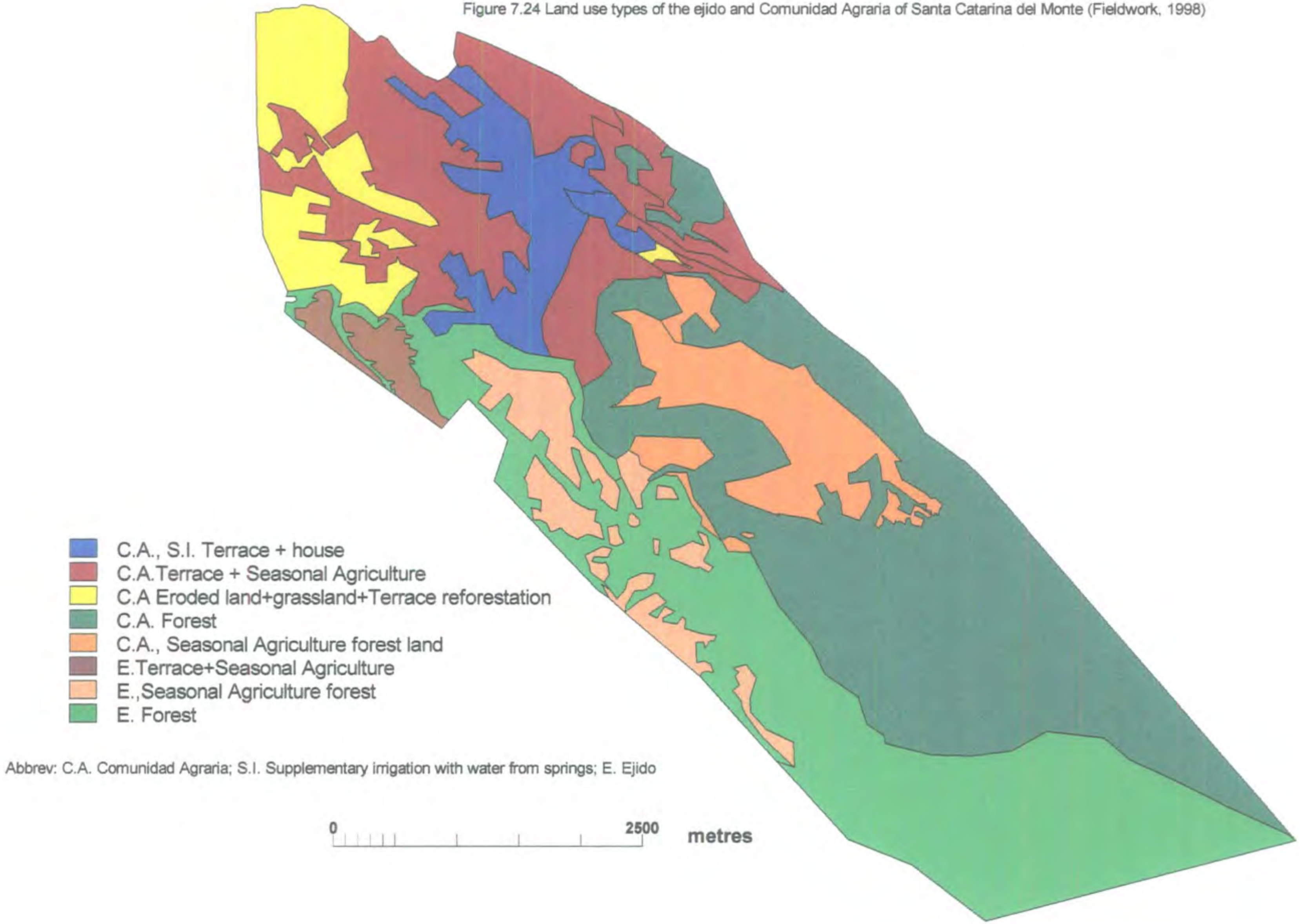
7.4.2.5 Map of land uses constructed with the ejidatarios

A land use map was produced together with the *ejidatarios* during transects, and using aerial photographs. The *ejidatarios* described the spatial distribution of land use characteristics such as tenure (*ejidal* and communal), land use (housing, agriculture and forest), degradation (erosion), infrastructure (irrigation, terracing and reclamation of *tepetate*), and consider the variation in altitude that produce changes in rainfall patterns. In the forest they identified the different types of trees, and the types of products extracted from each of them such as charcoal, wood and firewood.

Mapping involved exploring local knowledge and understanding of land use, and factors important to decision-making and historical relevant information. Their criteria for land use description first involved identifying land types of the *Comunidad Agraria* and *ejido.* Afterwards land use is cultivated and forestland. Agricultural land comprises two types: lands of the settlement area (*pueblo*), and the land of the forest classified by differences in rainfall pattern and the start of the rainy season. Agriculture areas were divided into irrigated and seasonal. The irrigated lands were those with houses, a diversity of crops and high yields, and seasonal land comprises areas under cultivation including those terraces of recent construction. Finally exposure of *tepetate*, evidence of erosion in channels and reforestation were used for identify erosion. Three types of vegetation in the forest were identified, oak, pine and Abies, but due to time constraints these were not mapped. However it is fair to say that the vegetation boundaries are similar to those of INEGI.

Figure 7.24 shows the lands identified as follows: *Comunidad Agraria* five types: supplementary irrigation in terraces with houses (159 ha), seasonal agriculture in land

Figure 7.24 Land use types of the ejido and Comunidad Agraria of Santa Catarina del Monte (Fieldwork, 1998)



reclaimed tepetate with terraces (331 ha), seasonal agriculture in the forestland (173 ha), grassland, eroded land, reclaimed tepetate with seasonal agriculture and reforestation in the west area of the settlement (168 ha) and forest[11] (784 ha). For the *ejido* three are types of lands: reclaimed *tepetate* in seasonal agriculture and reforestation (50 ha), seasonal agriculture in the forest (123 ha) and forest (650 ha).

The differences between the INEGI map of land use and vegetation and that produced by the *ejidatarios* are threefold: a) the area under irrigation is not identified on INEGI map b) in the INEGI map the areas under erosion are classified as grassland c) the areas under cultivation in the forest area are over-estimated on INEGI's map. One explanation for these differences could be because INEGI's map is outdated, with the interpretation of land uses based on aerial photographs from 1980. Also supplementary irrigation by springs was not considered as a land use class. In contrast the *ejidatarios* see land use as a dynamic process that has been driven by their own actions mainly by the incorporation of land into agriculture by both clearing of forest or reclamation of land by terracing or formation of soil from tepetate. Land is a resource for production of food and housing and is driven by social dynamics. The incorporation of land in agriculture was in areas with shallower slopes, but as the pressure of population increased, soils with deeper slopes were incorporated into agriculture sometimes with terraces but in other cases without any infrastructure, and erosion was the result. The overgrazing of grassland produced erosion; however terracing with investment of human work and recently with government support has reclaimed land. Food production, housing and reclamation of land are the forces that are producing the changes in land use, in a dynamic process that is identified in the classes of land identified by the *ejidatarios*.

[11] In the area of forest three types of vegetation were identified, oak, pine and Abies, Each have specific uses such as oak for the production of charcoal and wood, pine for the production of andiron, and Abies for the production of boards. However by constraints of time, the boundaries of the units were not checked.

7.4.3 Agriculture

7.4.3.1 Irrigated agriculture

The irrigated land covers an area of 159 ha, three springs Tlalticome, Tlaltecilla and Atexca with a yield of 37 Ls^{-1} supply water for irrigation (S.R.A. expediente *ejidal* No 727/974 Cited by Gonzalez R, 1993). During the fieldwork two other springs Cuautenco and Tamalacahipio, were mentioned as being used for irrigation. Catarina has an enormous advantage over other towns since the source of several springs are on their communal lands. This and the fact that half of the water of one of their springs is used for the supply of drinkable water to Texcoco ensure that they have a strong negotiating advantage with the government.

The irrigation system has three subsystems each associated with one spring with an independent network of tanks and channels. In Tlaltecilla, for example, the two main channels run perpendicular to the contour lines. Leading at right angles and running along the contour, secondary channels take water to the terraces. Tertiary channels distribute water onto the individual terraces. The system is extended as more houses are built in areas without channels, to provide water to the new houses (Figure 7.25).

Water distribution and supply is controlled by a Water Committee (Junta de Aguas) comprising a President, Secretary, Water Judge (juez de Agua) and two members (vocales). The President is in charge of maintenance of the springs and channels and acts as an agent in the financial procedures required with that purpose. The Water Judge is in charge of the distribution of water to the users. The Judge is the only person that has the power to open or close the tap of the tank. Water supply for irrigation and drinking is "free" of charge, although people are asked to contribute to the costs of any improvement or development of new infrastructure, e.g. new tanks or channels. The Assembly fixes the charge necessary for new developments and labour is organised through community work called "faenas"[12].

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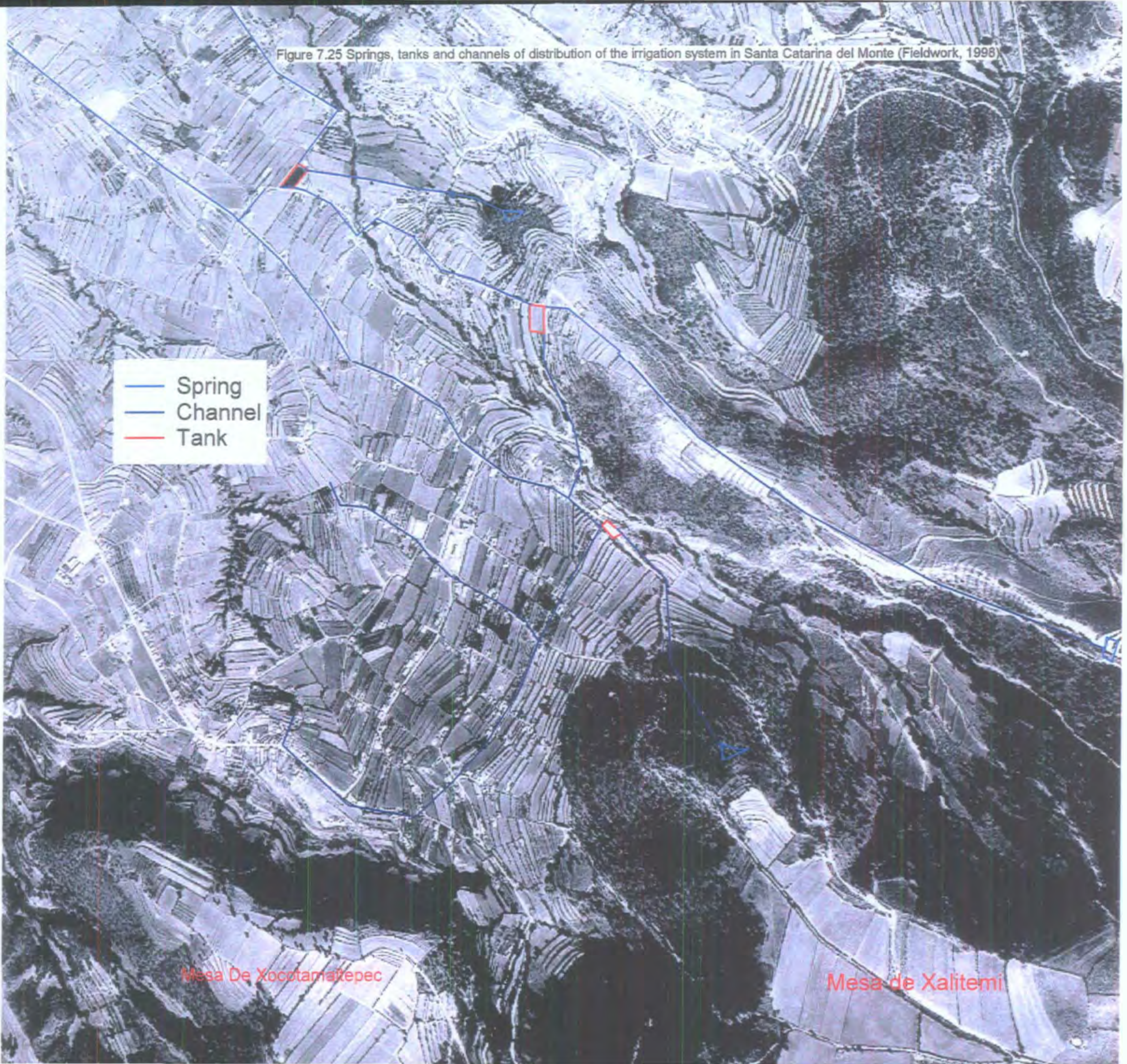
[12] *Faenas* are compulsory community work for males over 18 years of age in the agrarian community. It is realized one day a week or when works of common benefit like a road or the maintenance of channels are required.

Figure 7.25 Springs, tanks and channels of distribution of the irrigation system in Santa Catarina del Monte (Fieldwork, 1998)



Water rights are based on users' participation in community affairs, in the organisation of religious fiestas as members of the *Mayordomias*[13] and in work of common benefit (*Faenas*). Participation of the owner of a parcel with access to irrigation water is compulsory in the *Mayordomia* through attending church and organising the religious fiestas for one year. The allocation of the posts is based on a rotation system following the location of irrigated parcels along the roads. Each year from a block of ten parcels the assembly elects the *mayordomos* and the people not elected in the same block help them in their duties. This ensures the participation of all people with water rights in the *mayordomias*[14].

The system of irrigation is supplementary, and its major advantage is the sowing of maize with a long growth period (six months) and with high yields in March or April; sowing maize after April increases the risk of harvest lost due to frost. The distribution of water for irrigation is made in a way that all users throughout the year share the risk of an early frost. This has been achieved by water starting the irrigation one year in the parcels nearest to the water tanks, and in the next year in the parcels furthest away from tanks. The most intensive use of water for irrigation is from March to June when maize is sown; afterwards water is used only to irrigate fruits and family gardens.

There are six different types of maize with different lengths of growing period varying form 3 to 6 months (see Table 7.19). Harvesting of maize in Santa Catarina is between September and October. The yield varies; under irrigation in good years it is around 2.5 and 3 ton ha^{-1}. More accurate estimation of yield was not possible because as stated by some *Ejidatarios*, they sow maize on different parcels of land, at different rates or associated with other crops. Maize is harvested and stored with the

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[13] Mayordomias is collect contributions for the religious *Fiestas,* organise the *Fiesta* in the church, and works of maintenance of the church.

[14] Gonzalez R (1993) comments that until 1975 the mayordomias were in the hands of the people that could afford the expenses for the Fiestas. Only a few families had access to the main positions and these positions gave them more credit in the community and influence in political affairs. The system of participation was modified in 1975 based on the possession of irrigated land and a rotation system was instituted to ensure participation of all the people. Palerm V (1993) observed that for Santa Maria Tecuanulco around 1979 the positions were allocated in a way that all the houses of the community participated in the positions for the *mayordomias* also in a rotating way. Sokolsoky(1995) notes the change to the rotating system for San Jeronimo Amanalco since 1939.

kernels, the kernels being separated only when the maize is consumed throughout the year thus they have no means of recording the yield. When they run out of maize they buy it from other *ejidatarios* or in other communities or in Texcoco. When interviewees were asked about exact measurements of yields in kilograms, they noted that as it is essential to get some maize into storage, they therefore are not very worried about the actual yields. The main worry of the *ejidatario*s is to produce enough maize for their own consumption. Also other crops such as wheat, oat, barley, beans, broad beans, and chickpeas are sown in parcels that received irrigation in May.

7.4.3.2 Cultivation of commercial crops

Plants for the market such as flowers, fruits and medicinal herbs were introduced in the 1940s in the parcels with irrigation[15]. The production of these new plants changed the distribution of crops on the irrigated and seasonal land and produced an intensification of the crop growth for the market in the terraces and their combination with maize. There was also a gradual displacement or reduction in area of maize, broad beans, chickpeas, wheat and barley on irrigated land or their total displacement to seasonal land. Traditional plants used on the edges of the terraces for retention of soil (*Maguey*, *Nopa*l) and fruit trees (*Capulin* and *Tejocote*) were changed by more commercial fruit trees such as: apple, peach, pear and plum, and flowers such as: arum marguerite, chrysanthemum, *agapando* and rose. These plants are produced, sometimes combined with the maize sowing several furrows of flowers, or as strips of fruit trees and flowers. These products are produced in small quantities by season and sold by the people or by a middleman of the community.

Introduction of these new plants was made by trial and error planting fruits and flowers provided by people from other communities sometimes not adapted to the conditions of Catarina. Technology for the management of fruit trees and flowers is not used to improve productivity, for example through grafting and the application of insecticides, fungicides or fertilisers is rare, due to lack of capital. This situation produced low yields in fruits trees. For marketing other strategies are followed as in the case of peach that has low fruit yields due to crop diseases, but the flowers are accepted in the market for medicinal purposes. Gonzalez R (1993) reports that in 1980s there were diseases of the marguerite, after technical advice and identification of the disease the *ejidatarios* opted to sow other types of plant since they lacked the capital to buy the chemicals. A similar situation was commented on arum for this research; a disease attacked the arum several years ago and its cultivation was neglected or changed to marguerite or Agapando. Now some *ejidatarios* are again sowing arum because it achieves a good price in the market.

In general in Catarina there is a low level of investment of capital in agriculture, using as indicators the use of chemicals or machinery, or by the application of technical knowledge such as grafting or introduction of hybrid varieties of fruit trees. Gonzalez R (1993) notes that there are slow tendencies for the acquisition of this knowledge and during fieldwork for this research the *ejidatarios* expressed interest in learning how to grow vegetables. The use of chemical fertiliser is more common in the seasonal crops. Whereas on irrigated land the selective use of animal manure is more common. This low level of technology is compensated with the high input of human work and the diversity of plants that they manage for the market, such as the changing of plant where there are a disease or the prices fall and the intensive care of the flowers a and fruit trees on the terraces.

7.4.3.3 Family gardens

Family gardens are located in the terrace associated to the house with sizes that varies form 10 m^2 to 1000m^2 and in the edge of the parcel trees and flowers be grown. Mora and Buendia (1996) in the neighbouring community of San Miguel Tlaixpan, in a sample of three gardens found 91 different types of plants (trees, bushes and herbs). The plants have five different uses food, ornamental, medicinal, seasoning and ceremonial. From these plants sixty-six were oriented for self-consumption and 23 for self-consumption and marketing (Table 7.19) In a small garden observed in the

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[15] Gonzalez R (1993) notes that after the construction of dirty track to link Santa Catarina with Texcoco in 1940 the area sown with commercial crops increased in Catarina, because the people started to travel to the cities and sell the products by themselves.

fieldwork the main plants are flowers and medicinal herbs, with both family and marketing purposes; the garden is under the care of the woman,

Table 7.19 Diversity of plants their uses found in family gardens (huertos) in San Miguel Tlaixpan, Texcoco (Moran and Buendia, 1996)

	Number of species							
	Food	Ornamental	Medicinal	Seasoning	Ceremonial	Market	Self-consumption.	Both Market Self-consumption
Trees	16	2	2		1		12	8
Bushes	1	3	1	1	1		5	2
Herbs	16	22	16	7	2	6	49	13
Total	33	27	19	8	4	6	66	23

7.4.3.4 Seasonal agriculture

The area under seasonal agriculture is 895 ha from this 381 ha are with terraces reclaimed from *tepetate*, 296 ha are in the mountain, and 218 are in areas with a mix of seasonal agricultural reforestation and grassland. The selection of crops depends on location of parcels by its altitude. Selection of crops is determined by the start of the rainy season that is earlier in the highest areas, the date of the last and first frost in winter that determines the length of the growing period, and the conditions of the roads and animal tracks in the sierra that could affect access. There are three main areas of land for seasonal agriculture: the lower area is between 2,600m and 2,700m in areas adjacent to the settlement, the second between 2,600 m and 2,650 m in the west occupied by reclaimed terraces with shallow soils; and the third area exists between 2,700m and 3120m in the forest area, in the Mesa of Xalitemi and in the Mesa of Xocotamaltepec, and the hills of Cuacale in the sierra (Gonzalez R, 1993, Field observations, 1998).

The *ejidatarios* have selected through time a group of crops adapted to their different climatic conditions. Table 7.20 shows the crop periods of growth, decisions to sow according to the start of the rainy season and heights at which these crops are grown. The decision to sow depends on the start of the rainy season and the length of the growth period of the crops available, for example: if the rains starts in late April or early May maize with a longer growing period is sown, but if it starts from the middle

Plate 7.9 Parcel sown with flowers and maize in Santa Catarina del Monte

Plate 7.10 Terraces sown with maize in the Forest land of Santa Catarina del Monte

of May, maize with a shorter growing period is sown, or if rains starts later other crops such as beans, barley or wheat are sown. The decision is also related to availability of yolk or access to a tractor, the amount of land sown with crops for market in the specific year on irrigated land, and the number and location of parcels that the *ejidatario* have. As most of the *ejidatarios* have at least two parcels, one irrigated and one on seasonal land it is a common practice to plant maize in the irrigated land for self-consumption, and wheat, barley or oats in the other for animal consumption. However for people with more than two parcels the selection of crops is complex.

Table 7.20 crops growing periods, and height at which the crops are sown (Gonzalez, R, 1993; field work, 1998)

Crop	Growing period (months)	Decision to sow in irrigated or seasonal agriculture.	Height above sea level (m) in which the crops are sown.
Maine azul Mai violento	3	Seasonal (irrigated after May)	2750m-3120 m 2600 m in terraces with reclaimed tepetate
Maize chico Maize grande Maize pinto Maize Rojo	6 6 6 to 7 6 to 7	Irrigated (seasonal when rains started in March)	2600 to 2750m 2750 to 3120 m when rains start in March
Wheat Barley Oats	3 to 4 3 to 4 3 to 4	Seasonal (irrigated when crop sown after May)	2600 to 3120m, as alternative to maize when rains started after May
Broad beans, chickpeas	3	Seasonal (irrigated associated with maize)	2600 to 3120 m
Beans	3	Seasonal	2600m, in terraces with reclaimed tepetate
Potatoes	6	Seasonal	2900 to 3120m

7.4.4 Extraction of Forest Resources

Exploitation of the forest is an activity developed mainly by the poorest people of the agrarian community, that do not have opportunities of work outside the *ejido*, the oldest and people with formal education. However these people had a wealth of knowledge about the extraction of wood, medicinal herbs mushrooms. There are also other eleven products extracted from varying from Christmas trees, hunting, and peat for gardening.

7.4.4.1 Wood and firewood

Extraction of forest resources has taken place in Catarina since Colonial times; Villaseñor and Sanchez (1952, cited by Gonzalez R, 1993) note that in the eighteenth century extraction of wood and charcoal was an economic activity in Catarina. The extraction of wood from the forest is more intensive by the people with communal rights, by their tradition as woodcutters, formal education and opportunities to work outside the town. Palma (1996) reports that from a sample of 15 people that extract wood from the forest 50% finished primary education and the other fifty had less than three years of primary schooling. During the present research groups of woodcutters were father and sons or groups of relatives. The young people had education only to primary level. Exploitation of the forest is organised by a group designated by the communal assembly and they use traditional knowledge selecting areas of extraction of wood by types of trees in agreement with the product they wish to obtain and they determine the periods of return. The quantity of wood extracted is determined by demand, and the people requiring wood make requests directly to the woodcutter. The latter requests permission of the communal authorities and indicates the places where the wood will be cut. Extraction of wood is limited to the dry season (November to March) because access to the forest is by animal tracks, which are not passable during the rainy season. Another limitation for the extraction of wood is the number of animals owned by the people. The quantity is limited by the production of forage and the maximum number reported was four animals. The tools used traditionally have been axes but in recent years have been using chainsaws which have reduced the time to cut a tree from three days to five hours, but the time to transport the wood remains the same.

Extraction of firewood continues for self-consumption for a considerable number of people, and to a lesser extent, for marketing in neighbouring communities. A family of five use around 100 kg of firewood every two weeks. Firewood is collected from the parts of the trees that are left after the production of wood or from dead or diseased trees. There is an informal network of information between the people that usually go to the forest (mushroom collectors, shepherds and woodcutters) in which information about where there are trees with diseases or dead, areas with good grass, or where mushrooms grow better is exchanged.

7.4.4.2 Medicinal herbs

This activity is developed by few families that have local knowledge of the identification of herbs and other plants for traditional remedies. Marketing of herbs started in the 1940s. Gonzalez R (1993) identifies around 44 medicinal herbs and their use in Catarina. Medicinal herbs are sold in the market of Texcoco and Sonora in Mexico City. The plants are collected in three main areas: a) in the settlement area where special care is taken to keep the medicinal herbs where they grow amongst crops, near the channels or paths; also some of the most used herbs are produced in family gardens b) the eroded area where there are few species but their number by area is high c) In the forest where not only herbs are collected, also part of the tress and bushes are used in traditional remedies. Gonzalez R (1993) added that the diversity of species used for remedies allows the marketing of plants throughout the year. The most intense time for collection is between June and September with the best prices in the market being between January and February.

7.4.4.3 Edible mushrooms.

Collection of mushrooms is considered an important economic activity for the poorest people of Santa Catarina (Moreno, 1990; Villarreal 1996; Gonzalez, 1997; Cruz and Garcia; 1998). Mushrooms are an important dietary supplement. Cruz and Garcia (1998) note that collection of mushrooms for market started in the 1940s. They described a sample of 38 mushroom collectors and conclude that these activities are carried out by people with a low level of formal education and without job opportunities outside the *ejido*, were over 40 years old, and mainly men and widowed women formed around 30% of the sample. Villareal (1996) found 37 species of edible wild mushrooms in the forest, although only four types are picked for market; the others are used for self-consumption.

Areas of mushroom collection are identified by place names called *parajes* the name given to a place with a distinctive feature. Cruz and Garcia (1998) obtained from their informants the names of 21 *parajes* in Catarina. The areas are located in the forest with vegetation of Abies and pine between heights of 3,000m and 3,500m and the most visited *parajes* are three. The average collection is around 10 Kg/person/day. Although varies from 2 kg/day for an inexperienced picker to 17 Kg/day for someone more experienced (Moreno, 1990; Cruz y Garcia, 1998).

The importance of this activity in economic terms was studied by Moreno (1990), and in an area of 1 ha evaluated for one year she found 24 different species of mushrooms growing in different periods through the year. Higher production was in the Abies forest with 15 different types of mushrooms and a production of 214.2 Kg per hectare per year, and in the Pine forest production was 107.3 Kg per hectare per year. The profit obtained for the collection of mushrooms during the year by hectare, at prices updated to 2001 is around £170 in the pine forest and £383 in the forest of Abies.

7.4.4.4 Other activities in the forest

There are a number of products collected from the forest developed by people that have specialised knowledge for their collection and networks for commercialisation in the region. For example since the 1990s handcrafts made using the branches of a bush called *Perlilla* have been used for the manufacture of Christmas arrangements and baskets. Also Christmas trees, hay and moss are commercialised. Table 7.21 shows eleven such activities that require the verbal authorisation of the *ejidal* or communal authorities (Palma, 1990).

7.21 Seasonal activities of collection and type of authorisation required in the forest of Santa Catarina del Monte (Palma, 1996)

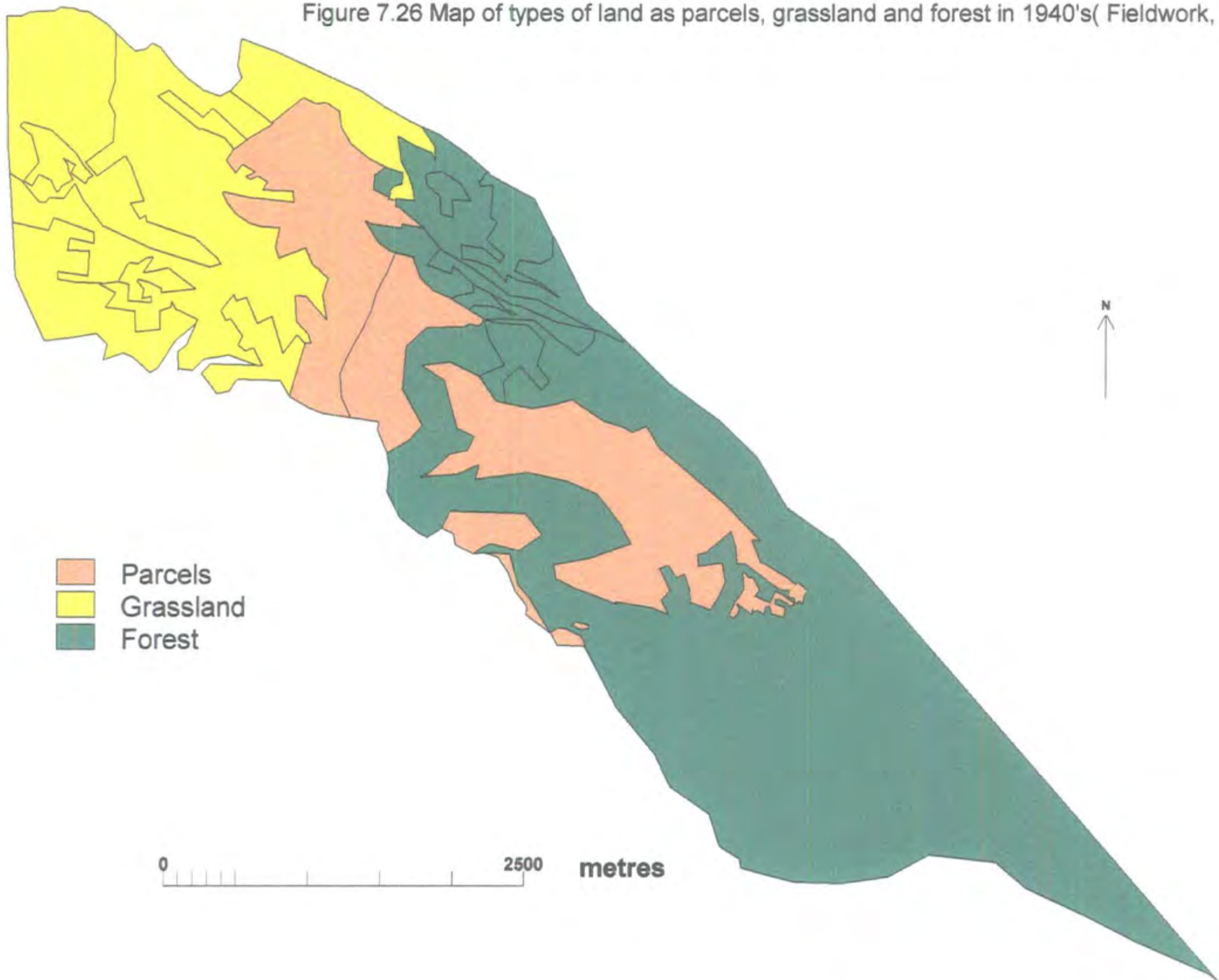
Products	Season	Type of authorisation
1) Cutting of Christmas trees in Abies and pine forests.	December	Permit from *ejidal* or communal authorities.
2) Collection of hay and moss.	December	Inform *ejidal* or communal authorities
3) Collection of branches of Perlilla for manufacture of Christmas handcrafts.	September-December	Inform to *ejidal* or communal authorities
4) Collection of peat for gardening.	Dry season	Permit from *ejidal* or communal authorities.
5) Production of charcoal from holm oak	Dry season	Permit from *ejidal* or communal authorities.
6) Collection of fern (helecho).	Rainy season	Inform to *ejidal* or communal authorities
7) Collection of resin from ocote pine	All year	Permit from *ejidal* or communal authorities.
9) Collection of foliage of Abies and pine to manufacture handcrafts.	All year	Inform to *ejidal* or communal authorities
11) Hunting of wild animals	All year	None

7.4.5 Second step of the land reform

7.4.5.1 Lands of the Comunidad Agraria

The *Comunidad Agraria* of Catarina does not participate in the PROCEDE certification programme and the map of land tenure was produced for the present research based on the map of land tenure 1:50,000 (INEGI, 1989). A map was produced using as a base map aerial photographs of 1989, transects and the participation of one c*omunero* with knowledge about the limits of the *Comunidad Agraria.* Two maps were produced with the purpose of explaining the process of subdivision of land, by the mapping of areas under cultivation and forest. The first map was for the location of areas of parcels, grassland and forest in 1940s. The area of parcels in the 1940s was identified in the aerial photograph by the location of the area of settlement with older houses and irrigation. It is said that prior to the 1940s agriculture was constrained within the settlement, and the land surrounding the pueblo was under grassland or was eroded. Areas under seasonal agriculture were in the Mesa of Xalitemi and Xocoltamaltepec in the mountain, and the rest of the land was forest (Figure 7.26).

Figure 7.26 Map of types of land as parcels, grassland and forest in 1940's(Fieldwork, 1998)



7.4.5.2 Subdivision of land in the Comunidad Agraria

The subdivision of communal land in Santa Catarina, arose for several reasons: a) communal land is seen as a reserve of land that is allocated to the natives of the town for the production of crops for self consumption as the population increases b) as in Nativitas the ban on exploitation of the forest by the government in the 1940s, and the decline of timber and firewood markets produced changes in the system of production. Agriculture oriented to flowers and fruits were introduced in the irrigated land, and maize displaced to seasonal land. The land under grassland was put into agriculture. c) from the 1980s further subdivision of communal land was achieved to incorporate these lands into cultivation.

Figure 7.27 shows the areas under cultivation, forest, and eroded areas .The amount of land subdivided into parcels is 380 ha of these 99 have come from the clearing of the forest and 281 ha by the subdivision of grassland. Incorporation of these latter lands into cultivation has required the building of terraces and the reclamation of soils. There are 160 ha of eroded land but as the increase in population continues, together with further reclamation, this land will be reclaimed and subdivided into parcels in the near future.

7.4.5.3 Programme of certification of ejidal PROCEDE in the ejido

The certification of *ejidal* rights finished in 1997, and the decision of the ejidal assembly was to continue as an *ejido*. The lands in possession of the *Ejido* currently are 869 ha from these: 694 ha are of communal land, and 159 ha as parcels. The parcel area is subdivided in 300 parcels from these, 76.6 ha were allocated to 72 *ejidatario*s who held 119 parcels; and 82.8 to 142 *posesionario*s who held 181 parcels and 1 parcel belonged to the school (Figure 7.28).

7.4.5.3.1 Subdivision of land in parcels

The beneficiaries of the ejido carried out the subdivision of land into parcels for cultivation in 1927, without any supervision by Government agents. This was commented on by one *ejidatario* and was reinforced by the information obtained in

Figure 7.27 Lands as parcels, grassland and forest of the Comunidad Agraria of Santa Catarina del Monte in 1998 (Fieldwork, 1998)

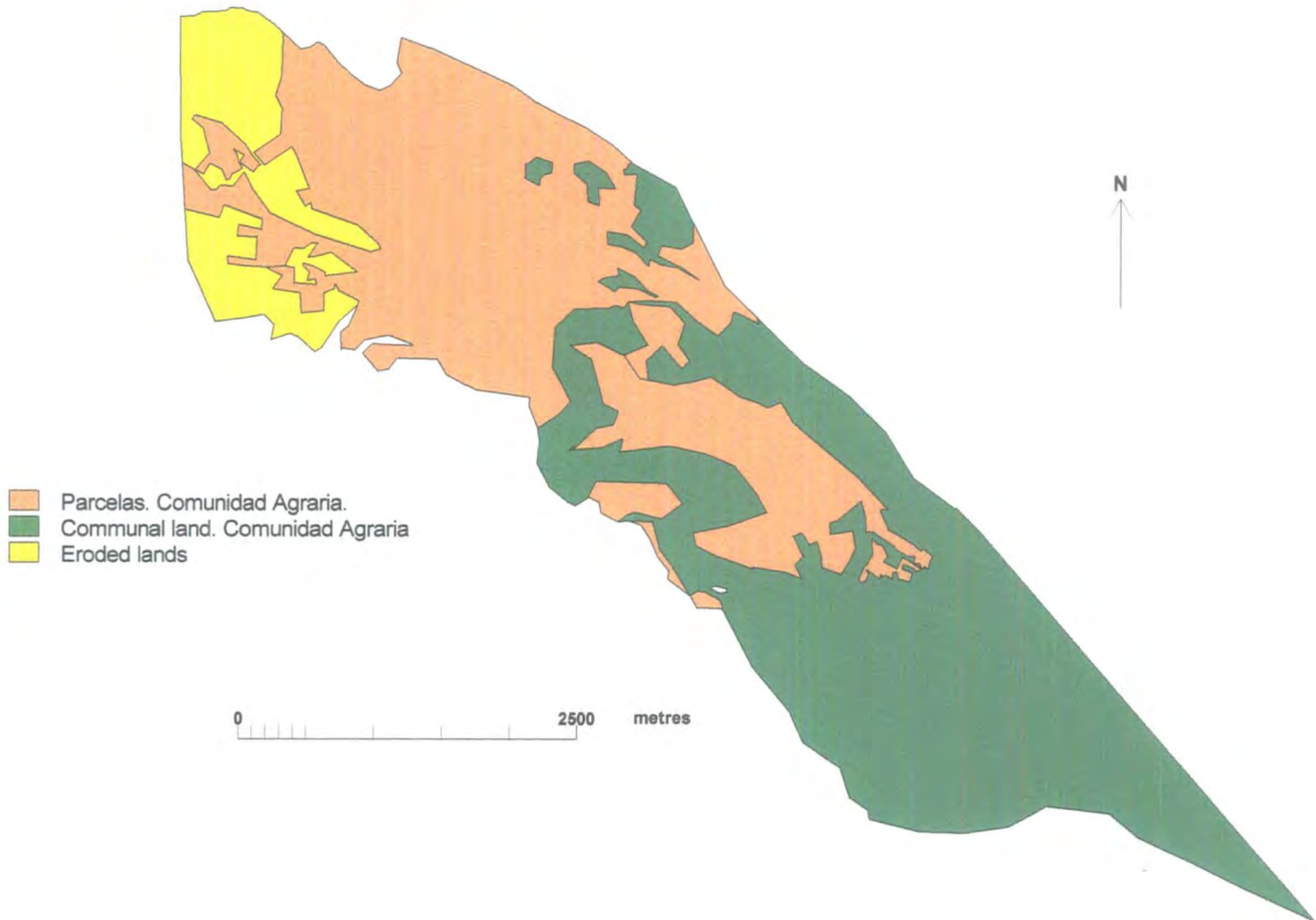
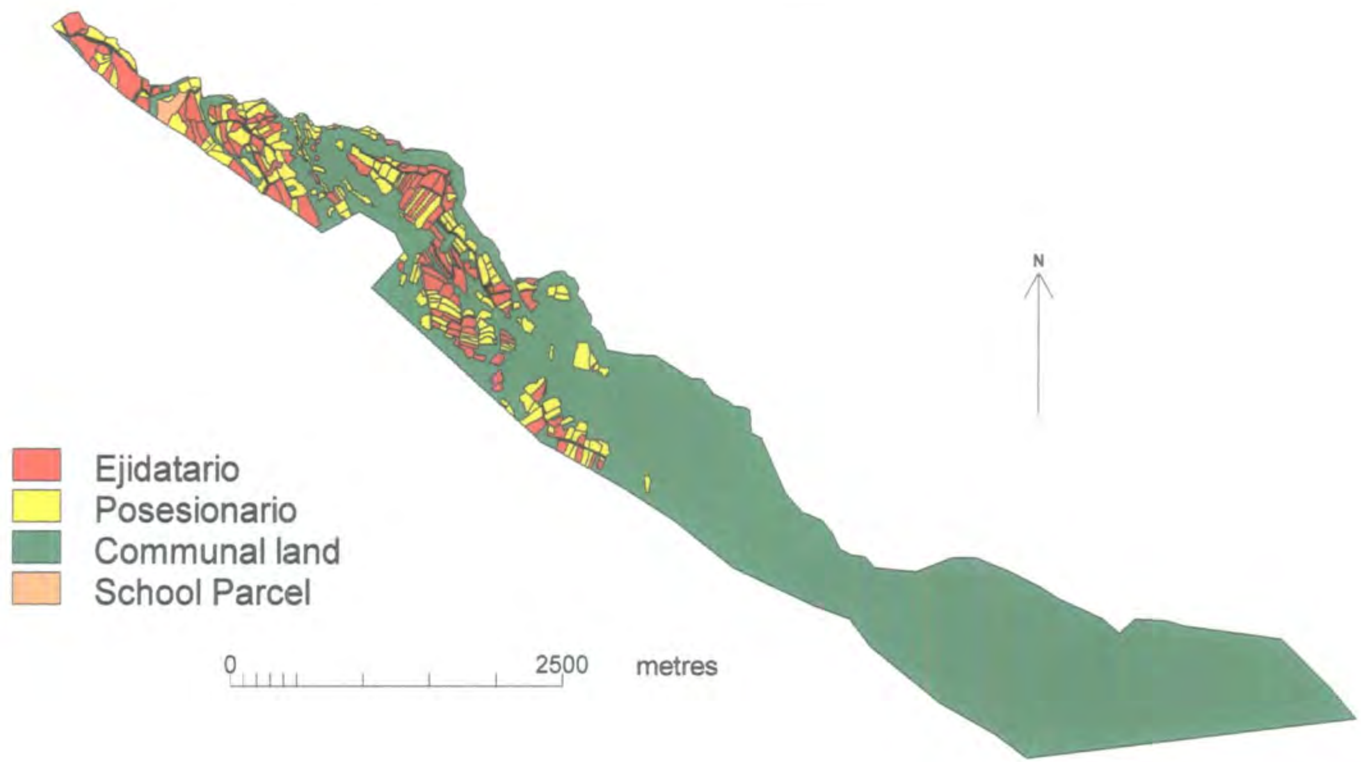


Figure 7.28 Land tenure of Santa Catarina del Monte (Author, based on map of PROCEDE,1997).



this research. Also during the analysis of PROCAMPO's data in the present research it was found that 45 people have parcels in both *ejido* and *Comunidad Agraria,* and that PROCEDE certificated 869 ha of *ejidal* land, 175 ha more than that stipulated in the presidential decree of 1927.The current area of parcels is 159.53 ha subdivided into 300 parcels. The size of parcels varies from 0.035 ha to 4.4 ha (See Tables A7.2 and A7.3 Appendix 8).

Table 7.22 shows that half of the land for cultivation has been allocated to *posesionarios* however most of their parcels have areas of less than 1.0ha, and some 16 have access to parcels of bigger size. The *ejidatarios* have access to parcels of diverse sizes, some 101 parcels of less than one ha and 18 of more than this size.

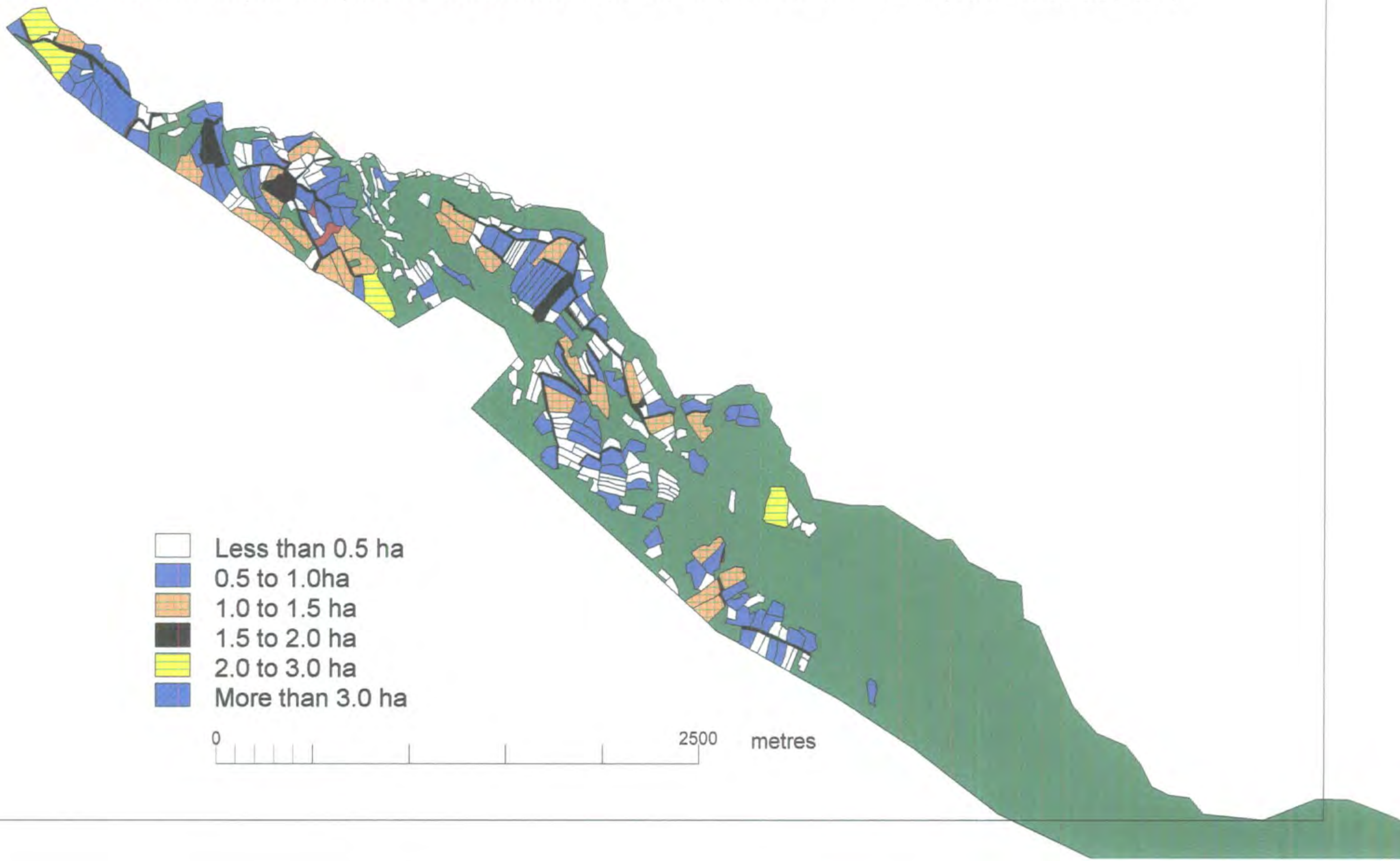
Table 7.22 Number of parcels of *Ejidatario* and *posesionario* by area held in Santa Catarina del Monte (PROCEDE, 1997)
(Source: tenure map of Santa Catarina PROCEDE (1995) Areas calculated in ILWIS)

Area (ha)	No of Parcels of *ejidatarios*	No of parcels *posesionarios*.	Total. Parcels.	Total (ha)	Average . Size(ha)	% Tot parcels.
<0.5	56	117	173	47.06	0.2721	57.67
0.5-1.0	45	48	93	63.77	0.6858	31.00
1.0-1.5	13	13	26	30.26	1.1641	8.67
1.5-2.0	1	2	3	5.02	1.6752	1.00
2.0-3.0	3	1	4	8.98	2.2471	1.33
3.0-4.6	1		1	4.41	4.4120	0.33
	119	181	300	159.53	0.5318	100.00

Figure 7.29 shows that most of the parcels are of variable sizes and are sparse throughout the *ejido*, with some near the settlement used for housing.

The differences in size are a result of the different strategies applied for the subdivision of land, that was carried out in three ways. First in 1927 parcels were opened to cultivation by the beneficiaries themselves in the areas with gentle slopes and the best soils by opening of grassland or clearing of forest. The size of parcels was usually of more than 1 ha. Secondly, sub-division was supervised by the *ejidal* authorities in which was agreed that the size of parcels be limited to 0.5 ha. These were in areas of low slopes being converted into cultivation to cover population expansion. Thirdly more recently steep slopes which require terrace construction

Figure 7.29 Distribution of parcels by area in Santa Catarina del Monte (Author, based on map of PROCEDE,1997)



before being suitable for cultivation have been subdivided and, again the size of the parcels is small.

The number of parcels held by individual *ejidatario/posesionario* varies from one to six, with 74.3% of the posesionarios/*posesionario*s holding one parcel, and 25.7% with more than one parcel. Some 9.87% of the *ejidatarios*/*posesionario*s held more than 3 parcels (Table 7.23).

Table 7.23 Number of *Ejidatarios* and *posesionario*s by number of parcels held in Santa Catarina
(Source: tenure map of Santa Catarina PROCEDE (1995) Areas calculated in ILWIS)

No of plots	Number *Ejidatarios*	Number *posesionarios.*	Total Parcels.	Total (ha)	AverageSize (ha)	% Tot parcels.
1	45	114	159	86.39	0.5434	74.30
2	16	20	36	42.27	1.1743	16.82
3	7	6	13	17.80	1.3696	6.07
4	2	1	3	4.86	1.6216	1.40
5	1	1	2	5.26	2.6331	0.93
6	1		1	2.92	2.9283	0.47
Total	72	142	214	159.53	0.7455	100.00

The fact that some *ejidatarios*/*posesionario*s hold variable number of parcels is indicative of a process of differential access to land within the *ejido*, however how information on how this was achieved was not obtained in the present research

The differences in size of parcels and number of parcels held by *ejidatario/posesionario* show that the area of land held by individuals varies. Table 7.24 shows these differences. Most of the landholders, 75.24%(161), have less than one ha, and some 24.76 (48) have more than 1 ha.

Table 7.24 Area held by *Ejidatarios* and *posesionario*s in Santa Catarina (Source: PROCEDE, 1998)

Area held (ha)	No of *ejidatarios*	Area (ha)	No of *posesionarios.*	Area (ha)	No of holders	Total (ha)	Average Size (ha)	% Holders
<0.5	18	5.61	75	20.73	93	26.35	0.2833	43.46
0.5-1.0	25	17.67	43	28.39	68	46.06	0.6775	31.78
1.0-1.5	11	12.84	17	20.84	28	33.68	1.2032	13.08
1.5-2.0	9	15.63	4	6.52	13	22.15	1.7043	6.07
2.0-2.5	4	9.03	3	6.35	7	15.38	2.1979	3.27
< 2.5	5	15.8			5	15.88	3.1768	2.34
	72	76.68	142	82.85	214	159.53	0.7455	100.00

Figure 7.30 shows the distribution of parcels of a sample of ejidatarios with more than one parcel. A single *ejidatario's* parcels can be spread throughout the *ejido*, (Table 7.25). This implies a lot of time spent in displacement, as only ploughing, all the other activities are carried out with animal traction.

Table 7.25 Number and size of parcels of some *Ejidatarios* in Santa Catarina del Monte

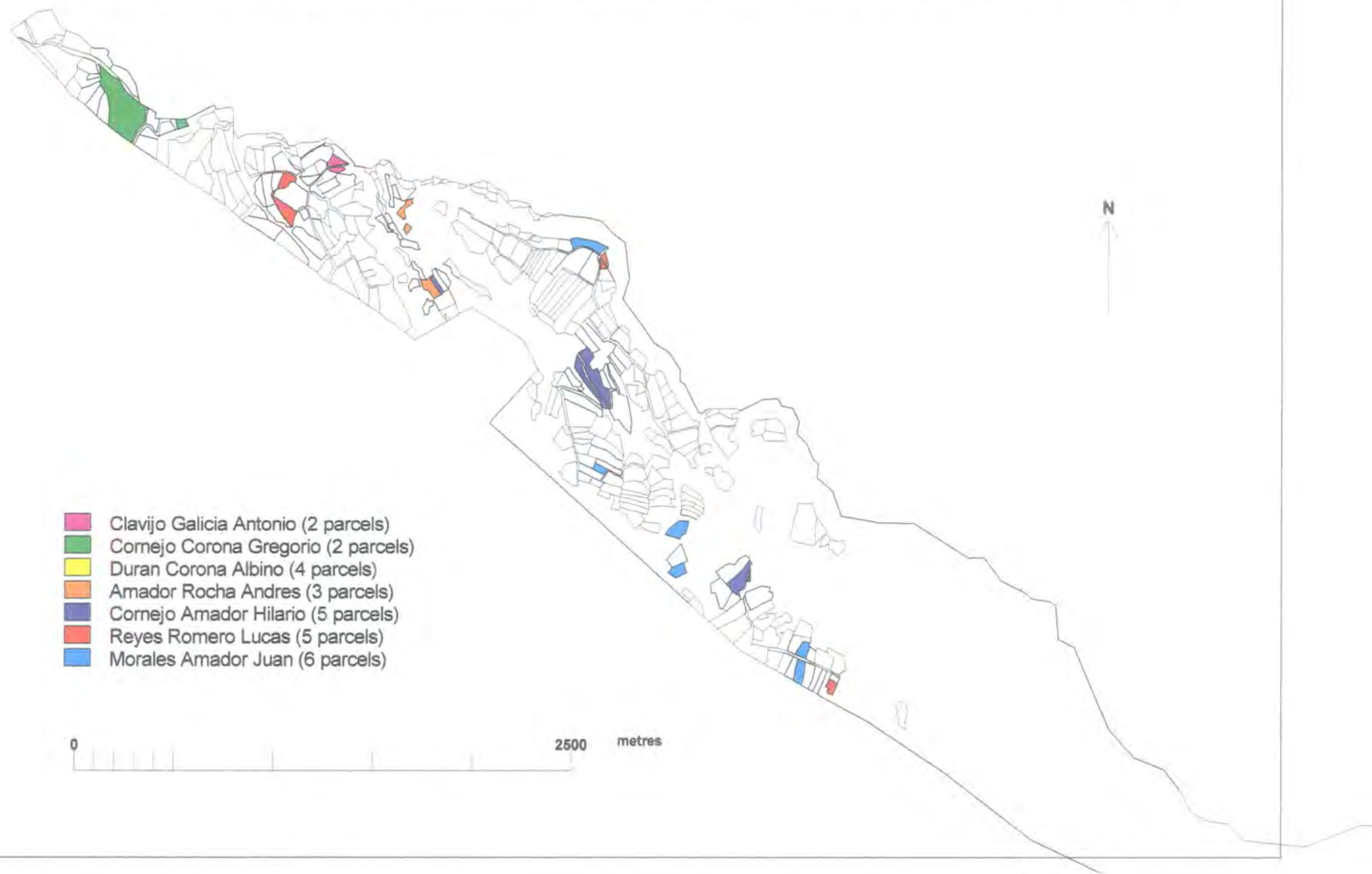
Ejidatario	No parcels	Size of parcels (m^2)	Total area (m^2)
Clavijo Corona Albino	2	1874, 3378	5252
Cornejo Corona Gregorio	2	2316,44120	46436
Amador Rocha Andres	3	1262,2879,4950	9091
Duran Corona Albino	4	922,1671,3191,4573	10357
Reyes Romero Lucas	4	1034,1388,2623,12292	16407
Cornejo Amador Hilario	5	499,2152,7584,8669,13005	31909
Morales Amador Juan	6	2428,3683,4183,5268,6514,7237	29213

7.4.5.3.2 Transfer of land in the *Ejido* and *Comunidad Agraria*

Although certification of parcels ended in 1997 no sales of land were reported by the *ejidatarios* or *comuneros.* Transfer of land was said to be in general by inheritance and rarely the land is put for sale, although when this does happen, the land is transfered to relatives or people of the town.

In the *Comunidad Agraria* the communal authorities continue to keep the register on the use and assignment of parcels. Any transaction of land has to be registered in the communal offices. For example when a parcel is transferred to another person, there is a ceremony in which the authorities, neighbours and friends of the family testify the transfer of the land. In the case of inheritance, most of the land is transferred to the male sons, but more of the land is for the oldest son. In a case described by one *comunero*, his father was a *Comunero* and woodcutter, and he had 4 parcels, 3 in the town with irrigation and one in the mountain. Two sons and four daughters composed the family. The land was divided as follows: the irrigated parcels were inherited by the two sons, and the oldest received two parcels, one of 0.5 irrigated and 0.5 ha the parcel in the forest. The third parcel in the town was divided between the youngest son 0.3 ha and a widow daughter 0.3 ha. The married daughters' husbands inherited land from their families and the daughters lived in the parcel that their husband inherited. One of the daughter was a widow with seven children, and had the parcel of

Figure 7.30 Example location of parcels of ejidatarios in Santa Catarina del Monte (Author, from PROCEDE,1998)



her husband. She divided the husband's parcel between the seven children. The transfer of the land was recognised by the widow and the *ejidal* authorities were notified that she was transferring the land. Other transfers of land are made by the *ejidatarios*, for example when the male sons married, the father gave a parcel of land to his son or to the daughter when the family of the husband does not have enough land to grant him.

The fact that 82 ha have been transferred to *posesionarios* indicated that land has been transferred to non-*ejidatarios* through inheritance or other type of transaction. There was one case, for example, in which the parcel was given as a guarantee for a loan. As the *ejidatario* did not pay the loan, during the PROCEDE programme those in possession of the parcel claimed their rights, and received the parcel as *posesionario*.

7.4.5.4 Participation in *Alianza para el Campo*

Participation in the programme for marginal areas took a number of different forms. First 250 lots of chickens were purchased and people considered the price to be reasonable and a good investment of their money. As part of the programme for genetic improvement of livestock, sheep imported from Australia were sold for breeding, and one *ejidatario* acquired five sheep. His experience was disappointing, and he said that the sheep were not adapted to the conditions of the region; they do not like the grass of Catarina, losing weight in the first weeks. Two of the sheep were pregnant, but after giving birth did not 'bond' with lambs. The *ejidatario* said that the sheep lost their maternal instincts (people that bought sheep in other *ejidos* noted the same problem). Finally he decided that the best thing to do was to sell the sheep. Since they cost 23% under the normal cost, by selling them was able to make a small profit.

In the programme of infrastructure for irrigation, the *Comunidad Agraria* bought 3000 m of 0.10 m PVC pipe to conduct spring water in the sierra. The spring is situated in the boundary with Santa Maria Tecuanulco that for some years has claimed ownership of the spring. The building of infrastructure and use of the water insures the rights of the spring Catarina and it is hoped by the *comuneros* that this will end the dispute.

The people of Santa Catarina have not participated in other programmes, such as those which involve the breeding of seeds, or use of fertilisers because they select seeds from their own crops for the following year, and they use whatever farmyard manure they have at their disposal. In addition they have experienced problems with the use of fertilisers, saying that they burn the plants and poison the land. They have used improved seeds and fertilisers, but they observed problems when the maize is stored for long periods. With the improved seeds and using fertilisers, after six months in storage the seeds are attacked by pests, whereas their own seeds can be stored for one or two years without problems.

The *Comunidad Agraria* participates in a special Government programme (ASERCA cosechas) for building and repairing roads to areas of production. Seven kilometres of dirt track were levelled using a bulldozer, although with the first rains, the road located in steep area was eroded, and by the end of 1997 the roads were in very poor condition.

7.4.5.5 Participation in PROCAMPO

The total area of land in Catarina eligible for PROCAMPO subsidies is estimated in this research as 836 ha. In 1997 159 ha (19%) were registered with PROCEDE. The number of farmers registered in PROCAMPO was 78 out of 452 entitled, with 159 ha receiving a subsidy of £6809. Land registered was from the *Ejido* and the *Comunidad Agraria,* and this indicates that people have dual tenure as *Comuneros* and also *ejidatario*s or *posesionario*s. The number of parcels registered varies from one to seven of different sizes and the amount of subsidy by farmer from £8 to £ 215 (see Table A7.4 Appendix 8).

Table 7.26 shows the percentage of land registered by tenure was as follows: 3.4% were *ejidatario*s, 8.73% *posesionarios*, 14.9% *Comuneros* and 72.9% have lands in both the *Ejido* and *Comunidad Agraria*. Most of the subsidy (87.9%) was received by people that have communal land.

Table 7.26 Farmers receiving subsidy of PROCAMPO* in Santa Catarina del Monte in 1997 (Archives DDR, 03 Texcoco)

Tenure	No beneficiaries	No parcelas	Area(ha)	Subsidy (£)	% participación
Ejidatarios	4	5	6.5	233	3.40
Posesionarios	13	21	16.7	598	8.73
Comuneros	17	35	28.5	977	14.90
Posesionario/Comunero	21	27	25.81	920	13.49
Ejidatario/Comunero	23	79	113.81	4,081	59.49
TOTAL	78	167	191.32	6,809	

*For detailed information see table A4 Appendix 14

The fact that the group of people with dual tenure have access to more land is indicative of a process of unequal access to land during the internal distribution of land within Catarina. Several people with dual tenure have more than 2 ha of land (for detailed data about size of landholdings see table a7.2 and 7.3 appendix 8. The access to more land combined with other income activities in the forest allowed them to raise livestock, or mules for yolk. This situation makes agriculture more productive and landholding profitable. It seems that with new legislation and the sale of parcels this process of unequal access to land in Catarina will be magnified.

Low levels of participation in the programme could be due to several causes, but the most likely is the unwillingness of people to disclose information about how much land they own, and the way in which the programme was promoted. The promotion of the programme was in the *ejidal* assembly. This is reflected in the fact that 85.1% of the beneficiaries are *ejidatario*s, *Comuneros-ejidatario*s or *posesionario*s-*Comuneros* and only 14.9% *Comuneros.* Only 14 *posesionario*s participate because in 1994-1995, when parcels had to be registered, they did not have land titles.

The subsidy is supposed to be a support to promote shifting crops with no competitive prices in the market such as cereals. However the crops sown were oriented to self-consumption in the *ejido, eg*: maize (134 ha), beans (15 ha), wheat (21 Ha), oats (10 Ha) and other crops 10 ha. Farmers sow different crops in each of their parcels and sometimes inter-crop (see Table A7.4 appendix 8).

7.4.5.6 Programme of ecological restoration

Participation was in three programmes: 16 *ejidatarios* participate in reforestation and 5 of them in fencing the reforested areas, 18 *comuneros* participate in the construction of gabion dams. Reforestation was on 30 ha planting 75,000 trees. Reforestation was completed in 4 weeks with each participant receiving £6.4 daily, 4.3 times over the minimum wages. Fencing was integrated by 5 *ejidatarios* and completed in one week, each participant receiving £12.44 daily, 8.4 times over the minimum wage. Three gabion dams two of 200 m^3 and other of $100m^3$ were carried out in twelve weeks, each person receiving £7.9 daily, 5.3 times over the minimum wage. The people that participated were happy with the programme because they received salaries higher than the normal daily wages.

Reforestation was carried in both eroded areas and in areas with a low forest cover in the mountain: 30,000 trees were planted in the sites with failures in previous reforestation, and 45,000 trees were planted in forest areas with low density of vegetation in the sierra. Enclosure of reforested areas was far away from the town in the boundary with a neighbouring *ejido*. The agent in charge of the programme commented that he proposed to fence an area near the town of Catarina, where he observed that grazing was common. The people proposed fencing boundaries with two purposes: to demarcate the limits and to avoid grazing livestock on land of the neighbouring *ejido*. Two areas of reforestation were visited in 1998, one with fencing and one without. In the two areas the failure of reforestation estimated by the agent was around 40%, but in the area without fences, it rose to 60% because the livestock ate the small trees. The agent explained the highest rate of survival in fenced areas because the time of reforestation was at the end of the rainy season, and afterwards the trees had shortages of water. In contrast in the mountain with more humidity and rain the estimated success of the reforestation was 80%.

During an interview with the *comisario ejidal* he said that the support that they require from the government is an inventory of the forest resources, support for the building of the *ejidal* salon and the support to acquire a tractor with implements for the *Ejido*.

7.4.6 Occupational activities

Detailed information about occupational activities for the *Comunidad Agraria* was not collected for the present research mainly due to constraints of time. The *Comuneros* interviewed said that their main source of income is agriculture and the extraction of products from the forest supported by temporary work. As stated by one of the *Comuneros*

'Most of the *Comuneros* hardly finished grade six at school starting to work in agriculture with their father. When we were young we also worked outside the *Ejido* as labourers in the ranchos, porters in the markets, cleaners in the shops. Some that finished the secondary education have their jobs in the groceries, or as bus conductors. Much of this work however was temporary sometimes for the day or a week. We learn that when you do not find job or the pay is so lower that you only can pay the cost of travel, or you marry, you realise that you need to have a secure food source for your family. In the 'pueblo' if you work hard, a while in the *milpa*[16], taking care of the flowers and fruit, a while in the forest collecting firewood, or making charcoal, collecting mushrooms in the rainy season, or herbs. At Christmas collecting hay and moss and making handicrafts, you always have something to do. Maybe some days you can only eat one tortilla with beans, but always you have something to eat and to do. Your children can study here until the secondary education and with money you can send them for technical training. With studies they can have a better job, and they would find a job in the city, if they can not find a job, or do not like that type of life, they can come back here and they will always have a piece of land to produce their food or something to do'(Interview with *Comunero*)

The occupational activities of 218 *ejidatarios* are as follows: 150 have agriculture as their main source of income, 41 have non-paid work as housewives, nine are musicians, four shopkeepers, two labourers and four are self-employed (Table 7.27).

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[16] Field sown with maize

Table 7.27 Income activities of *Ejidatarios* and *posesionarios* in 1997 (Source: Expediente Santa Catarina, Procuraduria Agraria; 1997).

Income activiy	Total	*Ejidatario*	*Posesionario*
Campesino	151	61	90
Housewife	41	7	34
Musician	9	1	8
Shopkeeper	4	1	3
Employee	3		3
Worker	2		2
Electrician	1		1
Decorator (Flowers)	1	1	
Mason	1	1	1
Student	1		1
Professional	1		1
	216	72	144

The main occupational activities developed in Catarina are around the use of land resources; 452 people and their families have access to 2,419 ha that are under diverse uses: 159 ha irrigated, 678 ha seasonal agriculture, 168 ha with grassland and eroded and 1,414 ha of forest and combined income activities using these resources. The income activities area a combination of agriculture for self-consumption, flowers, fruits and medicinal herbs to sell in local markets, extraction of diverse products from the forest, rising of livestock, and also temporary wage work outside the ejido.

Whilst the use of land resources has remained as the main income source of the people own land, there have however been changes in the way in which these resources have been used depending on the nature of land ownership; in terms of land owned and whether irrigated or not five modalities of income generation can be identified. The variation on area of land owned reflects the complex customs of land inheritance.

(i)*Ejidatarios* and *Comuneros* who inherited both irrigated and seasonal land, which provided the farmers with both sufficient seasonal lands to provide their families with maize and the irrigated land enabling them to grow market crops. Additional income is obtained from small flocks of sheep.

(ii) *Comuneros* who did not inherit enough land under irrigation and in seasonal agriculture to met their family requirements of maize. They therefore continued the production of maize both in the irrigated area and seasonal areas. Where possible, they grew some flowers, fruit and medicinal herbs on the edge of the maize terraces and in the family gardens for the market. They continued income generation activities in the forest with the extraction of wood, charcoal plus other seasonal activities of collecting mushrooms, peat, moss and Christmas trees. Some *Comuneros* have small folks of sheep and two or three head of cattle in the forest.

(iii)The *Comuneros* who inherited only irrigated land, continued with the production of maize and where possible grew some fruits, flowers and medicinal herbs on the edge of the terraces for market. The income activities in the forest are much the same as the previous group. However most of their income is generated by the activities carried out in the forest.

(iv) he *Comuneros* who had access to irrigated land, however as the parcels are some distance away from the sources of water, crops sown are fodder crops, wheat and barley for livestock. The activities in the forest are the same as the previous group (see ii), whereas most of their income is from the raising of livestock.

(v) *Ejidatarios* that did not have enough land to meet maize requirements for their family rely mainly on income activities outside the *ejido.* It was said that very few work as woodcutters.

Temporary wage work in agriculture outside the community and the raising of sheep and cattle are also a source of income for all the groups.

The income strategies followed in Catarina are based on the re-arrangement of the distribution of crops for markets in the irrigated areas and maize in the seasonal land. The settlement area is expanding by the construction of terraces, but expansion is restricted owing to lack of water. Also seasonal land is expanding by incorporating areas of reclaimed forest and also by terracing. The exploitation of the forest has declined, but some people continue selling wood, and firewood and charcoal to order and also other products such as mushrooms, peat and medicinal herbs collected in the forest.

Recently the increase in the population, and improvement in communications and the opening of new markets in new residential areas of Mexico City has encouraged an increase in cultivation of flowers, fruit and medicinal herbs in the irrigated land and the seasonal collection of seasonal forest products. The commercial crops and products of the forest are sold by farmers travelling to Mexico City once or twice a week where they sell their products either to people with stalls in the markets or sell them themselves in the streets outside the markets. The opportunities for temporary work in agriculture declined and other members of the family however, are involved in salaried work outside agriculture, the women with technical qualifications as secretaries or cashiers, or as shops assistants; the men gain employment in shops and as bus drivers and market porters. The market for wood and firewood has declined and only a small group of *Comuneros* continue with the extraction of wood and firewood to provide other people of the town.

The use of agricultural resources and the agricultural system remains much as before, with subsistence from maize and commercial growing of flowers, fruit and medicinal herbs, supported by livestock production.

The main changes in the system of production have been in the forest of the *ejido* following the lifting of the ban on exploitation of the forest in 1995. The extraction of wood has increased, however the extraction of timber is difficult due to access problems. It is largely cut to order and processed as boards, and only about twenty-five families are employed in forestry activities. However firewood is still used as fuel by a considerable number of *Comuneros*. With the lifting of the ban on the forest the *ejidal* authorities requested the support of the Government for assistance with the development of a Government programme for management of the extraction of wood. To date this inventory has not been made, however the idea of the *ejidal* authorities is to build a sawmill for the production of planks and sawn timber.

Chapter VIII Contrasting understandings of land resources in the three *ejidos*

8.1 Introduction

Maps of inventories of resources are produced so that such resource data can be used as the basis for land use planning. In this chapter maps produced for the *ejidos* by both government and *ejidatarios* for three *ejidos*, and their utility for planning, are considered. The contrasting process of decision-making on land use are analysed and differences among the three *ejido*s are also highlighted.

8.2 Government maps for planning land use in the *ejidos*

8.2.1 Soil maps of INEGI

Despite the fact that the maps and areas of soils can be produced at *ejido* level with GIS, and are very impressive for planners in the government, the main drawback for the use of the soil maps of INEGI at *ejido* level are that the land of the *ejido*s is covered by several cartographic units, and the scale of the map means that the soils are aggregated into composite cartographic units, making uncertain which soil unit is present in the *ejido*. Thus the maps of INEGI are not at all a reliable basis for land use planning based on soil units for the *ejido*s. However they can be used for identification of the soil units in the *ejido*s, and for an initial assessment of the soil suitability and the associated problems for its management.

Table 8.1 shows the soil units in the three *ejido*s, land uses under agriculture or forest, their areas, and the evaluation of the soils units according to FAO (FAO, 1985). The soils in Pedro are suitability class S1 without problems for its use in agriculture. Nativitas and Catarina have diverse types of soils, but the dominant soil unit are Cambisols (61.6%) suitable for agriculture (S1); however the main restriction for its use in agriculture is the slope over 4%. Currently 626 ha are under agriculture, most of them already have conservation works and 1352 ha remain under forest vegetation. Phaeozems and Regosols are suitability class S1; most of these soils are currently under agriculture and terraced. The soils of class S2, Vertisols are under irrigated agriculture, and Andosols are under forest vegetation. Finally Lithosols are not suitable for agriculture (N.S), these soils have been either incorporated by terracing into agriculture or remain under grassland or forest vegetation.

Table 8.1 Soil units in the three *ejidos* (Author based in soil maps of the *ejidos*, based on INEGI soil maps)

Ejido	Land use	No Cart. Units	Phaeo. (ha)	Regosols (ha)	Cambsiols (ha)	Vertisols (ha)	Andosols (ha)	Lithosols (ha)	Total (ha)
Pedro	Agric.	2	100			63			163
Nativitas	Agric.	5	246		98	17		36	397
	Forest	4	47		316		98	63	524
Catarina	Agric.	5*	155	141	528			5	829
	Forest	5*			1046		260	104	1410
Total		21	548	141	2186	80	358	208	
%			13.9	4.3	61.6	2.4	11.1	6.4	3223
Clasif FAO			S1	S1	S1	S2	S2	N.S	

Note: S1: very apt S2: marginally apt N.S: No apt S2 investment is required to improve the condition of the soil. * One cartographic unit have association of two soils. Abbr: Agric: Agriculture; No Cart: Number of cartographic; Phaeo: Phaeozems. Suitability FAO: S1: suitable for agriculture S2: marginally suitable: investment is required to improve the condition of the soil. N.S No suitable for agriculture.

8.2.2 Soil surveys

The soil survey at the level of soil series was produced for the assessment of soils based on land capability classification and suitability for irrigation (Cachon *et al.* 1974). Table 8.2 shows the suitability classes in Pedro and Nativitas. For irrigation in Pedro the restriction is water level in the soil series Horno that requires adequate management of irrigations. In Nativitas the restriction is the permeability of the soil by presence of sandy layers in the soil profile; and the soil series Nativitas sandy loam is not suitable for irrigation. For their land capability the soils of Nativitas have restrictions due to their retention of moisture and their susceptibility to erosion.

Table 8.2 Soil series and land suitability classification in two *ejidos* (compiled from Cachon et al, 1974)

Ejido	Soil series	Class of Land capability	Class of Suitability for irrigation	Area (ha)
Pedro	Boyeros	I	I	42
	Horno	I	IIIh	67
	Chapingo	I	I	56
Nativitas	Aclipan	Iis	IIc	36
	Nativitas loam	Iie	IIt	125
	Nativitas sandy loam	Ve	VII	93

Subclass limitations: h: water table at 1m; e: erosion c: texture sandy t: permeability s: low retention of water.

The classification for irrigation is useful in Nativitas where irrigation has not yet introduced. However the classification of land suitability has to be updated as most of the soils in Nativitas are incorporated into agriculture with conservation works, and the series Nativitas sandy loam has been terraced and soil tepetate has been reclaimed to form soils; this requires the updated of the suitability classification.

8.2.3 Land system survey

The inventory of resources using the land system approach compiled from Ortiz (1977) produced a detailed inventory of the types of land and a wealth of information about the physical characteristics of land based on land forms, soils, vegetal cover and the classification of the land facets by land suitability for agriculture. Table 8.3 shows the variability in landscapes in the three *ejidos* with eight different land systems and seventeen land facets. However the recommendations of land use were that most of the soils in Nativitas and Catarina are suitability class VII, due to their steep slope or forest vegetation. Only 289 ha were recommended for use in agriculture and then only after soil conservation works.

Table 8.3 Land capabilities by facets in the municipality of Texcoco for the three *ejidos* (compiled from Ortiz, 1977)

Ejidos	TEX-3	TEX-4	CO-1	CO-4	TL-3	IX-1	IX-2	TE-1	TE-2	TE3a	TE3b	TE3c	SN-1	TLA-2
SPYSU	I													
SMN		II-sc	III-es	VII-es	IV-es	VII-es	VII-e		VI-e	VII-e			VII-e	VI-e
SCM						VII-es	VII-e	V-e	VI-e		II-e	VII-e		
Area (ha)														
SPYSU	166													
SMN		11	55	89	128	14	8	296	50	252			72	136
SCM	166					348	8	296	1327		95	103		

Abbr. Land systems: TEX: Texcoco; CO: Coatlinchan TL: Tlaminca; IX: Ixayoc; TE: Tecuanulco; SN: Sierra nevada; TLA: Tlaloc. The Numbers indicate the facet. For example IX -2 is the facet number two of the land system Ixayoc. .Suitability limitatios: e: erosion; c: climate; s: depth of soil; SPYSU: San Pedro y Santa Ursula; SMN: Santa Maria Nativitas; SCM: Santa Catarina del Monte.

The reclamation works of the late 1970s and the contrasting visions of the government technicians and the *ejidatarios* about the erosion hazard and reforestation of terraces are described by Aldana (1994); he pointed out that the technicians ignore in the evaluation of the problem erosion in intensive agriculture in the area and the existence of Prehispanic terraces.

The results of the evaluation of the rates of sediment yield from facets (Figueroa, 1975) showed that the annual production of sediments in the facets of the land system Ixayoc ranged from 5362 t ha^{-1} to 20,461 t $ha^{-1;}$ he concluded that the problem of erosion was the cultivation of the land without conservation measures. Ortiz (1977) recommended a change of use from agriculture to forest in the areas with high risk of erosion. In 1978 however when the works started in San Pablo Ixayoc, the *ejidatarios* were worried about what would happen with the ejidal land after the reforestation. As consequence they did not allow the building of terraces until an agreement was reached with the government authorities- that the terraces could be incorporated into cultivation, providing the *ejido* and the *ejidatarios* that took possession of the land cultivated and maintained the terraces to avoid erosion. The *ejidatarios* agreed and the land reclaimed from tepetate was allocated to *ejidatarios*. Similar situations happened in the other *ejidos*. The works of reclamation of tepetate were done in the shared fashion the government participate with the machinery and the *ejidatarios* with the petrol and wages of the operator. Aldana (1994 p.54) concludes

> ‘ The social group that was considered by the technicians as the cause of the problem, was the people who reclaimed the land and who with their daily work are maintaining the terraces in production and doing sustainable agriculture. They reclaimed the land that was degraded in the ecosystem since the colonial period and this land had remained under agriculture production for the last 300 years.

8.2.4 Land evaluation map

Rivera (1993) adapted the framework of land evaluation (FAO, 1976, 1985) using the data available about the physical and socio-economic characteristics required for the identification of land use types. The land evaluation process for the evaluation of suitability of maize and beans was computerised using the Automated Land Evaluation System (ALES) (Rossiter, G and Wambeque, A, 1989). The physical suitability was evaluated by land facet, in three classes of suitability using as qualities of the land, a composite index for capacity of management. Table 8.4 shows the land suitability for maize and beans by facet for the three *ejidos*; at best it is moderately suitable (A2) and at worst marginally suitable (A3).

The facets of moderate suitability (A2) require investment in infrastructure for irrigation; production in this land is economically viable. The area marginally suitable is located in the land of the hills and mountains and requires high investment in infrastructure for soil conservation, and in some facets irrigation. Most of the areas of suitability A2 and A3 suitability were already under cultivation in the three *ejido*s and the *ejidatarios* and government have already made the investment in irrigation and conservation works in most of these facets.

Table 8.4 Land suitability by physical qualities of the land for the production of Maize and Beans based in the framework of land evaluation (FAO, 1976) And the directives of FAO for seasonal agriculture (Ojeda, 1993; Rivera, 1993)

Ejido	Land Facet	Maize	Beans
Pedro	Texcoco-3	A3	A3
	Texcoco-4	A3	A3
Nativitas	Coatlinchan-1	A3	A3
	Coatlinchan-4	N.S	N.S
	Tlaixpan-3	A3	A3
Nativitas			
Catarina	Ixayoc-1	N.S	N.S
Nativitas			
Catarina	Ixayoc-2	N.S	N.S
Nativitas	Tecuanulco-1	A2	A 2
Nativitas	Tecuanulco-2	A3	A3
Catarina			
Nativitas	Tecuanulco-3a	N.S	N.S
SCM	Sub Facet TC-3b	A2	N.S
Catarina	Sub Facet TC-3c	N.S	N.S
Nativitas	Sierra Nevada-1	N.S	N.S
Nativitas	Tlaloc-2	N.S	N.S

A2 Moderate suitable: The effect of the restrictions affects the productivity or income. A3: Marginally suitable. The effects of the restrictions make not economically viable the investment on the improvements required to put the land in cultivation, by the return of the crops. N.S No suitable: the restrictions in the land area so severe that the use of the land is no sustainable (FAO, 1976,1985)

8.2.5 INEGI map of land use and vegetation

The INEGI map of land use and vegetation presents land use types and vegetation types as simple cartographic units with one type of vegetation, or as composite units with two or more species of plants[1]. Table 8.5 shows the areas of land uses and types

[1] For a detailed description of land use and types of species in the vegetal associations see the back of the map E14 B21 Texcoco, INEGI (1982)

of vegetation for the three *ejidos*. The resources available are agricultural land, grassland and bushes and forest with different tree species.

Table 8.5 Land uses and types of vegetation in the *ejidos* of San Pedro y Santa Ursula, Santa Maria Nativitas and Santa Catarina del Monte (author based in maps of INEGI, 1982)

Ejido	Area hectares									
	Agriculture		Types of vegetation							
	Irrigated	Seasonal	Pine	Holm oak	Abies	Bushes	Grass land	Holm oak-pine	Pine-Grass	Bushes -pine
SPYSU	166									
SMN		361	128		155	51	13	62	73	
SCM		861	269	73	427	7	313	309		64

The problems of the use of the information from this map for planning are: a) the map is outdated based on aerial photographs of 1980. This research found that since the 1980s the cultivation of some agricultural areas in the forest has been abandoned, and the areas under seasonal agriculture in the INEGI map are overestimated. Many of these areas are actually shrub, b) the area with erosion is missing instead being identified on the map as grassland. Actually most of the area is terraced and reforested or under cultivation, c) in Catarina the irrigated area was not mapped. The information from the INEGI map is useful for its general identification of types of vegetation; however it has to be updated and for planning at *ejido* level it has to be taken with caution.

8.2.6 Forest inventories

From 1945 to 1990 the concession for forest exploitation was in the hands of San Rafael and Anexas Company (see section 6.3.2) and the extraction of wood was an illegal activity by the *ejidatarios*. Table 8.6 shows the results of the forest inventories in 1953, 1964 and 1998 (Nativitas and Catarina). This data shows that despite the illegal extraction by *ejidatarios* between 1953 and 1964, the area of exploitable pine and Abies increased, whilst areas of holm oak decreased due to extraction for charcoal, and by their incorporation into agriculture.

Table 8.6 Forest inventories in the *ejido*s of Nativitas and Santa Catarina (San Rafael, 1953,1964, Chavez, 1998)

Ejido	Year	Area of forest (ha)			Extractable Volume m^3		Total existences of wood m^3	Annual volume of wood extractable m^3
		Pine	Abies	Holm oak	Pine	Abies		
SMN	1953	51	57				n.a	
	1964	85	86	211	4817	7710	12,527	628
	1998	238	130	26	4,294	4235	8529	1214
SCM (*Ejido*)	1953	80	105				n.a	n.a
	1964	278	163	207	7932	22,664	30,576	1610
SCM (C.A)	1953	318	337					
	1964	852	339	108	28,750	52,514	81,264	3277

The lack of participation of the *ejidatarios* owners of the forest with companies promoting 'sustainable management' as envisaged by the Government shows the lack of understanding of the nature of the forest resource as understood by the *ejidatario.*

The result was control of degradation and recuperation of the forest of pine and abies but increased degradation of the holm-oak forest and erosion in the overgrazed grassland incorporated into agriculture to compensate the loss of income from the forest resource (see 7.2.3.4). Klooster (1997) describes the same situation throughout Mexico, whereby *ejidatarios* were excluded from participating in the exploitation and management of the forest and in consequence they continued their underground activities that in some cases led to degradation of the forest.

From 1997 with the granting to the *ejido*s of concessions for exploitation of the forest by the government, the extraction of wood in Nativitas has increased from 194 m^3 in 1997 to 790 m^3 in 1998, and the actual annual rate of extraction approved for a ten years period is 1238 m^3 per year. This is almost twice that recommended by San Rafael and Anexas in 1964 and suggests the need for a more detailed study to ensure that the new recommended rate of extraction is sustainable.

Thus the available evidence suggests that Government policy of restricting forest exploitation by San Rafael y Anexas Company, with the intention of reducing over exploitation of the forest, was at best only partially successful. Whilst the policy achieved recuperation of the pine and abies forest, the failure to realise the broad nature of the economic importance of the forest to the *ejido*s merely moved the problem. Thus the *ejidatarios* were forced to change economic activity by increasing exploitation of the grasslands and holm oak woodland, transferring degradation problems to these areas.

8.3 Participatory maps

As argued in previous sections the Government maps of land resources used for planning in the municipality designed for top down planning showed limitations for their use in planning at *ejido* level. The maps for the most part 'explain' the variation in land use from place to place. The failure of the traditional maps used to correspond to the reality in the *ejido*s, with a diverse resource base with soil and climatic variations at micro level, leads to the use of participatory maps as an alternative for the characterisation of resources in the *ejido*.

8.3.1 Soil maps

The identification of the lands (tierra[2]) by the *ejidatarios* is changing through time in Pedro and Nativitas, the perception of the land changes are according to the changes in land use. Table 8.7 shows the types of lands identified in the *ejido*s. In Pedro two land units were identified when the *ejido* was under seasonal cultivation according to differences in growth of the crop, however under irrigation only one unit[3] was identified. The actual criteria used to identify variation in soils are at the level of parcel, depending on the management of the parcel by the owner. In Nativitas the parcels allocated in 1926 were based on a classification using Spanish and Nahuatl names, but actually the *ejidatarios* differentiate land by a combination of physical soil properties, productivity and other factors such as the history of access, tenure and productivity. In addition soils are differentiated at parcel level, based on a combination of soil and the level of management.

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[2] The local term 'tierra' is translated as land (as recommended by Ortiz S.C, 1999). Ortiz S.C (1999) signals that 'tierra' is often equate with soil, where perception of soil relates entirely to the superficial layer of the soil.
[3] The *ejido* of Pedro may not be representative of the knowledge of the *ejidatarios* about soils in the municipality. Pedro is located in the plain, with a small area of 166 ha. Works by Pajaro and Ortiz 1984 and Ordaz, 1989 identified up to seven types of lands.

In Catarina the soils were identified with Nahuatl names that consider location, colour and workability. The *texoquilalli* are brown soils in the terraces of the settlement, very hard to work with yolk when dry, but very productive; *Costlatl* are *tierras amarillas* under agriculture in the forest, very loose, and maize does not grow well; *tlilticitlalic* are dark coloured soils, under forest vegetation, good for growing potatoes. The tepetate was classified by its colour and difficulty to break up to build terraces from softer to harder in yellow, and red or white.

Table 8.7 Types of soils identified by the *ejidatarios* of the three *ejidos* (fieldwork, 1998)

<table>
<tr><td></td><td colspan="7">Area Hectares</td></tr>
<tr><td></td><td>SPSU</td><td colspan="6">Santa Maria Nativitas</td></tr>
<tr><td></td><td>Clay Deep soils</td><td>N. P. Deep soil</td><td>N. P. Shallow. Soil</td><td>Private deep soil</td><td>Parcel Shallow soil</td><td>Terraces With and red tepetate</td><td>Slopes yellow tepetate</td></tr>
<tr><td>SPSU</td><td>166</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>SMN</td><td></td><td>58</td><td>82</td><td>56</td><td>44</td><td>53</td><td>41</td></tr>
<tr><td colspan="8">Santa Catarina del Monte</td></tr>
<tr><td colspan="4">Soils</td><td colspan="4">Tepetate (softer→ Harder)</td></tr>
<tr><td colspan="2">Texoquillali</td><td>Costatl</td><td>Tilticitlalic</td><td>Yellow</td><td>Red</td><td colspan="2">white</td></tr>
</table>

Abrev: N.P. :Numbered parcel. These are the parcels that were allocated in 1924 to the *ejidatarios* each of them with a number. The mapping of soils in Catarina was not carried out, by constraints of time.

Thus the information on the perception of land and landscapes by the *ejidatarios* is dynamic, and their identification of types of lands has been adapted through time. Also that names and boundaries of the units changes according to the perception of the land use and the interest of the people in the resource. For example in Catarina the original terms for identification of land have been preserved in Nahuatl names. However the meaning of the original language (i.e knowledge of land) being has been lost with the translation of names in Spanish.

8.3.2 Maps of land use and vegetation

The maps of land use produced for the *ejidos* were based on transects with the *ejidatarios* thus allowing for identification of land used by the *ejidatarios*, and the drawing of boundaries over aerial photographs. The result was a map of land use and its spatial distribution according to the perceptions of the people.

The final maps produced were based in both information from the *ejidatarios* and information from INEGI maps, two maps were produced one for main land use and other for the specific land uses.

8.3.2.1 Main land uses

On the main land use map, land was divided into three types: irrigated with a house in the parcel, irrigated without a house in the parcel and seasonal. The areas covered with vegetation were divided into seven types according the species of trees identified by the *ejidatarios* and on the INEGI map (See Figure 7.6, Figure 7.15 and Figure 7.23)

Table 8.8 shows the main land uses and their areas in the three *ejidos*. The types of vegetation in the forest are related with the products extracted, for example firewood, charcoal and hay extracted from the oak forest, and pine used for boards. This map gives updated information about the actual land uses and its areas in each *ejido*. It shows the perceived diversity in resource base available, and the possible combinations of uses available in the *ejidos*.

Table 8.8 Land cover in the three *ejidos*, *ejidatarios* and INEGI maps (Fieldwork, 1998)

Ejido	Area Hectares										
	Agriculture			Vegetation							
	Irrigated (Parcel + house)	Irrigated	Seasonal Agric.	Pine	Oak	Abies	Bushes	Grassland	Oak-pine	Pine-Grass.	Bush-pine
SPSU	75	67	22					2			
SMN	90		159	128	59(e)	155	51	13		73	
SCM C.A	159		501	86	73	326	7	113 160(e)	207		
SCM *Ejido*			160	183		101		40	102(e)		64

Abbrev: C.A: *Comunidad Agraria*; Agric: Agriculture
e: erosion. In the areas of grassland and oak erosion was associated as a composite cartographic unit.

8.3.2.2. Specific land uses

The maps of specific land uses identified by the *ejidatarios* shows the understanding of land uses in the *ejido*. Land use is produced by the identification of areas in relation to actual infrastructure and uses for example: irrigation, housing, terracing, type of resource (seasonal agriculture, grassland, forest). These land uses are the product of a combination of access, in terms of tenure and infrastructure and uses as limited by access (See Figure 7.6, Figure 7.16 and Figure 7.24)

Table 8.9 shows the specific land uses identified by the *ejidatarios* in each *ejido*. In Pedro 6 land uses were identified and the access to irrigation is the most relevant feature for differentiation. In Nativitas with more diversity of resources 12 land uses are identified and several criteria are used for differentiation: land tenure, housing, access to water, infrastructure, and type of vegetation. In Catarina 10 land uses are identified using as main criteria the access of land as *ejido* or *comunidad agraria*, and also infrastructure, housing, and types of vegetation.

The specific land uses reflect the actual perception of land uses, and the actual resource base in each *ejido*. For example in Nativitas the area under irrigation with housing is increasing due to the investment in increased water storage capacity resulting in a reduction in field agriculture and increased numbers of greenhouses. The eroded areas have been reclaimed by terracing and have been incorporated into cultivation. Similarly in the forest eroded areas in the holm oak woodland have been reclaimed.

The differences in the number of land uses among the three *ejido*s are by the diversity of resources and landscape. In Pedro the criterion is the land use itself. However In Catarina and Nativitas, with at least two types of tenure, and diversity in types of land, the number of specific land uses increased. For example in Nativitas the sand water tanks, sand mine, and ravine were included as a specific land use, the last because it is used for grazing. However in Catarina as the tanks are small, and ravines are under forest vegetation, these were not considered as criteria for identify land use. Also in Nativitas, the forest is not exploited, and was classified as one unit, however in Catarina, each type of tree is used for a specific purpose.

Table 8.9 Specific land use types in the San Pedro y Santa Ursula, Santa Maria Nativitas and Santa Catarina del Monte by the *ejidatarios*(author, 1998).

San Pedro y Santa Ursula

Land use	Sp. Irrigation ULC	Sp. Irrigation UEB	Irrigation Sewage water	Seasonal agriculture	Grassland	Parcel with house
Area (ha)	47	67	15	22	2	7.7

Abbr: Sp: suplemmentary; ULC :Unidad de Irrigacion La Concepcion; ULB: Unidad de Irrigation El Bolito

Santa Maria Nativitas

Land use	Sp. Irrigation +house private land (greenhouses)	Sp. Irrigation +house *ejido* (greenhouses)	Seasonal agriculture	Seas. Agric. Terraces + reclaimed tepetate	Ravine	Sand quarry	Water tank	Seas. Agric. forest land	forest	Forest oak with erosion	Bushes	Reforestation
Area (ha)	56	44	137	22	12	5.5	2	36	407	59	25	11

Abbr: Sp: Supplementary irrigation; Seas. Agric. : Seasonal agriculture;

Santa Catarina del Monte

Land use	Sp. Irrigation +house terraces	Grassland + eroded land	Seasonal agriculture Terraces + reclaimed tepetate in terraces		Seasonal agriculture forest land		Forest pine		Forest abies		Forest Oak	Forest Oak- pine		Forest pine-bushes	Pine grassland
Land tenure	Co. Ag.	Co.Ag.	*Ejido*	Co. Ag	*Ejido*	Co. Ag.	*Ejido*	Co. Ag.	*Ejido*	Co. Ag.	Co Ag.	*Ejido*	Co. Ag.	*Ejido*	*Ejido*
Area (ha)	159	160	40	380	123	187	184	87	101	336	73	102	237	64	17

Abbr: Sp: Supplementary irrigation; *Co. Ag.: Comunidad Agraria.*

8.4 Typology of land uses

Approaches to land evaluation (soil surveys, suitability classification) to support planning have been advocated as a practical way to address the conflicts over land use by matching land use with the land's ability to support them. But these approaches have concentrated on either production at all costs or conservation at all costs. Neglect of the priorities of the people who directly use the land has lead to a failure of the implementation of plans (Dent, 1997). Rossiter (1996) and Burrough (1996) proposed a 'demand driving approach' to improve the models of land evaluation, this is summarised by Rossiter as follows

> ' We should take a step back, away from the question What predictions can we make with the data we have?', i.e. a data-driven approach, to the question. Who are the decision-makers, Who actually affect land use?, How are they making their decisions?, and How could their decision be better informed? i.e. a demand driving approach'. (Rossiter, 1996, p186).

The concept of land use type (Beek, 1978; FAO, 1976) is the starting point for land evaluation. A land use type is defined as: 'an organisational unit under specific socio-economic and institutional environment'. It is defined as a specific way of use of land, current or alternative that is described with purposes of land evaluation in the following terms: (1) Product (2) Labour (3) Capital (4) Management (5) Technology (6) Scale of operations. In practice the definition of the land use type is constructed by the land evaluator, either on the basis of his/her interpretation, by using, to a large extent, individual experience. (Van de Putte, 1989; Rossiter, 1995).

Land use types are constructed in this research from the criteria that the *ejidatarios* are using for the definition the description of local resources and the associated institutions for their management. The modelling of land uses through typology and participatory mapping of resources in this research is an attempt to transform the perception of land use of the *ejidatarios* into a similar object in the western model. Molenaar (1993) called this approach a 'context transformation'. The semantic organisation of the land use maps is culture-specific with specific environmental conditions and practical considerations. In the present research seven criteria were identified for the definition of the land use types in the municipality. The criteria are: political category, land tenure, access to land, land use subdivided into irrigated and seasonal, types of water sources i.e. wells, springs and seasonal; organisation of water management, individual rights over the parcel and infrastructure. This is the level at which the individual *ejidatario* makes decisions about the use of his parcel.

Nine land use types were identified for agriculture (Figure 8.1) and four for forest uses (Figure 8.2). Land use types in the municipality are 14, and in each individual *ejido* each *ejidatario* have a complex array of land use types by the combinations of land use types. For Example an *ejidatario* in Nativitas could have several types of land use: a parcel with house and irrigation in private land, seasonal agriculture land in the *ejido*, access to communal land. In Catarina the land use types achieved for an individual are more diverse with individuals holding land in the *ejido* and *Comundidad Agraria*, and multiple products extracted from the forest.

The individual landholding is the lower level in the municipality typology and is at this level where individual decision-making process is achieved. Decision- making at this level depends in which resources in the *ejido* the *ejidatario* have access and in how the *ejidatario* is organised for the use of these resources. This involves several decisions such as: selection of crops determined by his access to irrigate or seasonal land, rising of livestock, and exploitation of communal resources. Also occupational activities outside the *ejido* as complement of income have to be considered in decision-making on land use. To understand the organisation of individual landholdings approaches such as farming system could be used in the *ejido*s (See Fresco et al (1994). However this is matter for future research.

8.5 *Ejido*s, tenure, size of landholdings and land reform

According to Goldering (1998) ejidal membership has several meanings for people in the *ejido*s:

Property rights as identity. They articulate this aspect of membership in terms of historical continuity of membership, struggles for land by grandparents, and the need to continue this tradition, emphasising the importance of agriculture as the only way of making a living. Their occupation, livelihood and lifestyle are crucial elements of their identity. During the interviews with the author the *ejidatarios*

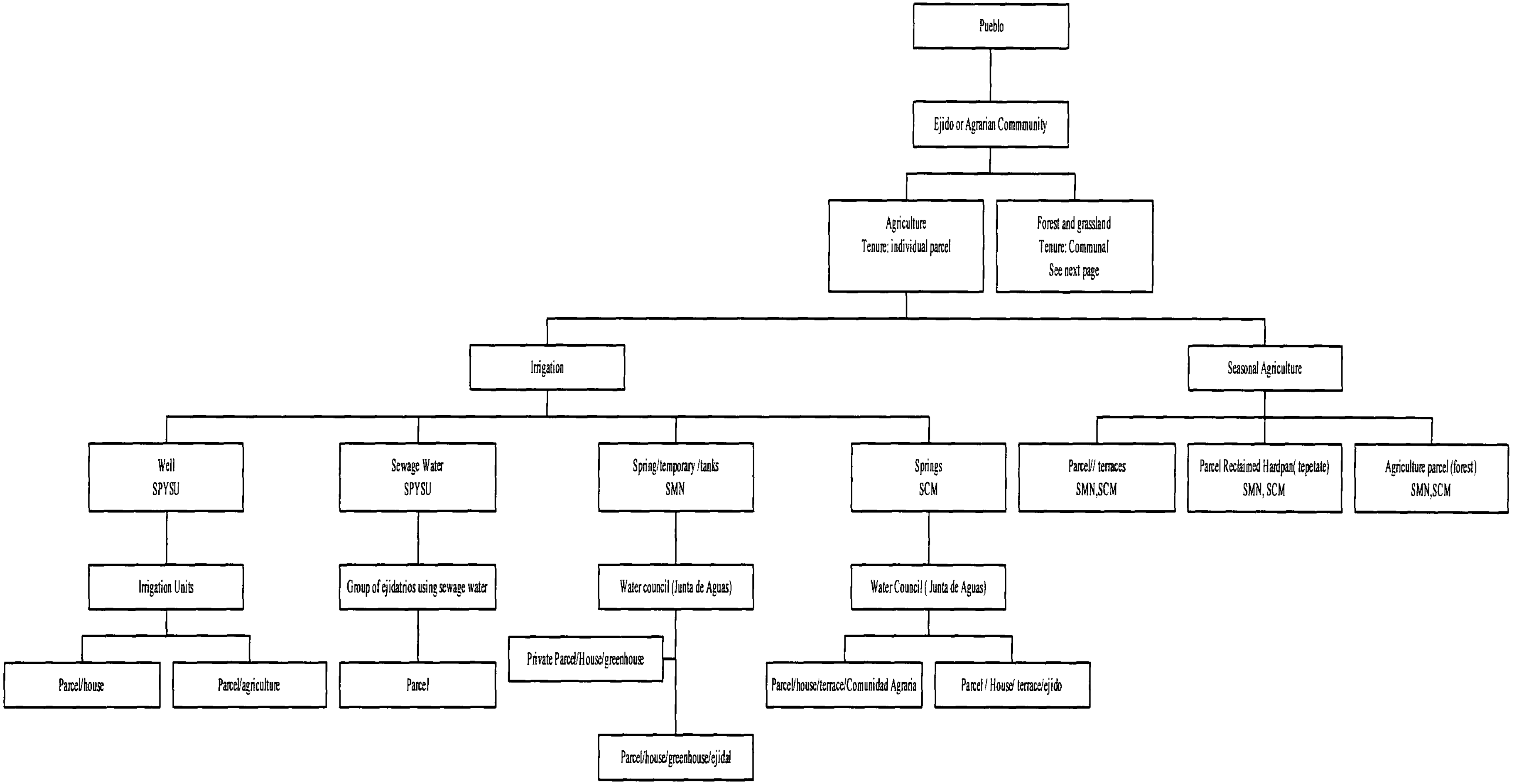
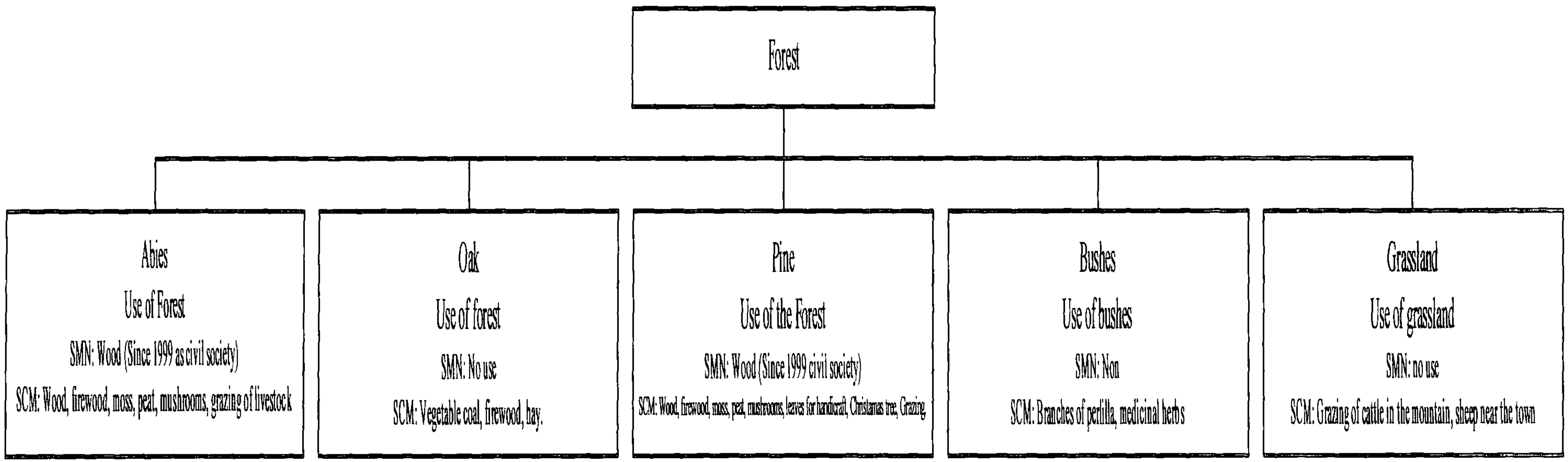


Figure 8.1 Typology of land uses in the three *ejidos* in the municipality of Texcoco (author, 1998).

Figure 8.2 Typology of land uses in the forest land of Santa Maria Nativitas and Santa Catarina del Monte (Author, 1998)



often talked about the struggles and negotiation in context of the histories of the struggle of their parents and grandparents to get land. In Catarina the land seen as a symbol of identity seems to be stronger by the fact that the *Comunidad Agraria* with minimal interference of government regulates the transfer of the land.

b) *Ejido* membership and property rights as economic resource: The membership and property rights are instruments that provide the member with goods beyond access to land under a given tenure arrangements such as:

b.1) *Ejido* rights as productive resource: The property rights are a source of arrangement. Rent and sharecropping was a usual practice in the *ejido*s of Pedro.

b.2) *Ejido* rights as producers of non-farming income savings: The *ejido* tenure provides other income and saving generating possibilities such as: a reserve for housing of future generations. There are no taxes for building a house on *ejido* land. In the three *ejido*s the building of houses is in *ejidal* land. In Nativitas and Catarina communal land is a source of income by the extraction of different products (wood, firewood, mushrooms). Also if communal land is rented the profit is divided among the *ejidatarios*. Also in Nativitas the sand quarry could be exploited. Degraded communal land is a reserve of agriculture or housing land.

b.3) *Ejido* rights as access to position and economic resources. For some people membership in the *ejido* is an opportunity to fill positions in the *ejido* organisation. This position could provide access to other positions in the municipal delegation or organisation of religious Fiestas. This is the case of the *ejidal comisario* of Nativitas that have held the post of *Comisario ejidal* twice, twice as *Mayordomo* in the religious fiesta, and once *Delegado* Municipal.

b.4) *Ejido* rights as a commodity: Selling and renting land to outsiders is an option fully open under the new tenancy arrangements. The sale of parcels and certification of rights to new *posesionario or ejidatarios* by the *ejidal* assembly under the new legislation is a potential source of income for the *ejido*.

b.5) *Ejido* rights as real estate: The land can be sold for urban development as parcels by individuals or for the building of estates in communal land to government or private investors. This is the case in Pedro where the idea of a group of *ejidatarios* was the inclusion of the *ejido* as part of the urban area of the municipality of Texcoco for the provision of services and its inclusion as an area for housing.

Goldering (1998) suggests that the privatisation process proposed by the government in the *ejido* reflect that the meaning of *ejidal* rights for the *ejidatarios* was not understood by the government. Hence the response of the *ejidatarios* was a rejection of the privatisation of the *ejido* land

> 'these meanings coexist in the ambiguous space generated by the incongruity between Agrarian laws and *ejidatarios*' technically illegal practices' (Goldering,1998 p 168).

He added that

> 'the reforms wanted to regularise existing practices, but they failed to take into account the distinction that the *ejidatarios* make between *ejido* rights as a near commodity and private property. Most *ejidatarios*, although they eventually supported PROCEDE, do not want their land to become a "fully private property" in a capitalist sense, that is fully alienable.......and removed from protections and restrictions of being attached to a community'.....They choose[4] the legitimate commodification of the *ejido* rights, while making an effort to retain the benefits of *ejido* membership and rejecting their own transformation into a fully market oriented producers (Goldering 1998, p169-170).

8.5.1 Access to land in the first period of land reform 1915-1992

As shown in Chapter four land tenure patterns found in the municipality of Texcoco in 1998 is the result of redistribution of land expropriated from the *Haciendas*. It produces an eclectic mixture of private, public land, *ejido*s and *Comunidades Agrarias* with individual and collective ownership. Table 8.10 shows the amounts and types of land allocated to each *ejido* since 1924. Land for agricultural use was limited in Nativitas and Catarina. The average size of agricultural land by *ejidatario* was less than 3 ha in Pedro and up to 1.2 in Nativitas. In Catarina the land allocated was classified as high mountain (forest) and there was no subdivision of parcels; however,

[4] In December 1999 with 20,000 *ejido*s with certification and 61 million of ha covered only 0.28 % adopted the *Dominio pleno* (SRA, 1999).

Gonzalez R (1993) and the *ejidatarios* report that after the allocation the *ejidatarios* opened the land into cultivation without the supervision of the government agents. In the *Comunidad Agraria* the land was already under cultivation in an estimated in this research in amount to 346 ha .

Table 8.10 Allocation of land as *ejidos* to Pedro, Nativitas and Catarina (Gobierno del Estado de Mexico, 1958, Areas and maps of Archives, Nativitas 1927 and Pedro, 1933)

Pueblo or Barrio Type/year of grant)	*'Fundo legal'*	Seasonal Agric.	*Suitability Class***	*High mountain*	Number Ejidatario	Parcel /size (ha)	Area (ha)
Pedro Dotacion/1927)	35	160	Class I (160 ha)		52	52/2.9 151 ha	195
Nativitas (Dotacion/1924)	66	300	Class II 59ha Class III 50ha		91	91 /1.21 110 ha	300
Nativitas (Enlargement/1938)			High Mountain	542			542
Catarina (Dotacion/1927				694	74		694
Catarina (Restitution/1964)	1637			1637	235	Variable* 346 ha	1637

*Estimated in aerial photographs of 1989.
** As defined in the maps of land tenure 1924, 1927 (for details see Fabela, 1959)

8.5.1.1 Increase in the number of *ejidatarios*, and access to *ejidal* land by *posesionarios* by encroachment on communal land

Between 1933 and 1992 the ejidal assembly was responsible for the allocation of non-cultivated parcels. Table 8.11 shows the changes in the number of *ejidatarios* between 1933 and 1997. In Pedro the increase was only in one since 1933. Whilst in Nativitas the number of *ejidatarios* increased in 20, with no information available for Catarina[5].

As described in chapter 7, the population in the three *ejidos* increased and due to the ban on exploitation of the forest, the *ejidal* assemblies to both *ejidatarios* and people living in the towns allocated parcels in communal land. The process of allocation was regulated by the ejidal assembly, but not registered officially. The legalisation of the subdivision of communal land in parcels was only done in the second phase of land reform during the certification by PROCEDE. The people in possession of parcels in ejidal land were recognised as *posesionarios* (Table 8.11).

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[5]The Carpeta Basica with this information was not available in the archives of the Procuraduria Agraria.

Table 8.11 Confirmation and privatisation of *ejidal* rights in the *ejido*s of SMN and SPYSU (Source: Gaceta del Gobierno del Estado De Mexico 1980, 1989, Archives Procuraduria Agraria, Texcoco, 1998))

Ejido	Year	Confirmation of Rights	Privation of Rights	Total confirmed	*Ejidatarios* with guarantee	*Posesionario*
Pedro	1933			49	70	
	1980	47	12	47		
	1989	49	12	49		
	1993	49	-	50		5
Nativitas	1923			91	35	
	1973	58	31	89		
	1989	111	14	111		
	1995	111	-	111		125
Catarina	1997	72	-	72	n.a	142

The increase in numbers in Nativitas was explained by the *comisariado ejidal* as

> ' To get an *ejidal* parcel you have to show the assembly that you deserve the parcel working for the *ejido* (*hacer meritos*) anyone that likes to work and was landless could get a parcel until the 1970s. When the terraces were built the land was given mainly to the landless of the pueblo that reclaimed the land'.

Thus as a result of increasing population pressure and limited area of land in all *ejido*s and the 1945 ban of forest exploitation in Nativitas and Catarina, the first phase of land reform resulted in encroachment into communal land. This resulted in increased fragmentation of land, as the land allocated was often poor quality, and erosion became a problem. All this took place against the government agrarian policies.

8.5.1.2 Size of parcels

Table 8.12 shows the number of parcels by their size and type of holder for the three *ejido*s. In Pedro 90.4% of parcels is more than 1 ha with an average size of 2.7 ha. In Nativitas 96% of parcels is less than 1 ha, with most of these parcels in the communal lands. In Catarina 88% is less than 1 ha. As explained in chapter 7, the parcels over 1 ha in these *ejido*s were those in which the *ejidal comisariado* did not check the size of the parcels authorised by the *ejidal* assembly and some *ejidatarios* therefore obtained more land that had been authorised.

Table 8.12 Access of *ejidatarios* and *posesionarios* to parcels by area in San Pedro Y Santa Ursula, Santa Maria Nativitas and Santa Catarina del Monte (Author, areas calculated in ILWIS 2.2, based on maps of PROCEDE).

Area (ha)	Number of parcels *ejidatarios*	Number of parcels Posesionarios	Total Parcels	Total (ha)	Average . Size(ha)	% Total of parcels.
Pedro SPYSU						
< 1ha	37	5	42	15.0917	0.3593	9.6
> 1ha	52	0	52	141.518	2.7213	90.4
	89	5	94	156.5067	1.6649	100
	155.2373	1.2694				
Nativitas						
<1 ha	257	194	451	206.229	0.4572	96.16
>1 ha	12	6	18	26.0121	1.4456	3.84
	269	200	469	232.2411	0.4952	100
	157.03	75.2		232.23		
Catarina						
< 1 ha	101	165	266	110.8416	0.4166	88.67
> 1 ha	18	16	34	48.6937	1.4320	11.33
Total	119	181	300	159.5353	0.5318	100
Area (ha)	76.68	82.85		159.53		

Most of the parcels allocated in Nativitas and Catarina *ejido*s are of less than 1 ha which is indicative of the objective of the subdivision of land was to give access to land for both increasing the area under cultivation and to give land to the landless. In Pedro on the other hand the average parcel size is more than 1 ha, because the original allocation was 2.9 ha, there were only 2.9 ha of communal land, and only 5 parcels have been subdivided.

8.5.1.3 Number parcels held by individual

The number of parcels held by *ejidatarios* and *posesionarios* varies and hence the area held by an individual (see table 8.13 for details table in appendix 5). Table 8.13 shows that the number of parcels to *ejidatarios* has not increased in Pedro; the initial number of parcels was two parcels with 2.9 ha by *ejidatario*, currently only two *ejidatarios* have more than two parcels. In Nativitas where the initial number of parcels was two, 19 *ejidatarios* lost one parcel 47 keep two parcels and 45 increased the number of parcels to three or more. In Catarina 45 *ejidatarios* have one parcel and 30 more than one parcel. Non-*ejidatarios* (*posesionarios*) also have access to ejidal land in the three *ejido*s; most of them have access to one parcel, and however some have access to more than one parcel.

Table 8.13 Access of *ejidatario* sand *posesionarios* to parcels by the number of parcels held in San Pedro Y Santa Ursula, Santa Maria Nativitas and Santa Catarina del Monte (Author, areas calculated in ILWIS 2.2, based on maps of PROCEDE).

No of parcels owned	Number of *ejidatarios*	Number of *Posesionarios*	Total Parcels	Total (ha)	Average . Size(ha)	% Total of parcels .
Pedro						
1	19	5	24	53.28	2.22	42.12
2	29	0	58	93.19	1.60	50.88
3	2	0	4	10.03	2.51	7.00
	50	5	86			
Area (ha)	155.23	1.26		156.50	2.73	100
Nativitas						
1	19	79	98	44.60	0.45	41.53
2	47	27	148	82.84	1.12	31.36
3-6	45	19	207	105.00	1.63	27.12
	111	125	453	232.44	0.9841	100
Area (ha)	157.03	75.2				
Catarina						
1	45	114	159	86.40	0.54	74.30
2	16	20	72	42.27	1.17	16.82
3-6	11	8	67	30.86	1.62	8.88
	72	142	298	159.53	0.74	100
Area (ha)	76.28	82.85				

In the case of Nativitas several *ejidatarios* have lost parcels whilst others have gained parcels. The reasons for this are not clear; it could be inheritance, lack of control by the *ejidal* authority or purchase, although the *ejidatarios* always claimed that land have never been bought or sold. In Catarina there is no information about the number of parcels allocated initially, but the fact that 9.9% of the people have more than 1 parcel, indicates that some people have access to more land; how they got is not clear but it could also be inheritance or lack of control by *ejidal* authorities. In Pedro most of the *ejidatarios* kept the parcels allocated in 1933, only one *ejidatario* bought a parcel, and five small parcels have been sold to *posesionarios*.

This information indicates that before the reforms of 1992 there was already a process of accumulation of land by a group of people in the *ejido*s. Although, this only been made legal by PROCEDE land registration.

8.5.1.4 Size of the landholdings in the *ejidos*

The area of land held by individuals within and between *ejidos* varies in the three *ejidos*. In Pedro most of the *ejidatarios* have landholdings of more than 2ha and the area held varies from 0.42ha to 6.43ha, in Nativitas most of the landholdings have more than 1 ha with holdings between 0.0243ha to 2.3 ha and in Catarina most of the people held more than 1 ha and size of landholdings between 0.00400ha to 4.4 ha.

Table 8.14 emphasises the variability of area of land holdings amongst the *ejidatarios* and *posesionarios*. In Pedro few transfers of land has been achieved, and only 6 people have access to less than 2 ha and only one held 6.43 ha, and there are 6 people with less than 1 ha. In Catarina and Nativitas the amount of land held by individuals varies by the allocation of land within the *ejido* by the ejidal assembly. In these *ejidos* in general the *ejidatarios* have bigger landholdings than posesionarios. Most of the *posesionarios* have landholdings of less than 1 ha mainly used for housing.

Table 8.14 Access of *ejidatarios* and *posesionarios* to parcels by area total hold in San Pedro Y Santa Ursula, Santa Maria Nativitas and Santa Catarina del Monte (Author, areas calculated in ILWIS 2.2, based on maps of PROCEDE).

Size of landholding	Number of *ejidatarios*	Area (ha)	Number of *Posesionarios*.	Area (ha)	Number total of Holders	Area total (ha)	Average size (ha)	% total holders
SPYSU								
> 2 ha	1	0.42	5	1.27	6	1.69	0.28	1.06
2.0-6.43	52	154.82	0	0	52	154.82	2.93	98.94
	53		5	1.14	58	156.51	2.70	100
SMN								
> 1ha	25	12.72	101	41	126	57.19	0.45	24.61
1.0-3.9	86	144.31	24	34.1	110	175.04	1.59	75.39
	111	157.03	125	75.2	236	232.23	0.98	100
SCM								
> 1 ha	43	23.29	118	49.13	161	72.32	0.45	45.38
1.0-4.6	29	53.40	24	33.71	53	77.11	1.46	54.62
	72	76.69	142	82.84	214	159.43	0.75	100

A common future of Catarina and Nativitas is the fragmentation of the holdings affecting the original allocation of land by inheritance of parcels held by one *ejidatario* among several sons; illegal subdivision of one parcel for housing and additional allocation from communal land has taken place.

8.5.2 Second phase of Land Reform 1992 to date

The second phase of land reform is essentially a tenancy reform to allow rent and sale and mortgage of parcels, and the rent of communal land. The result of this first step of the reform in the *ejidos* was an improvement in security in land ownership by the certification of rights to the individual tenant. This involved decisions by the *ejidal* assembly on several matters: a) the type of tenure adopted with two choices *Dominio pleno* or *ejido* b) The confirmation of the list of *ejidatarios* with rights c) the confirmation of the list of people with communal rights d) the recognition of the rights of non-*ejidatarios* in possession of *ejidal* land as *posesionarios* e) the recognition of people of the town with the category of *avecindados*.

Table 8.15 shows the outcome of this process in the three *ejidos*. The decisions in the three *ejidos* were to continue as *ejido*[6], however in Pedro the decision was reversed in 1998 to adopt *Dominio Pleno*[7].

Table 8.15 Type of tenure, confirmation of rights to *ejidatarios* and *posesionarios* and number of avecindados nominated in the second land reform (Acts of assemblies, SPYSU 1993, SMN 1995 and SCM 1997)

Ejido	Year	Type of Tenure	Confirmation of Rights	Communal Rights/ha	*Posesionario*	*Avecindado*
SPSU	1993 1998	*Ejido* *Dominio Pleno*	53	53/2.9	5	200
SMN	1995	*Ejido*	111	239/542	127	200
SCM	1997	*Ejido*	74	220/694	146	n.a

The initial decision of the three assemblies to continue as *ejido* meant that the privatisation and sale to private investors in *ejidal* land was not the outcome of the Land Reform in Texcoco. Neither was the hoped for resultant redistribution of land. This emphasis of Government policy in achieving redistribution reflects the ignorance of the 'centre' of the fact that since the first land reform the *ejidal* assemblies had

[6] In January 1998 14,950 were already certificated by PROCEDE and only 0.5% adopted *Dominio pleno* (El Dia 19 January, 1998). In December 1999 with certification of 60 m ha only 0.28 % of the ejdios adopted *Dominio Pleno* (SRA, 1999)

[7] The *ejidal* assembly in September of 1998 adopted *Dominio Pleno*. The request was submitted, to the SRA but the request has not yet been approved. The reason is that the required environmental impact assessment has still not been carried out (Personal communication Agent P.A Texcoco, May 2000).

been involved in land redistribution usually involving eroded communal land. This illegal activity was then legalised as a result of the certification by PROCEDE.

The law prevents the acquisition of land in the *ejido*, limiting the ownership of land by one *ejidatario* to 5% of the area[8] of the *ejido*. Moreover the certificate of rights issued by PROCEDE under the *ejidal* tenure is not a full private property title, it contains several limits and 'safeguards' that prevent the sale of parcels to non-natives of the nuclei of *ejidal* population. Furthermore the right of first purchase for the first 30 days has to be given to the wife or concubine or sons of the *ejidatario*. The sale to outsiders can however be circumvented if the potential new purchaser is recognised as an *ejidatario* or *avecindado* by the *ejidal* assembly. Thus in Nativitas and Catarina this is the only route for land sale. Furthermore with soils of relatively low quality, sale of land for agriculture is not economically viable; however as the demand for building land increases, their land could become attractive for housing. So far however only six parcels has been sold in Nativitas, only one of which has been to an outsider. In Catarina no land appears to have been sold. If the demand for building land becomes sufficient strong, the *ejidatarios* could decide to follow Pedro and change tenure. The small area of parcels however could be mitigatory against this.

In Pedro, the decision to change the form of land tenure reflects both the high quality of land in relatively large parcels and the fact that the *ejido* is within the urban area of Texcoco City. The *ejidatarios* see the increased value in their land and the possibility for sale as building land.

8.5.2.1 *Alianza para el Campo*

The participation in this programme in the three *ejido*s was in four programmes, those with high subsidies and appropriate to the requirements of support for the *ejidatarios*: the hydraulic programme to improve infrastructure for irrigation; the programme of technical assistance, the programme for improvement of livestock and the programme of support of marginal areas. The *ejidatarios* of the three *ejido*s or do not have the

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[8] Or an area equivalent to that states for small property (Article 47 Agrarian law (1993). The ceiling for small property is established as 100 ha of irrigated land or its equivalent in other types of land.

money or were not willing to spend it in other programmes such as machinery and cattle. From interviews the problems in each *ejido* were site specific: in Pedro drilling of a well and help in commercialisation of vegetables; in Nativitas the increase in the storage and management of water, and support for the management and commercialisation of flowers produced in greenhouses, in Catarina the improvement in the management of water for irrigation and introduction of new crops such as vegetables.

The programmes of *Alianza para el Campo* do not promote investment to improve agricultural production as predicted by the government. The government considers only the lack of investment in machinery, technology and training as the main drawbacks to agriculture. However it is the diversity of land uses, resource base, and organisation for production in each *ejido* that determines the type of support required. Long term planning based on the current land uses and organisation for production in each *ejido* has to be designed by *ejidatarios* and government agents together. The plans have to include commercialisation of products in the market. In this way with a common understanding of the actual land uses and needs for investment in key issues, programmes based on shared investment could be successful.

8.5.2.2 PROCAMPO (Programme for the support of the countryside)

This programme has its objectives the compensation and protection of farmers producing staple crops from the opening up of the international market to supplies from abroad at cheaper prices. It was also designed to encourage conversion of farmers from staple crops to crops that achieved a more competitive value in both internal and external markets. Table 8.16 shows the percentage of area registered in the programme by *ejido* and beneficiaries. In the three *ejido*s only a percentage of the areas entitled to the subsidy in each *ejido* were registered, and the numbers of beneficiaries varies from 17 to 81 with subsidies per *ejido*s between £1465 to £6004 and the amount of subsidy per beneficiary from £8 (2000 m^2) to £215 (5.9 ha).

Table 8.16 Participation in PROCAMPO by tenure and area in the *ejido*s of SPYSU, SMN and SCM (Compiled by the author from archives of PROCAMPO, 1998)

Ejido/ Tenure	Total *Ejido*		Number of Participants	Area registered (ha)	% Participation beneficiaries	% Area (ha)	Total Subsidy (£)	Range Subsidy (£)
	Area (ha)	People Entitled						
SPYSU	156	55	17	40	34	25	1465	44 to 110
Ejidatario	155	50	17	40	34			
Posesio.	1	5	-		-			
SMN	292	236	81	110	34	38	4004	18 to 44
Ejidatario	157	111	61	92	55			
Posesio.	75	125	15	13	12			
Small Prop.	60	-	5	5	5	8		
SCM	874	446	78	193	17.4	22	6004	8 to 215
Ejidatario.	76	72	4	7	5.5	9.2		
Posesio.	82	142	13	17	24	20.7		
Comunero	716	232	17	29	26	23.6		
Com/Pose			21	26	-			
Com/Ejid.			23	114	-			

As explained in Chapter 7 the low participation in the programme was due to several reasons, but it was mainly the *posesionarios* who did not register parcels as they saw the program as a possible government threat to take away their parcels, whilst the *ejidatarios* considered the subsidy too low and the procedures too bureaucratic. The subsidy is also insufficient to promote the change of staple crops to crops with competitive prices in market, as most of the areas are under seasonal agriculture and require investment in irrigation to become economically viable.

Table 8.17 shows the pattern of crops in the areas with subsidy. Only in Pedro where the crops are under irrigation in 44.8% of the area with subsidies for growing vegetables and alfalfa, is there any significant non subsistence crop growing. In both Nativitas and Catarina seasonal agriculture dominates crops and is oriented to self-consumption.

Table 8.17 Crops and areas sown with the subside of PROCEDE in SPYSU, SMN and SCM (author compiled from PROCEDE, 1998)

	Maize	Beans	Maize/ Beans	Wheat	Oat	Broad Bean	Alfalfa	Vegetable	Total	% staple crop
SPYSU										45.2
Crop(ha	8.7	7		2.8			5.6	16.7	40.8	
%Area	21.3	17.1		6.8			13.8	41.0		
SMN										100
Crop (ha)	79.8	20.3	9.5	1.5		1.1			112.2	
%Area	71.1	18.1	8.5	1.3		1				
SCM										100
Crop (ha)	134.5	15.8	4.2	21.8	10.7	6			193	
%Area	64.5	12.4	4	7.4	3.1	2.1	1.6	4.9		

Appendini (1998) argues that with a policy of subsidy per hectare of crop sown the principal beneficiaries of the programme are the poor and marginal subsistence farmers. The impact of the programme has therefore been social than a reward for effort by the more entrepreneurial farmers to increase production, through modernisation that was supposed to be the main aim of the programme. Appendini (1994) however argues that because the scheme was introduced in the 1994 election year the programme was actually more political than anything else. Even so, the participation of the *ejidatarios* in these three *ejido*s in shared investment in key agriculture products and training is far from being successful. The crop subsidy only reached a fraction of the area of the cultivated land and only a handful of *ejidatarios* were the beneficiaries in each *ejido*. The amount of subsidy was also too small to contribute to changes in the actual pattern of crops and hence to the modernisation of the production process.

8.5.2.3 Programme of Ecological restoration of the watershed of Mexico

This programme[9] was run in Nativitas and Catarina and focused on the construction of conservation infrastructures and in contrast to the previous programmes used a 'participatory' approach for the organisation of the works with the people in each *ejido* organised in committees, for the selection of sites for conservation works and providing labour. The government agents acted as technical advisors to the committees.

The works achieved were reforestation, fencing of reforested areas, and building of gabion dams. The process followed for the implementation of the programme illustrated the negotiations between the agents and the *ejidatarios*. The money allocated for labour was fixed, for example, at £ 0.037 for planting a tree, £186 per km of fencing, or £22.9 per m^3 of gabion dams. Also the money for the purchase of rocks for the gabion dams could be saved and divided among the participants if they broke up the rocks. This produced a conflict between the technicians who wanted to maximise the number of dams, and reforest tepetate land, and the *ejidatarios* that

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[9] Pedro does not have problems of erosion or forest land

wanted to maximise their wages.

In Nativitas reforestation was in areas with low densities of forest and grassland in the forestland. In Catarina the government agents proposed reforestation in areas with *tepetate*, the *ejidatarios* objected and proposed planting in areas of previously failed reforestation and in low-density forest. They did not want to plant in tepetate which is very hard to break up and hence too costly in terms of time, whereas replanting previously failed reforestation areas and in low density woodlands was easy and hence took little time and maximised the wages they could earn. The Final agreement was to plant 45,000 trees in areas previously reforested and 30,000 in the forest.

The selection of sites for the dams was also controversial the government agent wanted to build the dams in areas with maximum yield of sediments and in the narrow areas of streams and to build the maximum number of dams. The principal criteria considered by the *ejidatarios* in both *ejido*s for the location of a dam were the availability of stones near the site of dam construction. The availability of stones eliminated the need to purchase stones and reduced the effort to transport the rocks, thereby saving money and effort and maximising individual wages. In Catarina the people wanted to build a dam in the middle of the town with a double of retaining sediments and to use it as a bridge to link two areas of the town.

The agent in charge of the programme stated that the participation of the people was not as expected, and that the *ejidal* authorities 'work' very hard to convince the people to participate. The process of negotiation was lengthy and difficult but in the end the *ejidatarios* criteria overrode the technical advice, and this was achieved by the *ejidatarios* refusing to continue in the programme if the works had to be done at the sites proposed by the technicians.

The agency agreed to the *ejidatarios* demand, because

> ' We have to spend this money, it does not matter where the dam is located, or if the reforestation fails, the important issue is to have the work done as was required' (Anonymous informant).

Thus yet again the *ejidatarios* had their own way in the application of the programme overriding the recommended schemes. The ability of the *ejidatarios* to determine what is done reflects again the failure of government designed schemes to take into consideration the views and attitudes of the people at whom the legislation is aimed. Had local views and attitudes been considered then the programme could have been designed more efficiently to ensure willing co-operation from the *ejidatarios* in achieving the desired outcome of the programme as specified by the technicians.

The government programmes of this second step of land reform were designed in a top down approach. *Alianza para el Campo* was based on the premise that the 'engine' of development has to be investment in machinery, technology, training and subsidies in key inputs in a shared investment scheme. The *ejidatarios* in the three *ejido*s do not have the money to invest or were not willing to participate in most of the programmes. PROCAMPO was a subsidy programme, to move the *ejidatarios* from traditional crops to crops with more competitive prices in the market. However, the area of parcels registered in the three *ejido*s was at best 38%. It was constrained mainly by the small size of land held (less than 1ha) that means an annual subsidy of £35, and the bureaucracy involved to receive the subsidy. The *ejidatarios* who participated however, did not 'switch' to crops with competitive prices in Pedro only 18.1 ha are sown with vegetables and alfalfa, but in Nativitas and Catarina the *ejidatarios* are still producing crops for self-consumption. Finally the Government sees the programmes as investment in infrastructure in Nativitas and Catarina such as that for ecological restoration, and those for reforestation as sources of temporary employment for the *ejidatarios*.

8.6 Occupational activities

The resource base allocated to the three *ejido*s during the Land Reform was not enough to make a living only from agriculture in the three *ejido*s. The three *ejido*s were marginalized of commercial agriculture, with mainly seasonal agriculture and forestland. Then a strategy of production combining subsistence farming, multiple income activities within the *ejido*, communal land and wage work outside the *ejido* were carried out by most of the *ejidatarios* in Pedro and Nativitas. However in Catarina with more land and resource base, income activities continue around land use.

The strategies followed by the three *ejidos* to increase income were different. In Pedro emphasis has been placed upon investment in irrigation and commercial crops combined with activities outside agriculture. Nativitas, with limited availability of resources of land and water, followed a strategy for the production of maize for self-consumption on the seasonal land, with investment into increasing the availability of water for irrigation of commercial such as greenhouse flowers and income earning outside the *ejido*. Catarina, with adequate availability of water and land, followed a strategy for production of both subsistence combined with commercial crops, with maize being displaced from the irrigated parcels in favour of more commercial crops, and the maize moving to seasonal land. Additionally more forest and grassland was opened up to agriculture. Also both Nativitas and Catarina benefited from Government reclamation schemes for eroded land.

Table 8.18 shows the occupational activities in the three *ejidos*. In Pedro and Nativitas, occupational activities are diverse, with more of the *ejidatarios* with activities outside agriculture. In Catarina, agriculture is still the main occupational activity.

Table 8.18 Income activities in the *ejidos* (source: Archives of Procuraduria Agraria, and fieldwork, 1998)

Occupational activity	Pedro (%)	Nativitas (%)	Catarina (%)
Agriculture	33.4	22	70.2
Self employed	23.5	35	6.6
Wage work	17.6	38.2	4.2
Housewives	25.5	4.8	19

The actual pattern of occupational activities is a combination of the product of government interventions in the *ejido* through regulation of the use of resources and relative location in terms of opportunities for work outside agriculture

Thus income activities in Pedro and Nativitas have developed through a long process of adaptation and transformation. Occupational activities in the *ejidos* are characterised by production for self-consumption and crops to local markets, but also in wage work and self-employment with some *ejidatarios* with multi-occupational activities within and outside the *ejido*. In contrast Catarina activities are still dominated by agriculture and exploitation of the forest. Also *ejidatarios* in Pedro, in the outskirts of Texcoco, have access to sources of work in Texcoco and Mexico City around 45 minutes travel; however from Nativitas and Catarina times of travels are longer, up to 2 hours from Catarina, and with a job receiving a low salary by the high cost of transport is prohibitive. Thus each *ejido* followed their own path in land uses according to the resources available, the impact of government interventions, and the opportunities of work available in the region

8.7 Summary

In this chapter the inventories of resources produced by Government for land use planning were analysed for the three *ejido*s. The maps produced in the GIS by the present research yield a wealth of data useful for planning land use and could be very impressive for government agencies. The use of these maps for planning at *ejido* level have to be taken with caution due to the drawbacks of these maps found in this research such as: a) they are resource oriented and outdated, b) the scale is not adequate to represent the diversity of resources in the *ejido*s, c) composite cartographic units are used and two or more soils and types of vegetation are associated in one cartographic unit, and d) maps produced by government agencies by its scale, fails to describe the diverse resource base of the *ejido*s with micro-variations in soils, vegetation and climatic conditions, and hence land uses. However taking in consideration the limitations, these maps could be used for identification and description of land resources in the *ejido*s, and for the suitability assessment for planning at municipality level.

Participatory maps of resources constructed with the *ejidatarios* reflect the views of the resources by the *ejidatarios* respecting the semantic organisation of the topology of the maps as culture-specific in each *ejido*. The criteria that the *ejidatarios* are using for the definition and description of land resources were used for the definition of typology of land use types (Beek, 1978). Fourteen different land use types were identified in the three *ejido*s. This typology considers as essential the institutions of the *ejidatarios* involved in the process of land use (*ejidal* assemblies, water councils). It considers the implementation of programmes where those who make the decisions on changes in land use are adapting the Government programmes to their specific context of land use of each of the three *ejido*s.

The changes of the government policies is the second step of Land Reform and in general the Government interventions (concessions in the forest, reclamation of land, programmes of rural development) changed the access to land and relations of production and hence the structure of income opportunities. Thus land use decision-making process and land management practices will be reorganised in the three *ejido*s. As was shown in this chapter, changes in government policies and interventions in land use have been the dynamics forces for changes in land use in the *ejido*s. The recent modifications of the land tenure framework and government programmes will change gradually the decision-making processes in land use and management in the *ejido* institutions, planning procedures in the use of resources, and income activities will need to adapt to these new conditions.

Chapter 9 Conclusions

This study has undertaken the task of integrating into GIS available information and data acquired using a participatory approach to produce new land use information at the municipality and *ejido* levels. The description of changes in land use and the agrarian structure and the historical negotiation of resources among government and *ejidos* was analysed using the municipality of Texcoco and the three *ejidos* of San Pedro y Santa Ursula, Santa Maria Nativitas and Santa Catarina del Monte as case studies.

The understanding of land use by the Government agencies has been based on a resource-oriented approach where land is viewed as a commodity that has to be used to its maximum potential production. In contrast, the understanding of land in each *ejido* was based on self-consumption and provision of land for housing, with any excess production sold to the market. Land use and its changes emerged as a negotiated process between government and users in an iterative process of learning.

The conclusions that could be drawn from the study are related to a wide variety of topics from changes in policies of access to land and its impact in the use of resources, heterogeneity in the resource endowment of the *ejidos* and hence diversity of options for livelihoods. Two specific questions relate to the use of GIS to support planning, namely, the restriction of access to information by government agencies, and problems of the integration of data into GIS, and also the lack of standardisation of procedures for GIS and map production. From the information produced contrasting views about the understanding of land and its use emerged.

First and foremost the process of decision-making in land use in the *ejidos* emerges as an adaptive process depending on the socio-economic and land resources available and closely linked to the history of access to land that goes back to the Prehispanic period. Effectively each *ejido* is unique, as they have reacted differently through time in response to changing legislation for example to the land such as the laws of reform in the nineteenth century; this has had an effect on the ongoing strategies in each *ejido* of land use and management (see chapter 5). The strategies of decision-making for land management have been adapted at grassroots level by the people, following in general the loop decision process shows in Figure 2.2).

The uniqueness of development and response in the *ejido* communities is shown by the three *ejidos* studied. San Pedro y Santa Ursula with the best endowment of agricultural land has through irrigation become geared towards commercial agriculture. Santa Maria Nativitas and Santa Catarina del Monte with poor agricultural land and diverse resource endowments have developed strategies for self sufficiency based on the use of agriculture and forest resources. A divergence in development however occurred after the ban on forest exploitation led to more intensive use of grassland, encroachment of cultivation into communal land, eventually resulting in severe degradation. In Santa Maria Nativitas the *ejidatarios* continue with agriculture for self-consumption, and from the 1970s their livelihood became a mix of diverse activities in agricultural production of crops for self-consumption, flowers in greenhouses and non-agriculture activities such as traders, shopkeeper, etc. In Santa Catarina del Monte, however, with access to more land, irrigated cultivation of more diverse crops has occurred, many of which are geared to commercial production, though subsistence activity continues, supported by temporary non-agriculture work.

Second, the use of GIS in less developed countries is often criticised for its lack of accessibility to local communities; ownership of GIS lies with government, which too often controls data on which it is based. This is true in Mexico where GIS is considered by the agencies as an expert system thus reinforcing the politics of power on which the current top down development planning is based. This view hampers the use of GIS at grassroots level by the people working in the identification and implementation of projects, and also technicians and users themselves. Even where the necessary hardware and software is available, a serious additional problem is access to data which are centralised, and released on a 'case to case' basis, based on political and personal interest of the people in control of the release of data (see Chapter 4).

An important part of this study was to take GIS 'to the communities'; this was achieved using a lap top computer and ILWIS 2.2 software. The production of maps with the users using participatory methods, digitisation on screen with technicians and *ejidatarios* proved to be possible. Clearly however, widespread training in the principles of cartography and GIS will be required. One of the advantages of the use of ILWIS 2.2 is that the software is oriented towards users' needs and is updated according to these needs. This allowed the solution of problems such as conversion of data from ARC/INFO. Moreover the latest ILWIS 3.0 software has the capability of producing digital aerial ortho-photographs and mosaics of aerial photographs, thus eliminating the problem of geometrical correction of aerial photographs. However the problems in the use of GIS are sometimes not related with technical issues, but with the incompatibility of data sources. Thus the overlay of 1:50,000 maps with the digital maps of PROCEDE were not possible because a different ellipsoid was used in the georeference system. Furthermore policies also intervene in data release; thus whilst PROCEDE have digital map data on the same georeference base as the 1.50,000 maps they have to date refused to release this.

Third, land maps and land suitability classifications based on physical aspects without consideration of social aspects for planning in the municipality or *ejidos*, at most 'explain' types and variation of resources and land uses from place to place in the *ejidos*, but they fail to address the complexity and dynamics of the land use processes, as was the case of the forest inventories of San Rafael y Anexas (1966), the land system survey (Ortiz, 1975) and the evaluation of suitability for production of maize (Rivera, 1994), studies that were at best only partially successful for planning.

During the study it became apparent that many of these maps, especially land capability maps showed entirely different interpretations of the resource base to that 'used by' the *ejidatarios*. Lack of coincidence between the official and community maps was the key force that leads in this thesis to the acceptance that other factors, additional to physical and economic aspects were involved in land use decision-making. To the extent that conflicts of understanding with a shared base of information are not resolved, government plans will be only partially successful. Thus the first step for planning in the *ejidos* should be the building of a platform for negotiation between all parties involved rather than attempting to impose the will of government and development agencies on unwilling people. Without this, any attempt to impose a conservation or economic policy will fail. The failure of the traditional maps used to correspond to the reality in *ejidos* of Texcoco is caused by technical issues, such as scale, outdated information, diverse resource base and micro-variations in soils, land uses, vegetation and climatic conditions; however, how the people perceived the land, and make decisions on land use are related to the local context and associated institutions for management of resources.

Fourth, in the present research participatory maps are seen as 'cognitive maps' (see Laurini and Thompson, 1994). These maps are defined as a representation of spatial entities by the people with their 'own words' to locate spatial entities and as a help to explain how they are related to each other in their own contextual perception. Knowledge of such places in these maps is related to land uses and the capabilities of the land is often revealed by drawings of mental maps, although the conclusion about that knowledge is affected by the ability to draw it on paper. In this context the role of GIS experts is to make available these data to land use planners as Laurini and Thompson (1994 p 102) proposed

> 'A better design of interfaces between person and machine for spatial information systems requires that we know more about personal reference systems, how spatial data are processed cognitively, and if language has any consistencies across cultural subgroups of people'.

A 'demand driving approach' was used for the production of participatory maps in the *ejidos* as an attempt to transform the perception of land use of the *ejidatarios* into a similar object in the western model. The approach used is context transformation (Molenar, 1993). The semantic organisation of the land use maps is culture-specific and with specific environmental conditions and practical considerations. Thus local knowledge through the views of the resources by the people are imprinted in these maps, the map is a tool for documenting that knowledge. However comparison among maps produced in different *ejidos* is difficult. As Ortiz (1999) and Tabor (1992, 1995) argue local or indigenous systems of identification of land should be viewed as complementary to scientifically based systems and an integral part of the mapping of resources. The former have an advantage in that they are widely known by the people of the pueblos and can easily improve communication between farmers, Government agents and scientists.

As Gonzalez R.M (1995) signals, the growing recognition of the role of indigenous knowledge in sustainable development, faces us with the huge task of documenting and disseminating that knowledge, in the same systematic way that Western knowledge is generated, documented and disseminated. However the use of 'cognitive' maps for planning based on perceptions of the users are highly controversial (Agrawl, 1996; Niemeijer, 1995). But, how much precision is needed in locating objects is more a matter of purpose in having data in the first place. For many purposes highly generalised maps may be sufficient for the visual operation of the users. Also cultural factors may condition users to particular forms of ranges of language for dealing with objects in space. This is the case in the present research of the use of place names in the indigenous language of *Nahuatl.*

The maps in the present research were built from the views of the *ejidatarios* with their semantics about the local topology. The topology produced describes home and action space, is an innate and sustained knowledge about the land, identifies issues of immediate significance, and encodes information about the environment in a language the region's inhabitants understand. The topology of the maps was elicited through techniques of PRA transects and resource mapping. The Cartesian method was used referencing the entities (soils or land uses) identified by technicians or *ejidatarios* in satellite imageries and aerial photographs. The process was emic because the inclusion of the views of the *ejidatarios* about resources and their own topology, and etic because the researcher selected the materials for cartography (satellite imageries, aerial photographs) and organised the topology by the aggregation of the contrasting views to reach a topology that expressed these variations in perception based in historical information and other maps produced during the research. The final maps are a cognitive map that combines the different views of the same tract of land.

Fifth, PRA and RRA techniques such as mapping, transects, direct observation, historical access to resources and interviews, proved to be useful in building the maps and in the understanding of land uses and their associated decision-making processes in the *ejidos* for a number of reasons: a) developing the maps helped to break the ice with the people that identified which elements were important for different groups and hence provided a basis for comparison of different perspectives in the use of the resources; b) the researcher acted as facilitator in the production of the maps, with the prime concern being to enhance communication and learning by the representation of reality as seen by the users of the maps; c) the promotion of discussion about the relative location of resources; d) highlighted the importance of different resources for the people and raised issues that affected the use of resources e) allowed analysis of the actual situation of the resources and understanding of the decision-making processes in the use of resources.

Sixth as has been shown in this research, analysis of changes in agricultural practices and environment and ecological consequences associated with them have resulted from changes in agriculture policies and market conditions. The basic focus of the 'model' in this research was the agrarian structure as reflected in agriculture land use changes and resources as understood by the people on the 'ground'. The models produced are capable of reflecting the agriculture consequences of particular specifications of environmental and social characteristics for the particular areas or types of land in the *ejidos*.

In this thesis as proposed by Booth (1994) the focus has been on the heterogeneity of the agrarian structure of the municipality trying to explain significant variations in patterns of development in the local setting and how the diversity ins social organisation history and resource base of each *ejido* gives a different framework for decision making to the people. Land use and making a living from the resource base is portrayed as a multidimensional reality with contrasting views of what use of resources means for government and *ejidatarios* in the local and regional patterns of agriculture. Differences between 'scientific' and 'cognitive' maps as representations of land uses are highlighted. Land use is a heterogeneous process involving multiple levels of views and multiple patterns of organisation and management of resources emerging form the interaction of national development programmes, and their implementation at municipality and *ejido* level.

The *ejido* emerges in this context as the basic cell of organisation of the agrarian structure in the municipality, and the perceptions of the people on the 'ground' through maps and their views on land use and management show the significance of local resources and management practices for the *ejidatarios*, and how the changes in government policies are experienced by the *ejidatarios* themselves. Farming in the *ejidos* as suggested by Hebineck and Van der Ploug (1997) can be interpreted as a social construct as the outcome of 'actors' projects involved in agriculture such as farmers, planners, politicians, implementers.

Seventh, typology of land uses that describes organisation for production and land uses at local level namely land use types (Beek, 1978) or styles of farming (Hebineck and Van der Ploug, 1997) found in the *ejido* has the following characteristics: a) a specific culture repertory, composed of shared experiences, knowledge, insights, interest, prospects and interpretations of the context in which farms operate; b) an integrated set of practices and artefacts i.e. fields, crops, agricultural practices and so on, combined in such a way that they constitute a rational and internally coherent (land use) in each *ejido* and c) an ordering of interrelationships between the farming unit on one hand, and markets, institutions and technology on the other. *Ejido* land uses are thus the result of goal-oriented actions and related strategies, as *ejidatarios* projects are carried out in a particular historical context. As Hebineck and Van der Ploug (1997) suggest heterogeneity is of strategic importance for an analysis that deals with agrarian and rural development in less developed countries. The analysis of heterogeneity shows the contrasting responses to the processes of change and problems that characterise the *ejidos* of the municipality as shown through this research.

Eight, the neo-liberal economic policies in Mexico since the 1980s of sweeping privatisation, GATT membership, trade liberalisation, advocacy of the North America Free Trade Agreement (NAFTA), the changes in Agrarian Law and policy are all encouraging modernisation of agriculture focused on support to commercial agriculture. All convey the message that Mexican State development will be dependent on a private economy made strong by the exposure to the world market standards of competition. (see Erfani,1995). However, as shown in this research, while the political and corporate elite in Mexico will undoubtedly continue to conjure up images of a new agriculture sector, average landholders in the municipality of Texcoco will continue to attempt to secure socio-economic survival in their *ejidos* and local communities in multiple occupational activities, more concerned with subsistence farming rather than with the government policies. Thus, while the Government proceeds to build a new agriculture sector based on NAFTA, ordinary

Mexicans will increasingly find that their socio-economic security lies in the *ejido* and their adaptation of regional and national policies to meet their needs rather than those of the centre.

Finally, during the research the increasing disenchantment with conventional practices of contemporary agriculture advocated by professionals and their institutions, experienced by the author, were reflected by the increasing problems found in the *ejidos* such as environmental degradation, exclusion or minimum support to *ejidatarios* by government, the erosion of rural communities and occupational diversity. This was compounded by the concentration of agricultural support and economic wealth in the private sector; with land uses geared by government policies leading to erosion and a general lack of understanding of the Government agencies of the multiple realities co-existing in Mexican agriculture, and the impacts of the changing policies of the government at local level. In contrast, land use in the *ejidos* was found to have its own dynamics according to the availability and type of resources, social organisation, and response of the *ejidatarios* to government policies. Sometimes the environment has been degraded, but more recently the tendency has been towards reclamation. These contrasting understandings of reality call for methods to be developed to deal with the complexity of agricultural systems.

In this context Mexican researchers are facing an impasse in agricultural research. Findings from this research clearly support the increasing body of evidence world wide, that the 'top down' approach is not relevant to agriculture development. The Agriculturalist must learn how to deal in a dynamic, recursive and critical manner with the complex issues at the interface between natural and social worlds. This complexity leads to the need for new ways of thinking and methods of improving it, especially for people involved in agricultural education. This means not only knowing how to actually transform problematic complex agriculture situations in practice, but also to know how to transform his/her own practice in such a manner that improvements in the one also improve the other.

It is vital that agriculturalists and indeed the Mexican Government see agriculture development not simply as a 'technical' pathway of government policy driving practice but as a more complex interaction process, which considers the impact of policy on recipients for example *ejidos* or *ejidatarios*. This requires a significant change in attitude, as it implies the policy makers and their agents must learn and understand the attitudes and traditions of the very people they hope to help. Without this interaction and negotiation future agricultural policies will be as unsuccessful as those of the past.

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- Carpeta Basica of the ejidos with the documents about the original allocation, problems of boundaries, and the reports of the assemblies during the process of certification by PROCEDE. For the following Ejidos: San Pedro y Santa Ursula Santa Maria Nativitas. Santa Catarina del Monte: map of parcels and list of ownership.

Archives data consulted in the ejidos

- Rules for the use of water from the irrigation in Santa Maria Nativitas.

- Map of land tenure of the ejidos (PROCEDE, 1995) and list of ownership.

- Technical report for the request of permission for the exploitation of the forest to the SAGADER.

- San Pedro y Santa Ursula Map of land tenure (PROCEDE, 1993) and list of ownership.

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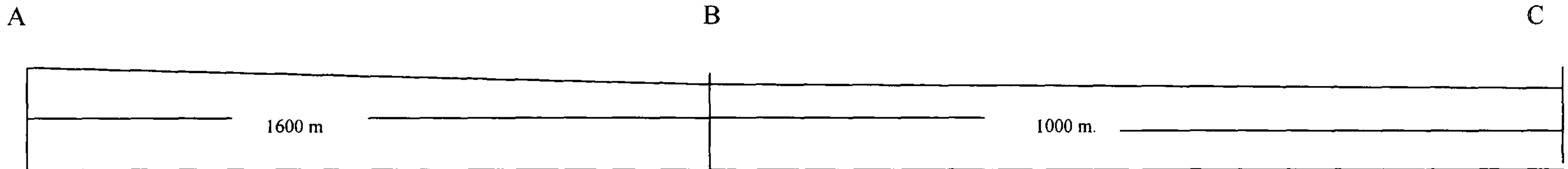
Archivos de la Promotoria Agraria (Delegacion Texcoco) SECRETARIA DE LA REFORMA AGRARIA

- List of the ejidos of the municipality of Texcoco with name of the ejidal authority, area of the ejidos and year of grant.

Appendices

Appendix 1 Schematic Diagram of Transects 2-5, 7, 9,10 in the municipality of Texcoco(author , Foieldwork,1998)

Transect 2 . Schematic diagram of the Transect in San Pedro y Santa Ursula.



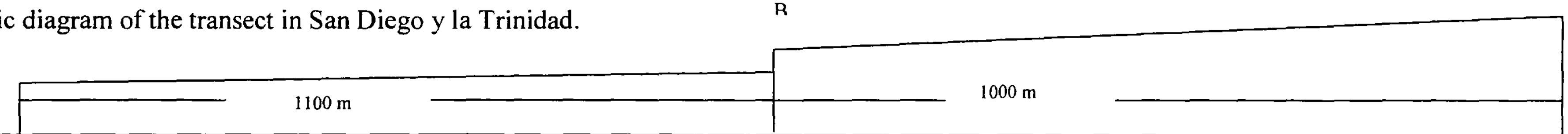
Soils	Depth more than 90 cm.	Depth more than 90 cm.. Outcrop of salts in areas not irrigated.
Land cover	Irrigation in 47 ha. Crops: alfalfa, maize and vegetables. And a small area of seasonal land..	Irrigation in 63 ha Maize in most of the area, and some parcels with alfalfa and vegetable.
Problems	Located in the outskirts of Texcoco city. Increase of urbanisation in ejido lands' without public services (water, electricity, sewage network). The well for irrigation collapsed in 1995, and sewage water is used for irrigation of maize and alfalfa. Problems for marketing of vegetables. Possible privatisation of ejido land.	Problems of drainage of water in the soil profile, and in some parcel outcrops of salts.
Opportunities	Soil of good quality for agriculture profitable under vegetable production.	Programme of management of water. Application of manure for reclamation of soils.
Slope	1 %	1 %
Land suitability	I-1	III s-2. Slow drainage
Classification of Irrigation	I-1	III h-1 Slow drainage
Altitude (masl)	2245m	

Transect 3 Schematic diagram of the transect in San Diego y la Trinidad.

C

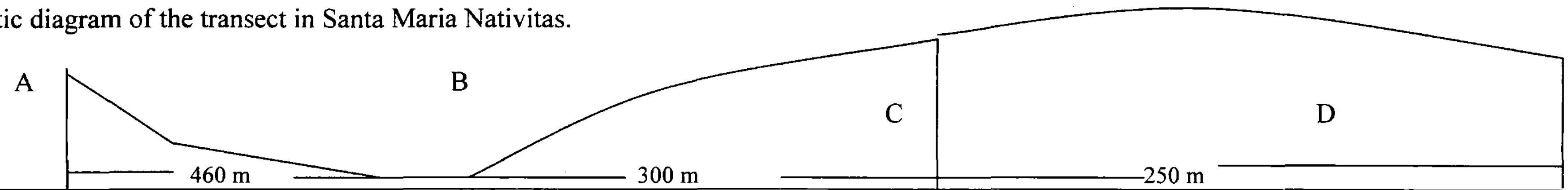
B

A



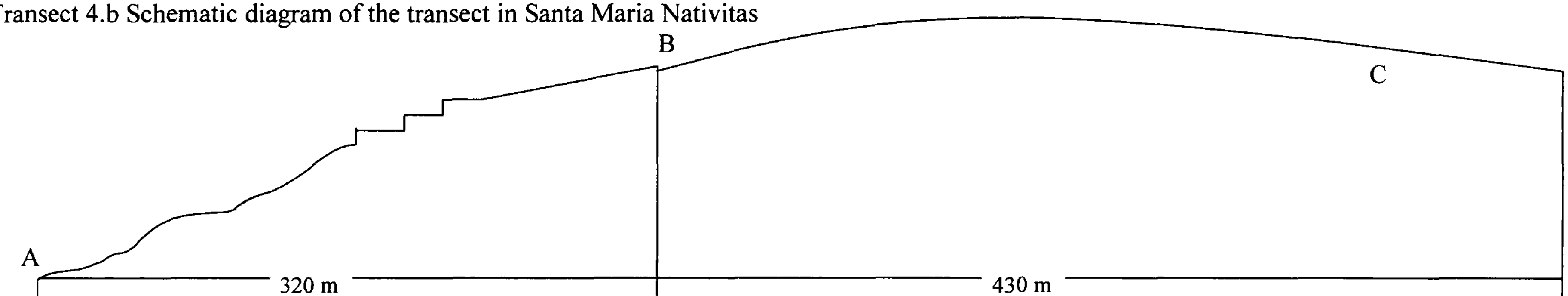
Soils	Soil texture loam. Depth of soil 90 cm.	Depth more than 50 to 90 cm
Erosion	No evident	Terraces are built in these lands. Crops maize and alfalfa.
Land cover	Irrigation, alfalfa, Parcels of half ha, sown with alfalfa, some with houses. Dairy farming.	The ejido has three wells for irrigation. Intensive use of the land. Most of the parcels have a house, a greenhouse for production of flowers (sizes from 200 to 300 m².) . Half of the plot sown with diverse vegetables,(each in two or three rows of 100 m length) carrots, onion, coriander, lettuce. The other half of the parcel sown with alfalfa. In the limits between parcels there different fruits tress apple, capulin and tejocote.
Problems	The lands surrounding the ejido are urbanised. and some ejidatarios has been selling small lots of 200 to500 m ² illegally.	Irrigation system with channels not surfaced, and in some points water goes out of the cause. Problems for the market of vegetables and flowers. Irrigation is intensive during all the year. The ejidatarios have the perception that the supply of water is not a problem. Because the wells were drilled to 300 hundred meters of depth, and they said that they will not have any shortage of water for irrigation.
Opportunities	Sell of land in small lots.	The irrigation system is organised as a trading society, and the rights of water are transferable, and treated as a commodity. The actual price of irrigation rights is around £4000. The ejido have also rights of water from a spring and water is stored in a tank with capacity of 30,000 m³. Recently this water is mixed with non treated water sewage water, and is used for irrigation of maize and alfalfa by few people. the ejidatarios are successfully organised for in two groups for commercialisation of flowers and vegetables and have access to the markets of Texcoco and Mexico city. There are negotiations with the municipality authorities to promote the marketing of their flowers and vegetables in Texcoco municipality. The sell of agriculture land has been among the ejidatarios or their relatives.
Slope	1 to 2 %	2-5%
Land capability classification (Ortiz, 1975).		IIe-1
Classification of Irrigation (Ortiz, 1975)	I	II e-1
Altitude (masl)	2260-2300m	

Transects 4.a Schematic diagram of the transect in Santa Maria Nativitas.



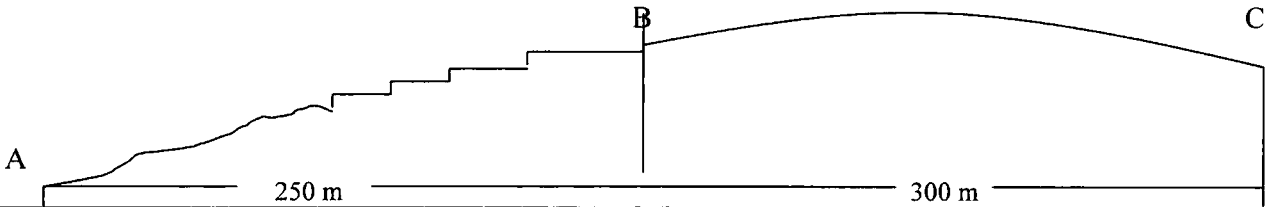
Soils	Depth of soils 10 to 50 cm. Texture loam	Depth less than 10 cm outcrop of *tepetate*	Depth 50 to 90cm
Erosion	Slightly, laminar. Trees and magueyes in the limit of plots	Erosion severe in the areas with more slope, slightly in the cultivated plots. Some areas with *tepetate* exposed.	Erosion laminar in areas with more slope
Land cover	Seasonal crops, maize and few plots with wheat or broadbeans. Areas not cultivated grassland and bushes.	Maize, grass and in some areas the *tepetate* exposed. Production of maize 500 to 1000 kg/ha	Crops Maize, beans and broad bean. Production of maize 1000-1500 kg per ha
Problems	Shallow soils. Starting of rain between may-July with a period of drought in July. Yields of maize variable within the years and relying in the precipitation. Yield from 500 to 1000 Kg/ha.	Erosion. Use of limited amount of fertiliser urea 40 kg/ha.	Use of fertiliser in reduced amounts 40 kg/ha.
Opportunities	Use of fertiliser and addition of organic matter to increase yield.	Building of Terraces by breaking up of *tepetate* and incorporation to agriculture by incorporation of organic matter and cultivation of maize.	The best soils of the ejido. Project to build a plant for the treatment of sewage water for irrigation of these lands. Scarcity manure.
Slope	5 to 9%	10 to 15%	5 to 10%
Land capability classification	II e-1	VII e-1	II e-1
Classification for Irrigation	II t e-1		II t-1
Altitude (m asl)	2290- 2300 m.		

Transect 4.b Schematic diagram of the transect in Santa Maria Nativitas



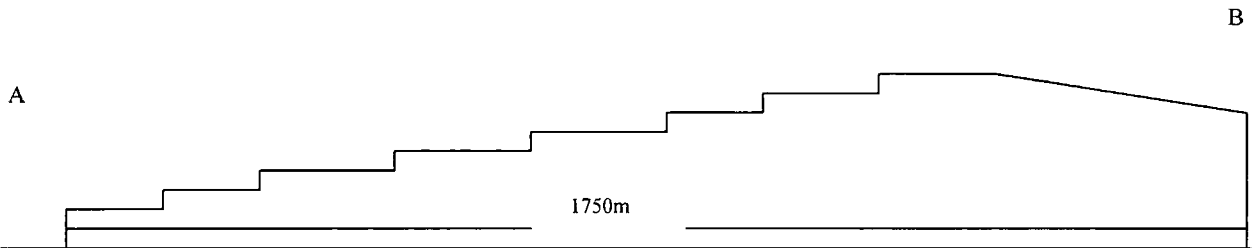
Soils	Depth 10 to 50cm. Outcrops of duripan (*tepetate*). Terraces shallow soil 10-20cm.	Depth more than 90 cm
Erosion	Erosion in sheet severe in the areas with more slope. No evident in the terraces	Non evident
Land cover	Crops maize. Non cultivated land grassland.	Area of settlement houses associated with plots for the production of crops of around half hectare. Crops maize, fruit trees, beans, Family gardens, greenhouses. Production of maize above 2000 kg/ha.
Problems	Seasonal crops. Maize and wheat. Areas with severe erosion near the ravine. Low yields from 500 to 1000	Building of houses and division of plots. Scarcity of water for irrigation of family gardens and for greenhouses. Diseases of fruit and flowers.
Opportunities	Building of terraces. Addition of organic matter.	More efficient use of the water for irrigation of crops in the green houses. Improvement of technology for the management of water and the more technology for the production of flowers.
Slope	5 to 10%	5%
Land capability classification USDA (Ortiz, 1975).	VII e-1	IIe-1
Classification of Irrigation capability USBR (Ortiz, 1975)	VI e-1	II t-1
Altitude (masl)	2390-2400m	

Transect 4.c. Schematic diagram of the transect in Santa Maria Nativitas.



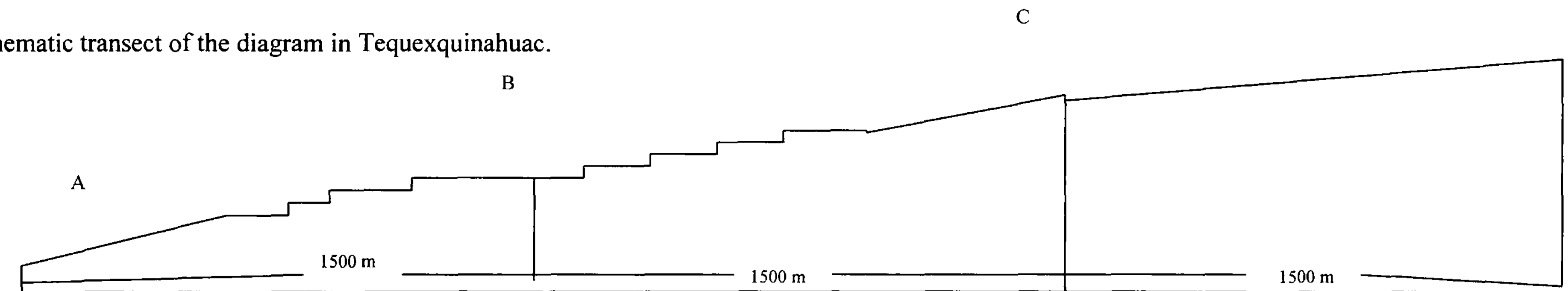
Soils	Depth 10 cm. The *tepetate* exposed in most of 50 % of the area.	Depth 50 to 90 cm
Erosion	Severe.	Erosion slightly sheets.
Land cover	Grass and bushes in the non cultivated area. Maize in the terraces.	Maize. Production of maize 500 to 750 kg/ha.
Problems	Steep slope, erosion in most of the area. The *tepetate* is exposed,.	Shallow soils, Magueyes in the limits of the parcels. do.
Opportunities	In 1980's the people started to build terraces using machinery to broken down the *tepetate*. The soils have been reclaimed by cultivation of maize, and in some parcels manure is applied. The production is around 500 kg. Sell of sand from the sand quarry.	Erosion, shallow soils and low yields.
Slope	10 to 15%	5%
Land capability Classification USDA (Ortiz, 1975).	VII e-1	Iie-1
Classification of Irrigation capability USBR (Ortiz, 1975)	VII e	II t-1
Altitude (masl)	2430-2440m	

Transect 5 Schematic diagram of the transect in Tequexquinahuac.



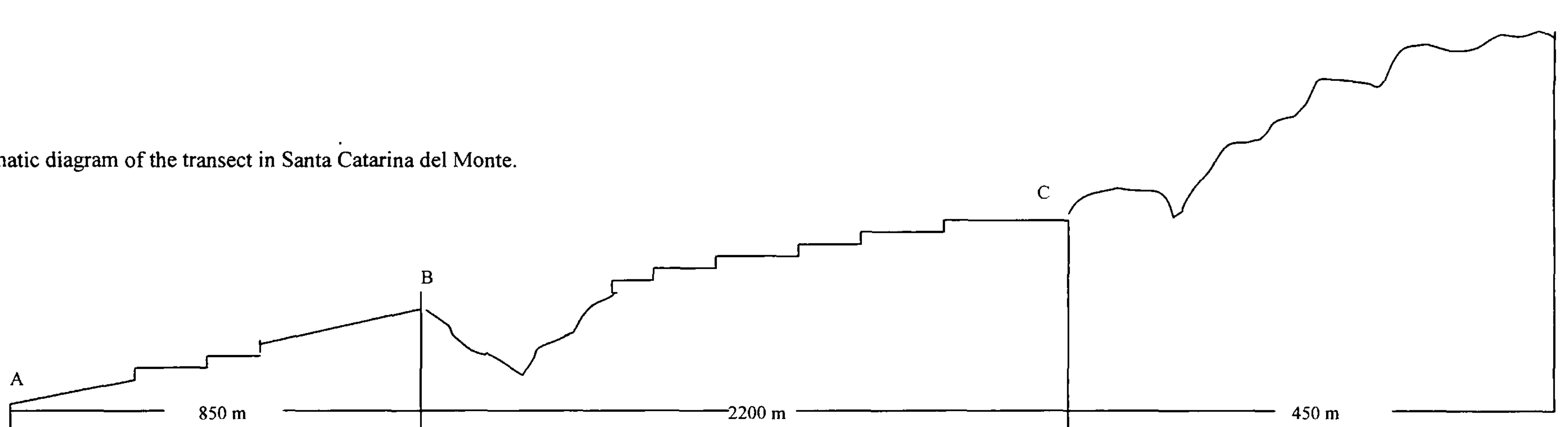
Soils	Depth 50 to 90 cm. The ejidatarios identified three types of soils Barrial (clay soils), sandy soils(sand). There are patches with outcrops of duripan (*tepetate*). The North and South boundaries are rivers. In this are slopes are steep and soils shallow (depth 10 cm) with erosion and outcrop of *tepetate*.
Erosion	Sheet, slightly in the clay and sandy soils. Severe in some areas of the alongside the rivers. Terraces with maguey and trees, planted in the limits of parcels to reduce erosion.
Land cover	Seasonal agriculture. Crops maize, wheat, beans, broadbean.
Problems	Drought, shallow soils. Yields of maize from 500 to 1000. The maize cobs are stolen during the night when the maize is ready to harvest. No addition of manure. Limited use of fertilisers, they apply only 40 kg/ha of urea and 40 of phosphate. Grassing of cattle in agriculture plots after harvest. The drilling of the well was illegal, and the government,
Opportunities	Application of manure and the fertiliser. The ejidatarios drill a well in 1997 and a channel for irrigation. Reclamation of *tepetate* by terracing and cultivation.
Slope	1 to 5%
Land capability classification (Ortiz, 1975).	Barrial II-s Sand II e
Classification of Irrigation capability USBR (Ortiz, 1975)	n.a
Altitude(masl)	2360-2420

Transect 7. Schematic transect of the diagram in Tequexquinahuac.



Soils	Shallow soil (10 cm), grass in small patches. Most of the area with outcrops of *tepetate* (white tepetete).	Soils formation in the terraces, by the incorporation of the leaves from trees. Some terraces have shallow soils of 10 cm.	Texture clay: Depth 50 to 90 cm.
Erosion	Erosion severe, *tepetate*) exposed in most of the area. Terraces built in 1975-1980 by the broken of the *tepetate*, with machinery, and reforested. Secondary Vegetation, grass and bushes.	Some erosion in channels in the areas without trees.	Erosion is in sheets, slightly with evidence of some channels.
Land cover	Eucalyptus and pine in the terraces with height of 2 to 5 meters, secondary vegetation of bushes and grass.	The main species of trees are Eucalyptus and pines there are some bushes and grass as secondary vegetation.	Area of around 57 ha under seasonal agriculture maize and wheat in parcels with sizes 2 ha or more. The area was deforested in the 1940'sa to sown potatoes. There are still some lines of pines in the boundaries of the plots.
Problems	Severe erosion. Reforestation has failed in some areas and the growth of the trees is very slow. Grassing of cattle.	Reforestation was not successful in some areas and the *tepetate* is exposed.. The height of trees planted in 1975-1980 is around 4 to eight meters (eucalyptus) and 1 to 4 m (pine). Grassing in the terraces because is the near the town and there are stores of water in tanks built by the herders. Roads in bad conditions.	The distance to this area from the settlement is around five kilometres, roads are in bad conditions.
Opportunities	Temporary job in government programmes of reforestation works.	Temporary job in government programmes of reforestation works.	This is the area with best soils and climatic conditions in the ejido. Rains starts in March or April. Yields of maize are around 1500 to 2000 kg. And wheat 1 to 2 tons per hectare. Chemical fertilisers applied (N 40 Kg/ha and P2O5 30 kg / ha). Maize is gradually substituted by wheat
Slope	9 to 13%	9 to 13%	15 to 30 %
Land capability	VII e-3	VII e-3	VIIes-1
Altitude(masl)	2400 to 2500 m	2500-2600 m	2600-2900 m

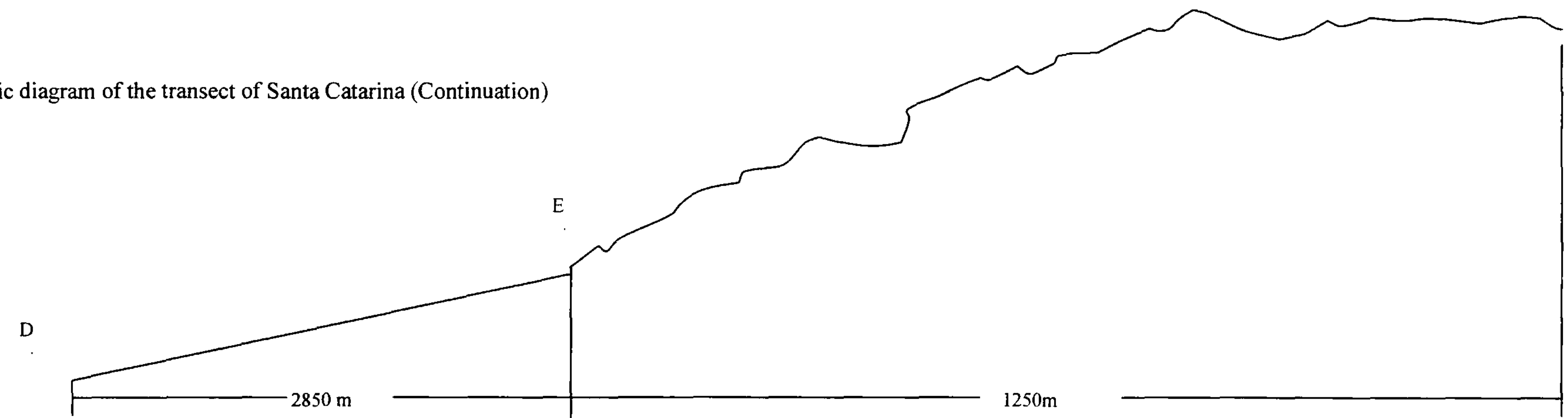
Transect 9. Schematic diagram of the transect in Santa Catarina del Monte.



Soils	*Tepetate* exposed,. patches of soil with depth of 10-20cm. Terraces and reclamation of soils by break up of *tepetate* in the 1970's	Texture clay, soil depth 50 to 100 cm. In Ravine rocks and outcrops *tepetate*.	Depth 10 to 30cm
Urbanisation		Urban area, recently increase in numbers of houses by parcel. Access to land by inheritance. Each parcel have a name in Nahuatl.	
Erosion	Severe. Erosion in channels and small gullies (0.50 to cm.)	No evident. Severe in the ravines.	Moderate erosion in the areas under cultivation in channels, some small gullies (in the forest (30 cm).
Land cover	Maize in the terraces. Patches of grassland and bushes. Terraces and reclamation of soils by break up of *tepetate* in the 1970's.	Houses. Irrigated and seasonal Crops: maize, beans, broadbean, wheat, flowers. Fruit trees pears, apples and peach.	Dominance of Oak (Quercus sp.). Small plots cultivated with maize. Abandoned plots with grass.
Problems	Severe erosion. Yield of maize in reclaimed terraces under agriculture 500 kg. Scarcity of manure for incorporation in the terraces.	Seldom use of chemical fertilisers. Terraces are built in the ravines in area of settlement. Diseases in fruits and flowers, but non use of pesticides.	Moderate erosion in the cultivated areas. Overgrazing in the areas with grassland. People use to graze livestock in this area because is near the settlement. Mixed herds of sheep, cows and mules. People use to graze livestock in this area grazing of cattle is in a radius of 2 hours walk from the town. Erosion along the roads. The roads are in bad conditions.
Opportunities	Addition of organic matter. Building of terraces in the eroded lands.	Improvement in management of water to increase efficiency. Introduction of intensive crops such as vegetables in the irrigated lands.	Production of vegetable coal. Grassing of the livestock (sheep) during all the year. Pick up of Eno (a parasite plant of the oak) during Christmas season. Extraction peat.
Slope	9 to 15%	5 to 9%	15-30%
Altitude (masl)	2500- 2600	2600 to 2800	2800 to 2900

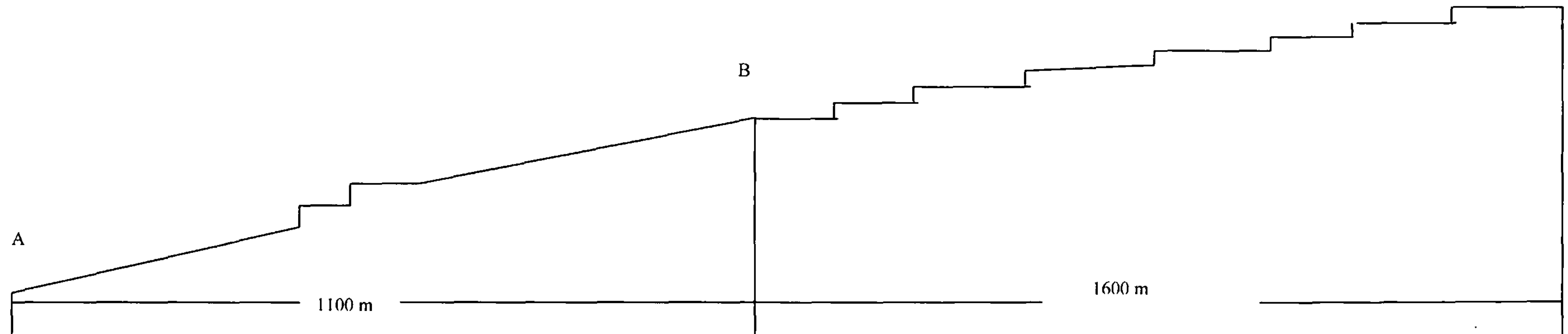
Transect 9. Schematic diagram of the transect of Santa Catarina (Continuation)

Transect 9. Schematic diagram of the transect of Santa Catarina (Continuation)



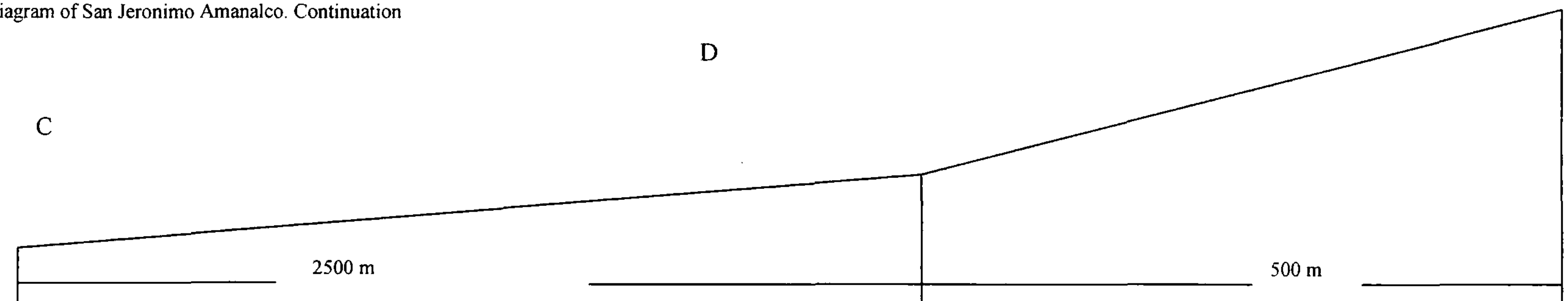
Soils	Depth 30 to 50 cm.	30-50cm
Erosion	Laminar and in channels in the areas without vegetation.	No evident
Land cover	Seasonal crops: Wheat, barley and some plots with maize and broad bean.	Forest vegetation of pine
Problems	The road for access to these areas is in bad conditions. In 1995 the program ASERCA rebuilds the dirty track but after the rainy season it was washed out again. There are several plots not cultivated.	The access of the forest is by small tracts for animals. Tracts are very steep and the extraction of wood restricted to the dry season. The extraction and sell of wood is illegal. Recently chainsaws are used to cut trees. . Burning of grass in the dry season (December to march) to promote the growing of grass. Low regeneration of secondary vegetation. Problems with government agents by the illegal extraction of wood. Perlilla a bush used to make handcrafts is overexploited. Disagreement among ejidatarios and comuneros about the right of access for extraction of wood from the forest.
Opportunities	This area has good precipitation and the yield of maize is 1 to 1.5 tons. Wheat and barley is around 1 to 2. ton/ha.	The forest is a source of income for the oldest and poorest people of Santa Catarina. The collection of Mushrooms and medicinal herbs allow the generation of income through all the year. During Christmas they sell hay, moss, Christmas trees. The market of wood has been increased in recent years, the main product is andiron used by the builders. The exploitation of the forest is organised by a group of ejidatrios appointed by the communal assembly. The ejidatrios believe that is in the forest are were the springs are feed and the conservation of the forest is very important in the life of the community.
Slope	9-15%	15 t0 50 %
Land capability Classification (Ortiz, 1975)	IV s	VII
Altitude (masl)	2940-3140	3200-3800

Transect 10 Schematic diagram of the transect in San Jeronimo Amanalco.



Soils	*Tepetate* exposed. Some terraces and reclamation of *tepetate*	Texture clay . Soil depth 50 to 100cm.
Urbanisation	Some parcels with houses.	Houses built in the terraces. The parcels with houses are identified by Nahuatl names.
Erosion	Severe *tepetate* exposed. Terraces	No evident in the areas of terraces.
Land cover	Patches of bushes and grassland scattered in the landscape. Few recent terraces with maize.	Houses. Irrigated and seasonal. Crops: maize, beans, broadbean, wheat, some greenhouses
Problems	Severe erosion. The soil is lost in most of the area and *tepetate* exposed.	The people are afraid that the government takes the water from the springs to supply the city of Texcoco. During the works of reclamation of lands (1975-1980) this is the ejido with less participation few terraces and mound contour line were build. The area near the settlement is severe eroded. Non participation in forest programmes promoted by the government. The municipality agent said that the people are closed minded Indians, very attached to their traditional systems of production and reluctant to participate in government programmes. The last year in this town there were riots and confrontation with the authorities by a problem related to extraction of wood.
Opportunities	Terracing and reclamation of soils.	This is the town that have access to more water from springs in the municipality. But is required improvement in its management such as surfacing of channels,. But the comuneros refused to participate in the programme of hydraulic infrastructure promoted by the government.
Slope	5 to 13%	5 to 13%
Altitude (masl)	2600 to 2650 m	5650 to 2750 m

Transect 10 Schematic diagram of San Jeronimo Amanalco. Continuation



Soils	Depth 50 to 90 cm .	Depth 10 to 50 cm.
Erosion	Severe in some plots channels of 5 to 10cm.	No evident in the areas with forest cover. Channels in the area with crops.
Land cover	Crops wheat, barley and potatoes.	Forest vegetation of pine. Maize in small plots in the lower and intermediate part of the slope.
Problems	Erosion, the plots are of three or four hectares and square, there are any plants sowed in the edge of the parcels to prevent erosion. Decline of soil fertility. The yield was usually from 3 to 4 ton ha. The lands have been overexploited ("cansadas"). The production is around 500 to 1500Kg of wheat. Sown of potatoes by ejidatarios in some plots. Also yield decreasing over the years from 20 to 5 tons/ha. The people of the community sow only small areas. Some of these lands are rented to ejidatarios that have stores in the market of "la Merced" in Mexico City. These people used fertilisers and pesticides and the yield was around 30 tons. However after five years production decline to 10 tons. The ejidatarios said that the use of chemical product such as fertiliser and pesticides poisoned the land. The distance of this land from the settlement and the roads in bad conditions a problem for during the harvest. In the area there is a sand mine for possible exploitation. There are a Ravine of around 20 meters of depth and 100m of length that has been formed in three years. In the deforest areas and the agriculture land without terraces the problem of erosion is severe.	Areas of forest open to agriculture in the last 10 years. Erosion severe in areas with steep slopes and gullies. Erosion in channels in the parcels. The cut of tress in these areas is without the government authorisation and is producing deforestation and erosion by the incorporation of lands with steep slopes to the agriculture. The government agents said that the ejidatarios and comuneros cut the trees to obtain wood and firewood to supply their requirements and sell. There are no plan of forest management. Burn of grass under the forest cover during December to February to promote the growing of grass in the spring.
Opportunities	The rainy season in this land started in March and the crops are sown in this month. The plots of these lands are big 2 to 4 ha. The people sown wheat, barley or potatoes. Some plots are rented to sown potatoes. In the past there were a rotation in the use of these land, the plots were in fallow for two years. The building of mound contours lines.	Cut of forest for incorporation of land into cultivation in areas with slopes of more than 15%. People do not have work outside the community. The controls of erosion by the building of terraces. The elaboration of plan for the exploitation of the forest (Government agents).
Slope	5 to 10%	15-35%
Altitude (masl)	2700 to 2900 m	3000-3300

Appendix 2 Uncompress and conversion of Arc/Info files to ILWIS 2.2 format

The process required to uncompress the files sent by PROCEDE in MIME2CIS, in UNIX environment and afterwards convert the .E00 files from ARC/INFO 7.02 UNIX to PC format required the following steps: Uncompress the ej01.z file that contain the .E00 files by using the command Gunzip ej01.z . This command produced the tar files in which the .E00 files are compressed. It is then necessary then to use the command ej01.tar to uncompress the .E00 file. The next step is transform the ej.001.E00 to a PC format compatible with ILWIS 2.2. The formats of the .E00 coverages sent by PROCEDE were as compressed double precision coverage, whereas ILWIS2.2 only accepts single precision. The coverage were therefore first converted into single precision coverage in ARC/INFO 7.02 and then exported as .E00 coverage using the commands used were:

ARC: <COPY name of the coverage1> <name of the coverage2> SINGLE

e.g ARC: COPY nativita nativita1 single

ARC: <CLEAN coverage name2>

e.g ARC: CLEAN nativita1

ARC: <EXPORT cover name of coverage 2> < name of coverage 3>

e.g ARC: EXPORT COVER nativita1 nativita2

The final step was to import the .E00 coverages from UNIX to PC environment using the interface software LAN work Place Rapid Filer. V.5.00.100 Copyright © 1992-1995. Novell,Inc.

Appendix 3 Land tenure and access to land in the Texcoco municipality: Prehispanic to and post independence periods

6.1 Period of the Acoluha civilization (Tezcocans).

The settlement of Texcoco was founded in the tenth century on the East Shore of Texcoco Lake. In 1521 with the arrival of the Spanish the population of the Señorio of Texcoco was around 540,000 inhabitants (Cook and Simpson, 1948, cited by Perez-Lizaur, 1975). The social organization was based on agriculture with the land distributed as *callpuli.* Cultivation was carried out on terraces using irrigation, a system of irrigation reportedly developed in the fifteenth century, after five years of drought and early frosts (1450-1455) that caused loss of crops leading to famine and diseases resulting in a massive migration (Hassing, 1981). Terraces were built in the steep areas with water supplied from springs in the Sierra, distributed through streams and systems of channels built for this purpose (Palerm and Wolf 1972, 1980a, 1980b). After the construction of the irrigation system, agriculture became highly productive and capable of sustaining a growing population (Carrasco, 1996 cited by Navarro, et al. 1997). The main crops were maize, beans and squash frequently planted together with fish and game birds supplementary the diet. Simultaneously with agricultural activities there was specialization in the manufacture of different products using non-agricultural resources available to the communities (Corona 1976 Cited by Gonzalez, 1993).

The development of Agriculture in the Prehispanic period in the region of Texcoco was the result of the responses of successive populations to long-term variations in moisture and aridity. Aridity may have stimulated adoption of aquatic gardens called chinampas and of systems of irrigation. With increased humidity the agriculture was extended as was the economic base of the civilizations. By the sixteenth century a sophisticated system of dams, causeways, aqueducts, canals, irrigation systems and settlement situated partly in the water part in the land had been developed (Gibson, 1964).

Figure A6.1 shows a diagrammatic representation of land tenure and land uses in the area of Texcoco in the sixteenth century, with intensive agriculture and irrigation in terraces and in the plain areas. The extraction of wood and firewood was regulated, and limited to those necessary for use by the members of the calpulli.

6.2 The Colonial period.

6.2.1 Changes in the land tenure system during the colonial period (1521-1821)

In the early years after the conquest in the 16th century, the *calpulli* continued as the basic unit of agriculture production. The epidemics[1], in the middle of the century reduced the number of people in the calpullies and the population was dispersed throughout the region of Texcoco. By the Ley de Congregaciones[2] the *Indian*s still living in *callpulies* were removed to new settlements and granted with land for their

[1] Gerhard (1986 cited in INSTRUCT, 1997) the *Indians* in Texcoco who had to pay tribute to the Spanish crown numbered some 100,000 in the early years after the conquest, after the epidemic diseases of 1545-1548 the number fell to 18,551. After a further epidemic of 1576-1580 the population decreased by two-thirds and finally in 1802 the number of tributaries was around 7456 (Villaseñor and Sanchez (1952, cited by Gonzalez, 1993).

[2] There were four main settlements in Texcoco where the nobles lived, most of the people were commoners and live in *Callpulies* (Rosenzweig, 1987)

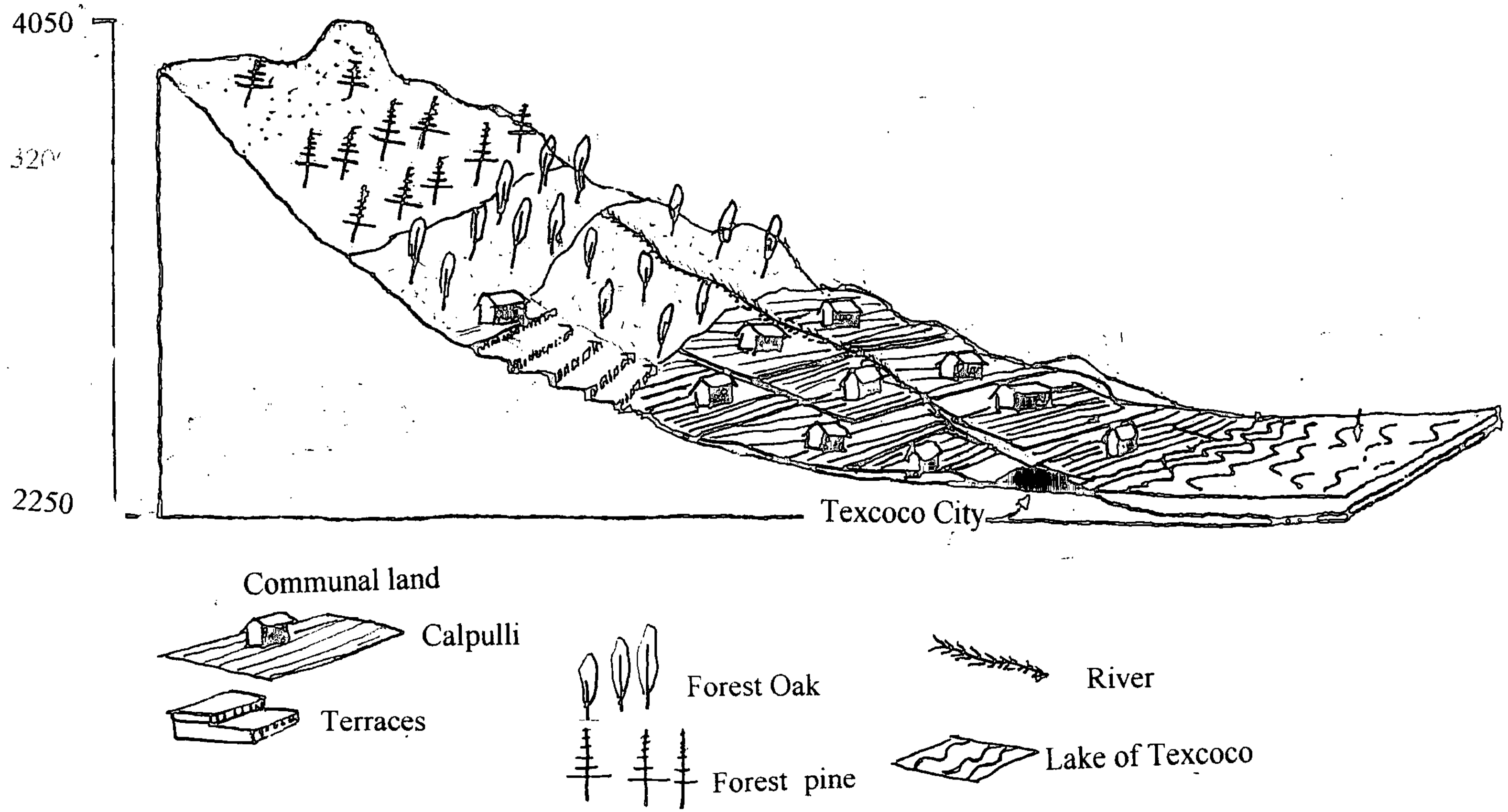


Figure A6.1 Diagrammatic representation of land tenure during the Acolhuas period (Aztecs, 1521 A.D) in the municipality of Texcoco (Author, 1998 based on Gibson, 1964; Palerm, 1980; Ortiz, M.L, 1986) subsistence as land holding *Pueblos* (Rosenzweig, 1987).

During the Colonial Period the *Indians* were gradually deprived of water for irrigation of the terraces and the system gradually fell into disuse. In 1539 Fray Juan de Zumarraga ordered the destruction of the irrigation system of Tetzcutzingo in Texcoco (Navarro et. al, 1998). Gibson (1964) argues that during the Colonial Period that new conduits for water were built almost entirely for the *Haciendas* rather than for the *Indian pueblos*, and that the existing community conduits were not maintained. He believed that by the eighteenth century the water conduits were almost totally destroyed. Palerm and Wolf (1972) support this view suggesting that after the Spanish conquest most of the irrigation system was destroyed as a result of the disintegration of the indigenous social system. The system of terraces was largely abandoned and erosion destroyed the terraces in the hillside of the Sierra. Stream water was instead used for the irrigation of wheat and to supply power to the mills in the lower part of the valleys. In a few locations, where *Indians pueblos* were able to keep their legal allocation of land the system of terraces and irrigation was preserved in the hilly areas. (Palerm and Wolf, 1972, 1980b; Sokolosky, 1995; Rodriguez, 1993).

After the conquest, the growing of the *Haciendas* became the most important force in the organisation of the agricultural production and it was oriented towards the supply of Mexico City with wheat, livestock (Gonzalez M 1993). Texcoco became a centre for the production of cereals and of wool. Torquemada (cited by Gibson, 1964) observed in the earlier seventeenth century that all the slopes near Texcoco were occupied by wheat farms and that there where almost no areas without Spanish settlers, extensive areas of cultivation were causing erosion and already subsoil

Tepetate (Hardpan) was exposed in several areas. Incursions of Spanish in communal land of landholding *Indian Pueblos* for the use of the forest and water were also frequent despite being illegal. The Viceroy authorised this increments despite the existing laws. The Spanish build dams in the communal land of the *Indian*s, cut tree and seized community water rights. But the main concern of the *Indian*s was the pasturing of cattle in the *Indian* agricultural lands that caused soil erosion[3] (Gibson, 1964). In the hilly areas over-exploitation of the forest and the introduction of cattle accelerated the erosion of lands. Intensive *Indian* agriculture and the terraces survived only in some communities of the hilly area (Palerm and Wolf, 1972 cited by Gonzalez M, 1993) (Figure 2). Thus the *Indian* landholding *Pueblos* lost most of their lands and the control over management of the water resources (Palerm, 1993). The *Indian pueblos* through this period continued to grow traditional crops, forest was also used for extraction of wood and production of charcoal and handicrafts were also made to be sold in local markets, many *Indian*s also worked as temporary labourers in the *Haciendas* (Villaseñor and Sanchez, 1952, cited by Gonzalez, 1993)

6.2.2 The *Haciendas* in Texcoco.

During the Colonial and independence period ten *Haciendas* were created in Texcoco with an area of 25, 211 ha see table A 6.1.

The *Hacienda* of Chapingo occupied most of the area of the municipality and is well

[3] Aliphat and Werner, 1994 pointed that the abandonment of the agriculture system of terraces and waterworks combined with overgrazing, triggered a series of devastating events. In the absence of maintenance, a domino effect was unleashed on the hillsides, in which deterioration of one element of the system, led to the destruction through erosion of entire systems, leading to the exposed tepetate situation of the present day.

Table A 6.1 *Haciendas* and area hold in the Municipality of Texcoco in 1910.

Haciendas	Area (ha)
Chapingo	15,378
Tepetitlan	3,834
Batan y Molino de las Flores	2,496
Tierra Blanca	2,234
La Blanca	375
Santo Tomas	368
San felipe de las Majadas	342
Xolache	244
El Jardin	222
El Caracol	118
Sum	25,211

documented (Gonzalez M 1996). Thus between the sixteenth and the twentieth century there were 8 proprietors of the *Hacienda*, they increased the area from an initial area of 2,213 ha to 15,527 ha. The period of greatest increase was 1699-1767 during which the area increased by 7,105 ha. This increase of area was possible because of the drastic reduction in the *Indian* population by diseases and thus land available could be bought a low cost. The way in which these lands were acquired is not clear, but is supposed that the owner bought the land from other persons, the church or from the *Indian Pueblos*. Gonzalez M (1996) suggests that this was exchange rather than purchase, with neighbours and *Indian*s could be a favour, interchange of commodities such as, a permit to use water or extract wood, etc. For legal registration the new acquired land the *Hacendados* used the law of *Composiciones*. Between 1767 and 1783 the area of the *Haciendas* increased by a further 3,097 ha there is however no information about how this land was acquired, a final increase of 2,490 ha took place between 1884-1923, the procedure of acquisition in this instance was by the payment to the government of a *Demasias* for 925 ha after a survey in 1894, followed by a further payment of a *Demasias* because some years later with the fall in water level of lake Texcoco more land available. The remainder land was bought in 1904 to reach the final area of 15,378 ha (Table A 6.2 Fig A 6.2). The *Haciendas was* confiscated by the government in 1914 for use by the *Escuela Nacional de Agricultura* (National School of Agriculture) and was legally expropriate in 1923 (Gonzalez M, 1996).

Table A 6.2 Expansion of the *Hacienda* of Chapingo from the 16th to 20th century.

Century	Year	Area (Ha.)	Increase of area (Ha.)	Acquisition of land
17th	1690	2213.40		Purchase
	1699		470.58	
17th –18th	1699	2683.98		Purchase
	1767		7105.44	
18th	1767	9789.42		Purchase
	1786		3097.14	
18th-19th	1786	12886.50		Purchase
	1884		1	
	1884	12887.5	2490.50	Purchase
20th	1923	15378.00		
20th	1923	15378.00		Expropriation

6.2.3 Indians and the *Haciendas*

In the years following the conquest and the steep decline in the *Indian* population, the expansion of the *Hacienda*, through often illegal acquisition of *Indian* lands caused little conflict other than local problems of access to forest lands. As the *Indian* population began to increase in the late seventeenth and eighteenth century, the *Indian* communities, now being short of land started to claim the lands in possession of the *Hacienda* that in the past belonged to them, so pressure on land increased and more serious conflicts arose between the *Indian*s and the *Hacendados* eg. *Hacienda* of *Chapingo*.

There is evidence of four claims made by the *Indian*s to the *Hacienda* of Chapingo, the first in seventeenth century involved a claim for a piece of land called "montecillo" by the *Pueblo* of San Bernardino. The claim took 41 years to settle, with the outcome that the Government ruled in favour of the *Indian*s, but in fact the piece of land never was returned to the *Pueblos*. The most usual claims by the *Pueblos* were for the extraction of firewood from the forest, thus in 1776 seven towns claimed through the authorities that the owner of Chapingo did not allow them to cut firewood in the forest, as stated in the law. They argued that the owner of the *Hacienda* did not have any right to forbid the cutting of firewood and further argued that " the *Indian* rights laws specify that the cutting of firewood is an essential means for their subsistence and that they need to cut firewood for the subsistence of the seven *Pueblos*" (Gonzalez, p70, 1996). The ruling was in favour of the *Indian*s.

The relations between the *Haciendas* and indigenous communities was characterised by the continuous interchange of pressures over the land by the *Hacendados* and responses by the *Indian Pueblos* defending their boundaries. The *Indian*s of the *Pueblos* of Texcoco were able to create in the *Pueblos* a system of production for subsistence and local markets by the cultivation of land and exploitation of the communal areas. They also would work as temporary labourers in the *Haciendas* on a seasonal basis. This symbiotic relation between the *Haciendas* and the community allowed the evolution of both in separate ways, and shows that despite the fact of tensions between the *Haciendas* and *Pueblos*, the *Indian*s living in the *Pueblos* were not incorporated into the *Haciendas* . This allowed the persistence of the indigenous ways of production as long as the communities could retain their lands (Risenzenwig et. al. 1987).

The seizing of *Indian* land during the colonial period was frequently illegal, though the state came to tolerate it and to profit from it through the devices of *demasias* and *composiciones*. The *Hacienda* became the dominant mode of control. The land was important to the *Indian*s, and some of the more revealing documents of *Indian* history are the 'native titles' for community land possession. The titles were an *Indian* response to the Spanish seizure and Spanish legalism. Their purpose was to integrate community opposition against alienation. The *Indian* documents speak only sparingly, or not at all of conquest, tribute and labour, they see the essential threat to the community existence being in fact the Spanish seizure of the land (Gibson, 1964).

The need for land in the late seventeenth and early eighteenth century, when the population began to increase meant that, the population could not be incorporated in the *callpuli* and the excess in population was incorporated into the land of the *Haciendas*. The *Hacendados* authorised towns to rent land or gave permission to individuals to occupied huts on the *Haciendas* (Mc Cutchen Mc Bride, 1923). However in Texcoco it seems that the *Pueblos* had been able to keep more of their land. Castellanos and Figueroa (1993) documented the process of access to land for the *Pueblo* of Santiago Cuautlalpan in the South of the municipality as follows: "The land in possession of the *Indian*s of Cuautlalpan in the fifteenth century was recognised by the Spanish crown in the sixteenth century. Due to problems with the neighbours for the use of land for livestock in the grassland areas, in 1609, the community requested the delimitation of their *ejido*. After the survey the community was given possession of 929 ha and 205 litres of water per minute. In 1752 the community sought a *composition* to guarantee their ownership (They applied for this because they had probably lost the original documentation). The *composicion* granted the community only 642 ha land. It is presumed that the 301 ha lost were to the hands of the *Hacienda* had or possibly been converted in private property by people of the region. The renting out of land was a common practice by the *pueblos* and frequently the tenant (*Haciendas*, *Ranchos* or private agriculturist) didn't return the land to the communities after the period of rental established. Finally in a survey made in 1918 the community was in possession of 590.25 Ha having lost another 35 ha in 146 years (Castellanos y Figueroa, 1993 p388-344). After the land reform the *Pueblo* of Cuautlalpan was granted with an area of *ejido* of 930 ha. Actually the current amount of land in possession of people of the town of Cuautlalpan as private and *ejido* is in the order of 1500 ha.

The Colonial period had an important impact in two spheres; ecological and social. The first suggested by Gibson (1964) was that Spanish colonialism produced a deteriorating environment, as it was only through the use of natural and human resources that it was able to flourish. The *Indian* original agricultural organisation based on communal use of resources and organised access to water was largely destroyed by the Spanish: by the introduction of intensive agriculture and new crops such as wheat, the felling of tress to obtain timber for building, the incorporation of land unsuitable to agriculture and the introduction of livestock resulted in erosion of land. This was exacerbated by the Spanish seizing and re-allocating of the *Indian*s in new towns in areas of poor soils, which again increased erosion.

At the regional level the partial draining of lake Texcoco destroyed the ecosystem in which *Indian* culture flourished, it also meant that the *Indian* no longer had direct access to the markets of Mexico City. Gibson (1964) described the changes involved in the environment deterioration of the Valley of Mexico as follows:

'with the Spanish conquest the equilibrium of the population changed abruptly. The conquerors cut down huge quantities of timber for building materials and fuel. Their ploughs cut more deeply into the earth than had the *Indian* digging sticks, and their cattle and sheep cropped the land bare. New irrigation system and gristmills concentrated or redistributed the water flows. Not one of the new development was disastrous in itself, but the combined effect over the years was an accelerated depletion of agricultural land. In the rainy season, topsoil was washed to the valley bottom, erosion produced gullies, and slopes that had once been capable of cultivation became barren".(Gibson 1964, p5.)

Gibson (1964) argued the Spanish colonial civilisation was based on ideas from abroad, but it relied upon native resources for the means to implement it. These produced that each community confronted the *Haciendas* as separate unit. The impact of the colonial system was the collapse of the Aztec Empire into fragmented individual communities as landholding *Pueblos* that survived during the colonial period Gibson (1964) noted:

'the community during this period proved to be the largest *Indian* social unit capable of survival, and it survived in spite of manifold and severe stress. To support it the 'cofradia', the fiesta and the communal system of land tenure were enlisted' (Gibson, 1964 p409).

Figure A 6.2 is a diagrammatic representation of land tenure and land uses. The changes in tenure were the introduction of private property and intensive use of land for agriculture, grazing and extraction of wood produced the erosion of the areas with steep slope that had once been of terraced. The *Indian* communities were re-located in new *Pueblos*, and provided with an area for the settlement (fundo legal) with water from the springs and some *Indian* communities through '*Mercedes Reales*' kept the possession of their land agriculture and forest. However at the end of the colonial

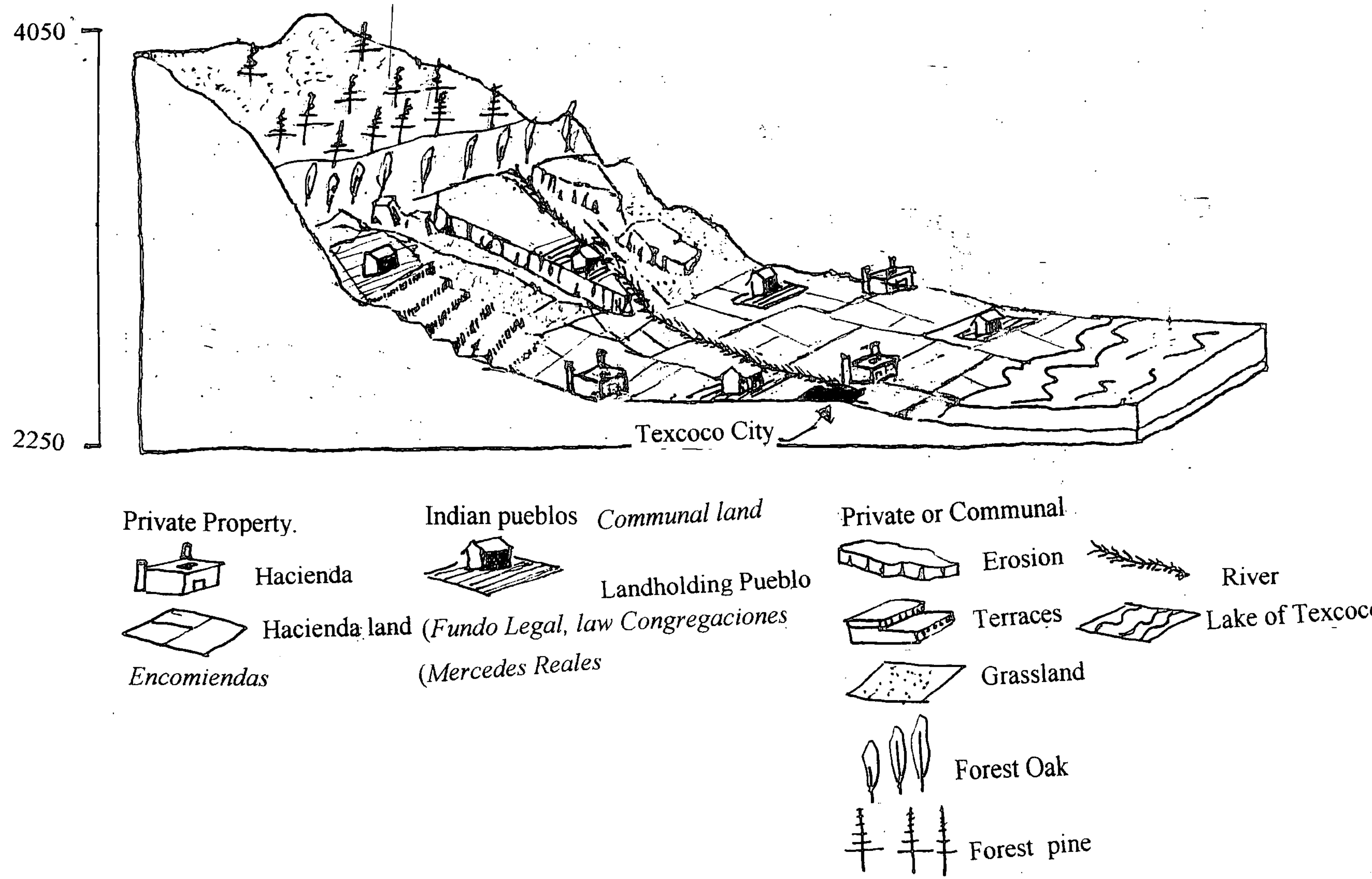


Figure A6.2 Diagrammatic representation of land tenure during the Colonial period and erosion (1521-1810 A.D) in the municipality of Texcoco (Author, 1998 based on Gibson, 1964; Palerm, 1980; Ortiz, M.L, 1986) period they were generally left with the land of poor quality and without water for irrigation as the *Haciendas* expanded.

6.3 Period of Independence 1821-1910

6.3.1 Expansion of the *Haciendas*

During this period the expansion of the *Haciendas* continued. The *Hacienda* of Chapingo grew by 2491 by purchase of land and the *Hacienda* of Tierra Blanca added 2234 ha in 1827 seized from the pueblo of San Jeronimo Amanalco (Mexico D.F. S.A.R, Amanalco, 1925 cited by Sokolosky, 1995). Information on the impact of reform laws of 1857 that enforced the division of the *ejido*s in plots and its impact on the land in possession of the towns was not fully available for the research. However the fact that during the land reform in the twentieth century the Government recognised the rights of 1395 Agrarian communities in the state of Mexico (Risenzenwig et. al. 1987) and that the town of Cuautlalpan lost only 35 ha between 1752 and 1917 suggest that some of the land remained in possession of the towns. Also Gonzalez Perez (1995) noted that during the process of allocation of land to Huexotla that 742 ha of the communal lands reported as in possession of the town, were in possession of 3 *Ranchos* (size of 80 to 120 ha) and 11 plots (from 20 to 50 ha) all considered private property (Expedient: 2338; *Ejido*s, Dotaciones, Huexotla Municipio de Texcoco, Archivo del Departamento Agrario SRA).

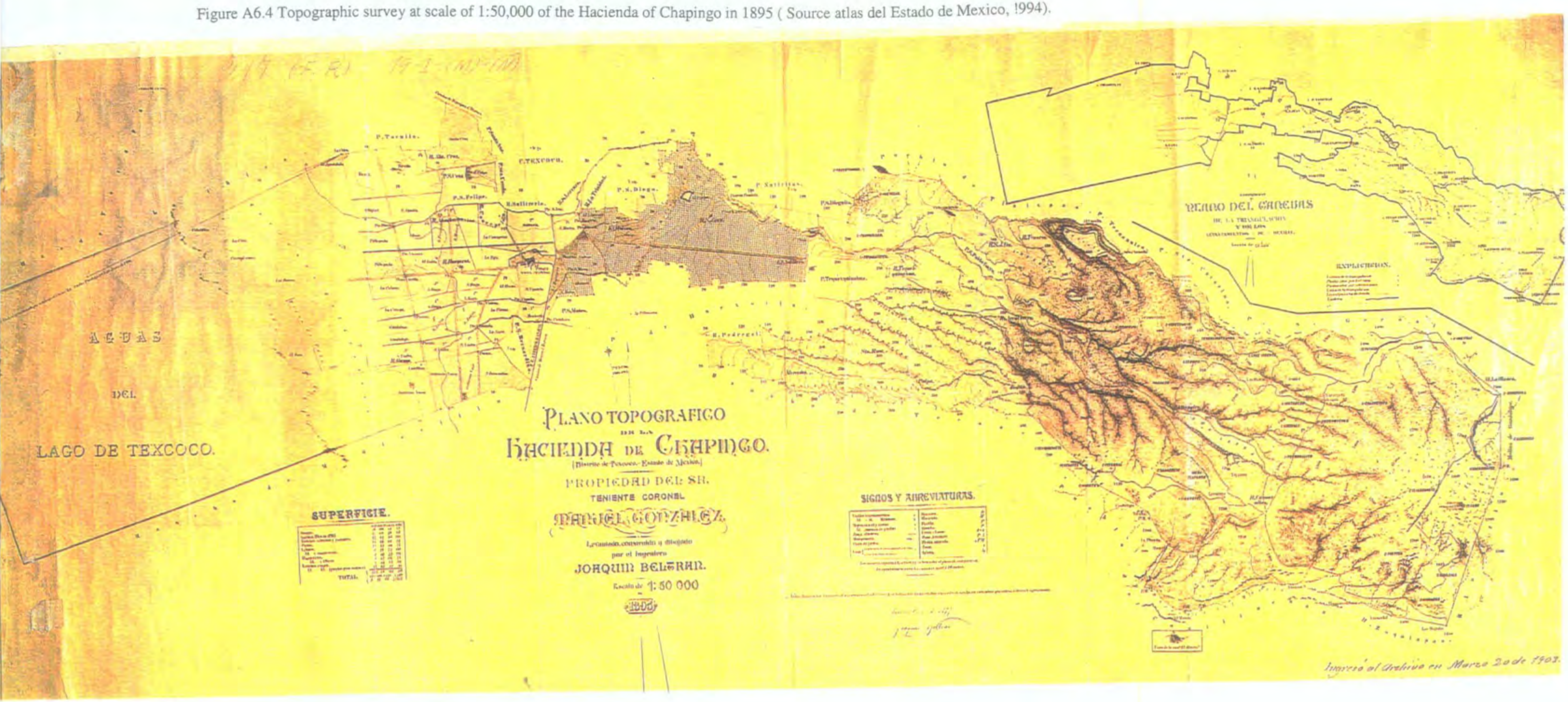
During the nineteenth century and until the revolution most of the land in the municipality was controlled by ten *Haciendas* that held 25,369 ha (Recio, 1973) and wheat was the predominant crop (Palerm 1993). Gonzalez (1996) describes the *Hacienda* of Chapingo as a profitable estate with a good administration of resources with mixed production of goods for the market (mainly wheat) and others for own consumption such raising of cattle and production of maize, pulque and milk. In the eighteenth century more emphasis was given to the production of pulque. During its last period from 1884-1923 the *Hacienda* was very profitable, the main activities being the production of cereals (wheat, maize and oat), alfalfa, dairy farming and production of pulque. The sale of wood, firewood and charcoal was also important (Gonzalez, 1996). The land type of lands owned by Chapingo according to a survey of 1896 (Fig 6.3) was as follows: 1343 ha of first class land, 1946 ha of second class land, 216 ha of third class land, 1484 ha of grassland, 332 ha of plantations, 1337 ha non productive land, 5009 ha of forest and 3708 ha of saline lands and swamps (Fernandez, 1976 cited by Parra, 1981). Resident and temporal labourers provided the work force in the *Haciendas* the recruited during planting and harvest from the neighbouring *Pueblos*.

The people living in the towns around lake Texcoco continued with activities such as fishing, collecting of aquatic plants production of salt and hunting of aquatic birds. Some towns produced textiles and pottery (Pomar 1975; Herrera, 1895, cited by Gonzalez, 1993). They continued largely subsistence agriculture and extraction of firewood and wood from the forest to sell in the local markets (Palerm 1984, Solokosky, 1994).

Figure 6.4 is a diagrammatic representation of land tenure and land use 1810-1910. Until 1856 the system of land tenure remained as in the colonial period with

Haciendas and landholding *Pueblos* as the main forms of tenure. After 1856 with the laws of reform, communal land had to be allocated to individuals of the landholding *Pueblos*, and some of the land from the *Pueblos* after the allocation in individual tenure was transferred to *Ranchos* and *Haciendas*. Despite the requirements in the law to break up communal property most of the *Pueblos* in Texcoco remaining under the system of land tenure as landholding *Pueblo*. During this period the *Hacienda* of Chapingo gained control of more agricultural land, grassland and forest.

Figure A6.4 Topographic survey at scale of 1:50,000 of the Hacienda of Chapingo in 1895 (Source atlas del Estado de Mexico, !994).



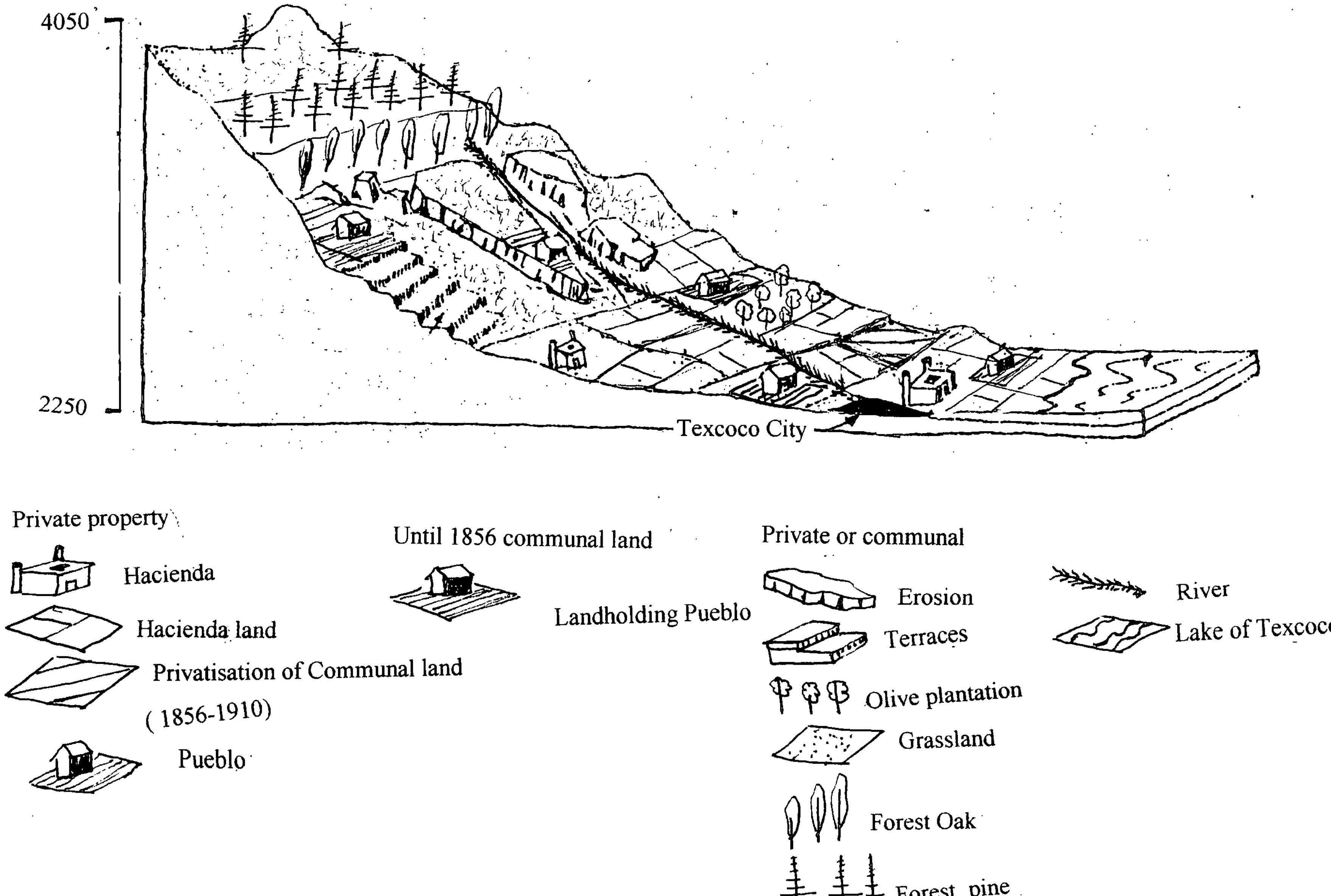


Figure A6.3 Diagrammatic representation of land tenure and erosion in the period of (1810 to 1910 of the municipality of Texcoco (Author, ity 1998 based on Ortiz, M.L, 1986; Rosenweig et al, 1987; Gonzalez M, 1996)

Appendix 4 Tables of data collected about land tenure and government programmes for the municipality of Texcoco

Table A6.1. Haciendas and types of land expropriated during the land reform in Texcoco by holder (Compiled by the author from Fabela, 1959).						
Holder/Hacienda	Seasonal	Irrigated	Grassland	High Mountain	badland	Total land
	Land	land	land	land		Expropriated
	Hectares					
Federal government						
Chapingo	2232	154	2132	5302	98	9918
Governmnet of the State of Mexico						
Las Majadas	336					336
Total government type of land	**2568**	**154**	**2132**	**5302**	**98**	10254
Territorial Bank						
Tepetitlan	340		1642			1982
Tecoac	214	218	54			486
Total by type of land	**554**	**218**	**1696**			2468
Private						
Tierra Blanca	800			1155		1955
Molino de Flores y el Batan	962	41	236		18	1257
Tlalminilolpan	547			155	22	724
La Grande	285	115				400
La Blanca		158				158
Nextlalpan	120			6		126
Santo Tomas	114					114
El Jardin	48		18			66
El Xolache	42					42
Total Private type of land	**2918**	**314**	**254**	**1316**	**40**	4842
Source: Compiling by the author from Gobierno del estado de Mexico(1958)						
For more information about the land composition used during the land reform see Sanders, 1984						

Table A6.2 Types of land granted as ejidos of Texcoco by as states in the Presidential resolution (Compling by the author from Fabela, 1958)

	Hectares					
Ejidos	Seas. Agric	Irrigated	Badland	High mountain	Grassland	Total
La Magdalena Panohaya	285				115	400
Extension of land					50	50
La Purificacion	217				41	258
La Resurreccion	131					131
Montecillo	120			6	126	252
Pentecostes y los Reyes		150				150
San Bernardino	256		98			354
San Diego-La Trinidad	131					131
Extension of land				760		760
San Dieguito Xochimaca	90				140	230
Extension of land				527		527
San Jeronimo Amanalco	800			1155		1955
San joaquin Coapango		8				8
San Juan Tezontla	216					216
S.L. Huexotla-San Mateo	20	154			63	237
S. Martin Netzahualcoyotl	208					208
Extension of land	98					98
San Miguel Coatlinchan	201				1163 ©	1364
First extension of land	580		54		479 ©	1113
Second extension of land				218		218
San Miguel Tlaixpan.	198				133	331
Extension of land	108			1628		1736
S. M. Tocuila- S.Cruz S.Felipe	961				342	1303
Extension of land	853				101	954
San Nicolas Tlaminca	186					186
San Pablo Izayoc	39				361	400
Extension of land				496		496
San Pedro y Santa Ursula	160					160
San Simon y Texopa	214		18			232
Santa Catarina del Monte	30			664		694
Santa Cruz de Arriba	18	12				30
Santa Ines	116					116
Santa Maria Nativitas	180				120	300
Extension of land				542		542
Santiago Cuautlalpan	212		22		107	341
Extension of land	216					216
Tequexquinahuac	94				256	350
Extension of land				1349		1349
Tulantongo	104					104
Xocotlan	15	29			7	51
Total	7057	353	192	7345	3604	18551

Table A6.3 Allocation of land to the ejidos in the municipality of Texcoco (1923-1992)
(Compiled by the author from Fabela, 1958; SRA, 1998 Promotoria Agraria)

Ejidos	Year of decision		Year	Year	Area	No of ejid.	Number of	Area with	Size of	Rigths to	Pueblo Prev.
	Provisional.	Presidential .	Offic. Daily	Posse.	Granted (ha)	with right	parcels	Parcels (ha.)	Parcel (ha.)	water (ha.)	Poss. (ha)
La Magdalena Panohaya	1923	1925	1925	1925	400	382	n.a	n.a	n.a		90
Extension of land		1930	1930	1930	50						
La Purificacion		1928	1928	1928	258	158	69	124	1.81		430
La Resurreccion		1928	1928	1928	131	69	69	129	1.81	32	33
Montecillo	1931	1936	1936		252	50	49	114	2.33		16
Pentecostes y los Reyes		1929	1929	1929	150	122	123	100	0.82	47	82
San Bernardino		1925	1927	1927	354	129	95	187	2.00		78
San Diego y La Trinidad		1927	1927	1928	131	124	106	130	1.00		
Extension of land		1938	1940		760						
San Dieguito Xochimaca		1925	1925	1925	230	112	110	110	1.00		186
Extension of land		1937	1940	1941	527						
San Jeronimo Amanalco	1929	1930	1930		1955	33	33	198	6.00		607
San joaquin Coapango		1935	1955	1935	8				n.a	8	60
San Juan Tezontla		1935	1936	1936	216	57	n.a	n.a	1.00		30
S. L. Huexotla y San Mateo		1935	1935	1936	237	163	n.a	n.a	1.00		
Confirmation of lands		1927	1927		742©		n.a	n.a			742
San Martin Netzahualcoyotl		1935	1935	1935	208	55	85	300	4.00		
Extension of land	1938	1938	1938	1938	98						
San Miguel Coatlinchan	1929	1930	1930	1930	1364	328	n.a	n.a	2.00		467
First extension of land		1939	1939	1939	1113						
Second extension of land		1940	1940	1952	218						
San Miguel Tlaixpan.		1927	1927	1927	331	213	145	197	1.00		
Extension of land		1937	1940	1941	1736						
S. M.Tocuila,S.Cruz y S.Felipe	1925	1927	1927	1927	450	328	n.a	n.a	0.50,1.00,2.00		
Extension of land		1934	1935	1935	954						
San Nicolas Tlaminca	1925	1926	1926	1926	186	64	55	54	1.00	71	66
San Pablo Izayoc		1925	1925	1925	400	35	n.a	166	3.00	77	35
Extension of land		1937	1940	1941	496						
San Pedro y Santa Ursula	1933	1935	1935	1935	160	63	52	150	2.90		
San Simon y Texopa		1926	1926	1926	232	133	133	211	1.80		102
Santa Catarina del Monte	1923	1927	1927	1927	694	190	n.a	n.a	1.00		354
Santa Cruz de Arriba		1936	1936	1936	30	27	n.a	n.a	0.8		
Santa Ines	1937	1938	1939	1938	116	14	n.a	n.a	1.00		4
Santa Maria Nativitas	1923	1924	1924	1924	300	36	91	110	1.21		56
Extension of land		1937		1938	542						
Santiago Cuautlalpan	1929	1930	1930	1930	341	95	116	212	1.80	25	590
Extension of land		1937	1937	1938	216						
Tequexquinahuac	1923	1924	1924	1924	350	248	160	90	0.57		373
Extension of land		1937	1940		1349						
Tulantongo	1929	1929	1929	1929	104	73	73	98	1.35	29	50
Xocotlan		1928	1928	1928	51	29	42	n.a	1.00	29	29
Total (muncipality)					17698	3330	1606	2680		318	4480

Abbrev:Offic: Official; Posse:possession;ejid: ejidatarios;prev. Posse: Previous possesions of land

Note:The Grant of land of land were approved first by the governor of the state (provisonal allocation). Afterwards the President of The Republic have to issue the decree for expropriation, following this the decree is published in the official diary of the federation. After this the land was measured in the field and given in possesion to the beneficiaries

Area with parcels is the area that was divided in parcels among the beneficiaries

Table A6.4 Sources of water not registered as irrigation units, and used for irrigation in the Municipality of Texcoco (Source: Archives DDR O3 Texcoco, interviews, 1998)

No Sources	Name of The Ejido	Structure for storage of water	Type of source	No of sources	
1	S.M. NETZAHUALCOYOTL	Lake	LAGO	1	
3	TEQUESQINAHUAC	JAGUEY	SPRING	1	
	TEQUESQINAHUAC	JAGUEY	SPRING	1	
1	SN. DIEGO Y LA TRINIDAD	JAGUEY	SPRING	1	
2	SN . JUAN TEZONTLA	JAGUEY	SPRING	1	
1	SN DIEGUITO	JAGUEY	SPRING	1	
	SN . JUAN TEZONTLA	JAGUEY	SPRING	1	
1	SN. JOAQUIN	SPRING	SPRING	1	
1	SN. JERONIMO AMANALCO	SPRING	SPRING	1	
1	SANTA MARIA TECUANULCO	SPRING	SPRING	1	
1	LA PURIFICACION	SPRING	SPRING	1	
1	SAN MIGUEL TLAIXPAN	SPRING	SPRING	1	
1	SANTA INES	SPRING	SPRING	1	
1	STA. CATARINA	SPRING	SPRING	1	
1	SN BERNARDINO	Sn Bernardino River	RIO	1	
2	CUAUTLALPAN	PRESA AZOLVADA	RIO	1	
	CUAUTLALPAN	STA. MONICA River	RIO	1	
	SN. PEDRO Y STA URSULA	TEXCOCO River	RIO	1	
1	NATIVITAS	JAGUEY C49	RIO	1	
1	TULANTONGO	COXCACUACO River	RIO	1	
1	LA RESURECCION	JAGUEY	RIO	1	
1	PENTECOSTES	Dam	RIO	1	
1	SN. LUIS HUEXOTLA	CHAPINGO River	RIO	1	
2	SN BERNARDINO	SN ISIDRO	PP	1	
	SN BERNARDINO	EL CARRIZO	PP	1	
4	SN. DIEGO Y LA TRINIDAD	POZO 1	PP	1	
	SN. DIEGO Y LA TRINIDAD	POZO 2	PP	1	
	SN. DIEGO Y LA TRINIDAD	POZO 3	PP	1	
	SN NICOLAS TLAMINCA	POZO	PP	1	
2	SN. PEDRO Y STA URSULA	POZO	PP	1	
	TEQUESQINAHUAC	POZO	PP	1	
	SAN DIEGUITO	POZO	PP	1	

Note: The wells were drilled illegally withouth the autorishation of the National Comission of Water (CNA)

Table A6.5 Irrigation units in the ejidos of the municipality of Texcoco (Archives DDR03,1998)

Ejidos	No of wells	Irrigation unit	Year	No of *Ejidatarios*	No of Plots	Average Size (ha)	Total area(ha)	supply of water Mm
Coatlinchan	1	La presa	process	114	114	0.5	57	964.96
Cuautlalpan	2	El jardin	process	82	82	1	82	725.76
Cuautlalpan		El Pino	process	49	49	1.75	85	1244.16
Huexotla	3	Gama	1978	53	53	1	53	1010
Huexotla		San andres	1978	66	66	1	66	907
Huexotla		Sta Irene	1977	83	83	1	83	1710
La purificacion	1	Candelaria	1978	29	29	1.1	41.4	725
La Resurrecion	2	La Resurrecion	1979	49	49	1.8	79.2	933
La Resurrecion		Moral	1979	23	23	1.2	41	913
R. San salvador	1	La casita	process	42	30	1	30	1166
Montecillos	2	Sn. Felipe	process	46	46	1	46	881.28
Montecillos		El Huizachal		42	42	1	44	777.6
Pentecostes	1	La Loma	1980	87	79	0.75	59.25	984
San bernardino	2	La garita	process	89	89	1	89	1373
San bernardino		Noria	process	119	119	1	119	1373
San Diego Y la Trinidad	1	La Cruz	1982	23	23	1	23	570.24
San Felipe y Sta Cruz	2	Salitreria	1983	61	61	0.5	31	673
San Felipe y Sta Cruz		El almacigo	1983	90	90	0.5-1.5	50	838
San Jose Mecatillo	1	Mecatillo	1979	51	24	1.75	42	1399
San M. Netzahualcoyotl	4	Sauce-Cieneguillas	1978	75	24	4	96	1632
San M. Netzahualcoyotl		San Borja el bolito	1978	14	14	4	64	1477.44
San M. Netzahualcoyotl		Guadalupe II	1980	31	31	4	124	1632
San M. Netzahualcoyotl		Teja	1980	20	20	4	80	1814
San Nicolas Tlaminca	1	Netzahualcoyotl	1981	62	55	1	55	285
San pablo Ixayoc	1	Texapo	process	83	83	0.9	72.4	492.48
San Pedro Y santa ursula	2	El Bolito	1976	21	21	3	63	1114
San Pedro Y santa ursula		La concepcion	1975	16	16	2.93	47	466
San simon	1	El carretero	1976	24	24	1.75	40	1347
San simon		El salto	1976	24	24	1.75	42	1140
Tocuila	1	Salitreros	1978	56	56	0.5	28.5	1373
Tulantongo	1	San cristobal	1978	50	50	1	50	1114
Xocotlan	1		1978	22	22	1.35	28.15	622
19EJIDOS	31			1696	1591		1910.9	33676.92

Table A6.6 Existences of wood and extractable volume in m³ in the forest of the municipality of Texcoco. (San Rafael, 1965)

	Real existence cubic meters				Extractable volume cubic meters				Annual possibility cubic meters			
Ejidos	pine	oyamel	cedro	total	pine	oyamel	cedro	total	pino	oyamel	cedro	total
San Jeronimo Amanalco	259999	42429	234	302662	119278	12729		132007	6278	670		6948
Santa Maria Tecuanulco	28358	23269	369	51996	10432	9540		19972	552	502		1054
Santa Catarina del Monte Ejido	22633	52708	1406	76747	7932	22664		30596	417	1193		1610
Santa Catarina del Monte	82144	125033	3008	210185	28750	52514	572	81836	1513	2764	30	4307
San Pablo Ixayoc	2083	20607	1372	24062	542	9479	453	10474	29	499	24	552
Santa Maria Nativitas	13381	19751	504	33636	4817	7110		11927	254	374		628
San Miguel Tlaixpan	8825	37683	3197	49705	3001	17334	927	21262	158	912	49	1119
San Dieguito Xochimacan	18656	10740	239	29635	6880	4837		11717	362	253		615
Tequexquinahuac	72039	6491	382	78912	26654	1298		27952	1403	68		1471
TOTAL (Cubic meters)	508118	338711	10711	857540	208286	137505	1952	347743	10966	7235	103	18304

Table A6.7 Types of lands in the 26 ejidos certificated by PROCEDE in 1998 (Compiled from digital maps, PROCEDE, 1998)

Ejido	Total area (ha)	Parcel (ha)	Communal (ha)	Infrastructure	Settlement	RAYCA	TEC
San Miguel Tlaixpan	1846.30	233.80	1627.50	33.60	48.60		0.33
San Pablo Ixayoc	976.76	125.84	838.28	11.44		1.20	
Santa Catarina del Monte	839.20	159.60	659.90	9.70			
San Bernardino	398.45	308.17	56.94	29.08	4.26		
Tequesquinahuac	356.47	246.82	86.25	21.95		1.45	
San Martin Netzahualcoyotl	330.38	288.72		10.04	28.27	3.35	
Santiago Cuautlalpan	314.82	232.02	55.57	16.26	7.99	2.97	
Santa Maria Nativitas	284.01	247.43	9.15	27.43			
La Purificacion	273.94	216.84	18.64	23.14	4.72	10.59	
San Dieguito Xochimacan	230.00	90.20	139.80				
San Juan Tezontla	226.24	180.30	22.57	13.88		9.48	
San Nicolas Tlaminca	203.90	81.84	11.77	8.08	29.09		73.12
San Pedro y Santa Ursula	166.93	156.90	2.06	7.98			
San Luis Huexotla	159.50	145.95	0.63	9.99		2.92	
San Simon	144.30	131.00		11.00	1.40		
San Diego y La Trinidad	140.98	133.80	1.82	5.36			
La Resurreccion	136.30	126.30		9.24		0.77	
Montecillos	129.39	114.51		14.88			
Santa Ines	110.66	67.03	19.84	4.26	9.99	9.54	
Pentecostes	93.85	74.98	2.59	16.28			
San Jose Mecatillo	87.69	80.71		4.84		2.09	
Los Reyes San Salvador	53.28	48.76		4.52			
Xocotlan	28.17	15.00	0.82	7.11	5.24		
Tulantongo	25.31	23.70		1.62			
Santa Cruz de Arriba	19.39	14.62	2.49	0.97	1.31		
San Joaquin Coapango	9.14	7.64		1.51			
Total	7585.36	3552.47	3556.63	304.16	140.87	44.35	73.45

RAYCA:Streams and ravines. TEC :Collective land.

Table A6.8 Programme of ecological restoration of the valley of the Valley of Mexico.(Archives SEDAGRO, Texcoco, 1998)

EJIDO		CONSERVATION WORKS				BUDGET ((£)			
	WORKS	DITCHES	REFORES-	FENCES	DAMS	LABOUR	CONSUMABLES	TOTAL	BY EJIDO
		HA.	TREES	KM.	M3				
E. SN JERONIMO AMANALCO	Reforestation		50000			1852	9407	11259	
C. SN JERONIMO AMANALCO	Reforestation		50000			1852	9407	11259	
SN JERONIMO AMANALCO	Dams				300	6884	2896	9780	
									32299
SAN PABLO IXAYOC	Ditches	90				19160	1164	20324	
SN PABLO IXAYOC	Reforestation		80000			2963	15052	18015	
SN PABLO IXAYOC	Dams				400	9179	3861	13040	
									51379
TEQUESQUINAHUAC	Ditchs	77				16392	996	17389	
TEQUESQUINAHUAC	Reforestation		70000			2593	13170	15763	
TEQUESQUINAHUAC	fences			3		561	2467	3028	
TEQUESQUINAHUAC	Dams				1000	22948	9652	32600	
									68780
SAN MIGUEL COATLINCHAN	Ditchs	30				6387	388	6775	
SAN MIGUEL COATLINCHAN	reforestation		60000			2222	11289	13511	
SAN MIGUEL COATLINCHAN	fences			2		374	1645	2019	
									22305
STA. CATARINA	Reforestation		75000			2778	14111	16889	
STA. CATARINA	Fences			2.2		411	1809	2221	
C. STA. CATARINA	Dams				300	6884	2896	9780	
									28890
LA PURIFICACION	Reforestation		40000			1481	7526	9007	
LA PURIFICACION	Fences			1.8		337	1480	1817	
									10824
SAN MIGUEL TLAIXPAN	Reforestation		20000			741	3763	4504	
									4504
NATIVITAS	Reforestation		10000			370	1881	2252	
NATIVITAS	Dams				400	9179	3861	13040	
									15292
TOTAL		197	455000	12.1	2400	115550	118723	234273	234273

Table A6.9 Programmes of Alianza para el Campo in the muncipality of Texcoco in 1997(Compiled from archives, DDR03 Texcoco)

PROGRAM	SUPPORT OF MECHANISATION (30% tractors, 15% tractor implements, Tractor wheels 50%)					
AGRICULTURE	PRODUCT	Units	Subside (£)	Farmers		Beneficiary
	Purchase of tractors	4	13,164	30,716		4
	Reparation of tractors	3	963	2,889		3
	Purchase of tractor wheels	24	6,197	6,197		24
	Purchase of tractor implements	2	488	2,765		2
	Moto cultivators	2	1,269	2,960		2
	Spray pumps	9	255	255		9
		44	22,336	45,782		44
	BREEDING SEEDS (Subside 100% of difference in price with the price of conasupo)					
	Crop	Area (ha)	Kg	Subside(£)		Beneficiary
	Maize	283	7,700	7,410		33
	Regional maize(seed	531	40,700	6,119		152
	Wheat	168	25,200	4,222		90
	Oat	80	7,800	1,156		29
		1062	81,400	18,907		304
	Fertiliser and reclamation of soils(subside fertilser 15%, manure 100%)					
	PRODUCT	Hectares	Metric tons	Subside(£)	Farmers (£)	Beneficiary
	Subside of fertiliser	783	140	1,556	8,817	260
	Manure application	184	184	n.a	n.a	18
		967	324	1556	8,817	278
	Irrigation infrastructure(subside 80%)					
	PRODUCT	Length km.	Subside (£)	Farmers (£)		Beneficiary
	Surfacing of irrigation channels	20	7,407	1,852		10
			7,407	1,852		10
LIVESTOCK	**Genetic Improvement (mejoramiento Genetico)Subside 23%)**					
		Heads	Subside (£)	Farmers (£)		Beneficiary
	Cattle	2	1,185	3,967		2
	Sheep	607	5,216	17,462		48
		609	6,401	21,429		50
	Establishment of pastures (subside 40%)					
		Area (ha)	Seeds (kg)	Subside (£)	Farmers (£)	Beneficiary
	Grass seed	34	1,360	2,519	3,778	11
		34	1,360	2,519	3,778	11
	Integral use of maize (subside £ 37 for each silo)					
		No of silos	Vol.(cubic m)	Subside(£)		
	Building of silos	11	1,870	815		
		11	1,870	815		
	Milking and other equipment (Subside 66% stockpile, 30 % other items).					
	PRODUCT	Units	Subside (£)	Farmers (£)		Beneficiary
	Centre for stockpile of milk	1	13,643	7,038		1
	Milking equipment	10	2,957	6,899		10
	Thermos for artificial insemination	4	683	1,594		4
	Grain mills	5	2,034	4,746		5
	Sheepsharer	9	744	1,736		9
	Electric fences	2	394	919		2
		31	20,455	22,932		31

Table A6.9 continuation. Programmes of Alianza para el Campo in the municipality of Texcoco in 1997(Compiled from Archives, DDR 03 Texcoco)

CREDIT FOR PRODUCTIVE PROJECTS	**Fund for the support of productive projetc in the State of Mexico (FAAPEM)**				
	Project	Projects	Credit (£)	Beneficiaries	
	Sheeps	1	2,400	1	
	Production of Tomatoe	1	620	1	
	Production of chesse	1	1,567	1	
	Floriculture	2	3,689	2	
		5	8,276	5	
	Program for support the production of mushrooms				
		Projects	Credit (£)	Beneficiaries	
	Credit for production of mushrooms	4	6,430	4	
		4	6,430	4	
AGRICULTURE EXTENSION AND TRAINING	**TECHNICAL ADVISE FOR PRODUCTION OF BASIC GRAINS**				
	CROP	Maize	Subside (£)	Beneficiary	
	Maize	944	100%	154	
	Wheat	1,027	100%	103	
	Beans	72	100%	16	
		2,043	3	273	
	TRAINING COURSES				
	Course	Total courses	Subside (£)	Beneficiary	
	Floriculture	4	100%	48	
	Chesse production	2	100%	17	
	Edible mushrooms	4	100%	39	
		12		104	
SEETING UP OF ORGANISATIONS	**Setting up of organisation**				
	Local Associations for Rural Development(ALPR)				
	Objective of the organisation	Organisations	Partners		
	Milking production	1	37		
	Floriculture	1	16		
	Mushrom production	1	13		
SUPPORT OF MARGINAL AREAS	**Programmes for the support of marginal areas**				
		Units	Subside (£)	Farmers	Beneficiary
	Poultry Chicken	2803	18,687	2,076	2803
	Rabbits	128	948	105	128
		2931	19,636	2,181	2931
DISTRIBUTION OF BASIC FOOD (Four pueblos)	**PROGRAMME FOR THE DISTRIBUTION OF BASIC FOOD (FAO**				
	Maiz(Kg)	Frijol(Kg.)	Meat(Kg.)	Oil(Lts.)	Beneficiary
	6440	1,180	820	462	428

Total subside government £98,873; total investment farmers £106,771.

Table A6.10 Participation and investment of the Alianza para el campo Programmes in Texcoco in 1997(Compiled from Archives of the DDR03 Texcoco in 1998)

	Support of mechanisation																				
Pueblos	Purchase of tractors			Refurbishment of tractors			Purchase of wheels			Purchase of tractor tools			Motocultivator			Spray pumps			TOTAL		Total
	Gov.(£)	Benef.(£)	units	Gov.(£)	Benef.(£)	units	Gov.(£)	Benef.(£)	units	Gov.(£)	Benef.(£)	units	Gov.(£)	Benef.(£)	units	Gov.(£)	Benef.(£)	units	Gov.(£).	Benef.(£)	Pueblo
Coatlinchan							5751	5751	22										5751	5751	11502
Cuautlalpan				334	1002	1													334	1002	1336
Huexotla							223	223	1										223	223	446
S.C de Arriba				213	639	1													213	639	852
Texcoco	13164	30716	4	416	1248					488	2765	2	1269	2960	2	255	255	9	15592	37944	53536
Tezontla							223	223	1										223	223	446
																			22336	**45782**	

Continuation Table A6.10

Pueblos	Centre of stocpile of milk			Thermos for insemination			Milking machine			Animal food mills			sheep shearer			Electric fences			Total		Total
	Gov. (£)	Benef.(£)	units	Gov.(£)	Benef.(£)	Units	Gov.(£)	Benef.(£)	Units	Gov.(£)	Benef.(£)	Units	Gov.(£)	Benef.(£)	Units	Gov. (£)	Benef.(£)	Units	Gov.(£).	Benef.(£)	pueblo
Coatlinchan	13662	7038	1	239	239	1	1479	986	5	1479	629	3							16857	8891	25749
Cuautlalpan							591	395	2				80	40	1	217	217	1	889	653	1542
Huexotla													175	88	2				175	88	263
Resurreccion							296	167	1	278	185	1	175	88	2				837	440	1277
Montecillo							296	167	1										296	167	463
S.diego				206	206	1													206	206	411
S.Jeronimo													56	28	1	177	177	1	233	205	438
S.C Arriba													105	52	1				105	52	157
Texcoco				477	477	2													477	477	954
Texopa							296	167	1	278	185	1	76	38	1				650	391	1040
Tocuila													76	38	1				76	38	114
																			20800	**11608**	100526
Abr: Far= Benef.; Gov =Government; Benef=Beneficiaries																**Total investment**			**43136**	**57390**	
																	Grand Total			**100526**	

Table A6.11 Area of the *ejidos* registered in PROCAMPO in the municipality of Texcoco in 1997 (Archives, PROCAMPO, DDR03 Texcoco, 1997)

	Total	Total	Beneficiaries by PROCEDE										% area	% subsidy
Ejido	No *ejidos*	Area (ha)	No Benef.	Parcels	Area (Ha)	Allocation (£)	No ejid.	Ejido(ha)	No Comu.	Comm. (ha)	No Small Property	S.Prop. (ha)	Registered	by pueblo
S. J. Coapango	37	7	24	28	156.3	5513	10	3.3			14	153.09	47	3.54
S.C.de Arriba	26	14	21	22	11.85	418	21	11.85					85	0.27
R.S. Salvador	42	53	44	90	53.55	1888	39	49.85			5	3.70	94	1.21
S. Ines	32	67	33	37	60.64	2138	33	60.64					91	1.37
Pentecostes	87	74	67	130	117.8	4152	54	44.41			13	73.39	60	2.66
S. J. Mecatillo	51	80	50	58	93.98	3313	45	62.14			5	31.84	78	2.13
S. N. Tlaminca	62	81	41	45	47.44	1672	41	47.44					59	1.07
S. D. Xochimacan	110	90	56	82	50.55	1782	56	50.55					56	1.14
S. P. Ixayoc	124	125	92	139	119.63	4217	92	119.63					96	2.71
La Resurreccion	69	126	55	58	65.94	2324	55	65.94					52	1.49
S. Simon	83	131	19	21	28.59	1008	19	28.59					22	0.65
S. Diego y Trinidad	116	133	48	51	60.79	2143	45	48.9			3	11.89	37	1.38
S. L. Huexotla	196	145	44	60	106.94	3759	31	41.96			13	64.68	29	2.41
S. Pedro y S. Ursula	52	156	19	20	48.62	1714	18	39.62			1	9.00	25	1.10
S.C. del Monte	132	160	216	300	185.84	6568	93	94.94	112	91.15	1	0.25	59	4.22
S. M. Tlaixpan	348	174	132	186	185.72	6547	101	130.58	27	43.98	4	11.16	75	4.20
S. J. Tezontla	55	180	90	115	128.64	4535	84	124.04			6	4.60	69	2.91
S. M. Nativitas	126	232	82	167	110.87	3908	82	110.87					48	2.51
Tequesquinahuac	161	246	110	233	142.82	5034	102	127.7			8	15.12	52	3.23
La Purificacion	410	273	118	147	134.3	4734	111	125.74			7	8.56	46	3.04
S. M. Netzahualcoyotl	75	288	54	55	164.63	5803	54	164.63					57	3.72
S. Bernardino	129	308	112	205	251.99	8883	106	186.58			6	65.41	61	5.70
Xocotlan	22	n.a	20	34	99.45	3506	17	27.95			3	71.50	n.a	2.25
Tulantongo	66	n.a	50	52	104.5	3684	47	54.5			3	50.00	n.a	2.36
S. Cuautlalpan	214	n.a	158	233	369.84	13037	148	253.14			10	116.70	n.a	8.37
S. Felipe y S. Cruz	340	n.a	109	251	199.33	7025	109	199.3					n.a	4.51
S. J. Amanalco	33	n.a	82	184	271.38	9563	58	167.79	23	103.31	1	0.20	n.a	6.14
S. M. Tecuanaulco	n.a	n.a	2	5	2.45	86	0	0	2	1.92		0.53	n.a	0.06
S. M. Coatlinchan	353	n.a	277	543	877.50	30951	251	708.6			26	169.44	n.a	19.86
S. M. Tocuila	310	n.a	99	199	168.2	5929	99	168.2					n.a	3.80
TOTAL	**3861**		**2324**	**3750**	**4420.1**	**155833**	**2021**	**3319.38**	**164**	**240.36**	**129**	**861.06**		100.00
Average subside							**87%**	**57.89**	**7.10%**	**51.66**	**5.90%**	**235.28**		

Table A6.12 Crops sown with subside of PROCAMPO in the municipality of Texcoco in 1997(Archives PROCAMPO, DDR03 Texcoco, 1997)												
Ejidos	Area Total (ha)	Maize	Beans	Broadbeans	Chickpeas	Wheat	Oat	Alfalfa	Tomato	Succini	Carrot	Other crops
Tecuanulco	2					2						
S.Cruz De Arriba	6	3	2			1						
Xocotlan	23	12	2				2.1	4.2	1.4			
S.Simon	25	11	3					9.7	0.3	0.8		
S.Pedro y S.Ursula	33	13	1					7.8	8.6	3.6		
Los Reyes	36	14	16	1.3	0.5		1.8	0.4	0.8			
S Diegiuito	44	30	10	2.0		2						
Pentecotses	45	31	6	0.2				7.6				
S.N Tlaminca	46	26	14	0.6		3	1.6		1.0	0.7		
S Diego Y La Trinidad	50	33	10			1		2.4	1.3	1.7		
S.Ines	59	11	16		0.6	1	30.4					
Resurreccion	65	50	7					3.3	0.8	4.3		
SJ Coapango	73	20	8			42	1.1	0.1				
S.J. Mecatillo	84	49	4				1.4	5.4	5.6	7.7		
Tulantongo	98	43	14				5.4	34.4	0.4	0.7		
S.M Nativitas	105	74	29			1	0.4			0.2		
S.L Huexotla	106	18	11			2	13.4	33.0	3.0	1.0		
S Pablo Ixayoc	107	71	6	3.8		6	15.8					
S. J Tezontla	108	45	50	1.2	1.4	2	4.5			1.5		
Purificacion	116	67	30			7	11.0					
Tequesquinahuac	127	53	45	1.9		22	1.5			2.8		
Cuautlalpan	127	72	7			5	9.0	28.3	0.4	0.9		
S.C del Monte	135	50	8	6.4	12.8	36	18.2					
S.M Netzahualcoyotl	143	72	9			3	13.8	14.7	9.8		16	
Tocuila	150	130	1				5.3	12.8			2	
S Felipe uy Sta Cruz	167	110	2			3	23.8	20.8	0.5	0.8		
S Bernardino	180	104	2				6.2	37.8	11.0	11.3	5	
S Miguel Tlaixpan	188	75	36	4.9		67				0.1		
S J Amanalco	214	44	9	20.4	5.3	59	58.8					
Coatlinchan	703	197	40	0.3		447	12.3	2.5		1.3		
TOTAL	3621	1528	398	43	20	711	238	225	45	39	23	291
% of area sown		42.2	11.0	1.2	0.6	19.6	6.6	6.2	1.2		0.6	8.0

Appendix 5 Steps for certification of ejidal rights followed by PROCEDE.

Step I In each of the 31 states the State Committee integrated SRA/INEGI/RAN define and establish the inter-institutional capacities to support PROCEDE. This ensures that the States with more infrastructure and personnel are targeted first.

Step II once selected the State the SRA produced the '*Carpeta Basica'*, which include all the information available for the *ejido*s in archives of the SRA.

Step III The Procuraduria Agraria (PA) promotes PROCEDE in the *ejido*s from which an assessment of a favourable outcome of the program was made. If the ejidal authorities agree, the ejidal assembly is called for information and consent.

Step IV The PA and INEGI in an assembly of ejidatarios with a minimum quorum of 50% plus 1 ejidatarios, ask for the approval of assembly for the incorporation of the *ejido* to PROCEDE. If the program received the approval the assembly appointed a commission of ejidatarios (Comision Auxiliar (CA) for the identification of boundaries.

Step V Together CA/PA/INEGI, demarcate and agree the boundaries among neighbours (of the *ejido* and among the plots of the ejidatarios) produce a sketch map, prepare the agreements among neighbours and the list of possible individuals with rights over the plot. The sketch map is produced on aerial photographs in which the vertices of the boundaries of the *ejido* and plots are identified.

Step VI Once the ejidal land has been demarcated the ejidal assembly is called to approve the sketch map, and the documents produced in the previous step (sketch map, agreements and list of ejidatarios.

Step VII INEGI demarcated the lands of the *ejido* and produced the final map. The Procedure is a Geodesic survey and/or topographic survey, in which the geodesic coordinates of the vertices of *ejido* and plots are identified. The lands identified are: plot area, communal land, human settlement and plots, the identification of the vertices is done by topographic survey or using high technology such Total Stations and Global Positioning Systems (GPS)[1].

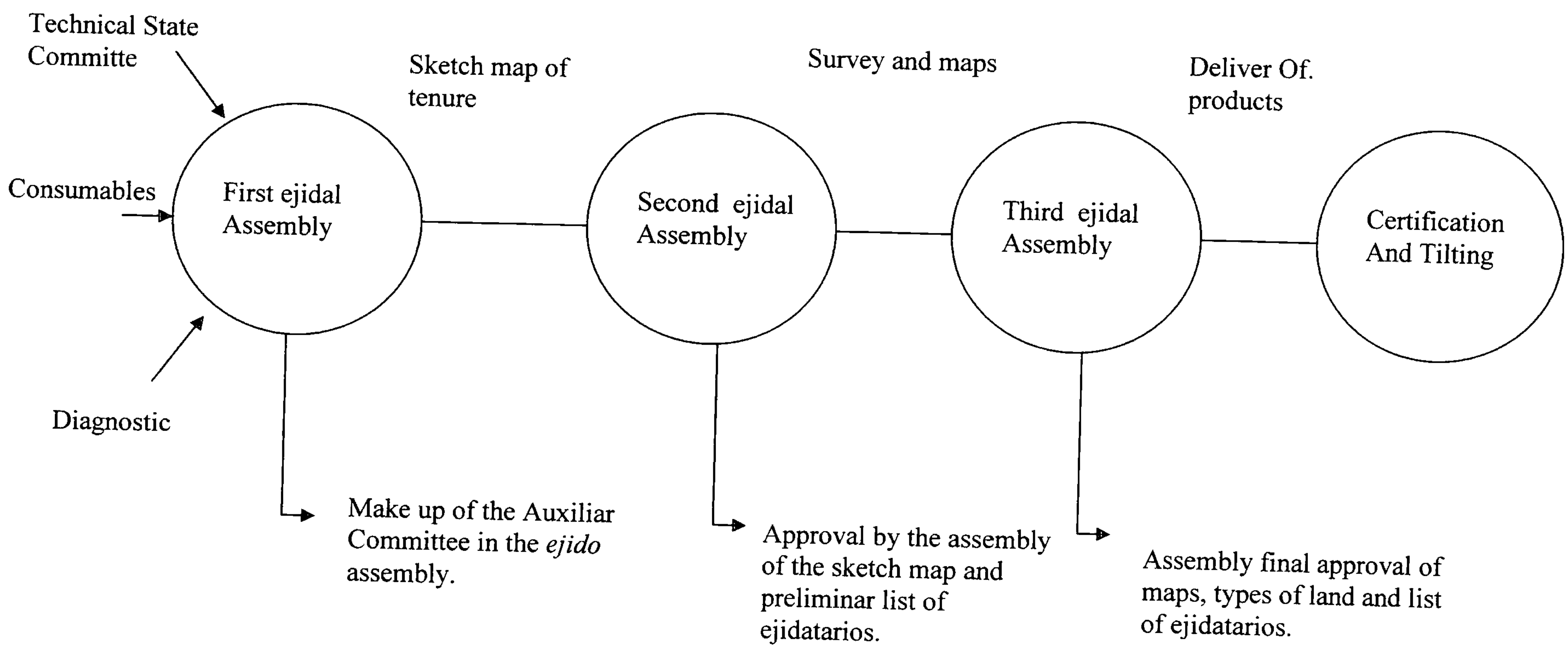
Step VIII the final map is displayed for 15 days prior to an ejidal assembly for the approval of the map. In this assembly with a quorum of at least 75% plus one of the ejidatarios, the ejido must approve the map, list of ejidatarios with rights, rights over communal land and the request for the integration of the information in the RAN. Also in this assembly the ejidatarios are asked to decide if they wished to continue in the same regimen of property as *ejido* or change to private proprietorship.

Step IX PA deliver the information produced to the RAN for its register.

Step X The RAN delivers the certificates of rights to the individuals.

[1] INEGI created in 1992 the Red Geodesica Nacional Activa (RGNA,Active Geodesic National Network). It consist of 14 GPS stationary stations, distributed strategically to cover all the country by the scanning of satellites and the register of the data in a continued way, 24 hours a day 365 days of the year. The RGNA is an integral reference framework to which all the measurements made by INEGI in the *ejidos* are related.

Figure A 6.5 General procedures for the certification of *ejidos* by PROCEDE/RAN (INEGI, 1997)



Appendix 6 Tables of data collected for the ejido of San pedro y Santa Ursula

Table A 7.1 Data about the ejidatarios of San Pedro y santa Ursula (Fieldwork, 1998, Archives ejido San pedro Y Santa Ursula)

Ejidatario	Age	Sex	ACTIVITY	Area(ha)	Tenure	Number of Parcels
1	74	F	Shopkeeper	3.5859	Ejidatario	2
2	52	F	Housewife	0.4158	Ejidatario	1
3	56	F	Employee	2.5109	Ejidatario	2
4	64	F	Housewife	0.0138	Ejidatario	3
5	65	F	Housewife	2.8475	Ejidatario	2
6	54	F	Shopkeeper	2.9958	Ejidatario	2
7	50	F	Housewife	2.9499	Ejidatario	1
8	52	F	Shopkeeper	2.5427	Ejidatario	2
9	38	F	Housewife	2.8484	Ejidatario	2
10	45	F	Housewife	3.0149	Ejidatario	2
11	65	F	House wife	0.6756	Ejidatario	3
12	48	F	Housewife	2.8000	Ejidatario	2
13	70	F	Pensioner	2.8351	Ejidatario	2
14	58	F	Pensioner	2.6409	Ejidatario	1
15	48	F	Shopkeeper	3.0236	Ejidatario	1
16	75	F	House wife	2.7040	Ejidatario	2
17	65	F	Housewife	3.0443	Ejidatario	2
18	48	F	Housewife	2.9309	Ejidatario	1
19	60	M	Baker	2.6620	Ejidatario	2
20	50	M	Employee	2.4056	Ejidatario	2
21	75	M	Farmer	2.7491	Ejidatario	2
22	65	M	Shopkeeper	2.5787	Ejidatario	2
23	60	M	Farmer	2.6846	Ejidatario	2
24	49	M	Farmer	2.9657	Ejidatario	1
25	42	M	Farmer	2.6201	Ejidatario	2
26	98	M	Pensioner	3.1287	Ejidatario	1
27	75	M	Farmer	2.8322	Ejidatario	1
28	55	M	Shopkeeper	2.5925	Ejidatario	2
29	42	M	Farmer	2.7540	Ejidatario	1
30	65	M	Farmer	2.5513	Ejidatario	2
31	60	M	Employee	2.1724	Ejidatario	3
32	50	M	Employee	2.8354	Ejidatario	2
33	54	M	Farmer	2.6963	Ejidatario	2
34	70	M	Farmer	2.7704	Ejidatario	2
35	72	M	Farmer	2.4033	Ejidatario	2
36	60	M	Farmer	2.4448	Ejidatario	2
37	72	M	Employee	2.9369	Ejidatario	1
38	68	M	Farmer	2.3192	Ejidatario	2
39	70	M	Shopkeeper	2.5951	ejidatario	2
40	58	M	Shopkeeper	1.2817	Ejidatario	1

Table 7.1 Continuation Data about the ejidatarios of San Pedro y santa Ursula (Fieldwork, 1998, Archives ejido San pedro Y Santa Ursula)

41	49	M	Butcher	3.0916	Ejidatario	1
Ejidatario	Age	Sex	Occupation	Area (ha)	Tenure	Number of parcels
42	74	M	Shopkeeper	2.4741	Ejidatario	1
43	65	M	Farmer	2.9640	Ejidatario	2
44	49	M	Farmer	3.1734	Ejidatario	1
45	60	M	Farmer	3.0236	Ejidatario	2
46	50	M	Employee	3.0319	Ejidatario	2
47	70		Housewife	3.205	Ejidatario	1
48	75		Shopkeeper	2.9309	Ejidatario	1
49	65		Farmer	2.4573	Ejidatario	1
Posesionarios						
1		F	Housewife	0.0470	Posesionario	1
2		F	Employee	0.175	Posesionario	1
3		M	Shopkeeper	0.2766	Posesionario	1
4		M	Employee	0.2339	Posesionario	1
5		M	Employee	0.5639	Posesionario	1
Ejido de SP y S Ursula				2.7885	Ejidatario	1
Parcela en Conflicto				3.0180	Ejidatario	2
TUC1			Communal	1.8838		
TUC2			Communal	0.172		

Appendix 7 Tables of data collected for the *ejido* of Santa Maria Nativitas

Table A7.1 Soil series in the *ejido* of Nativitas(Cachon et al , 1974)

Soil	Depth and slope	Limitations	Recommendations	Land suitability, suitability for irrigation	Area(ha)
Aclipan sandy loam	Slope 2 to 4%; Depth 30 to 50 cm; texture in A horizon loam	Presence of stones in the topsoil, Cemented layer at 50 cm of depth Medium capacity of retention of moisture and medium content of organic matter	Rotation of crops, terracing, contour lines, use of fertilisers and addition of organic matter.	III-es-1 Irrigation IVs-3	35
Nativitas loam	Slope 2 to 4 %; Depth 70 to 80 cm; slope 3-4 % texture in A Horizon Loam.	Soil with weak structure and susceptible to erosion Layer of sand at 50 cm of depth. Medium fertility, medium capacity of retention of moisture, rapid permeability and high content of organic matter.	Practices of conservation of soils: building of terraces and rotation of crops Irrigation limited by the high permeability of soil.	IIe-1 Irrigation IIt-1	124
Nativitas sandy loam erosionado	Depth 10-15 cm sandy loam slope from 5 to 6%	Limited by a hardpan with outcrop of tepetate in 60 % of the area	Shallow soils with high with outcrops of tepetate and risk of erosion exposed	Ve-1 Irrigation: VIe-1	92

Restrictions: e= risk of erosion; t= permeable layer at 60 cm of depth; s= low retention of moisture and gravel in the soil

Table A72 Land facets in Santa Maria Nativitas (Compiled from Ortiz, 1977)

Facet	Form	Soils	Vegetal cover	Land suitabilityy Klingebiel,A Montgomery P,1965)	Area (has)
Coatlinchan-1	Gently slopes from 5 to 10 %	Dark brown, medium depth and coarse texure	Annual crops and Agaves in the edge of the parcel	IIIes-1	55
Coatlinchan-4	Steep slopes and bottom of rivers	Shallow, with outcrop of hardpan	Bushes	VIIes-1	89
Tlaminca -3	Gently slopes with steps of 5 to 10 %	Dark and shallow soils with tepetate and texture from medium to coarse	Annual crops	IVes-2	128
Texcoco-4	Level with slopes lower than 2%	Soils dark grey depth and with coarse texture	Annual crops	II es-1	11.3
Ixayoc-1	Slope and bottom of streams	Very shallow, highly eroded and with outcrop of rocks	Trees and bushes.	VIIes-1	14
Ixayoc-2	Inter fluvial area with slopes from 9 to 15%	Very shallow with hardpan outcrops in more than 70 % of the area	Crops: Maize Reforestation Eroded soils	VIIe-2	8
Tecuanulco-2	Smooth incline with slopes from 7 to 10%	Balck, depth with medium texture and rich in organic matter	Crops and association of Pinus Abies and Oak.	Ve-1	50
Tecuanulco-3a	Incline with slope from 35 to 45%	Balck , depth with medium texture and rich in organic matter	Associations or compact areas of oak and abies y en some areas grassland.	VIIe-3	252
Texaltepc-1	Incline with slope, 35 to 40%	Balck, depth, medium texture and rich in organic matter	Forest with Pinus and grasslands.	VIIe-1	72
Tlalcoc-2	Incline with slope 25 to 30%	Balck, depth, medium texture and rich in organic matter	Forest with Pinus and grasslands.	VIe-1	136

e= erosion s= shallow soils

Table A 7.3 Ejidatarios by number of parcels and area of land held in Santa Maria Nativitas (Author: 1997)

Ejidatario	No of parcels	Area (sq m)	Ejidatario	No of parcels	Area (sq m)	Ejidatario	No of parcels	Area (sq m)	Ejidatario	No of parcels	Area (sq m)
1	1	399	34	1	11258	67	2	15318	100	3	19998
2	1	492	35	2	11301	68	3	15336	101	3	20160
3	1	1048	36	2	11405	69	2	15360	102	2	21055
4	1	1293	37	2	11422	70	3	15715	103	4	21184
5	2	1890	38	2	11426	71	3	15930	104	4	21582
6	2	2673	39	2	11628	72	3	16086	105	4	23089
7	1	3245	40	2	11746	73	3	16319	106	4	23417
8	1	3254	41	2	11804	74	2	16349	107	5	24161
9	1	3256	42	2	11911	75	3	16358	108	5	24394
10	1	3311	43	2	12039	76	2	16414	109	4	24508
11	1	3469	44	2	12040	77	2	16511	110	3	25438
12	2	4097	45	2	12199	78	2	16673	111	4	27046
13	1	5064	46	2	12266	79	4	16741	112	5	31885
14	1	5315	47	2	12539	80	3	16780	113	6	32719
15	1	5723	48	2	12725	81	3	16876	114	3	39638
16	1	5977	49	2	12730	82	3	16931	TOTAL	276	1572192
17	3	5988	50	2	12740	83	3	17345			
18	1	6339	51	2	12837	84	3	17348			
19	2	6408	52	2	13114	85	2	17578			
20	1	6410	53	2	13165	86	4	17864			
21	1	6920	54	2	13207	87	3	18018			
22	2	7202	55	2	13437	88	4	18124			
23	1	7752	56	2	13578	89	2	18222			
24	2	7880	57	2	13690	90	4	18257			
25	1	7921	58	3	13719	91	3	18578			
26	1	8226	59	2	13763	92	2	18645			
27	1	8324	60	2	14125	93	2	18671			
28	4	8772	61	2	14308	94	3	19123			
29	2	9079	62	2	14478	95	3	19129			
30	3	9377	63	3	15011	96	2	19157			
31	1	10992	64	2	15212	97	4	19262			
32	3	11058	65	3	15295	98	4	19542			
33	2	11177	66	4	15300	99	3	19609			

Table 7.3 Posesionarios by number of parcels and area of land held in Santa Maria Nativitas (Author: 1997)

Posesionario	no of parcels	Area (sq m)	Posesionario	no of parcels	Area (sq m)	Posesionario	no of parcels	Area (sq m)	Posesionario	No of parcels	Area (sq m)
1	1	243	34	1	1981	67	2	5569	100	1	9754
2	1	244	35	1	2178	68	1	5689	101	1	9815
3	1	356	36	1	2180	69	1	5692	102	2	10146
4	1	378	37	1	2383	70	2	5711	103	1	10216
5	1	401	38	1	2607	71	2	5717	104	3	10238
6	1	406	39	1	2668	72	1	5847	105	2	10575
7	1	461	40	1	2701	73	1	5896	106	4	11636
8	1	490	41	1	2760	74	1	5995	107	1	11706
9	1	525	42	1	2918	75	1	6042	108	2	11717
10	1	546	43	2	3220	76	1	6053	109	3	12080
11	1	654	44	1	3231	77	1	6059	110	3	12376
12	1	659	45	1	3329	78	1	6214	111	2	12812
13	1	676	46	1	3456	79	4	6254	112	4	13567
14	1	792	47	1	3519	80	2	6410	113	2	13772
15	1	928	48	1	3579	81	1	6522	114	2	13986
16	1	994	49	1	3614	82	1	6605	115	4	14146
17	1	1059	50	1	3651	83	1	6743	116	4	14388
18	1	1083	51	1	3773	84	2	6859	117	4	14678
19	1	1112	52	1	3780	85	2	6871	118	3	14812
20	1	1120	53	2	3811	86	4	7028	119	1	14850
21	1	1133	54	1	3937	87	1	7043	120	3	14921
22	1	1145	55	1	4006	88	1	7368	121	3	17428
23	1	1363	56	1	4131	89	1	7509	122	4	18657
24	1	1543	57	1	4408	90	3	7693	123	3	18937
25	1	1548	58	2	4420	91	1	8221	124	2	20249
26	2	1657	59	1	4452	92	2	8622	125	3	24154
27	2	1695	60	1	4662	93	1	8729	Total	178	751448
28	1	1771	61	2	4870	94	2	8805			
29	1	1872	62	2	4929	95	1	8822			
30	1	1874	63	1	4977	96	3	8867			
31	1	1915	64	1	5095	97	1	8921			
32	1	1923	65	2	5385	98	4	8924			
33	1	1975	66	2	5389	99	2	9063			

Table 7.4 Information by parcel registered in PROCAMPO (Archives, DDR,03 Texcoco, 1997)

Beneficiary Ejidatario	Area(ha)	Subsidy(£)	Parcels	Crop	parcel1	Parcel2	parcel3	parcel4	Tenure
1	1.89	67.76	4	maize	0.40	0.33	0.61	0.55	Ejid.
2	1.00	35.85	1	maize-beans	1.00				Ejid.
3	1.34	48.04	2	maize	0.66	0.68			Ejid.
4	1.23	44.10	2	maize	0.71	0.52			Ejid.
5	1.95	69.91	3	Maize	0.63	0.61	0.71		Ejid.
6	1.21	43.38	2	Beans	0.53	0.68			Ejid.
7	1.19	42.66	2	maize	0.58	0.61			Ejid.
8	1.17	41.95	2	maize	0.64	0.53			Ejid.
9	1.64	58.80	2	Beans	0.94	0.70			Ejid.
10	1.61	57.72	3	maize	0.45	0.65	0.51		Ejid.
11	0.76	27.25	1	maize	0.76				Ejid.
12	2.00	71.70	3	beans,wheat,maize	0.42	1.00	0.58		Ejid.
13	0.50	17.93	1	Maize	0.50				Ejid.
14	1.97	70.63	3	Maize	0.68	0.50	0.79		Ejid.
15	1.59	57.00	2	maize, beans	0.80	0.79			Ejid.
16	1.43	51.27	2	Maize	0.66	0.77			Ejid.
17	1.22	43.74	2	Maize	0.54	0.68			Ejid.
18	1.46	52.34	2	Maize	0.70	0.76			Ejid.
19	2.62	93.93	3	Maize	0.62	0.69	1.31		Ejid.
20	1.25	44.81	2	maize, beans	0.62	0.63			Ejid.
21	2.14	76.72	1	maize-beans, Broadbean,maize	0.88	0.50	0.76		Ejid.
22	1.42	50.91	2	Maize	0.66	0.76			Ejid.
23	2.59	92.86	3	maize-beans, maize, maize	1.35	0.63	0.61		Ejid.
24	1.30	46.61	2	Maize	0.60	0.70			Ejid.
25	1.26	45.17	2	Maize	0.60	0.66			Ejid.
26	4.02	144.12	3	maize-beans, maize, maize	2.41	0.94	0.67		Ejid.
27	1.81	64.89	2	maize, maize-beans	0.71	1.10			Ejid.
28	2.40	86.04	4	Maize	0.43	0.51	0.83	0.63	Ejid.
29	1.67	59.87	3	beans, maize, wheat	0.55	0.59	0.53		Ejid.
30	2.30	82.46	4	Maize	0.41	0.62	0.68	0.59	Ejid.
31	1.26	45.17	2	Maize	0.66	0.60			Ejid.
32	1.26	45.17	2	Maize	0.64	0.62			Ejid.

Table 7.4 Continuation.information by parcel registered in PROCAMPO (Archives, DDR03 Texcoco, 1997)

33	0.50	17.93	1	maize	0.50				Ejid.
34	1.31	46.97	2	beans., maize	0.66	0.65			Ejid.
35	1.67	59.87	3	maize	0.77	0.65	0.25		Ejid.
36	1.26	45.17	2	maize	0.64	0.62			Ejid.
37	1.25	44.81	2	maize	0.65	0.60			Ejid.
38	1.26	45.17	2	maize	0.58	0.68			Ejid.
39	1.22	43.74	2	Maize	0.60	0.62			Ejid.
40	1.19	42.66	2	beans	0.58	0.61			Ejid.
41	1.15	41.23	2	maize	0.56	0.59			Ejid.
42	1.81	64.89	3	maize, beans, maize	0.73	0.65	0.43		Ejid.
43	1.36	48.76	2	maize	0.65	0.71			Ejid.
44	1.30	46.61	2	maize, beans	0.68	0.62			Ejid.
45	2.05	73.50	3	wheat, maize, maize	0.50	0.86	0.69		Ejid.
46	1.19	42.66	2	barley, maize	0.56	0.63			Ejid.
47	1.42	50.91	1	maize, beans	1.42				Ejid.
48	1.20	43.02	2	maize	0.58	0.62			Ejid.
49	1.31	46.97	2	maize	0.62	0.69			Ejid.
50	1.43	51.27	2	maize	0.68	0.75			Ejid.
51	1.29	46.25	2	maize	0.63	0.66			Ejid.
55	1.31	46.97	2	maize	0.70	0.61			Ejid.
56	1.30	46.61	2	maize	0.47	0.83			Ejid.
57	1.22	43.74	2	beans, maize	0.66	0.56			Ejid.
58	1.57	56.29	2	beans, maize	0.96	0.61			Ejid.
59	2.06	73.85	3	beans, maize-beans, beans	0.65	0.65	0.76		Ejid.
60	1.16	41.59	2	maize	0.62	0.54			Ejid.
61	1.20	43.02	2	maize	0.65	0.55			Ejid.
Subtotal	92.28	3308	135		42.13	37.05	11.33	1.77	
Beneficiary Posesionario	Area(ha)	Subsidy(£)	Parcels	Crop	pacel1	Parcel2	parcel3	parcel4	Tenure
1	0.65	23.30	1	maize	0.65				Pos.
2	0.70	25.10	1	maize	0.70				Pos.
3	1.45	51.99	2	maize	0.45	1.00			Pos.
4	1.29	46.25	3	maize	0.40	0.28	0.61		Pos.
5	0.64	22.95	1	beans	0.64				Pos.

Table 7.4 Continuation.iInformation by parcel registered in PROCAMPO (Archives DDR 03, Texcoco, 1998)									
Beneficiary Posesionario	Area(ha)	Subsidy(£)	Parcels	Crop	pacel1	Parcel2	parcel3	parcel4	Tenure
6	0.57	20.44	1	maize	0.57				Pos.
7	0.55	19.72	1	maize	0.55				Pos.
8	1.88	67.40	3	maize, maize, beans	0.55	0.54	0.79		Pos.
9	0.59	21.15	1	maize	0.59				Pos.
10	0.79	28.32	1	Maize-beans	0.79				Pos.
11	0.65	23.30	1	maize	0.65				Pos.
12	1.00	35.85	2	wheat,maize	0.50	0.50			Pos.
13	0.55	19.72	1	beans	0.55				Pos.
14	0.50	17.93	1	maize	0.50				Pos.
15	2.11	75.65	2	maize	0.43	1.68			Pos.
1	1.00	35.85	1	Wheat	1.00				Priv.
2	1.46	52.34	2	Maize	0.70	0.76			Priv.
3	1.29	46.25	2	maize	0.63	0.66			Priv.
4	1.22	43.74	2	maize.beans	0.65	0.57			Priv.
5	0.55	19.72	1	maize	0.55				Priv.
subtotal	5.52	197.90	8		3.53	1.99			
Total 81	111.72	4005.37	165						

Appendix 8 Tables of data collected for the *ejido* of Santa Catarina del Monte

Table A7.1 Land facets in Santa Catarina del Monte Maria Nativitas (Compiled from Ortiz, 1977)

Facet	Form	Soils	Vegetal cover	Classification (Klingebiel A, Montgomery P,Modified by Hugthon and Melendez, 1965)	Area (has)
Ixayoc-1	Slope and bottom of streams	Very shallow, highly eroded and with outcrop of rocks	Trees and bushes.	VIIes-1	348
Ixayoc-2	Inter fluvial area with slopes from 9 to 15%	Very shallow with hardpan outcrops in more than 70 % of the area	Crops: Maize Reforestation Eroded soils	VIIe-2	306
Tecuanulco-1	Smooth incline with slopes from 7 to 10%	Balk, depth with medium texture and rich in organic matter	Crops and association of Pinus, Abies and Oak.	Ve-1	296
Tecuanulco-2	Smooth incline with slopes from 10 to 18%	Black, depth with medium texture and rich in organic matter	Crops and association of Pinus Abies and Oak. Grassland and patches with crops oat, maize and broad bean	VIe-1	1327
Tecuanulco Sub-Facet 3a	Sub faceta with terraces, slopes 4-10%	Black , depth with medium texture and rich in organic matter	Associations or compact areas of oak and abies y en some areas grassland.	VIIe-3	95
Tecuanulco Sub-Facet 3c	Eroded land	Shallow less than 10 cm, outcrops of hardpan (tepetate9 and rocks.	Patches of bushes and grassland	VIIe-1	103

Table A 7.2 Ejidatarios by number of parcels and area of land held in Santa catarina del Monte (Author: compiled from PROCEDE, 1997)

Ejidatario	No of parcels	Area (sq m)	Ejidatario	No. of parcels	Area (sq m)	Ejidatario	No. of parcels	Area (sq m)
1	1	909	28	1	5846	55	1	14203
2	1	1337	29	1	5935	56	1	14590
3	1	1452	30	1	6181	57	3	15107
4	1	2089	31	2	6448	58	2	16499
5	1	2344	32	1	6573	59	3	16572
6	1	2710	33	1	6681	60	2	17090
7	1	3060	34	2	6708	61	4	17337
8	1	3099	35	1	6899	62	3	17957
9	1	3201	36	2	7317	63	1	18413
10	1	3466	37	1	7792	64	2	18495
11	1	3560	38	1	8206	65	3	18878
12	1	3568	39	1	8611	66	3	20616
13	1	3718	40	2	8720	67	1	21211
14	1	3892	41	1	9030	68	1	22902
15	1	4070	42	3	9091	69	1	23969
16	1	4141	43	1	9279	70	3	24550
17	1	4209	44	1	9803	71	2	25496
18	1	4295	45	1	9847	67	1	21211
19	1	4614	46	2	10024	68	1	22902
20	1	4758	47	4	10357	69	1	23969
21	1	5089	48	1	10459	70	3	24550
22	2	5212	49	2	10507	71	2	25496
23	1	5268	50	1	10955	72	6	29283
24	1	5307	51	2	11536	73	5	31909
25	1	5463	52	1	11847	74	2	46436
26	1	5568	53	2	12167			
27	1	5827	54	2	12202			

Table A 7.2 continuation Posesionarios by number of parcels and area of land held in Santa Catarina del Monte (Author: 1997)

Posesionario	Number of parcels	Area (sq m)	Posesionario	No. of parcels	Area (sq m)	Posesionario	No. of parcels	Area (sq m)
1	1	355	33	1	2580	65	1	4101
2	1	409	34	1	2590	66	1	4234
3	1	540	35	1	2654	67	1	4335
4	1	688	36	1	2672	68	1	4481
5	1	831	37	1	2679	69	1	4537
6	1	985	38	1	2681	70	1	4540
7	1	1047	39	1	2739	71	1	4652
8	1	1159	40	1	2764	72	1	4708
9	1	1209	41	1	2796	73	1	4738
10	1	1226	42	1	2899	74	1	4747
11	1	1313	43	2	2903	75	1	4848
12	1	1337	44	2	2978	76	1	4894
13	1	1370	45	1	2983	77	1	4979
14	1	1422	46	1	2988	78	1	5040
15	1	1555	47	1	3061	79	1	5055
16	1	1560	48	1	3070	80	1	5058
17	1	1731	49	1	3071	81	1	5062
18	1	1778	50	1	3089	82	1	5210
19	1	1975	51	1	3154	83	1	5247
20	1	2026	52	1	3170	84	1	5334
21	1	2064	53	1	3285	85	1	5450
22	1	2074	54	1	3372	86	1	5612
23	1	2115	55	2	3447	87	1	5635
24	1	2188	56	1	3538	88	1	5650
25	1	2203	57	1	3617	89	2	5684
26	1	2217	58	1	3685	90	2	5793
27	1	2275	59	2	3710	91	1	5826
28	1	2372	60	1	3720	92	1	5845
29	1	2424	61	1	3754	93	2	5887
30	1	2425	62	1	3865	94	1	5908
31	1	2443	63	1	3879	95	2	6146
32	1	2534	64	1	3883	96	1	6148

Table A 7.2 Continuation Ejidatarios by number of parcels and area of land held in Santa catarina del Monte (Author: 1997)

Posesionario	No. of parcels	Area (sq m)
97	1	6229
98	1	6294
99	1	6311
103	1	6544
104	1	6782
105	1	6813
106	1	6927
107	1	6969
108	1	7487
109	1	7501
110	1	7514
111	3	7549
112	3	7930
113	2	7958
114	1	8295
115	1	8701
116	2	9125
117	1	9144
118	2	9155
119	2	9310
120	1	9368
121	1	10193
122	1	10195
123	2	10510
124	1	10576
125	2	10779
126	2	10785
127	2	10794
128	2	11023
129	1	11027
130	2	11082
131	1	11297
132	1	11372

Posesionario	No. of parcels	Area (sq m)
133	1	12276
134	3	12486
135	3	12562
136	1	14614
137	3	14744
138	1	15024
139	2	15861
140	1	16819
141	2	17503
142	5	20753
143	4	20955
144	1	21801

Table A73 Subsides, crops and areas supported by PROCAMPO by tenure in Santa Catarina del Monte (Archives PROCAMPO,DDR03 Texcoco, 1998).

	Ejidatario									Comuneros											Total			Tenure
	area(ha)	plots	Subsidy (£)	Crop	Plot 1	Plot 2	Plot 3	Plot4	Plot 5	area(ha)	Plots	Subsidy (£)	Crop	Plot1	Plot2	Plot 3	Plot 4	Plot5	Plot6	Plot7	Plots	Area (ha)	Subsidy (£)	Tenure
1	2.00	1	71.70	maize	2.00																1	2.00	71.70	Ejidatario
2	0.50	1	17.93	maize	0.50																1	0.50	17.93	Ejidatario
3	2.50	2	89.63	maize	1.50	1.00															2	2.50	89.63	Ejidatario
4	1.50	1	53.78	maize	1.50																1	1.50	53.78	Ejidatario
Total	**6.50**	**5**	**233.04**																		**5**	**6.5**	**233.04**	
	area(ha)	plots	Subsidy (£)	Crop	Plot 1	Plot 2	Plot 3	Plot4	Plot 5	area(ha)	Plots	Subsidy (£)	Crop	Plot1	Plot2	Plot 3	Plot 4	Plot5	Plot6	Plot7	Plots	Area (ha)	Subsidy (£)	Tenure
1	2.00	2	71.70	maiz	0.50	1.50															2	2.00	71.70	Posesionario
2	1.44	2	51.63	maize	0.75	0.69															2	1.44	51.63	Posesionario
3	1.00	1	35.85	maize	1.00																1	1.00	35.85	Posesionario
4	0.50	1	17.93	maize	0.50																1	0.50	17.93	Posesionario
5	1.50	1	53.78	maize	1.50																1	1.50	53.78	Posesionario
6	0.50	2	17.93	maize	0.25	0.25															2	0.50	17.93	Posesionario
7	0.50	1	17.93	maize	0.50																1	0.50	17.93	Posesionario
8	1.00	1	35.85	maize	1.00																1	1.00	35.85	Posesionario
9	1.00	1	35.85	maize	1.00																1	1.00	35.85	Posesionario
10	1.50	1	53.78	maize	1.50																1	1.50	53.78	Posesionario
11	2.00	3	71.70	maize(2), wheat(1,3)	1.00	0.50	0.50														3	2.00	71.70	Posesionario
12	2.50	2	89.63	maize, whet	2.00	0.50															2	2.50	89.63	Posesionario
13	1.25	2	44.81	Maize , wheat	1.00	0.25															2	1.25	44.81	Posesionario
Total	**16.69**	**30**	**1064.44**																		**30**	**16.69**	**598.37**	
	Ejidatario									Comuneros											Total			Tenure
	area(ha)	plots	Subsidy (£)	Crop	Plot 1	Plot 2	Plot 3	Plot4	Plot 5	area(ha)	plots	Subsidy (£)	Crop	Plot1	Plot2	Plot 3	Plot 4	Plot5	Plot6	Plot7	Plots	Area (ha)	Subsidy (£)	
1	5.00	1	162.96	beans	5.00					2.20	2	78.87	beans, maize-wheat	2.00	0.20						3	7.20	241.84	Ejidatario
2	1.00	1	35.85	beans	1.00					2.25	2	80.67	beans	1.50	0.75						3	3.25	116.52	Ejidatario
3	1.00	1	35.85	broad beans	1.00					0.50	1	17.93	beans	0.50							2	1.50	53.78	Ejidatario
4	1.00	2	35.85	maize	0.50	0.50				0.20	1	7.17	maize	0.20							3	1.20	43.02	Ejidatario
5	0.50	1	17.93	maize	0.50					0.65	2	23.26	maize , wheat	0.40	0.25						3	1.15	41.19	Ejidatario
6	0.75	1	26.89	maize	0.75					0.75	3	26.89	maize	0.25	0.25	0.25					4	1.50	53.78	Ejidatario
7	0.50	1	17.93	maize	0.50					1.00	1	35.85	maize	1.00							2	1.50	53.78	Ejidatario
8	1.00	1	35.85	maize	1.00					1.50	1	53.78	maize	1.50							2	2.50	89.63	Ejidatario
9	2.00	1	71.70	maize						2.50	4	89.63	maize (1,3,4) wheat	0.50	0.50	0.50	1.00				5	4.50	161.33	Ejidatario
10	1.00	1	35.85	maize	1.00					0.65	1	23.26	maize	0.65							2	1.65	59.11	Ejidatario
11	1.00	1	35.85	maize	1.00					0.50	1	17.93	maize	0.50							2	1.50	53.78	Ejidatario
12	0.90	2	28.30	maize	0.50	0.40				0.84	1	30.07	maize	0.84							3	1.74	58.37	Ejidatario
13	4.00	3	143.41	maize	1.00	0.50	2.50			1.00	2	35.85	oat maize	0.25	0.75						5	5.00	179.26	Ejidatario
14	1.00	1	35.85	maize	1.00					1.25	2	44.81	broad beans, maize	1.00	0.25						3	2.25	80.67	Ejidatario

Table A73 continuation Subsides, crops and areas supported by PROCAMPO by tenure in Santa Catarina del Monte (Archives PROCAMPO,DDR03 Texcoco, 1998).

15	1.50	1	53.78	maize	1.50					3.00	1	107.56	oat	3.00							2	4.50	161.33	Ejidatario
16	3.50	2	125.48	maize	2.00	1.50				1.00	3	107.56	maize	3.00							5	4.50	233.04	Ejidatario
17	2.50	2	89.63	maize wheat	1.50	1.00				1.00	1	35.85	beans	1.00							3	3.50	125.48	Ejidatario
18	3.25	3	116.52	maize(1,3) beans	0.50	1.75	1.00			1.50	1	53.78	wheat	1.50							4	4.75	170.30	ejidatario
19	2.75	5	83.70	Maize(1,3,5), wheat(2,4)	0.50	0.75	0.50	0.50	0.50	0.75	2	26.89	maize	0.25	0.50						7	3.50	110.59	Ejidatario
20	4.00	2	143.41	maize, wheat	3.00	1.00				4.00	2	143.41	wheat, maize	3.00	1.00						4	8.00	286.81	Ejidatario
21	2.50	1	89.63	maize,beans, broadbeans	2.50					1.36	4	48.74	wheat, beans	0.50	0.16	0.50	0.20				5	3.86	138.37	Ejidatario
22	6.00	3	118.59	oat	2.50	1.50	2.00			0.25	1	8.96	beans	0.25							4	6.25	127.56	Ejidatario
23	0.25	1	8.96	wheat	0.25					1.50	2	53.78	maize-broadbeans, maize-wheat	0.80	0.70						3	1.75	62.74	Ejidatario
24	2.00	1	71.70	wheat	2.00					2.50	2	89.63	wheat	0.50	2.00						3	4.50	161.33	Ejidatario
Total	**48.90**	**39**	**1621.48**							**32.65**	**43**	**1242.12**									**82**	**81.55**	**2863.6**	
	Posesionario									Comuneros											Total			Tenure
	area(ha)	plots	Subsidy (£)	Crop	Plot 1	Plot 2	Plot 3	Plot4	Plot 5	area(ha)	Plots	Subsidy (£)	Crop	Plot1	Plot2	Plot 3	Plot 4	Plot5	Plot6	Plot7	Plots	Area (ha)	Subsidy (£)	Tenure
1	3.00	2	107.56	beans	0.50	2.50				0.50	1	17.93	maize	0.50							3	3.50	125.48	Posesionario
2	1.00	1	35.85	beans	1.00					0.25	1	8.96	maize	0.25							2	1.25	44.81	Posesionario
3	0.50	1	17.93	broad beans	0.50					2.00	1	70.96	maize	2.00							2	2.50	88.89	Posesionario
4	0.80	1	28.68	maize	0.80					0.20	1	7.17	maize	0.20							2	1.00	35.85	Posesionario
5	1.00	1	35.85	maize	1.00					1.88	3	66.52	maize	0.75	0.13	0.25				0.75	4	2.88	102.37	Posesionario
6	1.50	1	53.78	maize	1.50					2.25	3	80.67	broad bean wheta , maize	0.50	1.00	0.75					4	3.75	134.44	Posesionario
7	5.00	3	107.56	maize	3.00	1.50	0.50			1.50	2	53.78	maize	1.00	0.50						5	6.50	161.33	Posesionario
8	1.25	2	53.78	maize	0.75	0.50				0.30	2	10.74	maize	0.20	0.10						4	1.55	64.52	Posesionario
9	1.00	1	35.85	maize	1.00					3.00	2	215.11	maize-wheat, oat	2.00	1.00						3	4.00	250.96	Posesionario
10	1.80	1	64.52	maize	1.80					1.00	1	35.85	broad beans	1.00							2	2.80	100.37	Posesionario
11	1.50	2	53.78	maize	0.50	1.00				4.00	1	143.41	maize	4.00							3	5.50	197.19	Posesionario
12	0.50	1	17.93	maize	0.50					1.25	2	44.81	oat, wheat	0.50	0.75						3	1.75	62.74	Posesionario
13	0.75	1	26.89	maize	0.75					1.00	1	35.85	maize	1.00							2	1.75	62.74	Posesionario
14	0.50	1	12.96	maize	0.50					2.00	1	71.70	maize	2.00							2	2.50	84.67	Posesionario
15	1.00	1	35.85	maize	1.00					1.00	1	35.85	maize	1.00							2	2.00	71.70	Posesionario
16	1.00	1	35.85	maize	1.00					1.00	1	35.85	maize	1.00							2	2.00	71.70	Posesionario
17	1.00	1	35.85	maize	1.00					1.00	1	35.85	maize	1.00							2	2.00	71.70	Posesionario
18	1.00	1	35.85	maize	1.00					0.37	1	13.26	maize	0.37							2	1.37	49.11	Posesionario
19	0.25	1	8.96	wheat	0.25					0.50	1	17.93	wheat	0.50							2	0.75	26.89	Posesionario
20	1.00	1	35.85	wheat	1.00					5.00	1	179.26	maize	5.00							2	6.00	215.11	Posesionario
21	2.00	2	71.70	wheat maize	0.25	1.75				1.19	3	42.59	maize	0.20	0.75	0.24					5	3.19	114.30	Posesionario
21	**27.35**	**66**	**913**							**31.19**	**79**	**656.37**										**58.54**	**2136.89**	
Total	**76.25**									**63.84**											140	**140.09**	**5000.49**	

Table A73 continuation Subsides, crops and areas supported by PROCAMPO by tenure in Santa Catarina del Monte (Archives PROCAMPO,DDR03 Texcoco, 1998).

	Ejidatario									Comuneros											Total			Tenure
	area(ha)	plots	Subsidy (£)	Crop	Plot 1	Plot 2	Plot 3	Plot4	Plot 5	area(ha)	plots	Subsidy (£)	Crop	Plot1	Plot2	Plot 3	Plot 4	Plot5	Plot6	Plot7	#REF!	TotArea	Subsidy (£)	
1										1.00	1	35.85	maize	1.00							1	1.00	35.85	Comunero
2										2.16	1	49.48	maize	0.30	0.60	0.48					1	2.16	49.48	Comunero
3										1.00	1	35.85	maize	1.00							1	1.00	35.85	Comunero
4										1.80	1	64.53	maize	0.42	0.90	0.48					1	1.80	64.53	Comunero
5										0.32	1	8.30	maize	0.32							1	0.32	8.30	Comunero
6										0.75	1	26.89	maize	0.75							1	0.75	26.89	Comunero
7										1.50	1	53.78	maize	1.50							1	1.50	53.78	Comunero
8										1.82	4	65.25	maize	0.62	0.42	0.40	0.40				4	1.82	65.25	Comunero
9										1.78	2	63.82	maize	0.28	1.50						2	1.78	63.82	Comunero
10										1.58	3	56.65	maize	0.45	0.73	0.40					3	1.58	56.65	Comunero
11										1.50	1	53.78	maize	1.50							1	1.50	53.78	Comunero
12										1.00	1	35.85	maize	1.00							1	1.00	35.85	Comunero
13										1.10	3	39.44	Maize(1,2), Beans	0.40	0.30	0.40					3	1.10	39.44	Comunero
14										4.64	4	166.35	maize(1,2,3), Wheat	0.40	0.15	0.43	0.50				4	4.64	166.35	Comunero
15										2.30	7	78.16	maize(1-4,5) wheat(5,7)	0.12	0.20	0.40	0.28	0.12	0.38	0.80	7	2.30	78.16	Comunero
16										1.00	1	35.85	wheat	1.00							1	1.00	35.85	Comunero
17										3.00	2	107.56	wheat, maize	1.00	2.00						1	3.00	107.56	Comunero
Total										**28.25**	**35**	**977.37**									**35**	**28.25**	**977.37**	
																				Total	**200**	**191.53**	**6,809.27**	