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Rapid Land Use Assessment Using Geographic Information Systems: Experience in Four Cities

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EXECUTIVE SUMMARY

The rapid urbanization of Philippine cities has presented tremendous challenges to the local governments responsible for managing growth. Confronted with the problems of congestion, squatter settlements, and inadequate infrastructure, urban managers must look for new ways to keep pace with urbanization and effectively plan for the future. Geographic Information Systems (GIS) and satellite imagery are new tools that offer a means to examine and assess the impact of urbanization and provide a basis for sound urban development.

As mandated under the Local Government Code of 1991 and Executive Order 72, the authority to approve land use plans prepared by the cities has been devolved from national government to the local and provincial levels. Accurate maps showing current land use are needed to serve as a basis for planning future city development. City Planning and Development Offices (CPDOs) charged with the creation of their respective city's land use map now realize that the existing map—out-of-date, rarely revised, and grossly inaccurate—cannot be used for this purpose. This deficiency has crippled the ability of Philippine cities to assume the planning responsibilities and functions devolved to them, and has limited the gains made under their decentralized empowerment.

Under the USAID-funded Decentralized Shelter and Urban Development (DSUD) Project, a pilot exercise entitled *"Support for Land Use Mapping: Utilizing Satellite Imagery and PC-Based GIS for Rapid Land Use Assessment"* was carried out in the cities of Cebu, Davao, Lipa, and Naga. Using an innovative methodology, generation of up-to-date land use maps was attempted in each of the four cities.

This final report provides a detailed description of the methodology used to create a land use map for each city and offers ways for other cities to achieve the same result. Current problems facing the City Planning Development Coordinator (CPDC) in relation to land use mapping and planning are highlighted, followed by a discussion on how these problems should best be addressed. While the land use mapping methodology is standardized, each city is different in terms of financial and technical resources, providing a spectrum of experiences.

The key technical and institutional problems that beset urban planning in the Philippines manifest themselves in the following:

1. ***An unrealistic land use classification scheme***—which fails to describe the true nature of urban land use. Critical social and environmental issues, such as squatter settlements, which fail to appear as a classification, are not addressed.
2. ***An inaccurate land use map***—out-of-date, and infrequently updated, the land use map is a simplistic representation of reality. As a consequence, planning mechanisms and processes are severely constrained. The lack of accurate information on the nature (type) and extent (spread) of urban expansion makes it impossible to realistically plan for city development.
3. ***Technical constraints***—the lack of formal geographic/spatial analysis training for staff in the CPDO and other planning agencies has resulted in them being unable to fully develop and incorporate the land use map in planning processes.

4. ***Poor inter-department coordination***—in general, cities fail to interconnect department activities. This has resulted in a duplication of data collection and planning activities among the various city departments. Uncoordinated functions and policies often operate at cross-purposes.
5. A ***"why bother or what difference can it make attitude"***—A majority of the city officials see planning as futile in the face of these challenges. One Mayor, for example, feels that if Los Angeles can only "change" two or three percent of its city landscape through planning then what can his city hope to do?

The project attempted to address these deficiencies by creating an up-to-date land use map based on satellite imagery. This map, a true reflection of city development, now forms the basis of a new land use planning process: a rigorous and disciplined approach to the collection, presentation, and application of land use information for effective city planning.

Key achievements of the project included:

1. ***A new land use classification scheme***—A new and realistic land use classification scheme was developed to accurately reflect the variety of land use types, such as squatter settlements, which in the past had been ignored, found in each city. With this detailed land use classification scheme, the CPDO can now accurately describe the variety of land use types found in their city.
2. ***A new land use map***—High resolution satellite imagery (recently declassified 2-meter Russian military data) was used to rapidly identify and record urban land use types in the four pilot cities. Officials were able, for the first time, to see the true nature and extent of urban expansion and assess its impact on urban development.
3. ***Training***—Staff training was undertaken for the use of maps, satellite imagery, GIS, and with their roles in assisting the city with decision-making and development.
4. ***Coordination***—A coordinated approach to data collection and analysis was adopted by incorporating different city department staff into a single GIS unit. In this way departments were able to realize that they all share a common interest in data collection. Sharing between cities was also promoted and will be facilitated under the DSUD-funded City Sharing Program.

With these achievements, the pilot cities are now moving toward the full integration of GIS and satellite imagery into the planning decision making process. In Cebu and Lipa, the city government provided funds for the purchase of GIS hardware and software. In Naga and Davao, similar equipment will be forthcoming. The cities must now focus on several key policy issues, including:

1. ***Process***—the entire process of land use mapping, land use zoning, and land use planning must be reevaluated. The CPDO has now developed accurate and realistic land use maps, which serve as the basis for developing meaningful land use zoning maps and land use plans. An environment (administrative and technical) must be created in which products from the GIS unit can be effectively used by planning staff.

2. ***People***—Staff members must be permanently assigned to specific tasks so that their duties are not interrupted by other demands of the planning office, e.g., issuing permits. Staff need to be properly trained to make the information they are now collecting available to those who need it.
3. ***Applications***—GIS and planning staff must develop applications that are supportive of city government and national policy objectives, for example, locating vacant land for the urban poor. Applications, which may include land suitability analysis (land that is suited to certain kinds of development) and land availability analysis (whether such land is available), need to be prioritized.
4. ***Funding***—City governments must ensure financial support for the newly created GIS units so as to build on their initial investment in this technology. This would include maintaining computer equipment and purchasing new satellite imagery at regular intervals.

The initial successes of these land use mapping exercises cannot be considered anything more than a good beginning. There is still much work to be done. For example, at least two of the cities (Naga and Davao) have not responded well to the first stage of the extended technical assistance and have exhibited problems in carrying the mapping exercise forward on their own. The other two cities (Cebu and Lipa) are performing fairly successfully, due in large part to the determination and initiative of the local staff.

There are several caveats that need to be outlined in order to balance the assessment of this first phase. They are:

- Naga and Davao have had difficulty after the initial round of training. This is not an indictment of the LGU technical staff, however. The technical staff of these two cities (especially Davao) performed extremely well during the training and technical assistance and are eager to move forward. Rather, it is the lack of a senior "champion" capable of moving the applications forward through the morass of local municipal bureaucracy that has hindered progress;
- The first stage of the land use mapping exercise did not provide detailed software training. This needs to be corrected in any follow on assistance. Cebu, for instance, is experiencing frustration in not being able to manipulate their data through advanced use of their software[1]; and
- Institutional support mechanisms (both for the system and for information sharing) are still in the early stages of development. These will require time and continual attention to develop and strengthen. Ultimately, institutional capacity will dictate the long-term success of the systems.

[1] It should be noted that Cebu has generated a large quantity of data and has initiated numerous preliminary applications far more quickly than originally anticipated.

1 INTRODUCTION

The United States Agency for International Development (USAID) launched the Decentralized Shelter and Urban Development (DSUD) Project in 1991 to support the Government of the Philippines' program to decentralize and devolve authority to local governments. Specifically, the DSUD program was designed to assist the 60 chartered cities[2] in developing their resources and capacity in order to efficiently and effectively carry out new responsibilities, as mandated under the Local Government Code of 1991.

The DSUD project has provided support and direct technical assistance to selected cities in the areas of:

- improved financial management;
- capital investment programming; and
- strengthened strategic and urban planning processes.

These are elements of a more broad agenda that encompasses the development of a self-sustaining system of financing, improved delivery of urban services and infrastructure, and improved access to sustainable urban shelter delivery for low-income households.

1.1 The DSUD Project: Task Order 11C

The DSUD project is implementing direct technical assistance to Philippine cities through a series of managed task orders. Task Order 11C, entitled "Support for Land Use Mapping: Utilizing Satellite Imagery and PC-Based Geographic Information Systems for Rapid Land Use Assessment," was designed to assist selected cities develop up-to-date land use maps as the first step toward understanding their respective urban resource bases. This accurate, detailed inventory of land in each city will serve as the basis for the development of a realistic zoning plan, a local shelter plan, and vacant land inventory, as well as the initiation of a process of information gathering for improved urban management.

The process of city selection for Task Order 11C took place over a number of months, beginning with an initial USAID-sponsored presentation and seminar given by PADCO at the Admiral Hotel in Manila (June 1992). National government agencies concerned with urban development and planning, as well as representatives from interested cities were invited to attend this seminar, entitled "Planning Applications and GIS Technology," which focused on the potential use of GIS and satellite imagery for urban management. At the end of this seminar, questionnaires were given out to the attendees in an attempt to gauge desire to use GIS and to survey which applications they felt were most appropriate or needed in their respective cities. The results of this questionnaire clearly showed that over 90 percent ranked land use mapping, followed by tax mapping and road and infrastructure maintenance as the three most important uses. Results from this survey also showed that all the cities represented at the seminar were interested in receiving technical assistance in this area.

[2] Now 61 with the inclusion of Mandaluyong, Metro Manila, which achieved cityhood on February 9th, 1994.

A detailed questionnaire surveying the interest and needs of pre-selected cities in five (5) areas of possible technical assistance was then sent out. Questionnaires were sent to 27 cities (out of a total of 60) which met the following criteria:

(a) population greater than 50,000;

(b) a growth rate of 2.4 percent per annum or more; and

(c) location outside Metro Manila.

Based on answers received, subsequent field visits, and the willingness of cities to provide counterpart funds for GIS hardware and software, the field of potential city recipients was further narrowed to four cities: Cebu, Davao, Lipa, and Naga (see Figure 1 below).

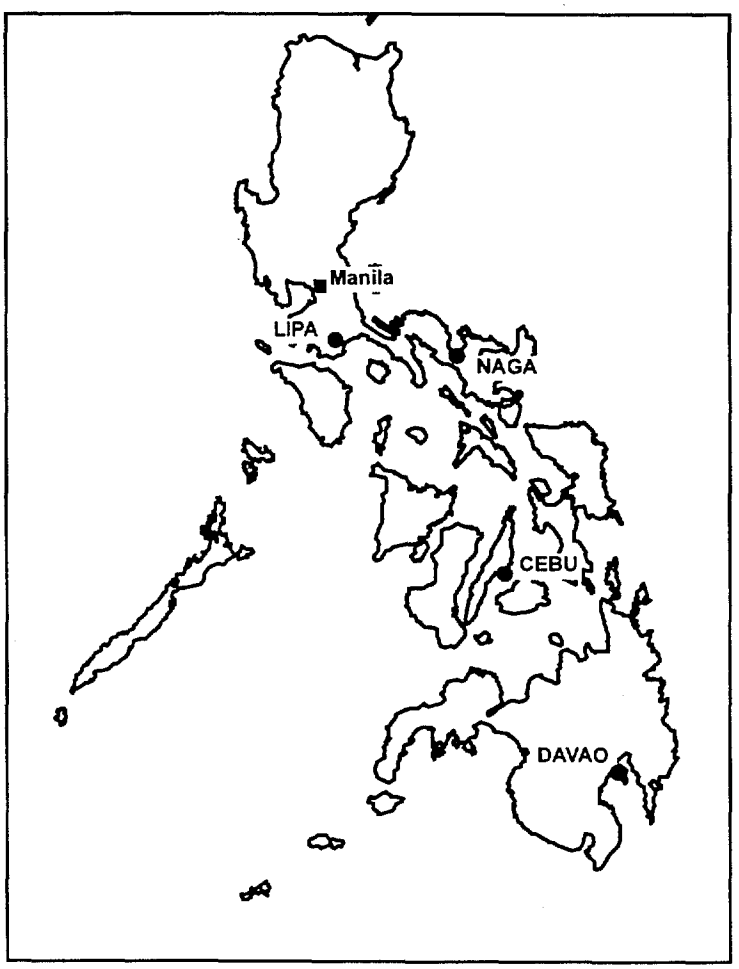


Figure 1- Map of the Phillipines showing the four DSUD land use mapping sites.

Future capability to replicate the pilot Rapid Land Use Assessment (RLA™) process was considered crucial, particularly in light of the rapid urbanization being experienced in cities throughout the country. Recognizing that one approach would not be appropriate for the diversity of Philippine cities (in terms of size, capacity, and financial resources), the four cities were selected to represent the spectrum of cities found throughout the Philippines. Cebu represented the larger, fast growing city and Lipa represented the smaller, less urbanized city. Davao would be similar to Cebu in size and resources; Naga closer to Lipa. (see Figure 2 below).

In this manner, a city hoping to replicate the land use mapping process in the future will be able to select from these four pilot cities the one that best approximates their size and resource base. Thus, the pilot experience funded under the DSUD project will serve as a model for replication.

Finally, it is envisaged that by producing accurate and timely land use maps within the framework of a locally based, sustainable process, the cities themselves would begin to understand its importance and use it to empower a vibrant, dynamic urban planning process.

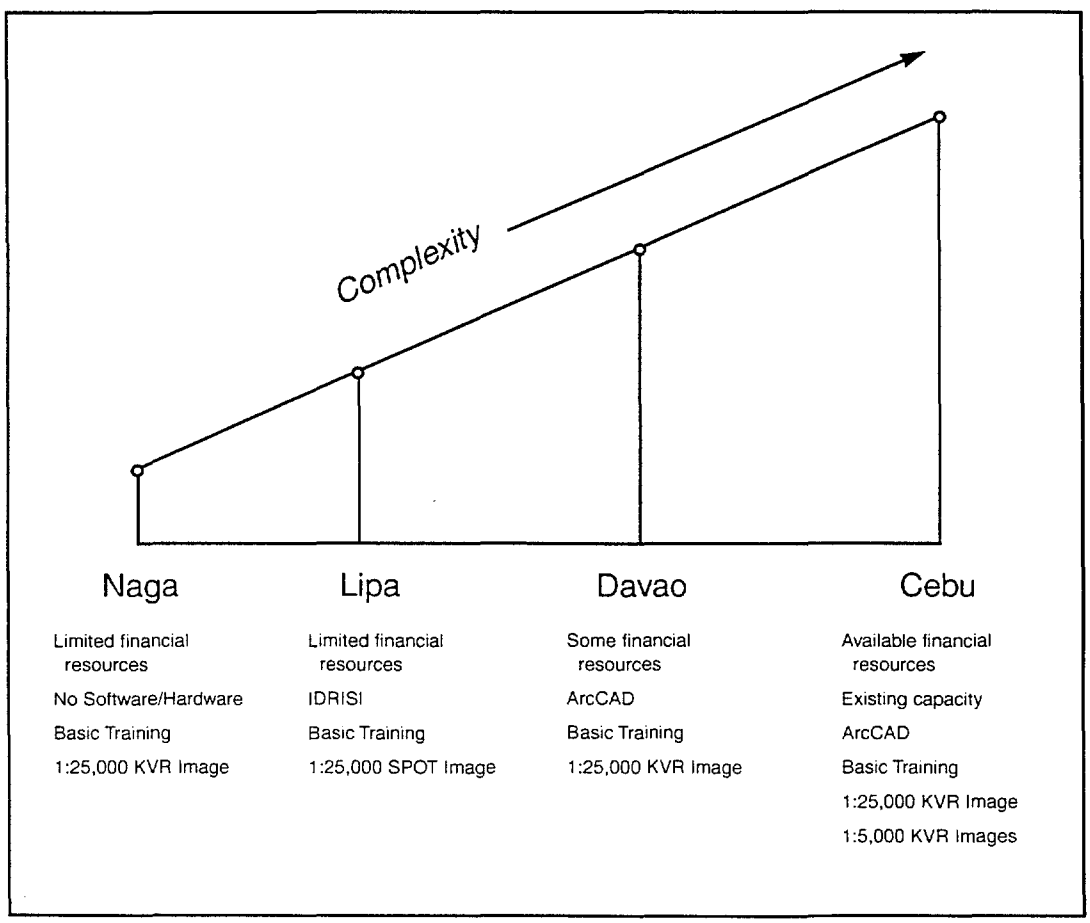


Figure 2- Charted range of development in cities.

2 BACKGROUND

The urbanization of Philippine cities has presented tremendous challenges to the local governments responsible for managing growth. Based on trends established by the 1990 Census, the Philippines is now more than 50 percent urban. Urban areas are growing at a rate 15 times faster than that of rural areas, and this trend shows no sign of slackening. Confronted with the problems of uncontrolled growth—congestion, squatter settlements, and inadequate infrastructure—urban managers must look for new ways to keep pace with rapid urbanization, understand its dynamics, and effectively plan for the future.

At present, most Philippine cities have very little or no access to up-to-date, accurate data on their respective urban resource bases. Such information is crucial to the urban planning process; without knowledge of what is there and what, how fast, and in what ways it is changing, effective planning cannot be done. A meaningful local shelter plan, for instance, is difficult to produce if data is not available on the number and location of squatter residents in a given city, and the vacant land available for relocation and resettlement.

The most elemental data required by urban planners, city engineers, city assessors, and health officers is in the form of an accurate and detailed land use map. Unfortunately for most City Mayors and their City Planning and Development Offices (CPDOs), the best map readily at hand is a 1970s- or 1980s-era land use map. Coupled with the simplicity of these maps, and in the light of rapid rates of growth and development, these maps are useless for urban and strategic planning, or other city management purposes.

As mandated under the Local Government Code of 1991, and Executive Order 72, land use maps prepared by local government units (LGUs) are now approved at the local or provincial level, rather than by the national Housing and Land Use Regulatory Board (HLURB). These maps are the basis for zoning and comprehensive development plans which chart long-term growth and the development vision of the LGU.

For virtually all Philippine cities, their land use maps are grossly out-of-date, are lacking in detail, and are the product of mechanical compliance with national government directives. In effect, these land use maps were created for "show," and not as a means for achieving sound and equitable development within their locality. Limited resources and a dearth of skills compound the problem. This is now changing with the implementation of the Local Government Code and other legislation, and a corollary demand by local constituents to take greater control of their city's development. Nevertheless, there is an entrenched "culture of expediency" which represents urban planning in the Philippines and which manifests itself in an inaccurate land use map. This "culture of expediency" can be defined through the following:

- ***Oversimplification of land use both in form and classification.*** This has taken place through a very simple and understandable process: if a local planner is tasked with creating a land use map of existing conditions, and is given a timeframe of several weeks to complete it (in addition to myriad other responsibilities), the results will be predictable. The planner will, over time, simplify the classification scheme in order to make it quicker to assign and easier to update. The result: a land use classification and interpretation scheme that fails to describe the city.

Secondly, the planner must perform all tasks manually. Every update necessitates a manual redrawing and recalculation of relevant shapes and areal statistics (usually by planimeter). This is a timely and boring process. The answer? Create land use shapes that are regular and simple in form (i.e., straight sides and regular angles). The result: a simplistic depiction of the city. This process of oversimplification is driven by an institutional set-up whose every incentive is to cut corners and generalize. If the basis for planning is an accurate and detailed land use map, it is hardly surprising that little planning has taken place in the past.

- ***A lack of understanding of the difference between zoning, a land use plan, and an actual land use map.*** Often, these various maps are merged into an idealized wall map in a given city, and play no role in local decision making.
- ***Obsolete data.*** This is closely tied to the process of oversimplification. If the only available data are old, then it merely exacerbates the lack of useful information. A land use map that is 10 or 20 years old is useless, especially in a city with urban growth rates above 2 percent per annum. The urban population in the Philippines is growing, on average, at an extremely high rate of 5.14 percent per annum.
- ***A lack of understanding of the importance of the local planning process and the role of a land use map.*** This is due to the inability by local governments to fully grasp and appreciate the concepts and ideas of self-empowerment and self-reliance embodied in the Local Government Code, but this surely will change with time. A general lack of training has also contributed to this problem.
- ***A lack of spatial analysis and knowledge.*** Geography is not taught at any level in the Philippines as a discrete subject. Only one university has a course in basic geography. This lack of training and spatial understanding[3] is at the core of the lack of sound, comprehensive planning. This creates even more problems when trying to incorporate and implement tools such as GIS and satellite imagery into planning. Not only does training have to take place on basic technology, but on spatial analysis as well. This makes the use of GIS for true analytical purposes a long-term proposition.
- ***Competition for planners' time.*** Carrying out regulatory functions (e.g., daily adjudication of zoning and building disputes, issuing permits, etc.) limits the time available for pro-active strategic planning. This is critical given the increasing responsibilities delegated to city staff already burdened with multiple job responsibilities. Clear, consistent job descriptions are lacking. Many local planning offices do not have an institutional capacity for planning.

[3] The lack of appreciation for one's place is a critical issue; without it one cannot understand the nature of the surrounding environment nor one's impact upon it.

- ***A fragmented data and information gathering process.*** A review of the steps that a person must go through in order to acquire a building permit, and the way that transaction is recorded, makes clear the need for fundamental changes. This process has developed over time and has been compounded by a lack of training, inefficiency, and a profusion of "toll gates" of illegal monetary recompense. In order for information technology such as GIS to play an effective and useful role, these systems of collection and transaction must be thoroughly overhauled.
- ***A lack of comprehension among city departments of the importance of strategic planning.*** Few cities, if any, bring together their various staff to conceptualize, develop, and implement a planning vision. Day-to-day realities, misplaced priorities, and limited resources direct their collective energy elsewhere. It is not surprising that in this environment, land use and zoning plans—based on "cartoon"-like, oversimplified maps—are not understood, used, or enforced.
- ***A lack of understanding among city departments of the interconnectivity of each other's functions and actions across the spatial dimensions of their urban area.*** This is particularly critical for GIS, as one of its greatest strengths is that of acting as an integrator of separate city departments and organizations and their information and activities.
- ***A lack of understanding that many of their cities' current ills are directly attributable to little or no strategic planning in the past and no adherence to any planning vision for the future.***

This "culture of expediency" has meant that cities currently prioritize and deal with what seem to be the more pressing issues—pollution, inadequate, unserviced shelter, urban squalor, lack of jobs, road congestion, poor drainage—yet fail to realize that these problems are the result of a lack of planning itself.

The weak planning process is understandable. A mayor cannot be expected to use the present land use or zoning maps in his or her decision-making process if they are neither realistic nor feasible. Can a mayor, while conferring with private developers or barangay captains on proposed development, use the existing plans and zoning mechanisms? Can he or she determine and present a vision for the future based on these decision-making tools? At present, the answer is no.

Unless these fundamental issues are addressed and corrected, there is little hope for effective and meaningful planning in Philippine cities as the very livability and sustainability of these cities depends on the success of local governments to achieve lasting solutions. This project attempts to introduce an innovative approach to data acquisition and new tools to counteract these problems.

3 PROJECT PURPOSE

The primary purpose of the project is to transfer data and skills to local city staff necessary to produce accurate, up-to-date, and detailed actual land use maps. The process uses PADCO's Rapid Land Use Assessment (RLA™) methodology which incorporates local knowledge, high resolution satellite images, and PC-based GIS to rapidly generate up-to-date, accurate land use maps over the course of 5-6 weeks.

By improving the existing land use mapping and classification process, it is felt that a basis for realistic and dynamic urban planning can be developed. This emanates from the precept that the more detailed and accurate the land use map, the more accurate and realistic the planning strategies that can be derived.

Finally, this project sets out to attack the issues as described by the "culture of expediency" previously highlighted, through the following activities:

- Use accessible, high-resolution Russian military satellite data[4] to allow the mapping of detailed land use, at appropriate urban scales (1:5000 and 1:25000);
- Train city staff in land use data collection, analysis, and basic GIS use; and
- Assist and advise the cities in implementing their own locally based GIS facilities for ongoing collection and use of information for development planning and analysis.

It is not melodramatic to state that Philippine cities are at a critical juncture: either they move forward on a path that allows incremental and sustainable development through the use of effective planning, or they sink further into the morass of urban blight and poverty.

[4] While some previously classified Russian military data has been used by private sector US aerospace companies for testing and by universities for evaluation purposes. KVR data has never been used before in the civilian arena. Its advantages both in terms of spatial resolution and cost are detailed in later sections of this report.

4 PROJECT PROCESS AND DESIGN

4.1 Process—Schedule of Activity

The project was implemented in two five-week phases. The first phase began in October 1993 and was completed in November 1993. The second phase began in February 1994 and was completed in March 1994. Two consultants, Peter Rabley and Nigel Edmead of PADCO, Inc., were assigned to cover the four pilot cities. The cities visited during the project are shown in Table 1 below:

Table 1. CITIES VISITED

Name	Oct. 1993	Nov. 1993	Feb. 1994	Mar. 1994
Rabley	Cebu	Cebu	Lipa, Cebu	Cebu, Davao, Lipa
Edmead	Cebu	Davao	Davao, Naga	Davao, Lipa

During the first phase, Rabley and Edmead worked in Cebu and Davao respectively, developing the land use classification scheme, providing the initial interpretation training, and helping to produce an initial land use map. Lipa City staff traveled to Cebu to participate in their training as imagery for Lipa was still being processed in Washington, DC.[5] In the gap in the phases of technical assistance (December 1993 to February 1994), Cebu and Davao continued to revise and refine their land use maps on their own.

In the second phase, satellite imagery and technical assistance was provided to Lipa and Naga. Lipa was visited first in order to further develop skills learned by their staff during their training in Cebu and to perform field work within their own city. After one week, Rabley then returned to Cebu to start the second input in that city. Edmead visited Naga for an initial week of training in manual methods of field work, and to devise a new land use classification schemes. Naga staff then traveled to Cebu, when their imagery was available, in order to receive more training and use the facilities now present in Cebu.

In the meantime, Davao staff had been receiving more training from Edmead and wrapped up their work with a final presentation on March 12, 1994. Following this presentation, Davao staff and officials traveled to Cebu where they attended additional training classes and participated in the presentation of future applications that the city of Cebu had developed.[6]

Two cities, Cebu and Lipa, developed GIS facilities during the second phase. Both cities were able to purchase hardware from local vendors and selected software was brought in from the U.S. by PADCO. In the case of Cebu, the facility was completed in three weeks, allowing the project to use this office as a central training site for Davao and Naga. Lipa's hardware and software arrived and was installed on the final day of the project. Edmead was extended an additional week in order to provide more training and to ensure a smoother implementation process.

[5] The imagery procured for Lipa City (SPOT) was processed by Earthsat Corp., of Rockville, MD based on inputs and specifications provided by PADCO GIS Services.

[6] A great deal of thanks must be given to the City of Cebu, in particular to Mayor Tomas R. Osmeña and Secretary to the Mayor, Rene Sanapo who graciously provided lodging and meals for the Davao and Naga staff during the final week of the project.

4.2 Design

The main concept of this pilot project was to develop a land use mapping process that would be applicable and replicable in other Philippine cities. This meant being as creative and adaptive as possible, and, in some cases, accepting compromises in less than ideal situations. Every attempt was made to use existing skills and facilities and, where possible, to involve other agencies and groups in the process. It was felt that by following these basic tenets, a better chance of long-term success could be realized. These approaches were implemented in the following manner:

4.2.1 Continuous Interpretation

The process of land use interpretation and classification was devised to be an ongoing process. Subject to continuous interpretation by City staff, the satellite map provided more detailed information on urban land use types. This also helped to reinforce among city staff that this project was only a starting point; they will be responsible for seeing this process continued and refined into the future.

4.2.2 Phased Visits

The phasing of the consultants input allowed the process of land use interpretation to be evaluated over intervening periods. This helped the project to achieve the maximum amount of coverage and output, given the considerable tasks to be performed in four separate cities over a relatively short time period.

4.2.3 Resource Sharing: Leveraging Local Resources into the Process

A detailed process of "sharing" among cities was devised to share products and processes developed under the technical assistance. This was based on the concept of the larger, USAID-funded "Sharing Program" component of the DSUD program. The Sharing Program brings cities together, in association with the League of Cities, to share successes in urban management in a hands-on fashion. In this instance, bringing staff from other cities together in Cebu allowed counterparts to work alongside each other and to evaluate and compare problems and solutions that each were considering or implementing. For example, staff from the EDP section of Davao were able to work alongside counterparts from Cebu's MICS department. Additionally, staff (Cebu and Davao) that had already been through various training cycles were able to help staff from cities just entering the project, i.e., Naga. This reinforced the consultant training both from the standpoint of additional help and in terms of helping to reinforce what the Cebu and Davao staff had already learned. This process of resource sharing has helped to ensure a "transfer" of ideas on a level that consultants alone could not have achieved.

In Cebu, considerable use was made of the existing facilities and resources of the University of San Carlos' Water Resource Center (USC-WRC) and the local Region VII office of the Department of Environment and Natural Resources (DENR). In the case of WRC, their GIS analyst, Robert Concepcion, was hired by DSUD to provide additional support and training to the city staff in both phases. WRC's equipment in the form of a digitizer and plotter were also used for training and production of the Cebu and Davao land use maps. DENR was also used both in terms of staff and equipment to help with training and production. In the case of DENR, payment was made in kind by providing new digitizing equipment and advanced GIS "tips and tricks" to their staff by Rabley. Since both facilities in Cebu were using the PC ARC/INFO GIS package, this software was used initially.[7]

In Davao, during both phases, the Davao Power and Light Company computer facility was utilized. This facility was originally identified during the first few days of Edmead's first visit. The facility consisted of PC-based CAD (AutoCAD) equipment, a 486 computer, a plotter, and a digitizer. Use of these facilities enabled the first draft land use map to be produced within five weeks of project startup.

This idea of resource sharing is not intended to stop here. One of the greatest potential benefits of developing such a sharing program is that "regional resource units" can be established that act as further conduits for decentralization. For example, some of the less affluent cities within Mindanao have just as much desire and need for this project, yet cannot afford them. By having Davao act as a local resource, these other areas can come to the city of Davao, receive training in the land use mapping process and application and use their computer facilities. In this way, they, too, can develop reasonable land use maps and develop strategies and plans for the future. In Cebu, this process is already being undertaken by Secretary to the Mayor Rene Sanapo who has extended help to the cities of Lapu Lapu, Talisay, Manduae, and Liloan, whose areas are covered by Cebu's satellite imagery. In addition, Batangas City, as well as the Province of Batangas, has asked the help of Lipa City in establishing their respective GIS capabilities.

Finally, the technical assistance has been designed to be shared under the USAID-funded Sharing Program itself. An initial activity took place April 25-29, 1994 in Naga City, Luzon, entitled "GO-NGO Cooperation in Urban Development and Housing." Presentations were made by Naga City Mayor Rebredo (Naga's Urban Development Strategy: Empowering the Urban Poor), Lipa City (SIPAGLAKAS Movement: An Ambitious City Development Strategy), and Cebu City (GIS and Rapid Land Use Mapping).

4.2.4 Matching Funds

Another unique aspect of the design of this project was to provide technical assistance to only those cities who had demonstrated serious interest. This "serious interest" was "tested" through a series of presentations, field visits, user surveys, and finally the commitment of counterpart financial resources.[8]

4.2.5 Spectrum of Application

A major design component of this project was the development of the land use mapping process in four cities that represented the broad spectrum of Philippine cities. To this end, Cebu was selected as the most developed and advanced case. Earlier field visits had indicated the presence of GIS facilities and projects already underway as well as additional data. In this way, Cebu was selected to receive 1:5000 scale satellite imagery to be used as the basis for pilot testing supplemental applications such as tax mapping, road maintenance, and infrastructure planning and management. Towards the other end of the spectrum, Lipa City received SPOT satellite data at 1:25000 scale which has been used for land use identification and as the basis for a general land use and zoning plan. Davao and Naga round out the selection of cities within this spectrum.

[7] In Cebu in the first phase, PC ARC/INFO was used. Cebu eventually purchased ArcCAD for their own use which is fully compatible with PC ARC/INFO. GIS software and hardware was present at WRC as a result of foreign donor projects. In the case of DENR, these facilities had been installed as part of the Australian (AIDAB)-funded, four-year NRMDP project.

[8] Many GIS installations in developing countries have failed for a variety of reasons. One of the major problems is that recipients of such technology are eager to avail themselves of new computers for computer's sake and the misguided perception that the GIS is a "magic wand" that will solve problems and absolve managers and decision makers from the tasks of management. By leveraging some reasonable payment from the potential recipient, a different atmosphere of desire was created within the agency.

5 METHODOLOGY

Recent technological advances, especially in the areas of desktop mapping, Geographical Information Systems (GIS), and satellite image gathering, have resulted in the ability to quickly produce accurate and up-to-date information on urban resources. However, it is the application and methodological approach to this application that is the key to the successful utilization of these technologies.

The Rapid Land Assessment (RLA™) methodology has been specifically designed to maximize local government resources, to integrate them with personal computers and satellite imagery, and to produce accurate and detailed land inventories and land use maps in a timely and sustainable manner.

As Figure 3 shows, the methodology generates several studies before an actual land use plan is developed. The two most important of these are the Land Availability and the Land Suitability Studies. These two studies are described in outline in Section 7 of this report.[9] This methodology has provided the cities with the ability to react more rapidly to land use change and to proactively anticipate changes in their urban space. The RLA™ methodology relies on several key concepts:

- High Resolution Satellite Imagery
- PC-Based GIS
- Land Use Classification
- Training
- Field Surveys
- Manual Image Interpretation and Field Knowledge

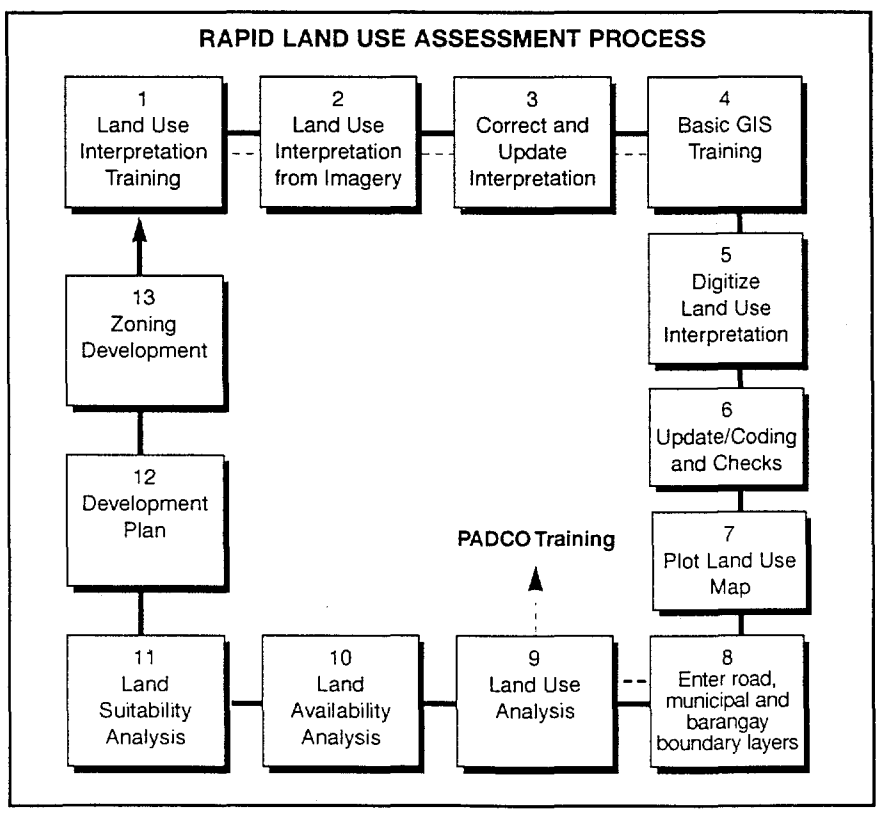


Figure 3- Illustration of RLA™ methodology

5.1 High Resolution Satellite Imagery

The spatial resolution[10] (see Figure 4) of the Russian KVR imagery makes it highly applicable for urban land use mapping. With a spatial resolution of up to 2.4 meters,[11] managers and staff can see the nature and extent of urban development from a "bird's eye view." Individual buildings, roads, and other features are clearly visible, presenting a single, comprehensive view of their entire urban expanse.

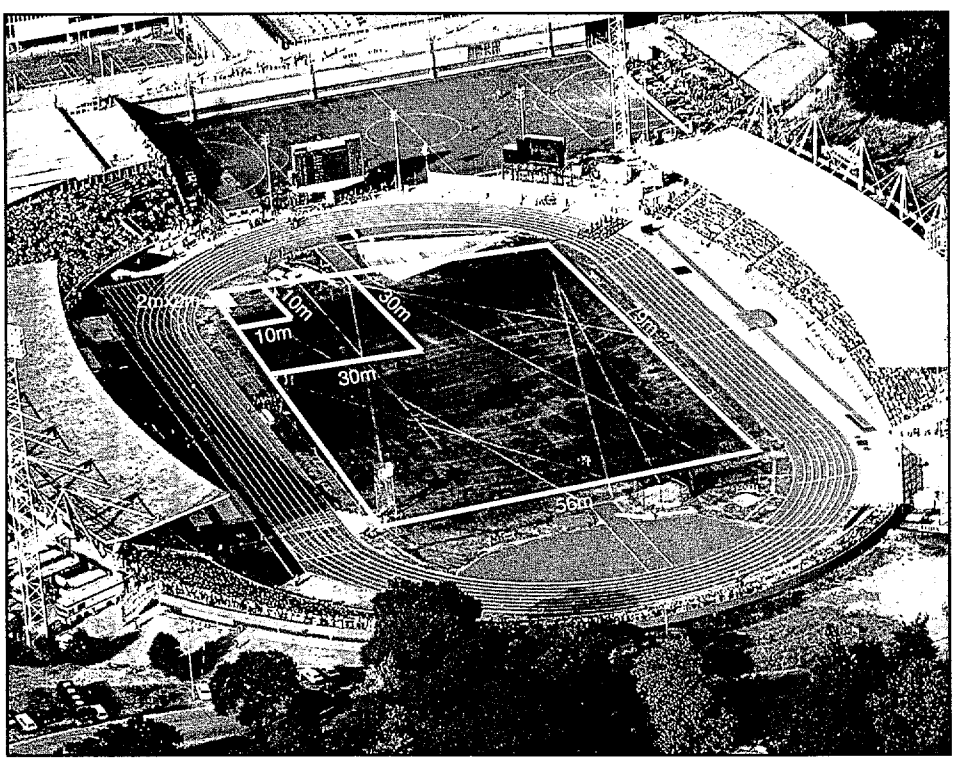


Figure 4- Diagram illustrating spatial resolution (adapted from Jensen, 1986.)

[9] The purpose of this study is not to do these two analyses, but rather to help the cities develop the necessary skills, tools, and data so that they can perform the work themselves. To some degree, Cebu has already begun this process.

[10] Spatial resolution refers to the minimum measurement that can be used to define objects on the earth's surface. The KVR data with a spatial resolution of 2 meters means that any feature larger than 2 meters square can be seen on the image. SPOT data with a spatial resolution of 10 meters is therefore 25 times coarser or larger than this. Spectral resolution refers to the ability of the sensor or recording device to collect different wavelengths, in this case across the visible spectrum (i.e., red, green and blue or RGB).

[11] The actual spatial resolution of the KVR data will vary depending on the period of orbital ellipse the satellite is in when the picture is taken. Although commonly described as 2 meter data, it is actually only possible to collect data at this resolution when the satellite-borne camera is at the closest point of its orbit to the earth's surface. In the case of Davao, the imagery collected has an actual spatial resolution of 3.075 meters.

This spatial resolution of the KVR data is extremely important as it allows mapping at scales as large as 1:5000. In comparison, other commercially available satellite data, such as SPOT and LANDSAT, allow mapping at maximum useable scales of 1:25000 and 1:50000, respectively. While scales of 1:25000 and 1:50000 are sufficient for general urban and regional planning, they are not detailed enough to allow intra-city planning and management. Mapping at 1:5000 scale from satellite imagery means that city infrastructure planning and management, tax mapping, environmental modelling, and analysis can now occur.

Satellite imagery has several advantages over other sources of remotely sensed data:[12]

- it is less costly[13];
- it is readily and frequently available[14];
- the SPOT satellite is in a sun-synchronous orbit. This potentially allows for multiple images of the same area to be acquired which is excellent for time-series analysis. The Russian KVR satellite[15] is launched every three months and returns to earth after three months in sun synchronous orbit allowing ready and continuous data collection. Additional Russian rockets are launched regularly;
- it covers a single area (i.e., the city extent) on one picture/print and is not subject to the color or tone variations that characterize a mosaic of aerial photographs. This makes visual interpretation easier.

The imagery provided to the cities is rectified and geo-corrected.[16] This means that it is a true map product and can be used for accurate interpretation, distance measurement, and areal calculation.

[12] Remotely sensed is, in effect, any data that is gathered from "above the earth's surface"; i.e., remotely from a collection device, such as a camera or sensor.

[13] Davao City government has recently awarded an 8 million Peso contract to fly 1:5000 aerial photographs for an area 20km sq. or 40, 000 hectares, less than the area covered by the current Davao KVR scene. The cost per hectare for the aerial photography is US$7.5 per hectare (with contours) and for the KVR data about US$.30 per hectare (with no contours).

[14] However, one drawback to satellite imagery is the difficulty of obtaining cloud-free coverage, particularly in the Philippines. Most satellites have the ability to collect data over two or three days; after that, they must revisit the same site 16-23 days later. After a few attempts to collect data (usually three), the decision is usually made to discontinue collection. Programming aerial photography, however, can be carried out in accordance with local weather conditions.

[15] The Russian KVR satellite data is different from that of its SPOT or LANDSAT counterparts in that it is not collected digitally. That is, KVR data is actually collected as an analog photo-negative (14" sq.) from a spaceborne camera. These negatives are then physically returned to earth. PADCO's joint venture partner, KIBERSO, a specialized Russsian image and GIS firm, then scans the negatives at 5,000 dots per inch (dpi) to produce digital data for further image processing.

[16] This process entails "adjusting" or transforming the image data to a real-world coordinate system, such as the Universal Transverse Mercator (UTM). Errors introduced by the curvature of the earth, tropospheric distortion, and the camera lens are corrected. Finally in order to produce the sharpest visual image, filtering, stretching, and re-sampling techniques are employed to reduce the effects of haze and enhance clarity of detail.

For each of the cities, a 1:25000 scale satellite map print was used as the basic data from which to prepare the land use map. Cebu also received a set of 1:5000 scale (see Figure 5 below and Map 1) satellite maps covering the major urban expanse, which allowed an additional pilot activity of tax mapping to be started. Imagery provided to each of the cities is detailed in Table 2 below.

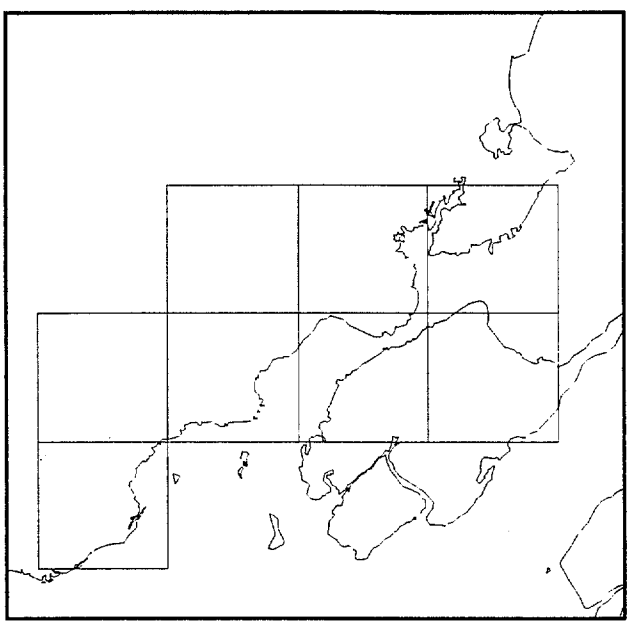


Figure 5- Russian KVR coverage of Cebu region mapped at 1:5,000

Exact acquisition dates are not provided for all KVR images. This is one of the demands that the Russian military archive still makes. The reason is simple: with the acquisition date and the area of coverage, it becomes possible to predict orbital paths of these military satellites.

Table 2. TYPES OF SATELLITE DATA PROVIDED TO EACH OF THE CITIES

City	Data Type	Scale	Acquisition Date	Quantity
Cebu	2.4 meter KVR data	1:25000	First Quarter 1992	1
Cebu	2.4 meter KVR data	1:5000	First Quarter 1992	8
Davao	3 meter KVR data	1:25000	First Quarter 1992	1
Lipa	10/20 meter SPOT	1:25000	March 21, 1991	1
Naga	2.8 meter KVR data	1:25000	July 30, 1991	1

As there were no KVR data available for Lipa, the French SPOT satellite was used. In order to provide the best possible image, PADCO used digital data taken two seconds apart in both panchromatic (black and white) and multi-spectral (color) modes. The former data has a spatial resolution of 10 meters and the latter 20 meters. By digitally merging these two files, an image containing the spatial resolution of one and the spectral resolution of the other was created. This color imagery is extremely useful for Lipa as the surrounding land use is predominantly agricultural. (Please see Map 2) Each satellite map was geo-corrected to the Philippines Traverse Mercator (PTM) projection system. The PTM projection system is used by NAMRIA for all its topographic maps and is derived from the Universal Transverse Mercator Projection System, which divides the earth into a series of zones. The PTM system divides the Philippines into five zones. Each zone is three (3) degrees east to west. This projection system ensures that measurements, in meters, are consistent across the Philippines. Imagery geo-correction was carried out using NAMRIA's 1:50000 topographic maps for each of the cities and, in the case of Cebu, 1:5000 (1988 GTZ-sponsored program) scale maps of the city center were also used. Thus, the images and resultant land use maps are consistent with Philippine national mapping standards.[17]

[17] Had extra time not been taken to obtain topographic maps for rectification, it would not have been possible to create a true rectified image product. This is important because the true value of the image beyond an artistic one is in referential integrity, i.e., its consistency to national mapping standards.

CEBU

IMAGE INFORMATION

Transverse Mercator Projection PTM Zone IV

Average positional error < 10 meters

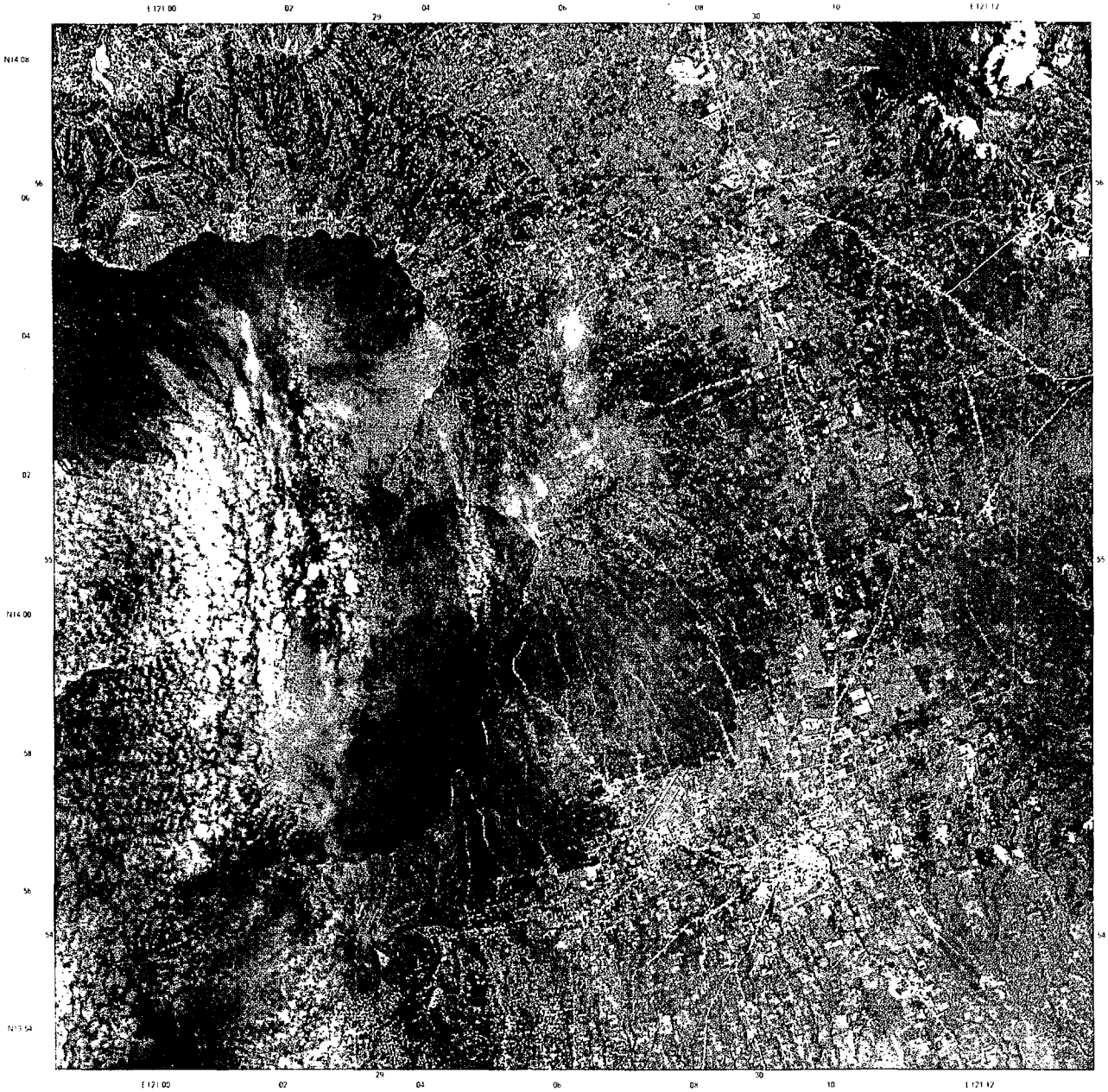
mage acquired 1992

N

0 1 KM

INDEX TO ADJOINING SHEETS

LIPA CITY, LUZON



Projection Universal Transverse Mercator
UTM Zone 51 Clarke 1866 Spheroid
10 000 meter grid ticks
Absolute positional error 40 meters
Relative positional error 21 meters

Images acquired 30 Jul 91

PADCO GIS Services

PADCO GIS
PH (202) 789 1140
FX (202) 789 0242
PADCO Manila
PH 63 2 813 3506
FX 63 2 817 2767

Processed by Earthcal for PADCO
Date Processed 24 Jan 94
Image data copyright CNES 1991

Images processed and projected under USAID contract PDC-0000-C-00-2005-00
task order #11 as part of the USAID-funded Decentralization Shelter
and Urban Development Project

Location Diagram

The use of a map projection[18] system is critical to any GIS; without one, there would be no real-world coordinate system present, and, hence, data layers in the GIS could not be referenced to each other, i.e., they would not align or overlay. For example, a data layer containing road information is stored in inches based on a scheme that was invented by a staff member who is no longer with the city; another layer containing information on the location and type of city water pipes has been entered in meters. When the computer attempts to draw these two layers, they will not "appear together" or overlay on the screen. Figure 6 below details this concept.

Information interpreted from the satellite image is used for spatial analysis in the GIS. This is an important point, because before the imagery was available to the cities, they had no way (or no understanding) to align different data types as no common geographic reference scheme was used.[19] Neither the CPDO nor the City Assessors office uses any geographic coordinates on their maps. The only use of geographic coordinates is found in the individual surveys of properties from the Bureau of Lands. However, the Bureau of Lands uses individual traverse surveys to demarcate the property and only a cursory attempt is made to tie these surveys to the PTM national grid system.[20]

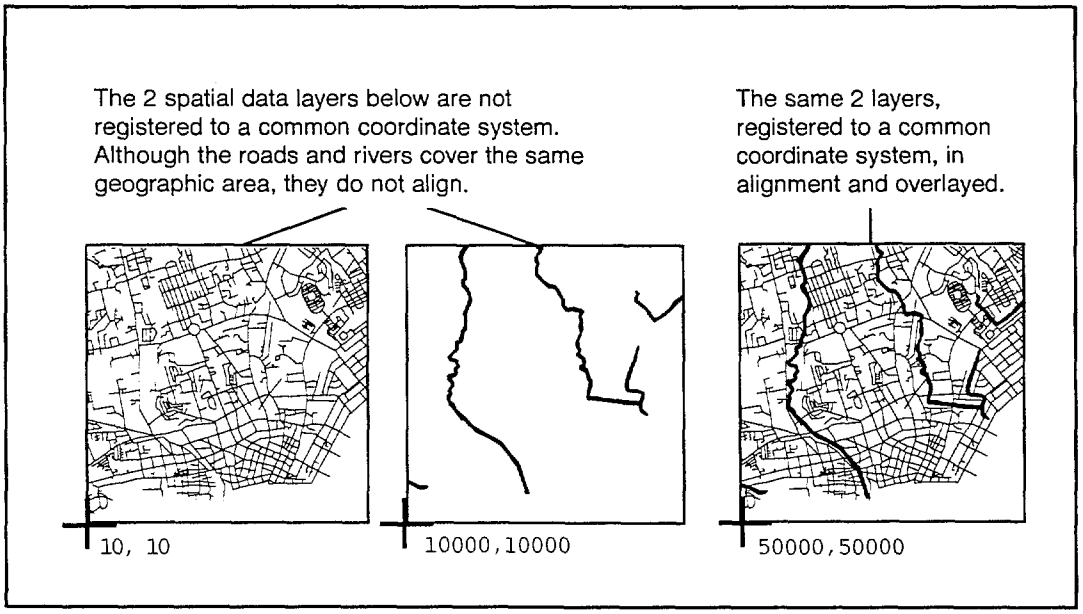


Figure 6- Illustration showing the need for layers to have common registration.

[18] Projection is the term given to the process by which cartographers translate a three-dimensional world into two dimensions on a map. The first projection system was the Mercator projection invented by the 15th century cartographer of the same name.

[19] This is not the fault of the cities. NAMRIA currently produces 1:50000 topographic maps which are merely reprints of 1950's era maps. Map reprints are supposed to entail field work that update features found on the original maps (i.e., revision updates). After a certain amount of time and/or sufficient change occurs the topographic maps are supposed to be completely redone (new edition) in a new series. NAMRIA has not been able to do this and so it merely reprints old maps with new dates. Use of this imagery shows many errors and omissions from the original NAMRIA 1:50000 topographic maps, e.g., roads in the wrong place or major features such as airfields missing, etc.

[20] The reasons for this are numerous: a lack of money, trained staff and equipment; and the presence of incentives to be inaccurate in measurements and demarcation of land parcels.

Each city conducted a data inventory to find out exactly what data were available and how useful it might be. The inventory also required the staff to visit various departments within the city and look for data. This exercise proved to be useful as staff were required to look at how other departments collect and use data, making them realize how little they really know about the inner workings of their city.

The result of these inventories is a wide collection of varying data types, scales, and accuracy levels. Some of the data that were collected and used includes: barangay boundaries and statistics from the 1990 census, road location and condition, hydrology, and land value.

5.2 PC-Based GIS

Recent advances in computing technology have allowed extremely powerful processors to be readily and inexpensively available in most developing countries. Additionally, software and operating systems are finally undergoing sufficient changes and improvements in capabilities and interfaces enabling powerful and easier-to-use PC-based GISs. The capabilities of these PC-based systems are beginning to approximate the systems previously found only on expensive UNIX-based workstations. Traditionally, many GIS "techno-jocks" would consider UNIX-based RISC[21] workstations as the only viable platforms for GIS use. This debate is now moot.[22] PC-based systems offer the following key advantages:

- PCs are now readily accessible and for the most part fully supported through local vendors. In Cebu, for example, the ElectroWorld vendor was available to deliver four 486/66 mHz computers in one week after receipt of order. In addition, the vendor is able to provide on-site service with a two-hour turnaround (this was witnessed twice during installation).
- Many municipal staff are already familiar with some basic operations of personal computers. For example, quite a few staff had already been using Lotus, Word Star, and dBase software, and in some cases, were familiar with Windows and other advanced applications such as Clipper.
- The ongoing maintenance costs of the PC equipment are significantly lower than minicomputer or UNIX workstation systems. Many vendors, such as IBM, charge maintenance fees equivalent to 10 percent of the purchase price, annually.
- Most PC systems are easily upgradable. New processors, hard drives, memory, video cards, and monitors can be purchased as separate components if utilization demands it. These peripherals are fairly inexpensive and readily available.

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[21] UNIX is a multitasking operating system designed by AT&T labs and is usually found running on engineering workstations or minicomputers. RISC refers to *Reduced Instruction Set Chip*, which is a powerful processor used in workstations (by comparison, the Intel-style chips are known as CISC or *Complex Instruction Set Chip*). RISC chips are now beginning to appear in PCs and can run the multi-processing PC operating systems such as OS/2 and Windows NT.

[22] The most difficult aspect of using the GIS hardware and software is not in the training or adoption of use for basic management, but in its use and employment for analysis and planning.

5.3 Land Use Classification

In the Philippines, the existing land use classification schemes[23] are either too general or are not constructed in the most efficient manner. To fully realize the value of the satellite maps, it was necessary to devise a detailed land use classification scheme; in other words, reflect all the land use types that exist in a city environment. The scheme had to be consistent, well described, and organized in a logical framework to accommodate future land use types.[24] Thus, before any training or interpretation took place, a new or revised classification scheme had to be designed and constructed, with a new numbering and coding scheme.

Existing land use classification schemes used by the local CPDO, the national HLURB, and the Japanese International Cooperation Agency (JICA)/NAMRIA were reviewed and used, where possible (see Figure 7) to cross-reference the consistency of the new land use classification scheme. Several drafts were developed before a final scheme of eighteen main land use classes[25] (and a number of sub-classes, dependent on the city in question) was decided upon.

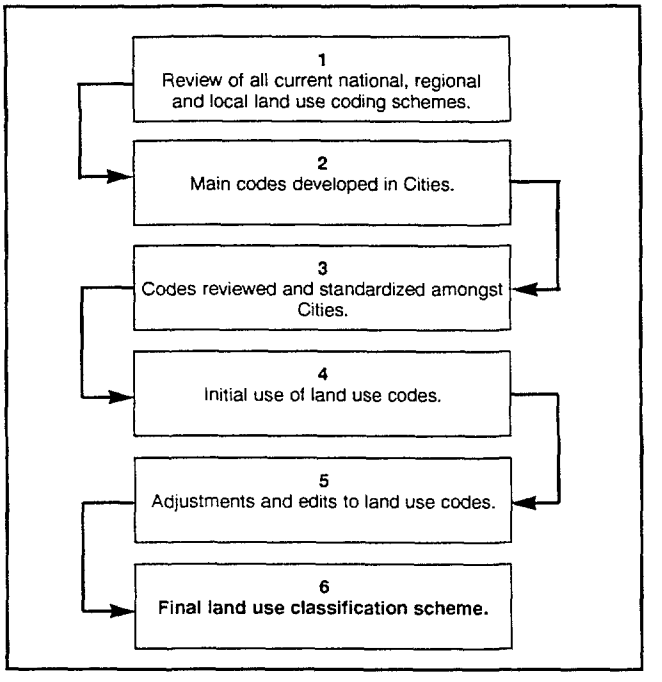


Figure 7- Development process of a land use classification scheme.

[23] An important distinction between land use classification scheme and land use code needs to be made, as the terms are often used interchangeably. In this report, land use classification scheme is a description of land use types. Land use codes are policy and planning guidelines regarding the use of land use.

[24] A hierarchical classification scheme was used similar to that employed for the classification of species in Biology (i.e., taxonomy). The main land use scheme can be considered as the trunk of a tree, the major land use types e.g., residential land use) as branches and the minor land use types (e.g., high density residential land use) as twigs. This means new land use types can be added either as "branches" or "twigs", making the classification scheme even more detailed.

[25] The subclasses can be collapsed back into 18 main land use classes, and the 18 main land use classes can be collapsed into the HLURB classification scheme (see figure 8).

The classification scheme was developed through a process of review and revision, the review being the land use types that could be identified on the image[26] and in the city and the revision, the inclusion of new land use types into the classification scheme. The final step was to develop a detailed classification description based on the characteristics of type and physical appearance on the image. The main land use classes are those that can be identified on the image and the sub-classes those that are described and known by staff based on local knowledge—hence the differences between the cities in sub-class descriptions.

Important urban land use types that were missing from existing schemes, e.g., squatter settlements, were added. Other land use types previously recorded as one land use class, e.g., Parks, Open Space, and Cemeteries, were disaggregated. Open land was separated into its own land use class, because when grouped with Parks and Recreation it grossly overstates the area of Parks and Recreation truly available. This has shown the cities the real lack of green space available for the city population. **Appendix A** provides a listing of the land use classification schemes used for each city.

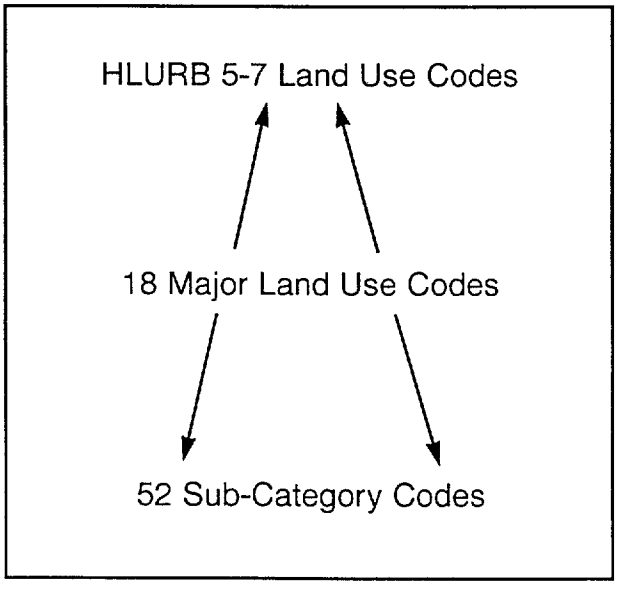


Figure 8- Hierarchy of land use classification used by the project.

[26] In the case of Naga, no image was available, so land use classes were described and developed based on the existing land use classification scheme utilized by the CPDO. Field visits highlighted the inadequacies in the existing land use map which were addressed in the revised land use scheme. This means that a land use classifications scheme can be effectively developed independent of the satellite image.

5.4 Training

Staff from different city government agencies were trained in all aspects of the land use mapping process. This training has helped foster an understanding that each department has a responsibility in the planning process.

Specifically, staff were trained in:

- ***Land use classification***: the development and description of a land use classification scheme and the use of a logical and consistent coding scheme to describe land use.

Figure 9- Staff classifying an image.

- ***Land use interpretation***: techniques and keys needed to interpret a satellite map to create a land use map. Staff from Davao and Lipa were also introduced to the use of Global Positioning Systems (GPS) to record the location of key features in the urban landscape.

Figure 10- Staff using GPS in the field during land use interpretation verification.

Figure 11- Staff at work digitizing land use interpretation.

Figure 12- Staff at work verifying digitized land use interpretation.

- ***GIS processing and software***: registering a map using a digitizing table, the process of digitizing a map, and the method of preparing a map for production. Most of the training provided for GIS was in the form of software techniques only, i.e., how to digitize a map using PC ARC/INFO. Specifically, the following courses were carried out: PC ARC/INFO Training, in Cebu and Davao; ArcCAD Training, in Cebu and Davao; IDRISI Training, in Lipa.
- ***Field surveys***: Field work and landscape interpretation for the update of the land map and the development and revision of the land use classification scheme.

The GIS training process was accelerated by the proactive stance the cities took with respect to counterpart staff support and investment. In the cases of Cebu and Lipa, hardware and software was acquired, new office space rented, and an attempt was made to incorporate the process into their city operations. GIS training included the introduction of key principles of GIS techniques and basic software operation.

5.5 Field Surveys

Although advanced technology was used in this project, successful use of technology will only come from a combination of traditional and new techniques. Field surveys and verification are an essential part of the RLA™ process, as it requires staff to go in the field and verify their assumptions and interpretation keys that have been developed to help identify different land use types.

The use of field surveys and manual methods for data updating and collection is often overlooked with today's new technology. For the city of Naga, during their first phase, manual methods were used exclusively to perform initial field reviews and to update their classification scheme. At first the staff were skeptical of the field work saying "we have done a new land use map and it is fine; what is more our definitions are fine." However, after several hours in the field and some pointed questions from the trainer, it became obvious that they did not in fact really know their own city. All their previous information was anecdotal and was not collected or analyzed in any systematic fashion.

Field work for urban analysis training as well as for structuring data categories can be started in all cities—it is not a process that requires satellite imagery or PC-based GIS. At a minimum, it starts the staff thinking systematically about defining and describing their city; at best, it allows organized and effective data collection.

5.6 Manual Image Interpretation and Local Knowledge

Manual image interpretation is perhaps the most important component of the RLA™ methodology. This activity consisted of local staff interpreting the image visually and then tracing the various types of land use onto acetate overlays. These acetate overlays were then digitized or "traced" into the computer.

The key components of RLA™ (see Figure 13), which combines new technologies and existing resources can be described by the following:

- ***The use of high resolution satellite imagery***: provided to Cebu, Davao, and Naga by PADCO/Kiberso, is an ortho-image product (i.e., a black-and-white aerial photograph), except in Lipa City where a color SPOT print was provided.
- ***A manual interpretation process***: means that advanced training in image processing software was not required.[27] Also, skills that some staff had with aerial photo interpretation were used. The manual interpretation process allows a minimum of 18 land use classes to be identified at 1:25000 scale. As the local staff are the ones performing the interpretation, they can bring their local knowledge of the area to bear and take ownership in the process from an early stage. Data compiled in this manner are easily checked for accuracy and usefulness.

[27] Highly trained image processing specialists have years of training and experience and in most cases are as much artists as they are scientists. In fact, even using the most sophisticated algorithms, it is possible for semi-automated classification routines to detect only five-to-seven classes of land use with any degree of certainty. Although semi-automated classification schemes may be able to detect the presence of buildings, they cannot detect the use of a building, i.e., commercial versus institutional. These factors are particularly true within an urban context where the landscape is far more complex than that of rural areas.

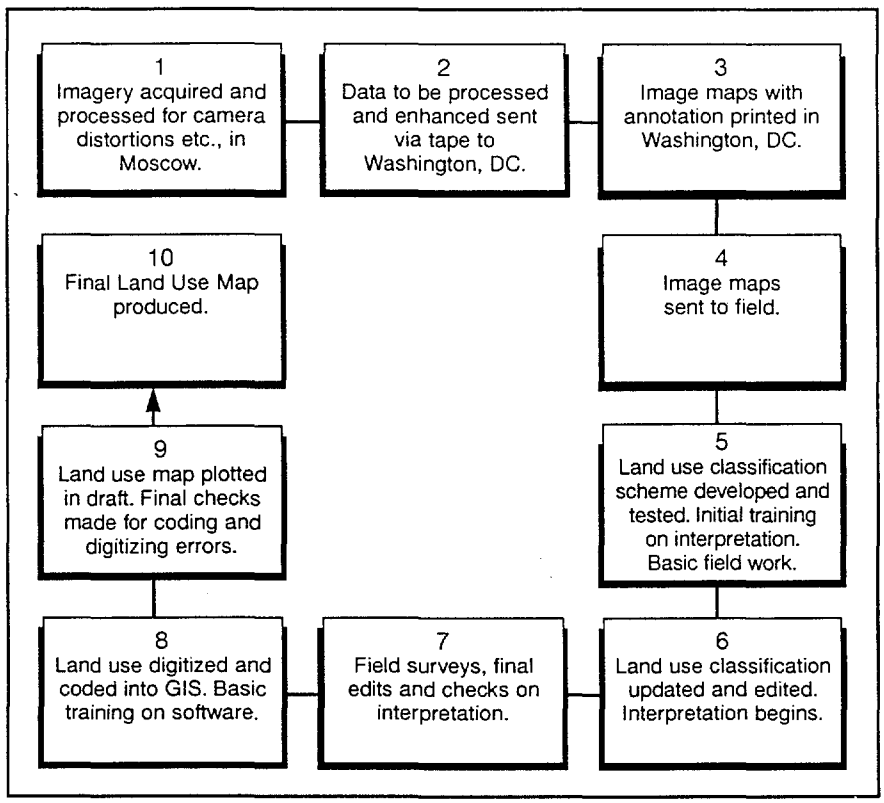


Figure 13- RLA™ process

- ***A visual interpretation process***: most cultures are visual in nature and the Filipinos are no exception. Thus, the use of a picture, which is also a map base, allows for more interaction with less training. Most maps in their traditional form (roads represented by single lines, buildings, black outlines, etc.) abstract reality and thus rely on some training in order to be utilized. For example, staff from both Davao and Cebu gathered around their respective imagery for the first time and immediately began to pick out landmarks and other key features. It became somewhat of a game, i.e., Where is the Cebu Plaza Hotel?, followed by a mad rush to be the first one to locate the hotel. The difficulty from an analyst's viewpoint is not that the staff cannot visually use the imagery, but that they cannot make analytical use of it without intensive training.
- ***A rapid process***: the whole process can be completed in 4-6 weeks, providing an instant output that can be used by the CPDO and others in decision making processes.[28]

[28] It is often the case that GIS fails to deliver the product that is promised as the presentation of results takes a long time, particularly in start-up or "pilot" exercises. Production becomes easier over time.

The manual interpretation of the satellite map was completed on acetate sheets using fine-tipped permanent pens. The interpretation of different urban land use types was based on the image's photographic characteristics: color, texture, pattern, shape, and size. Local field knowledge identifies specific sites and distinguishes their uses:

- ***Color*** refers to the range of greytones from black to white (for Cebu, Davao, and Naga) that appears on an image (white indicates high reflectance and black low reflectance, for example, a body of water). For Lipa, true color processing was applied so vegetation appears as green, water as blue, etc.
- ***Texture*** refers to the smoothness of the feature: a rough feature indicates an irregular surface (for example, a wooded area) and smooth feature suggests flatness (e.g., a body of water);
- ***Pattern*** refers to the appearance of regular shapes or features that together form a recognizable feature; and
- ***Shape*** refers to the physical shape which helps in the identification of features.

Field checking was essential for:

- Resolving areas that could not easily be identified on the image or were obscured by clouds; and
- Developing initial classifications.

5.7 Minimum Mapping Units

As land use types were identified on the satellite map, they were defined by a hand-drawn boundary recorded on an acetate sheet and coded with a numeric code representing the land use. Land use types that were too small to be represented as areas on the map were either not recorded or identified as points. This is referred to as the Minimum Mapping Unit (MMU); based on the scale of the source material, certain objects cannot be represented as areas. In the case of the 1:25000 scale satellite map, the MMU was chosen to be 1 mm by 1 mm (or 0.0625 ha). If the feature was important or significant, it was recorded as a point.

5.8 Digitizing and Plotting

The process of transferring the hand-drawn land use map to a GIS involved digitizing.[29] After the map was digitized, the land use types were coded and then checked. A rough plot was then made. This rough plot was checked in the field and the digitized map was subsequently corrected. Once all checks and verifications were completed a final plot is made using a standardized color and hatching scheme to represent the different land uses.

[29] Digitizing is the process which converts analog map features into digital format.

6 RESULTS

On the following pages, draft versions of the new land use maps for the cities of Cebu, Davao, and Lipa are presented. (Naga, due to delays in image acquisition, was unable to generate the data necessary for the production of a map within the timeframe of the DSUD-funded technical assistance.) These maps, based on the outputs produced under the pilot mapping exercise, were generated by PADCO staff in Washington, DC as examples of maps that each city should be capable of plotting in the near future.

It should be remembered that the technical assistance focused largely on image interpretation and land use classification; the phased inputs were too short to enable each city to develop fully functional, in-house plotting capabilities. The digitized land use data, however, has been produced by the staff of the cities. Plotting, it should be noted, is largely a mechanical activity.

Ultimately, it will be the ability of these cities to produce similar maps, on their own, that will determine whether the land use mapping exercise as funded under the DSUD Project by USAID has been a success.

For a variety of reasons—all valid (a lack of available computer equipment due to delayed procurement procedures; a need for additional software training; problems in the actual plotting of the map files, etc.)—each city has evidenced some level of difficulty in generating maps internally. The overall process, however, appears sound, and the start-up issues should be resolved over the short term. Participants within each city remain strong advocates of the process, and are enthusiastic about the potential of their fledgling mapping capabilities.

6.1 A New Land Use Map

The new land use map, far from being the sketch map that characterized the previous land use map, now conveys more meaningful and complex information on urban land use types. (Please see Maps 3, 7, and 8.)

Table 3. LAND USE STATISTICS BY GENERAL CODE

Land Use Code		Cebu		Davao		Lipa	
		Area in Hectares	Percentage	Area in Hectares	Percentage	Area in Hectares	Percentage
High Density Housing	100	1219.88	6.56	1286.67	8.84	68.64	0.38
Medium Density Housing	200	3784.57	20.35	250.51	1.72	1762.92	9.65
Low Density Housing	300	1152.37	6.20	599.72	4.12	82.08	0.45
Rural Settlements	400	35.99	0.19	0.00	0.00	227.96	1.25
Commercial	500	941.14	5.06	437.46	3.00	24.26	0.13
Industrial	600	769.73	4.14	106.28	0.73	42.29	0.23
Institutional	700	373.78	2.01	107.28	0.74	370.13	2.03
Transportation	800	84.80	0.46	25.82	0.18	1.19	0.01
Parks and Recreation	900	84.04	0.45	73.66	0.51	2.48	0.01
Utilities	1000	87.98	0.47	4.39	0.03	0.00	0.00
Agro-Industrial	1100	82.62	0.44	0.00	0.00	312.19	1.71
Agriculture	1200	1151.90	6.19	3917.16	26.90	15242.80	83.45
Forest	1300	4790.81	25.76	246.32	1.69	0.00	0.00
Land under Development	1400	737.27	3.96	157.26	1.08	109.81	0.60
Open Land	1500	584.37	3.14	254.83	1.75	18.67	0.10
Water	1600	1327.74	7.14	154.41	1.06	0.00	0.00
Quarries and Mines	1700	0.00	0.00	12.39	0.09	0.00	0.00
Beach Resorts	1800	18.18	0.10	27.26	0.19	0.00	0.00
Clouds	1900	1367.93	7.36	6901.42	47.39	0.00	0.00
Total		18595.10	100.00	14562.84	100.00	18265.42	100.00

Table 3 presents statistics for Cebu, Davao, and Lipa for general land use types only. A more detailed data set (by sub-category) is presented in Part I of the Technical Annex.

6.2 Results by City

6.2.1 Cebu

Cebu is by far the largest and most developed of the four project cities. Constrained by the foothills to the west and by the sea to the east, Cebu has developed in a north-south direction along the coastline. The Cebu land use map (Map 3) clearly shows a fragmented and complex city structure. The study area defined in this map was selected to cover the largest urban space contiguous to and including the city itself, and not the exact political boundary of the city of Cebu (which is smaller). Thus, statistical totals shown on the map and in **Appendix A.5.** may appear to be larger than normal. However, city staff can "cut" the land use with the peripheral boundary of Cebu to provide maps and summary statistics in detail.

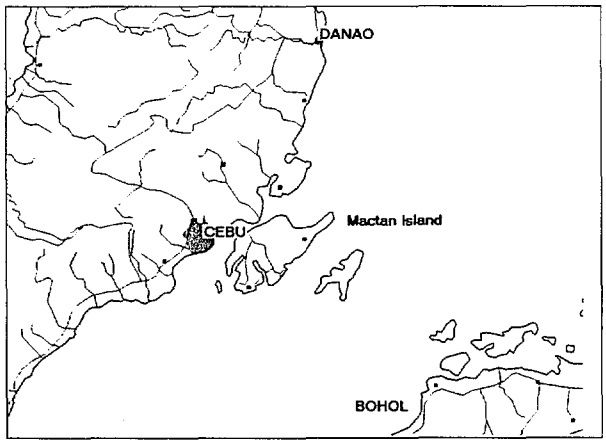


Figure 14- Regional map of Cebu.

The land use and zoning map (Map 4) was a quick analysis performed by PADCO DC staff in order to illustrate the usefulness of combining different layers of information. For example, by overlaying actual land use and zoning, an evaluation can be made on how effective the current zoning is, and where the areas of greatest conflict are located. In order to do this, zoning and actual land use layers were combined to highlight the most obvious conflicts. The areas plotted as yellow on the map are being used for agriculture and/or are mangroves and tidal flats, yet are zoned as industrial. This analysis raises pointed questions: Does the city therefore need to change the zoning? Or is the current use going to be replaced with future industrial parks?

The statistical table analysis presented on the map details all categories of actual land use compared to the zoning area they fall within. This is one example of the analytical power of a relational database that is tied to a geographic representation of urban form.

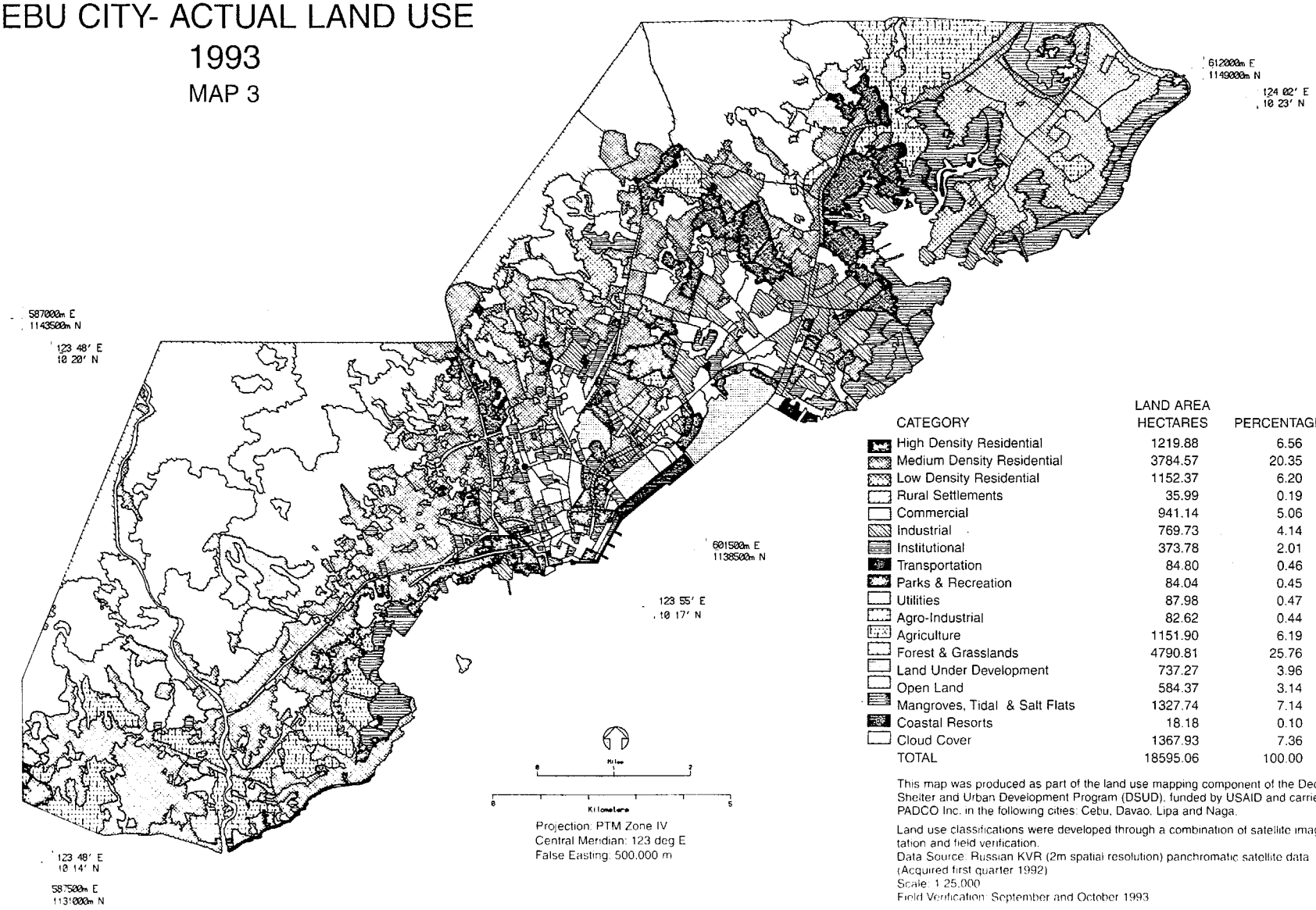
CEBU STATISTICS

1994 Population (in thousands)	664
Land Area (in sq. km.)	280.90
Population growth per annum (1980-1990)	2.21%
Population Density (persons/sq. km.)	2,363.83
Revenues 1994 (in thousand pesos)	797,000

Source: Mayor's Office, Cebu City, 1994

Figure 15- General Statistics for Cebu.

CEBU CITY- ACTUAL LAND USE
1993
MAP 3



CATEGORY	LAND AREA HECTARES	PERCENTAGE
High Density Residential	1219.88	6.56
Medium Density Residential	3784.57	20.35
Low Density Residential	1152.37	6.20
Rural Settlements	35.99	0.19
Commercial	941.14	5.06
Industrial	769.73	4.14
Institutional	373.78	2.01
Transportation	84.80	0.46
Parks & Recreation	84.04	0.45
Utilities	87.98	0.47
Agro-Industrial	82.62	0.44
Agriculture	1151.90	6.19
Forest & Grasslands	4790.81	25.76
Land Under Development	737.27	3.96
Open Land	584.37	3.14
Mangroves, Tidal & Salt Flats	1327.74	7.14
Coastal Resorts	18.18	0.10
Cloud Cover	1367.93	7.36
TOTAL	18595.06	100.00

This map was produced as part of the land use mapping component of the Decentralized Shelter and Urban Development Program (DSUD), funded by USAID and carried out by PADCO Inc. in the following cities: Cebu, Davao, Lipa and Naga.

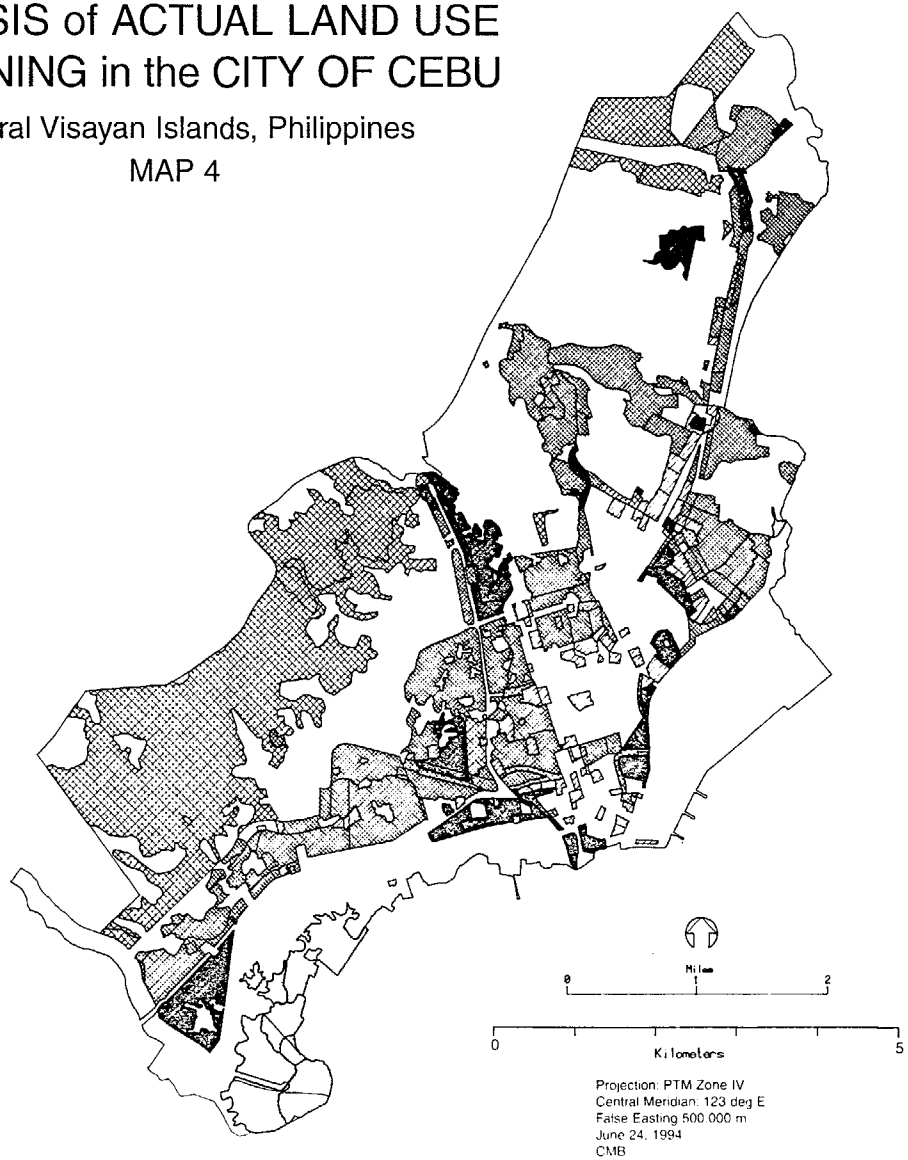
Land use classifications were developed through a combination of satellite image interpretation and field verification.
Data Source: Russian KVR (2m spatial resolution) panchromatic satellite data (Acquired first quarter 1992)
Scale: 1:25,000
Field Verification: September and October 1993

Printed: June 1994

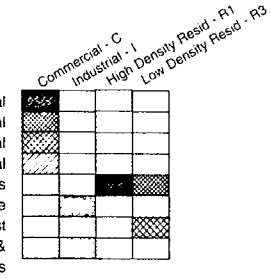
ANALYSIS of ACTUAL LAND USE and ZONING in the CITY OF CEBU

Central Visayan Islands, Philippines

MAP 4



Projection: PTM Zone IV
Central Meridian: 123 deg E
False Easting 500,000 m
June 24, 1994
CMB



Statistical Analysis

Actual Land Use \ Zoning	Agro-Industrial A1	Commercial C	Industrial I	Institutional N	Parks Open Spaces Cemetaries OS	Parks P	Planned Area PA	Parks Open Spaces Cemetaries POS	High Density Residential R1	Medium Density Residential R2	Low Density Residential R3
High Density Resid	9.09	272.67	211.28	3.78			1.77	1.21		6.35	31.71
100	1.69	50.70	39.28	0.70			0.33	0.22		1.18	5.90
Medium Density Resid	9.12	1006.06	165.50	41.97				4.44	13.59	82.39	452.63
200	0.51	56.66	9.32	2.36				0.25	0.77	4.64	25.49
Low Density Resid		6.83							61.10	37.34	
300		6.49							58.04	35.47	
Rural Settlements		0.28	2.63							5.33	
400		3.40	31.92							64.68	
Commercial		364.83	63.47	1.80			24.80				6.67
500		79.04	13.75	0.39			5.37				1.45
Industrial		64.12	45.52	9.44				2.53		13.17	1.87
600		46.92	33.31	6.91				1.85		9.64	1.37
Institutional		147.03	23.88	58.57	8.71		9.35	2.43	19.56		13.50
700		52.04	8.28	20.73	3.08		3.31	0.86	6.92		4.78
Transportation		3.50	5.48				56.81				
800		5.32	8.33				86.35				
Parks & Recreation		13.01	4.75		5.69	1.16		51.27		3.20	
900		16.45	6.01		7.20	1.47		64.83		4.05	
Utilities		5.90	0.26	12.56	1.30				21.68		29.81
1000		8.25	0.36	17.56	1.82				30.32		41.69
Agro-Industrial		0.80									1.19
1100		40.20									59.80
Agriculture	21.32	19.26	87.82								17.02
1200	14.66	13.24	60.39								11.70
Forest	57.06	258.97	34.08	3.11	32.95				49.24	52.90	1010.10
1300	3.81	17.28	2.27	0.21	2.20				3.29	3.53	67.42
Land Under Dev		93.23	10.82	3.31	1.44		62.96		19.18	18.00	77.55
1400		32.54	3.78	1.16	0.50		21.98		6.69	6.28	27.07
Open Land		139.24	47.14	0.45	29.89		0.61	1.21	33.18	9.76	42.13
1500		45.86	15.53	0.15	9.84		0.20	0.40	10.93	3.21	13.88
Mangroves, Tidal & Salt Flats			113.00								
1600			100.00								

The statistical analysis table shows actual land use versus zoning in hectares and percentage. For example, 9.09 hectares of high density residential land use is located within the agro-industrial zone, which is 1.69 percent of the total high density residential land use area

The shaded matrix is a subset of the statistical table. For example, areas with an actual land use of high density residential and falling within the commercial zone are shaded in solid brown.

This map was produced as part of the land use mapping component of the Decentralized Shelter and Urban Development Program (DSUD), funded by USAID and carried out by PADCO Inc. in the following cities: Cebu, Davao, Lipa and Naga.

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Data Source: Russian KVR (2m spatial resolution) panchromatic satellite data
(Acquired first quarter 1992)
Scale: 1:25,000
Field Verification: September and October 1993

Printed: June 1994

CEBU

IMAGE INFORMATION

Transverse Mercator Projection
Average positional error < 10 meters
Image acquired 1992

N

0 4 KM

0.5 0 2 MILES

Location Diagram

DAVAO

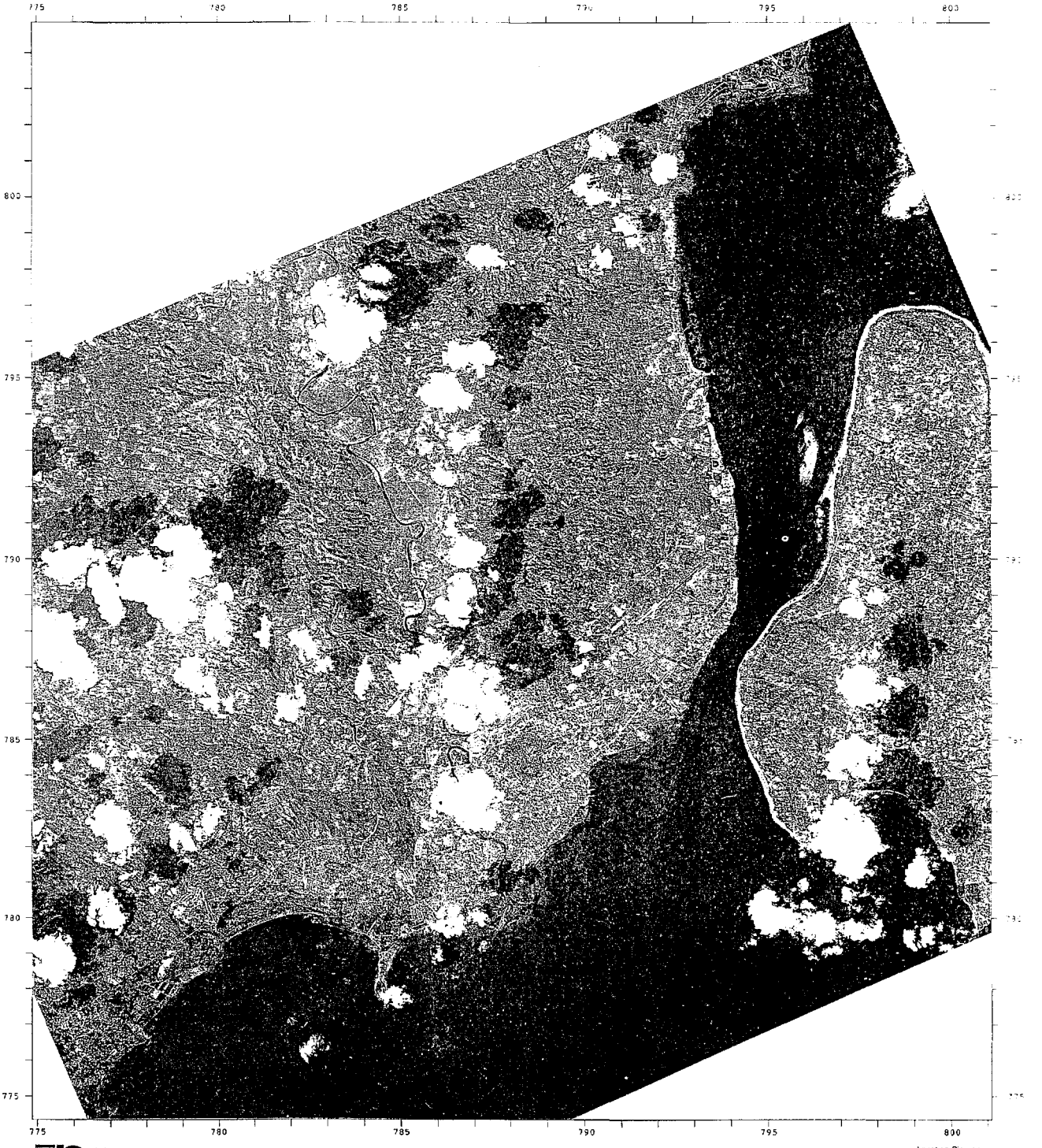


IMAGE INFORMATION

Transverse Mercator Projection
Average positional error < 10 meters
Image acquired 1992

N

0 2 4 KM

0.5 0 1 2 MILES

Location Diagram

PHILIPPINES

6.2.2 Davao

The city of Davao has developed along the coastline, with major industrial activity taking advantage of the deep harbors found in the Gulf of Davao. The land use map of Davao (Map 7) shows a considerably different pattern to that of Cebu. The area shown in this map is for presentation purposes only as the actual study area is much larger (more coverage to the north, south, and west) and therefore land area totals are not representative of the political definition of Davao.

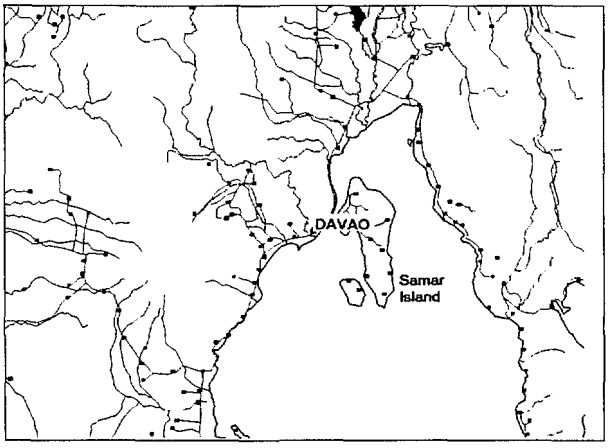


Figure 16- Regional map of Davao.

An interesting feature of the Davao land use map is the prevalence and dominance of the high density land use classification as compared to all residential areas (15.24 percent of the total land area shown and 60 percent of all residential areas). A zoning/land use analysis map was not created for Davao but the zoning information is present within the city and could be digitized as an additional layer in the GIS.

DAVAO STATISTICS

1994 Population (in thousands)	980
Land Area (in sq. km.)	2211.30
Population growth per annum (1980-1990)	3.37%
Population Density (persons/sq. km.)	443.18
Revenues 1994 (in thousand pesos)	908,000

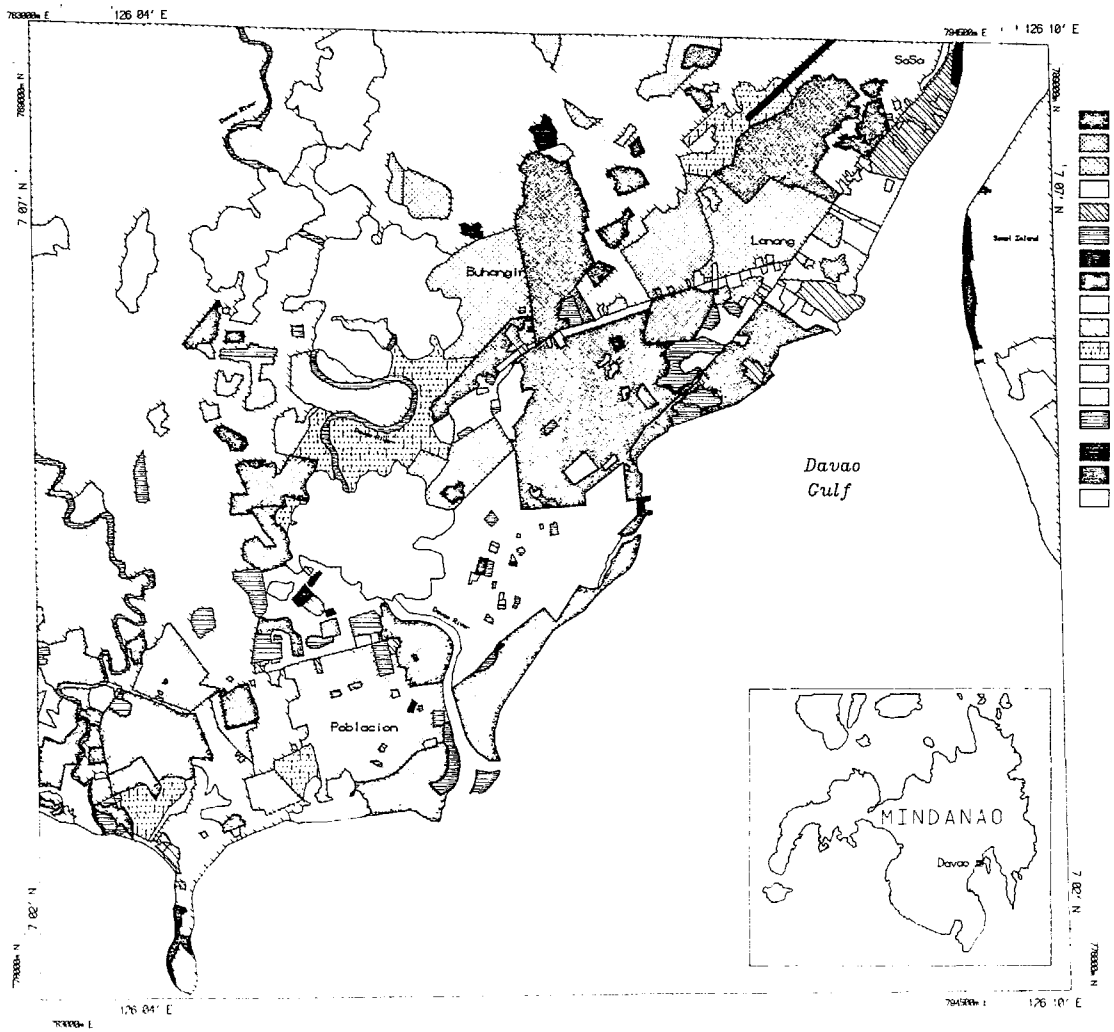
Source: Mayor's Office, Davao City, 1994

Figure 17- General Statistics for Davao.

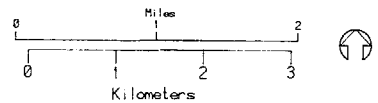
AC/DC

DAVAO CITY- ACTUAL LAND USE 1993

MAP 7



CATEGORY	LAND AREA HECTARES	PERCENTAGE
High Density Residential	1286.67	15.24
Medium Density Residential	250.51	2.97
Low Density Residential	599.72	7.10
Commercial	437.46	5.18
Industrial	106.28	1.26
Institutional	107.28	1.27
Transportation	25.82	0.31
Parks & Recreation	73.66	0.87
Utilities	4.39	0.05
Agriculture	3917.16	46.40
Forest & Grasslands	246.32	2.92
Land Under Development	157.26	1.86
Open Land	254.83	3.02
Lakes, Rivers, Swamps, Mangroves & Tidal Flats	154.41	1.83
Quarries & Mines	12.39	0.15
Coastal Resorts	27.26	0.32
Cloud Cover	780.44	9.24
TOTAL	8441.83	100.00



Projection: PTM Zone V
Central Meridian: 123.5 deg E
False Easting: 500,000 m

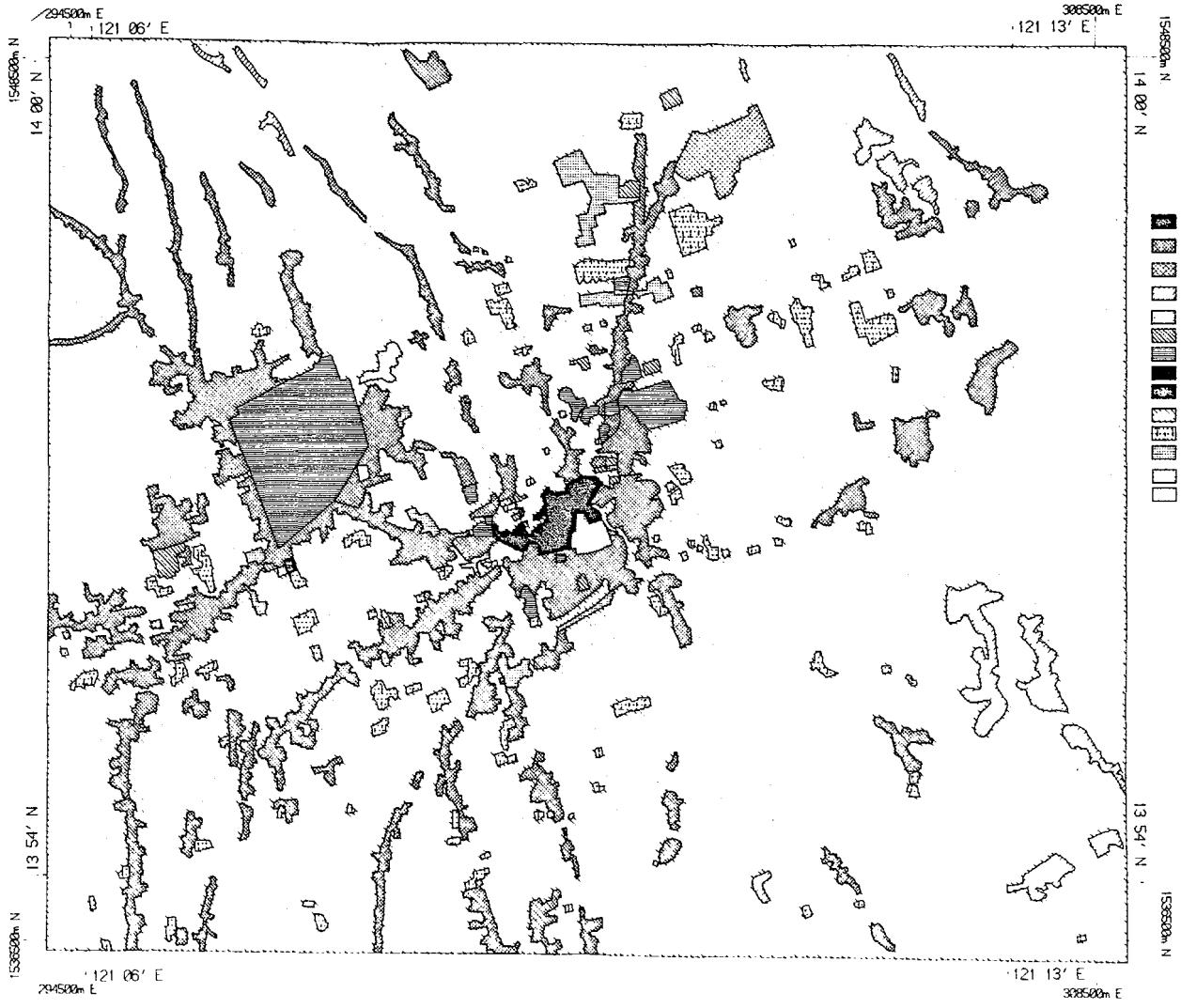
This map was produced as part of the land use mapping component of the Decentralized Shelter and Urban Development Program (DSUD), funded by USAID and carried out by PADCO Inc. in the following cities: Cebu, Davao, Lipa and Naga.

Land use classifications were developed through a combination of satellite image interpretation and field verification.
Data Source: Russian KVR (2m spatial resolution) panchromatic satellite data (Acquired first quarter 1992)
Scale: 1:25,000
Field Verification: September and October 1993

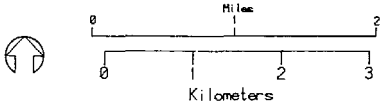
Printed: June 1994

LIPA CITY- ACTUAL LAND USE 1991

MAP 8



CATEGORY	LAND AREA HECTARES	PERCENTAGE
High Density Residential	68.64	0.38
Medium Density Residential	176.92	9.65
Low Density Residential	82.08	0.45
Rural	227.96	1.25
Commercial	24.26	.13
Industrial	42.29	0.23
Institutional	370.13	2.03
Transportation	1.19	0.01
Parks & Recreation	2.48	0.01
Agriculture	15242.80	83.44
Agro–Industrial	312.19	1.71
Land Under Development	109.81	0.60
Open Land	18.67	0.10
Unassigned	1.82	0.01
TOTAL	18267.24	100.00



Projection: UTM Zone 51
Central Meridian: 123.5 deg E

This map was produced as part of the land use mapping component of the Decentralized Shelter and Urban Development Program (DSUD), funded by USAID and carried out by PADCO Inc. in the following cities: Cebu, Davao, Lipa and Naga.

Land use classifications were developed through a combination of satellite image interpretation and field verification.
Data Source: SPOT panchromatic (10m) and Multispectral satellite data merge (Acquired July 30, 1991)
Field Verification: October 1993

Printed: June 1994

6.2.3 Lipa

The Lipa land use map (Map 8) and the color image (Map 9) show a clear dominance of agriculture and a simple radial pattern of land use. The major trunk road (Batangas/Manila) has had a clear effect on the location of residential areas. The commercial zone is still fairly restricted to the Poblacion area although some new development is beginning to appear on the outskirts of the town alongside the main roads. Of the three project cities that have a land use map, Lipa has the most obvious ability to control and guide its future development before it grows into another Cebu or Manila.

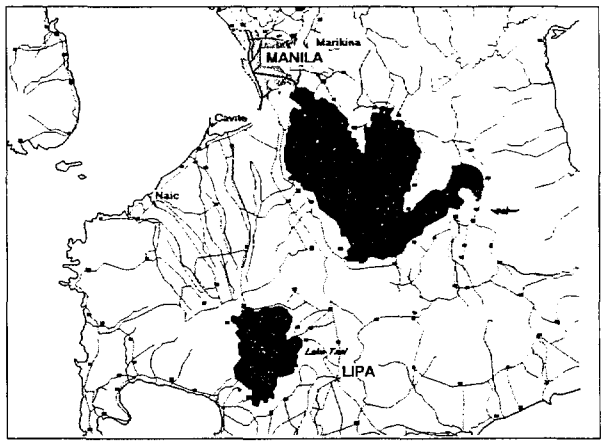


Figure 18- Regional map of Lipa.

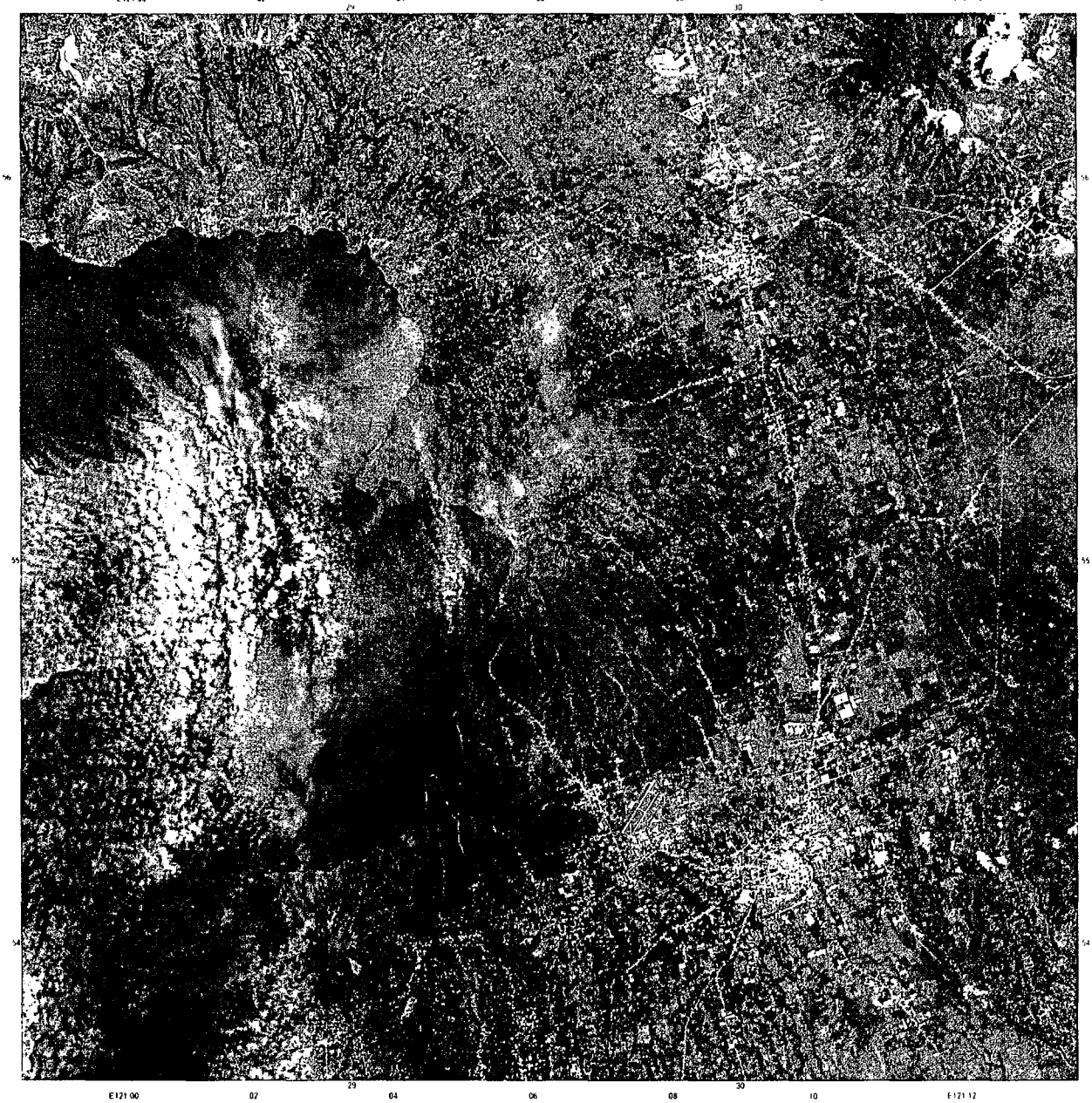
LIPA STATISTICS

1994 Population (in thousands)	171
Land Area (in sq. km.)	209.40
Population growth per annum (1980-1990)	2.8%
Population Density (persons/sq. km.)	816.62
Revenues 1994 (in thousand pesos)	150,000

Source: Mayor's Office, Lipa City, 1994

Figure 19- General Statistics for Lipa.

LIPA CITY, LUZON



Projection Universal Transverse Mercator
UTM Zone 51 Clarke 1866 Spheroid
10 000 meter grid ticks
Absolute positional error 40 meters
Relative positional error 21 meters

Images acquired 30 Jul 91

PADCO GIS Services

PADCO DC
PH (202) 789 1140
FX (202) 783 0247
PADCO Manila
PH 63 2 813 3906
FX 63 2 817 7767

Processed by EarthSat for PADCO
Date Processed 24 Jan 94
Image data copyright CNES 1994

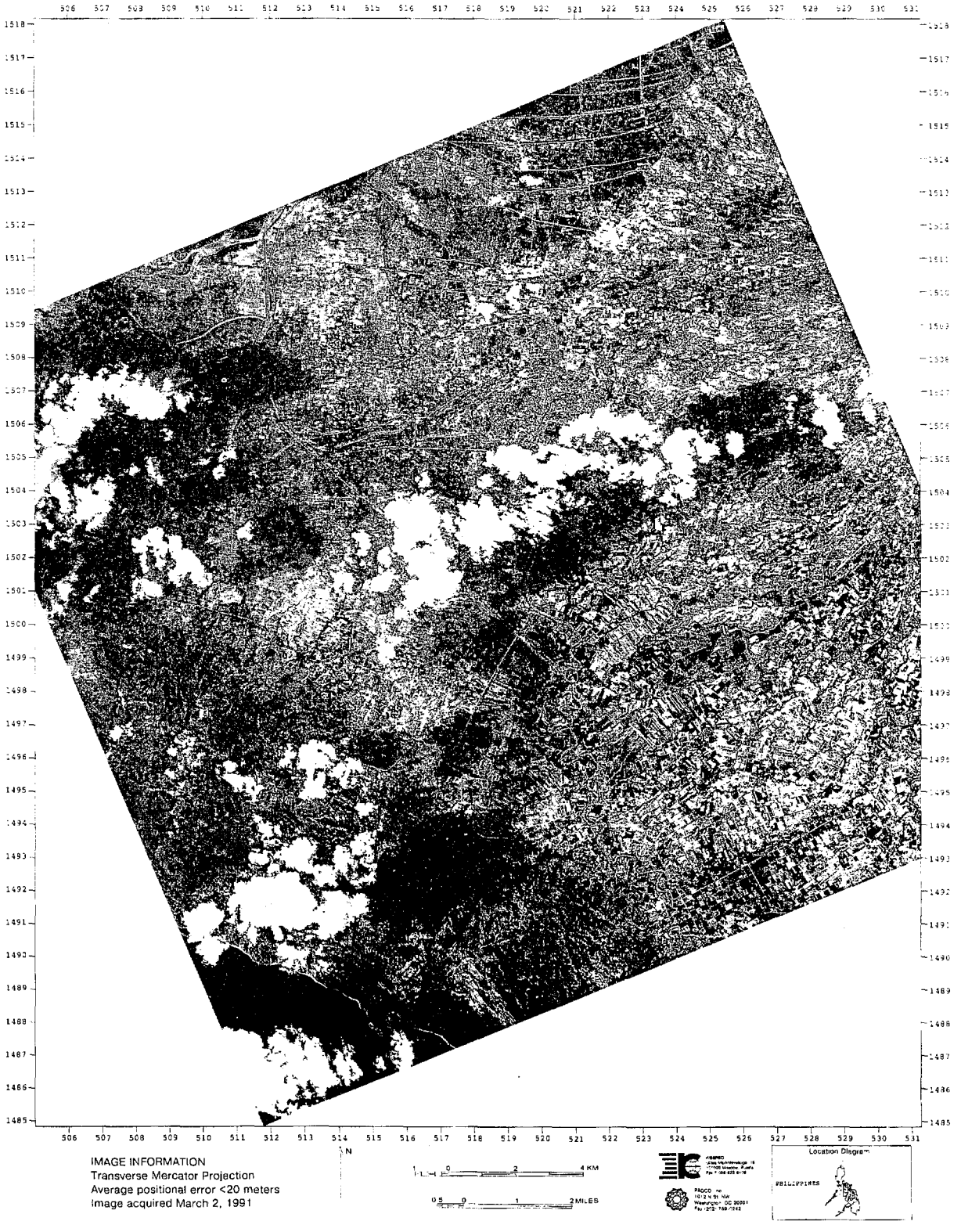
1 0 1 2 3 4 5 KM
1 0 1 2 3 4 Miles

Images procured and processed under USAID Contract #497 0388 C 00 2005 00
task order #11 as part of the USAID funded Development Shelter
and Urban Development Project

GN
N
Grid Convergence
0 deg 28 min
for center of sheet

Location Diagram

NAGA



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6.2.4 Naga

Naga (Map 10), like Lipa, is an agricultural city, with development occurring in a radial fashion along major roads. The land use map for Naga was not completed before the end of the project. However, staff have begun the manual interpretation of the satellite map.

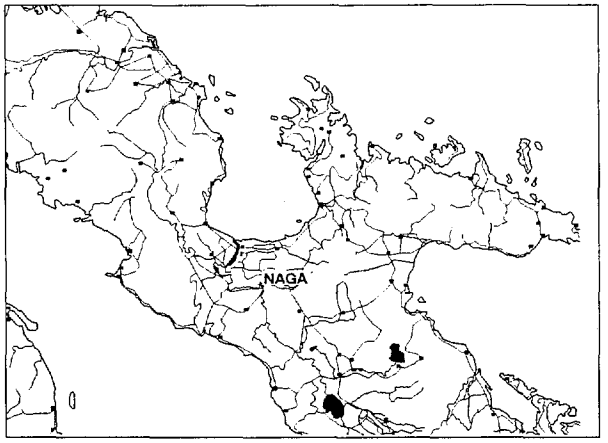

Figure 20- Regional map of Naga.

NAGA STATISTICS

1994 Population (in thousands)	126
Land Area (in sq. km.)	77.50
Population growth per annum (1980-1990)	2.37%
Population Density (persons/sq. km.)	1,625.81
Revenues 1994 (in thousand pesos)	145,000

Source: Mayor's Office, Naga City, 1994

Figure 21- General Statistics for Naga.

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7 POTENTIAL EXPANDED APPLICATIONS

The cities have an obvious local orientation and this should be the primary focus in developing initial GIS applications. While the Rapid Land Use Assessment process for the four pilot cities is useful, the impact of the study will be limited if a sustained use of this technique does not occur.

The following sections describe a number of potential GIS application areas which could be developed by the cities. While these descriptions are not comprehensive, they indicate directions for GIS development. Where appropriate, the descriptions are supplemented with additional comments relevant to that particular application. Actual implementation will require the use of both the technical skills and methodologies learned during the RLA™ process.

7.1 Voting Analysis

This application could potentially focus the attention and support of high level decision makers in the local governments on the capabilities of the GIS.

Local enumeration coverages could be used to geo-reference both demographic (census) profiles and voting patterns by area. In addition, the locations of polling stations could be geo-coded and analyzed to address the issue of voter accessibility and electoral service areas. The GIS could be used to generate alternate locations for polling stations based on the allocation of populations residing in the surrounding areas. Such an analysis could potentially reduce the number of stations required (and hence the administrative burden) while at the same time ensuring that the population is served based on spatial rather than political factors. In fact, it was recently mentioned by Mayor Osmeña of Cebu that to ensure complete and immediate support for the GIS at the local level, one should perform voting analyses for each of the city Mayors.

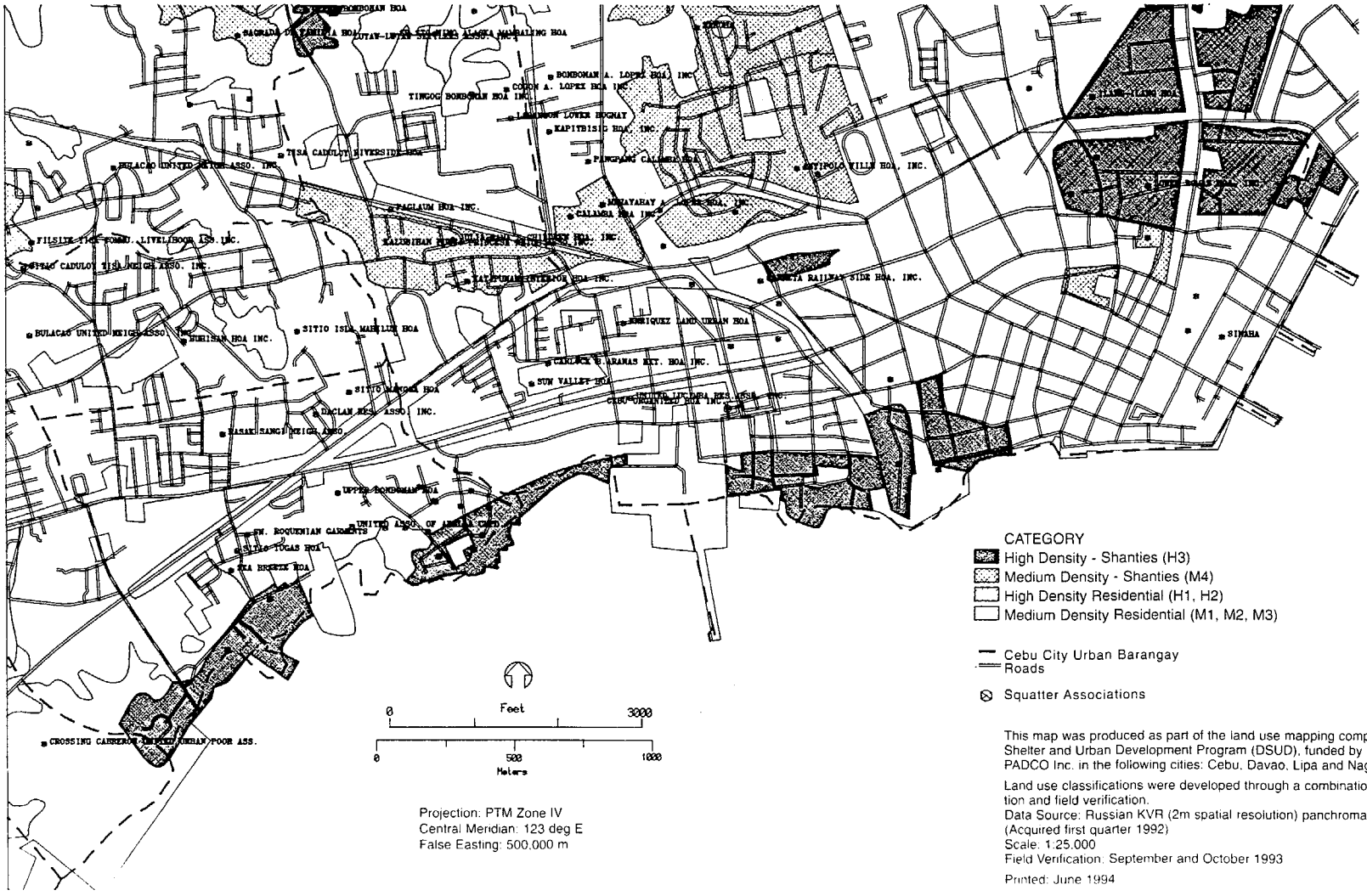
7.2 Low Income/Squatter Analyses

The identification of squatter or shanty areas in Philippine cities is of paramount importance to local, regional, and national officials. Identifying squatter locations and analyzing where they are in relation to economic activity, infrastructure, and valuable land allows planners to generate a comprehensive action plan for the effective relocation of squatters. This plan can then form the basis for action orientated policies.

In Cebu, the Cebu Commission on the Urban Poor (CCUP) has done a Herculean task of tabulating information regarding the city's squatter associations, including the number of members, the associations' addresses, and other pertinent data. The CCUP staff had been busy identifying the location of these associations on paper copies of the outdated city assessors maps. The CCUP team has also identified some of the vacant city land that might be available for relocating the squatters. Part of the land use mapping project in Cebu has trained CCUP staff and helped transfer their information onto the image map base and then into the GIS. Figure 22 shows a simple screen "grab" of these resulting data. The large window shows a map depicting the location of all the squatter associations, the land use code "high density residential-shanty," and the urban barangays. The two smaller tables on the left of the graphic show the results of selecting a particular land use area and squatter association and displaying the database results on the screen. As one can see from the information for squatters, many of the fields are empty because the CCUP inventory is still incomplete. This simple illustration also shows the utility of the GIS tool not only for displaying and querying data, but also as a means of data verification.

CEBU CITY- DETAILED SQUATTER ANALYSIS 1994

MAP 12



CATEGORY

- High Density - Shanties (H3)
- Medium Density - Shanties (M4)
- High Density Residential (H1, H2)
- Medium Density Residential (M1, M2, M3)

- Cebu City Urban Barangay
- Roads

- Squatter Associations

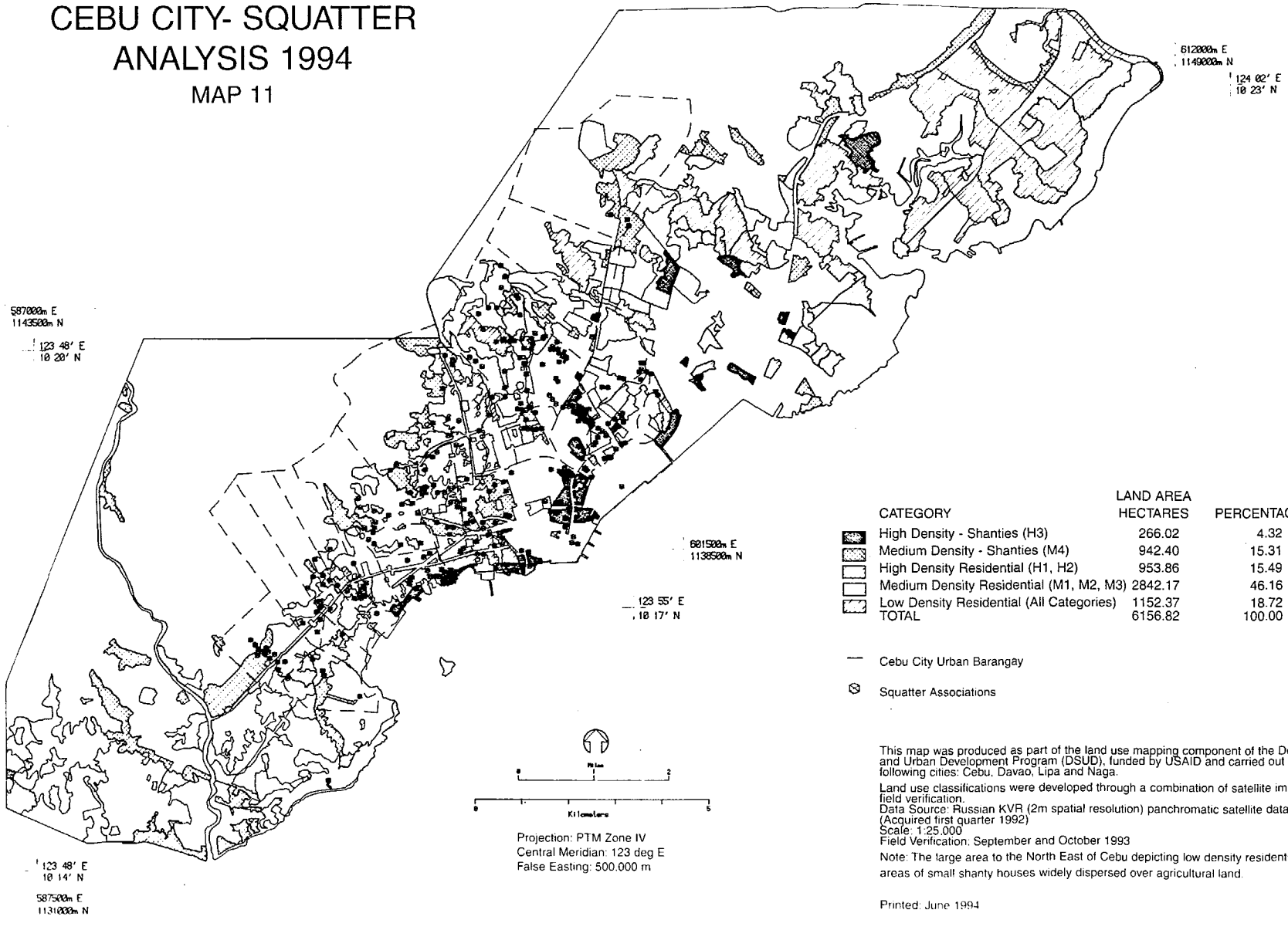
This map was produced as part of the land use mapping component of the Decentralized Shelter and Urban Development Program (DSUD), funded by USAID and carried out by PADCO Inc. in the following cities: Cebu, Davao, Lipa and Naga.

Land use classifications were developed through a combination of satellite image interpretation and field verification.
Data Source: Russian KVR (2m spatial resolution) panchromatic satellite data (Acquired first quarter 1992)
Scale: 1:25,000
Field Verification: September and October 1993

Printed: June 1994

CEBU CITY- SQUATTER ANALYSIS 1994

MAP 11



CATEGORY	LAND AREA HECTARES	PERCENTAGE
High Density - Shanties (H3)	266.02	4.32
Medium Density - Shanties (M4)	942.40	15.31
High Density Residential (H1, H2)	953.86	15.49
Medium Density Residential (M1, M2, M3)	2842.17	46.16
Low Density Residential (All Categories)	1152.37	18.72
TOTAL	6156.82	100.00

Cebu City Urban Barangay

Squatter Associations

This map was produced as part of the land use mapping component of the Decentralized Shelter and Urban Development Program (DSUD), funded by USAID and carried out by PADCO Inc. in the following cities: Cebu, Davao, Lipa and Naga.

Land use classifications were developed through a combination of satellite image interpretation and field verification.
Data Source: Russian KVR (2m spatial resolution) panchromatic satellite data
(Acquired first quarter 1992)
Scale: 1:25,000
Field Verification: September and October 1993

Note: The large area to the North East of Cebu depicting low density residential, actually represents areas of small shanty houses widely dispersed over agricultural land.

Printed: June 1994

Maps 11 and 12 are simple plots of the squatter database that is currently being constructed in Cebu. Map 12 shows how map scale can be changed to "zoom" into an area and display more details from the GIS database, in this case the location and name of each of the squatter associations.

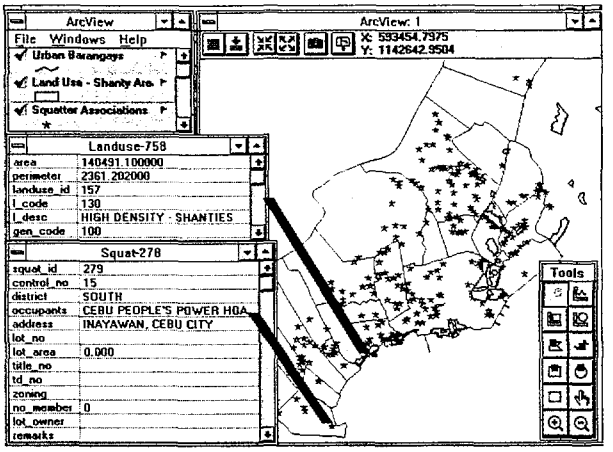


Figure 22- Squatter and high-density land use computer analysis.

Each city can begin this process of squatter analysis by manually identifying squatter associations, recording statistics about each group in a systematic fashion, and then spatially identifying the location of each association within the city. Layers such as roads, rivers, and barangays can be added to the analysis as they are generated. These data will provide a consistent and structured database that is accurate and effective in helping to deal with the squatter problem in the Philippines.

7.3 Land Availability and Suitability Study

Two key preliminary studies that should take place before Land Use Plans are developed and adopted are an analysis of land availability and suitability. The first study identifies areas that are available for development based on a series of qualitative criteria, such as land use, ownership, slope, and general location. These data layers can be combined to create an initial composite that will identify land that might be classified as open, owned by the city, have a slope of less than 5 percent, well drained, and within eight kilometers of the city center. This land might then be considered "available."

Land suitability is usually an analysis of land identified as available for development as well as additional data, such as condition and width of roads, quantity and quality of water/sewerage and telephones service, population density, slope, and land use. Based on a "ranking" or simple rating process for each data layer, a composite can be created. This composite would then be able to rank unique areas that meet a certain "score" suggesting that land might be suitable for development. Obviously different scenarios can be created depending on the potential final use of the land areas.

7.4 Road Inventory and Maintenance

In each of the four cities visited, road maintenance and inventory was a clear priority. In Cebu, this continues to be the application that receives the most resources. Almost all of the major road infrastructure can be identified on the 1:25000 scale imagery, and, in the case of the 1:5000 imagery, all minor roads and trails can be identified as well. As these graphic elements are entered into the GIS database, additional information can be entered, such as road quality/condition, road surface type, road width, and road name. From these data, project management of road resurfacing can take place as well as analyses of future expenditures and projects for road resurfacing. This is particularly important in Cebu where one of the most aggressive asphalting programs (Operation Road Storm) in Asian history is underway. This application offers tremendous rewards to the city both in terms of planning as well as in potential time and costs savings.

CEBU

IMAGE INFORMATION
Transverse Mercator Projection PTM Zone IV
Average positional error < 10 meters
Image acquired 1992

N

0 1 KM

INDEX TO ADJOINING SHEETS

Tax Sections

"Ludo"
Tax Section
Misalignment

7.5 Tax Mapping

Another potential application (1:5000 scale imagery only) is that of tax mapping. With the Local Government Code of 1991 the cities have been tasked with enhanced local revenue mobilization. This means that whatever funds can be generated locally from real property tax collection, business taxes, user fees, etc., can be spent by the cities. Unfortunately, real property tax collection performance (the primary source of local revenues) of local government units is poor. For cities, the overall collection efficiency in 1992 averaged 56.41 percent. In addition, the taxed properties are grossly underassessed, with most assessments dating back to 1975. It is estimated that only P0.07 is collected for every P100 of real property market value, far below the statutory rate of P2.00 per P100. Problems abound from data collection methods and accuracy, recording, assessment methods, archiving, collection, and enforcement. While a GIS will not solve any of these problems, it offers some extremely useful and cost-saving tools.

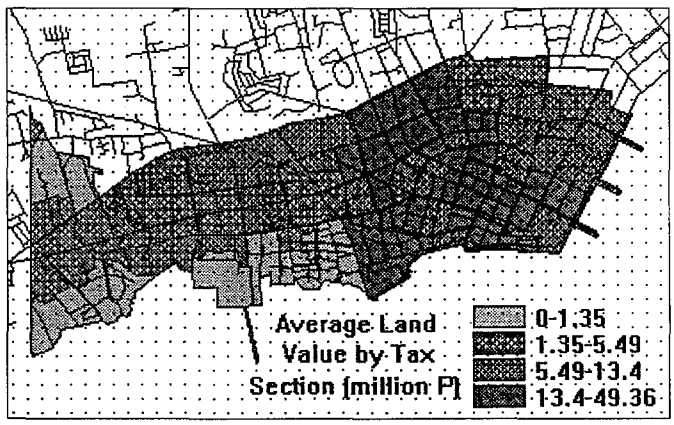


Figure 23- Average land value by tax section (million pesos).

In Cebu, a small pilot program was developed using a new methodology for real property tax collection known as Lots by Dots™, which isolates properties and stores them graphically in a GIS database as a point (rather than a polygon).
This allows a rapid assessment of the individual properties which can be identified from the image and cadastral maps. This approach has already proven to be useful in Cebu. When tax districts were overlaid with the image, it was found that at least three large buildings had several tax districts passing through the individual structures (e.g., Governor's Palace and Ludo). (See Map 13.) This is important because it quite clearly shows that the tax section boundaries are outdated and do not reflect what is currently present in the city. Since the tax section is the next step in geographical hierarchy above individual property parcels, misaligned tax section lines mean that the individual property boundaries are also inaccurate. This inaccuracy and outdated information base for real property means that local property taxes are not equitably and efficiently collected. Finally, tax sections can be interpreted onto the 1:5000 scale imagery and information from the City Assessors office attached. Data from the City's MICS department for several tax sections were loaded into the GIS and the corresponding graphic for the tax section then associated. Even with this quick demonstration it was possible to generate revenue and tax information for a small area of the city. (See Figure 23 above). These data can then be used in an analysis of land use as an additional overlay.

7.6 Health and Population Analyses

A GIS can collate and analyze information which broadly describes the health, education, welfare, and conditions of each city's population. All these indicators are spatial and subject to influence by diverse geographic factors. The GIS presents an opportunity to analyze these indicators and make assessments based on spatial relationships that certainly exist at various levels. In developing these applications, surveys can be used to collect data for more detailed spatial analyses. In addition, hand-held GPS units offer the capability to locate respondents (to surveys) in the field by precise coordinates. These locations can be subsequently stored and downloaded directly into the GIS together with the associated data for each respondent. Analyses can be executed using these precise locations or aggregated upwards to units such as barangays. This is a more robust methodology than collecting data at "regional" levels and attempting to extrapolate projections to micro-scales.

7.7 Housing Analyses

GIS can also be applied to the housing sector in each city. Various housing indicators can be generated and integrated into a GIS database at the barangay and city level. Specific applications may include:

- Location of all squatter settlements and available land to perform squatter settlement analyses;
- Thematic mapping of spatial trends in housing delivery (quality and quantity);
- Analysis of the relationship between changes in annual housing production by type/location and shelter service delivery;
- Comparison of demographic trends (income, savings, employment) with housing patterns;
- Compilation of GIS database(s) on the informal shelter sector based on the interpretation of housing typologies from aerial/satellite imagery and ground surveys;
- Comparison of various housing types versus the location of urban service infrastructure (water, sewer, electrical networks); and
- Analysis of housing patterns, sales and finances. Provision of mortgage facilities and study of possible loan "red-lining" in different areas.

Data resources for these and related applications include land use database, census, and various individual agencies including private and public sector institutions (such as USC-WRC). Since housing studies are holistic, involving the combination of diverse data sets, GIS provides an ideal mechanism for data integration. The GIS housing studies may provide products of direct value to the private sector. Maps showing various housing trends and patterns are invaluable to the private sector investing in real estate markets. As the cities develop their GIS capabilities, they can offer unique GIS skills and technology, which can conceivably attract sponsorship from the private sector, helping to co-finance the development of various databases and/or applications.

7.8 Infrastructure and Housing Vulnerability—Disaster Mitigation, Planning, and Risk Assessment

Traditional GIS based housing applications, as described above, can be expanded to include vulnerability and risk assessment for housing and infrastructure located in certain areas. This particularly applies to the informal housing sector which does not conform to urban plans and regulations. One possible application in each city could address the problem of housing and infrastructure located along storm channels and stream beds.

Regulations prohibit any residential and commercial activity within 10 meters of these gullies. However, high demand for urban land and housing have encroached into these buffer areas creating an obvious hazard to residents. The GIS could be quickly adapted to address this issue and highlight areas of particular concern. These may include areas where flooding is known to be frequent and severe. Risk mapping is a common output from multi-variable GIS analyses. In the Philippines, natural hazards such as flooding, earthquakes, and typhoons are omnipresent and can have a catastrophic impact on the fragile economy. A comprehensive program to map the risk for each hazard and assess vulnerability could provide the basis for disaster mitigation—that is, planning in advance of any event. Although hazard mapping can be complex and time-consuming, the products can be invaluable to both public sector policy makers and private investors wishing to minimize the risk of investment in various locations.

7.9 Project Management Applications ("Menu")

Each city, in addition to being the recipient of a diversity of donor agency-funded development programs, also has many of its own development programs underway. An obvious application for the GIS would be as a project management system. Project data banks can be developed in each city, containing geo-coded data that tracks each of these programs and describes the spatial distribution of various programs across the city. A spatial perspective on these activities can often show geographic bias, lack of coordination, and an imbalance between the location of development activities and actual need.

The ability to locate various indicators collected by the city could create a "needs"-oriented database for each city (by sector), graphically showing the various "needs" as they are distributed over the urban area. For example, various health issues may be shown to exist in areas removed from projects which could potentially affect these problems. A GIS-based project management database can assist in the targeting of activities based on need, rather than perceptions or political/administrative bias.

7.10 Environmental Applications

Environmental information is an increasingly important component in the planning process. The most common applications of GIS technology are in natural resource and environmental management. With the Local Government Code of 1991, urban environmental management functions have been devolved to the cities. This means the cities will become increasingly involved in addressing various environmental issues, particularly in the urban context. The holistic nature of many environmental problems will require data exchange and coordination with other GIS users in the Philippines. While these other users may collate and use environmental data, the city provides a unique interface between this information and local policy development.

A GIS can effectively manipulate and visualize environmental information to communicate various issues to decision makers. This should be the primary goal of environmental (GIS) applications developed by the city. Some possible application areas include:

- Development and mapping of environmental indicators and comparison with socioeconomic and demographic indicators, e.g., identify location of environmental hazard sites and possible impacts on population residing in a buffer area.
- Mapping of environmental "quality" of urban land (not only availability) based on the combination of a number of indicators. This "quality" index would indicate suitability of land for specific uses, as well as the potential impact on the environment.
- Comparison of environmental indicators to urban service provision. This would illustrate the spatial relationship and impact of infrastructure (water/sewer/electrical/road networks) on the condition of the urban environment.
- Development of environmental "zoning" based on collation of indicators within a GIS database. This will indicate which areas are vulnerable to certain land use type and/or planning policies.

7.11 Protected Areas and Resource Conservation Projects

The Philippines, through its Department of Environment and Natural Resources (DENR), has mandated effective eco-system management throughout the archipelago. This includes the designation of various protected and environmentally sensitive areas. At the local level, enforcement and monitoring is crucial.

GIS offers the potential to enhance local abilities in both the analysis and the management of these protected areas. This will be especially critical in conflict zones where human activities and development conflict with environmentally sensitive areas. The GIS facilitates access to information from other users who maintain baseline data such as topography, land use, vegetation, soils, and so on. While many activities and analyses easily conform to administrative units (barangays, etc.), environmental management demands a different approach. Ecological zones and watersheds frequently provide the necessary geographic frameworks for these studies. A GIS can prove extremely useful in defining these spatial units and facilitates the extension of activities to embrace numerous environmental issues.

These include:

- Monitoring of deforestation and management of reforestation programs;
- Protection of watershed areas from destructive land use practices and preventing soil loss/erosion;
- Monitoring all development activities in protected areas; multi-factoral environmental impact assessments; and
- Promotion of eco-tourism through the identification of areas of exceptional recreational value, improved but managed accessibility and service provision to eco-tourism sites.

Once again, the ability of a GIS to integrate data from diverse sources (urban, planning, environment, demographic, economic, infrastructure, etc.) allows environmental problems to be addressed in a truly holistic manner.

This capability should be harnessed by the cities through the development of various environmental applications. This will create products and opportunities which may ultimately lead to more informed public policy, and contribute to the sustainable development of the country.

8 CONCLUSION

This project originally set out to generate land use maps for three cities and to develop the necessary framework for a fourth to do the same. In large part it has been successful, but this initial success must be viewed in the broader context of local capabilities and long-term sustainability. Institutional and political problems, for instance, have made the initial output of this activity less than was desired, yet should not detract from the innovative approach and broad support among local government staff. In realistic terms, it should be viewed as a good beginning.

Many new concepts and technologies were introduced, and new ideas of sharing and leveraging resources were also used. Those proved to be extremely effective. However, if real planning is to take place in Philippine cities, a long-term commitment to training, resources, policy, and discipline must be made.

RAPID LAND USE ASSESSMENT:

Experiences in the Cities of Cebu, Davao, Lipa, and Naga

THE PHILIPPINES

VOLUME II:

TECHNICAL ANNEXES

JULY 1994

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Fig 1: GIS Implementation Planning Process C2

EXECUTIVE SUMMARY

The rapid urbanization of Philippine cities has presented tremendous challenges to the local governments responsible for managing growth. Confronted with the problems of congestion, squatter settlements, and inadequate infrastructure, urban managers must look for new ways to keep pace with urbanization and effectively plan for the future. Geographic Information Systems (GIS) and satellite imagery are new tools that offer a means to examine and assess the impact of urbanization and provide a basis for sound urban development.

As mandated under the Local Government Code of 1991 and Executive Order 72, the authority to approve land use plans prepared by the cities has been devolved from national government to the local and provincial levels. Accurate maps showing current land use are needed to serve as a basis for planning future city development. City Planning and Development Offices (CPDOs) charged with the creation of their respective city's land use map now realize that the existing map—out-of-date, rarely revised, and grossly inaccurate—cannot be used for this purpose. This deficiency has crippled the ability of Philippine cities to assume the planning responsibilities and functions devolved to them, and has limited the gains made under their decentralized empowerment.

Under the USAID-funded Decentralized Shelter and Urban Development (DSUD) Project, a pilot exercise entitled *"Support for Land Use Mapping: Utilizing Satellite Imagery and PC-Based GIS for Rapid Land Use Assessment"* was carried out in the cities of Cebu, Davao, Lipa, and Naga. Using an innovative methodology, generation of up-to-date land use maps was attempted in each of the four cities.

This final report provides a detailed description of the methodology used to create a land use map for each city and offers ways for other cities to achieve the same result. Current problems facing the City Planning Development Coordinator (CPDC) in relation to land use mapping and planning are highlighted, followed by a discussion on how these problems should best be addressed. While the land use mapping methodology is standardized, each city is different in terms of financial and technical resources, providing a spectrum of experiences.

The key technical and institutional problems that beset urban planning in the Philippines manifest themselves in the following:

1. ***An unrealistic land use classification scheme***—which fails to describe the true nature of urban land use. Critical social and environmental issues, such as squatter settlements, which fail to appear as a classification, are not addressed.
2. ***An inaccurate land use map***—out-of-date, and infrequently updated, the land use map is a simplistic representation of reality. As a consequence, planning mechanisms and processes are severely constrained. The lack of accurate information on the nature (type) and extent (spread) of urban expansion makes it impossible to realistically plan for city development.
3. ***Technical constraints***—the lack of formal geographic/spatial analysis training (map making and map use) for staff in the CPDO and other planning agencies has resulted in them being unable to fully develop and incorporate the land use map in planning processes.

4. ***Poor inter-department coordination***—in general, cities fail to interconnect department activities. This has resulted in a duplication of data collection and planning activities among the various city departments. Uncoordinated functions and policies often operate at cross-purposes.
5. A ***"why bother or what difference can it make attitude"***—A majority of the city officials see planning as futile in the face of these challenges. One Mayor, for example, feels that if Los Angeles can only "change" two or three percent of its city landscape through planning then what can his city hope to do?

The project attempted to address these deficiencies by creating an up-to-date land use map based on satellite imagery. This map, a true reflection of city development, now forms the basis of a new land use planning process: a rigorous and disciplined approach to the collection, presentation, and application of land use information for effective city planning.

Key achievements of the project included:

1. ***A new land use classification scheme***—A new and realistic land use classification scheme was developed to accurately reflect the variety of land use types, such as squatter settlements, which in the past had been ignored, found in each city. With this detailed land use classification scheme, the CPDO can now accurately describe the variety of land use types found in their city.
2. ***A new land use map***—High resolution satellite imagery (recently declassified 2-meter Russian military data) was used to rapidly identify and record urban land use types in the four pilot cities. Officials were able, for the first time, to see the true nature and extent of urban expansion and assess its impact on urban development.
3. ***Training***—Training staff was undertaken in the use of maps, satellite imagery, and GIS, and their roles in assisting the city with decision-making and development.
4. ***Coordination***—A coordinated approach to data collection and analysis was adopted by incorporating different city department staff into a single GIS unit. In this way departments were able to realize that they all share a common interest in data collection. Sharing between cities was also promoted and will be facilitated under the DSUD-funded City Sharing Program.

With these achievements, the pilot cities are now moving toward the full integration of GIS and satellite imagery into the planning decision making process. In Cebu and Lipa, the city government provided funds for the purchase of GIS hardware and software. In Naga and Davao, similar equipment will be forthcoming. The cities must now must focus on several key policy issues, including:

1. ***Process***—the entire process of land use mapping, land use zoning, and land use planning must be reevaluated. The CPDO has now developed accurate and realistic land use maps, which serve as the basis for developing meaningful land use zoning maps and land use plans. An environment (administrative and technical) must be created in which products from the GIS unit can be effectively used by planning staff.

2. ***People***—Staff members must be permanently assigned to specific tasks so that their duties are not interrupted by other demands of the planning office, e.g., issuing permits. Staff need to be properly trained to make the information they are now collecting available to those who need it.
3. ***Applications***—GIS and planning staff must develop applications that are supportive of city government and national policy objectives, for example, locating vacant land for the urban poor. Applications, which may include land suitability analysis (land that is suited to certain kinds of development) and land availability analysis (whether such land is available), need to be prioritized.
4. ***Funding***—City governments must ensure financial support for the newly created GIS units so as to build on their initial investment in this technology. This would include maintaining computer equipment and purchasing new satellite imagery at regular intervals.

The initial successes of these land use mapping exercises cannot be considered anything more than a good beginning. There is still much work to be done. For example, at least two of the cities (Naga and Davao) have not responded well to the first stage of the extended technical assistance and have exhibited problems in carrying the mapping exercise forward on their own. The other two cities (Cebu and Lipa) are performing fairly successfully, due in large part to the determination and initiative of the local staff.

There are several caveats that need to be outlined in order to balance the assessment of this first phase. They are:

- Naga and Davao have had difficulty after the initial round of training. This is not an indictment of the LGU technical staff, however. The technical staff of these two cities (especially Davao) performed extremely well during the training and technical assistance and are eager to move forward. Rather, it is the lack of a senior "champion" capable of moving the applications forward through the morass of local municipal bureaucracy that has hindered progress;
- The first stage of the land use mapping exercise did not concentrate on software training. This needs to be corrected in any follow on assistance. Cebu, for instance, is experiencing frustration in not being able to manipulate their data through advanced use of their software[1]; and
- Institutional support mechanisms (both for the system and for information sharing) are still in the early stages of development. These will require time and continual attention to develop and strengthen. Ultimately, institutional capacity will dictate the long-term success of the systems.

[1] It should be noted that Cebu has generated a large quantity of data and has initiated numerous preliminary applications far more quickly than originally anticipated.

PART I

LAND USE TABLES

Cebu Land Use Code			
CODE	**NUMERIC CODE**	**TITLE**	**DESCRIPTION**
H3	130	High density shanties	Very small units tightly packed together. Constructed of irregular materials such as palm fronds (nipa) and plastic/cardboard, no permanent floor. Later stages of this development can usually be identified through slightly more permanent building materials such as corrugated zinc/tin roofs (GI sheets) and these shanties have a permanent floor base. These units can be found mostly on marginal land such as that surrounding industrial areas and land fills, abattoirs etc. Also found in recently cleared land that will be used for later development. "Squatter"[1] and "informal" settlement are the definitions most often applied to this group. Many H3 areas have Sari-Sari type operations present.
M - Medium Density Housing			
Definition - GENCODE = 200			
Base Code Description - Mixed gray and white, more trees and grass than H. Building shapes are more regular and defined. Some internal roads are visible. Areas usually defined by major roads and other uses. Some medium density areas are found in marginal areas such as gullies and on the urban fringe - these areas appear as a darker gray with little or no internal roads.			
Shading Color and Pattern - Red medium density cross hatching, individual types contain black code text in polygons.			
M1	210	Medium density sub-divisions/villages/compounds	Organized communities with walls or other physical structures as defining boundary. Internal streets are paved, telephone and power poles are regular. Some commercial activity is found in these areas such as boutiques, elementary schools, and accounting services etc. These activities are not possible to identify from the image and can only be located through field surveys. Some open lots can be observed as well as small basketball courts, and group facilities such as missionary homes.

[1]Squatter is a problematic term as by definition it means people who occupy land illegally, i.e., without clear, legal title. If this criteria is applied to the city of Cebu, then more than 50 percent of all housing would classify as a squatter settlements. It is the holding type and not legal condition that is therefore more important to describe through high density shanty.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
M2	220	Medium density housing - bungalows	Medium density housing regular in form. Usually found in communities but not represented by walled compounds. Many houses in this type are bungalows and constructed of wood with tar and wood roofs. Some vegetation and open spaces with paved interior roads. Some commercial activity is present, typically car repair/body shops, sari-sari shops etc.
M3	230	Medium Density - town homes/condos	Fairly new developments of larger town homes contained within a single walled community, larger units adjacent to each other. Regular, paved interior roads, some vegetation and open space, usually pool and tennis facilities. Usually surrounded by some smaller scale commercial activity and housing of type M1.
M4	240	Medium Density shacks	Shacks and shanties larger than those found in H3, more open space and vegetation between units. Units mostly constructed of wood and corrugated zinc/tin roofs. Very little interior roads. Areas mostly found in marginal land such as steep slopes and river/stream gullies. Much of this type of housing surrounds small scale industrial activities such as rattan and glass factories. Areas are less dense with considerable vegetation, palms, trees, and bush. Schools and churches can be observed along major access roads.
L - Low Density Housing			
Definition - GENCODE = 300			
Base Code Description - Large white blocks, well defined, vegetation. Interior roads are well defined but do not appear as a regular grid fashion. Houses usually found in groupings which are loosely and irregularly defined in form. Large areas of dark gray appears and represents grass and vegetation. The other type of low density housing are medium to large blocks found mainly on the periphery of the city. Surrounding areas appear as dark gray and represent some grasslands and other vegetation, very few interior roads.			
Shading Color and Pattern - Red light density cross hatching.			
L1	310	Low density compounds/villages	Large lots with large buildings within, sometimes to maximum lot lines, mix of house

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
R - Rural Settlements			
Definition- GENCODE = 400			
Base Code Description - Very, small white dots, irregular pattern, clustered near a single access road. Usually less than 100 houses per settlements.			
Shading Color and Pattern - Mixed green and red fairly dense hatching.			
R	410	Rural settlements	Mainly found on single access roads going from the city to other sites within the province. Small groupings of shanties made of wood and with corrugated roofs and/or palm with some larger single houses constructed of cement.
C - Commercial			
Definition - GENCODE = 500			
Base Code Description - Larger, white blocks with some vegetation and car parks. Few interior roads. Mostly found next to major roads and surrounded largely by residential or industrial areas.			
Shading Color and Pattern - Yellow or orange medium dense cross hatching. Individual categories contain black land use code text.			
C1	510	Shopping Centers/Malls	Large single structures visible on image as large white outlines. Next to main access roads. Some gray areas present which represent parking lots. Some vegetation limited mainly to the perimeter of facility. These commercial types contained mixed commercial activity with various retail shops as well as restaurants and cinemas present.
C2	520	Business offices/buildings	Single white structures visible on the image and identified from other uses with similar appearances through local knowledge. Most structures are multi-story and in some cases contain ground floor retail activity.
C3	530	Hotels/motels	Single white structures with some associated annex buildings. Some gray representing parking lots and docking areas and in some cases grassy open areas.

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Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
C4	540	Markets	Small squares that appear as white/light gray on the image. Usually surrounded by high density housing and other commercial activity. As defined here markets represent a concentration of activity into a large area and does not include the sidewalk vendors and fruit sellers that establish small shops along the roadside.
C5	550	Mixed Use - Commercial District	Mainly found in the downtown area of the city represents mixed use of ground floor commercial activity such as tailors, electronics, general merchandise, fast food, and cinemas/movie houses etc. Most of the mixed use occurs due to offices located on higher floors. Some residential apartments are found above the commercial area. There is also some mixed institutional; use with small universities and colleges located within the area. Density is very high with no open space or vegetation. Streets are well defined and fairly regular. Most buildings are three stories with some five and six floor buildings present.
C6	560	Warehouses	Large white buildings found together with small regular internal roads. This type is distinct and separate from the warehouse facilities that are found contained within other land uses such as transportation i.e. port facilities. Very little or no vegetation found, adjacent to thoroughfares.
C7	570	Small scale retail	Small clusters of white buildings found along major thoroughfares, small patches of light gray represent parking lots. Very little vegetation, no interior roads. Small strips of activity such as car body shops, restaurants, boutiques, gas stations etc.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
I - Industrial			
Definition - GENCODE = 600			
Base Code Description - Large regular white shapes, small regular internal access roads with very little vegetation. Open areas inside appear as gray are unloading/loading areas. These areas are mostly found near the coastlines. Those on the coast have wharf or pier facilities that protrude into the water areas and appear as thin white lines on the image.			
Shading Color and Pattern - Orange high density cross hatching, individual types contain black code text in polygons.			
I1	610	Large Scale industry	Large areas of industry appear as multiple white buildings with gray areas in between. Some vegetation on the boundary of facility, interior roads and docking facilities. Most industries of this type are found on the coast and represent milling and petrochemical complexes. Areas usually found next to major thoroughfares.
I2	620	Mixed Use Medium Scale Industry with residential	Intermediate size industries, medium size white buildings fewer in number than I1. Located nearer to major thoroughfares and surrounded by residential areas. More vegetation and less open space then I1. Most industry of this type is found in rattan furniture and glass type factories. Industrial estates with packing facilities, manufacturing etc.
I3	630	Mixed Use Small Scale Industry with residential	Smaller scale cottage type industries found mainly along major and smaller roads. Characterized by low production and few employees. Generally found in or near residential areas type M3 and H3, generally body shop, charcoal generation etc.
I4	640	Depots/Storage complexes	Large storage complexes generally found along the coast and associated with petrochemical complexes. Facility appear as clusters of regular white circles with some light gray spots in between. Few interior roads.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
N - Institutional			
Definition - GENCODE = 700			
Base Code Description - These types appear similar to some commercial and industrial areas and are largely defined through local knowledge. These areas can be defined in several types: large, open areas which appear as black or dark gray on the image with a single white block, or group of clustered white blocks representing large buildings. Very few interior roads, some vegetation, mainly trees found on the perimeter of the area. The second type are single white blocks representing large buildings which occupy the entire area i.e. the Capitol building.			
Shading Color and Pattern - Purple medium density cross hatching, individual types contain black code text in polygons.			
N1	710	Government buildings/provincial offices etc.	Usually single large white buildings found in key, central areas of the city and adjacent to major access roads and/or junctions. Facilities such as city hall, provincial capitol buildings are included in this classification.
N2	720	Educational and cultural buildings. Schools, universities, colleges, museums etc.	Groupings of buildings usually with more open space and clearly defined access roads and paths between buildings. Universities and schools usually contain basketball facilities, small stadiums and large gymnasiums. These facilities are found nearer the outskirts of the city such as San Carlos Talamban and Cebu International School. Facilities in the city tend to have less open space. All facilities are found on major access roads.
N3	730	Health and Welfare	Facilities such as hospitals and clinics. University hospitals if part of a larger complex would be classified under N2.
N4	740	Religious, churches, mosques, temples, cemeteries	Large single buildings that appear as white blocks on the image surrounded by light gray representing open parking areas. Usually found near major access and surrounded by residential areas. Small sites such as chapels or shrines are not broken out here but are included as part of the description for various residential types i.e. M3 and H1.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
N5	750	Landfill/dumping site	Large open areas given over to the collection and dumping of refuse and solid waste. Categorized as institutional as almost all of these facilities are municipally or provincially operated.
N6	760	Prison facilities	Smaller single facilities usually surrounded by high density housing or small scale industrial facilities. Can only be detected through local knowledge.
N7	770	Military complexes	Large areas of open space surrounding clusters of regular, white buildings. Usually found near the outskirts of the city close to major access points.
T - Transportation			
Definition - GENCODE = 800			
Base Code Description - This type is represented in three major types. The first is airport/airfields which appear as areas of large open space surrounding large regular white lines (runways) and clusters of white blocks which represent operational facilities and buildings. The open area appears as dark gray/black. The second type of transportation represent the port facilities. These are found on the coastline and appear as regular shaped (round or square) white blocks. There are regular, interior roads, single white lines protruding into the water represent docks and piers. These areas are found next to major access roads. The final type of transport is bus terminals and these areas can only be identified on the image through local knowledge. They appear as single white blocks usually surrounded by major access roads and high density residential areas.			
Shading Color and Pattern - Brown medium density cross hatching, individual types contain black code text in polygons.			
T1	810	Airport/airfield	As described above, large open areas surrounding runways and operational buildings. Found on the island of Cebu surrounded by industry (EPZ) and high density housing. The old closed airfield is not classified here, rather it appears under open space. Can include smaller, private airfields as well.
T2	820	Port	Large areas of mixed use port use such as storage, unloading/loading, and docking facilities.

Cebu Land Use Code			
CODE	**NUMERIC CODE**	**TITLE**	**DESCRIPTION**
T3	830	Bus Terminals	Small buildings on major access roads. Can only be identified through site visits and local knowledge.
P - Parks & Recreation			
Definition - GENCODE = 900			
Base Code Description - Falls into two main types. The first represent the public parks which appear as dark gray or black on the image with very few if any internal roads or buildings. Where buildings do appear they are usually clustered groups of white blocks representing club houses/tennis courts etc. Trees are usually found and are seen as black lines or dots. The second type of park can only be identified through local knowledge and represent single park facilities such as stadiums. These facilities appear as single white blocks.			
Shading Color and Pattern - Green high density cross hatching, individual types contain black code text in polygons.			
P1	910	Public parks	Open areas of grass and vegetation for the most part found in the older parts of town such as Plaza Independencia and Fuente Osmena.
P2	920	Sports facilities	Large single areas solely for sport such as tennis, swimming pools, and stadiums. Usually surrounded by residential and commercial areas and next to access roads.
P3	930	Golf Courses	Large expenses of open areas with surrounding vegetation. Cebu Country Club near the Ayala Complex can clearly be seen as a gray area with black patches of trees and long "sausage-like" areas representing fairways.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
U - Utilities			
Definition - GENCODE =1000			
Base Code Description - This category represents all facilities involved with utility functions such as power, water, and telecommunications. Identification of these areas on the image is through local knowledge as the facilities are represented by single or small groups of small white blocks representing the facility buildings. Older facilities are generally found within the city limits and are usually not surrounded by an open areas, newer facilities are found on the outskirts of the city and tend to have more open areas surrounding the buildings which appear as light gray/dark gray on the image.			
Shading Color and Pattern - Magenta high density cross hatching, individual types contain black code text in polygons.			
U1	1010	Power	Small walled compounds found at the edges of the urban area. Small buildings surrounding large transformer units.
U2	1020	Water	Water tanks and small reservoirs are found through out the city.
U3	1030	Telecommunications	Small walled compounds found at the edges of the urban area. Small buildings surrounding tall microwave towers.
G - Agro-Industrial			
Definition - GENCODE = 1100			
Base Code Description - Regular white blocks, some open large open spaces, some interior roads which appear as thin white lines. Usually found along major roads, operations such as chicken farms are represented by a series of thin white lines. Older facilities such as the abattoir are found in the interior city whereas new facilities such as chicken farms are found on the outskirts of the city. Some areas must be defined through local knowledge.			
Shading Color and Pattern - Orange and green mixed medium density cross hatching.			
G	1110	Agro-Industrial	As per main classification above.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
A - Agriculture			
Definition - GENCODE = 1200			
Base Code Description - Appears on the image as dark gray, sometimes black, there is usually a lack of buildings, areas appear regular and well defined - usually by thin white lines that represent interior roads or footpaths. Those areas near the outskirts of the city are better defined, those found further from the city tend to be smaller, and less regular in form.			
Shading Color and Pattern - Green medium density single angled hatching, individual types contain black code text in polygons.			
A1	1210	Cropland	General crop lands.
A2	1220	Plantation/farms	Includes mango, banana, sugar cane, coconut, and pineapple.
A3	1230	Rice field	General rice paddies.
F - Forest			
Definition - GENCODE = 1300			
Base Code Description - General forests on the image are found mostly on the hills and appear as irregular groupings of dark granular or bumpy dots. Bare land is mostly located on steep slopes and appear as gray with a few black dots (trees). Grassland is mostly found on flat lands on the outside of the city. This particular category is the most affected by cloud, firstly through shadow from the clouds themselves which cast dark spots onto the image which are often confused with forest areas. The second type of cloud distortion is formed in gullies and other depressions due to the angle of the sun. These areas are also often confused with forest areas.			
Shading Color and Pattern - Green medium density cross hatching, individual types contain black code text in polygons.			
F1	1310	Forest	Includes broadleaf, bushes, scrub, bamboo, and others.
F2	1320	Grassland	open land at outskirts of city and into hinterland with grasses. Often used for small stakeholder farmers to graze animals. Usually found on foothills.
F3	1330	Bare Land	barren and sparsely vegetated open areas either as former forest now denuded or rocky slopes etc.

Cebu Land Use Code			
CODE	**NUMERIC CODE**	**TITLE**	**DESCRIPTION**
F4	1340	National Park/reserve	Areas defined and demarcated by law. can be found as water and land related. In the case of a conflict assessment the predominant use or distinction takes precedence i.e. a National park of mangroves would be classified as F4.
F5	1350	Protected Watershed	Areas defined and demarcated by law as protected watersheds. Form crucial catchment areas in foothills and mountains.
F6	1360	Mixed Vegetation	Includes mixed scrub/shrub with interspersed trees such as fruit and hard woods, coconuts, bamboo etc. Also contains some area of grass and bare land. Usually found in previous forested areas.
D - Land under Development			
Definition - GENCODE = 1400			
Base Code Description - Large irregular areas mostly white with some gray speckles. Mostly found on the outskirts of the city or along the coast.			
Shading Color and Pattern - Magenta angled single hatching.			
D	1410	Land Under Development	As defined in main body above.
O - Open Land			
Definition - GENCODE = 1500			
Base Code Description - Defined as open or vacant areas within urban areas only. Usually appears as dark gray with no visible active use, few interior roads, little or no structures and irregular in shape and form.			
Shading Color and Pattern - Open areas not colored with hatching merely indicated through the black letter O in the center of each polygon.			
O	1510	Open Land	As described in main body above.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
W - Water			
Definition - GENCODE = 1600			
Base Code Description - Lakes will appear black/dark gray and usually are irregular in shape. Mangroves are found on the coast and are irregular in form and appear as light gray with regular white dots, interior water channels appear as dark thick lines. Salt pans vary in appearance form light gray to black, with form described as regular and surrounded by thin white strips (footpaths), salt pans usually have a small river or stream passing through the area to the coast. Aqua-culture is found on the coast and also out in water channels. The first type appears very similar to salt pans and local knowledge is needed to distinguish the two. The second type appears as a collection of thin white strips (pen boundaries) and are surrounded entirely by water.			
Shading Color and Pattern - Blue medium density cross hatching, individual types contain black code text in polygons.			
W1	1610	Lakes	Single or connected bodies of water. Not currently found in Cebu City. Area to de defined larger than 2 hectares. Usually appears black or dark gray on a black and white image.
W2	1620	Mangroves	Coastal mangrove areas. Low lying areas identified on image as gray or white areas with difficult boundary definitions with surrounding water.
W3	1630	Swamps (Marshes)	Low lying areas usually found near other water bodies such as lakes, rivers, and streams. Areas are permanently inundated with water.
W4	1640	Salt Pans	Coastal areas of low lying land usually marginal in nature. Identified on image with thin white surrounds usually representing small footpaths and a dirt access roads.
W5	1650	Aqua-Culture	Fish ponds and hatcheries etc. Usually regular in shape and found next to or close to water bodies such as rivers and coast line. Line with regular fences, walls, or foot paths.
W6	1660	Tidal Flats	Areas surrounding coasts and at river mouths. Hard to define from surrounding water. Appears as whit/gray. Areas are exposed at low tide and covered at high tide. Can include reefs.

Cebu Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
Q - Quarries & Mines			
Definition - GENCODE = 1700			
Base Code Description - Usually found on the outskirts of the city on the foot hills. Usually delineated by a single round white area connected by a thin, regular white line representing an access road.			
Shading Color and Pattern - Black medium density cross hatching.			
Q	1710	Quarries/Mines	Areas usually found on outskirts of city and/or in foothills. Usually served by a single access roads. Area appears as white circle.
B - Beach Resorts			
Definition - GENCODE = 1800			
Base Code Description - Large developments found on the coast. Long white strips represent beaches, small regular buildings appear as both light gray and white. Small access roads with a few interior roads can also be seen. Most beach development is found at some distance from general urban development.			
Shading Color and Pattern - Yellow or orange dot pattern.			
B	1810	Beach Resorts	As description above.

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Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
H - High Density Housing			
Definition - GENCODE = 100			
Base Code Description - Gray, densely packed, a few white speckles. Internal roads not clear. Areas themselves usually defined by larger roads. Mostly found on marginal lands and close to industrial and commercial areas. Some housing of this type contains mixed use with small commercial activity occurring on the ground floor.			
Shading Color and Pattern - Red dense hatching, individual codes plotted in black text.			
H1	110	High density	Individual housing. Single family units, many stories with small grass areas, tightly packed. High density housing occurs within the urban core. Appears as densely packed black and white objects on the image, difficult to identify individual houses. Residential activity above commercial activity as classified as C5.
H2	120	High density sub-divisions	
H3	130	High density shanties	These are small units with no individual services, constructed of irregular materials such as palm, nipa, and plastic/cardboard with no permanent floor. Later stages of development can usually be identified by more permanent building materials. Located along the river, along the coastline within the city proper. Water is provided as standpipes, some upgrade schemes have provided services (roads and water). Subject to periodic flooding.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
M - Medium Density Housing			
Definition - GENCODE = 200			
Base Code Description - Mixed gray and white, more trees and grass than H. Building shapes are more regular and defined. Some internal roads are visible. Areas usually defined by major roads and other uses. Some medium density areas are found in marginal areas such as gullies and on the urban fringe - these areas appear as a darker gray with little or no internal roads.			
Shading Color and Pattern - Red medium density cross hatching, individual types contain black code text in polygons.			
M1	210	Medium density subdivisions	Organized urban communities with paved internal streets, telephone, and power poles. No or very little commercial activity is found in these areas. Houses are single-family units single or two stories. Units are separated by walls or fences and surrounded by some green space.
M2	220	Medium density housing	Medium density housing, regular in form, mostly found along major urban throughfares. Housing styles both one and two story. Not organized into a regular sub-division, occurs more commonly in urban core, with open space and vegetation.
M3	230	Medium density town homes	Not found in Davao
M4	240	Medium density shanties	Not found in Davao.
M5	250	Medium density villages	Located at outskirts of the urban area, family dwelling units with "Sari-Sari" stores these areas have large amounts of vegetation.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
L - Low Density Housing			
Definition - GENCODE = 300			
Base Code Description - Large white blocks, well defined, vegetation. Interior roads are well defined but do not appear as a regular grid fashion. Houses usually found in groupings which are loosely and irregularly defined in form. Large areas of dark gray appears and represents grass and vegetation. The other type of low density housing are medium to large blocks found mainly on the periphery of the city. Surrounding areas appear as dark gray and represent some grasslands and other vegetation, very few interior roads.			
Shading Color and Pattern - Red light density cross hatching.			
L1	310	Low density sub-divisions	Found inside the urban area. Large buildings set back from the access road, big compounds, fenced or walled. Surrounding areas are open, e.g. insular sub-division. Some areas have yet to be developed.
L2	320	Low density housing	
L3	330	Farm sub-divisions	Not found in Davao.
R - Rural Settlements			
Definition GENCODE = 400			
Base Code Description - Very, small white dots, irregular pattern, clustered near a single access road. Usually less than 100 houses per settlements.			
Shading Color and Pattern - Mixed green and red fairly dense hatching.			
R	410	Rural settlements	Mainly found on single-access roads going from the city to other areas; appears as ribbon development along rural roads. Small groupings of shanties and regular housing often combined and mixed with "Sari-Sari" stores.

fB

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
C - Commercial			
Definition - GENCODE = 500			
Base Code Description - Larger, white blocks with some vegetation and car parks. Few interior roads. Mostly found next to major roads and surrounded largely by residential or industrial areas.			
Shading Color and Pattern - Yellow or orange medium dense cross hatching. Individual categories contain black land use code text.			
C1	510	Shopping centers/ malls	Large building and associated car park, e.g. Victoria Mall. Located next to major roads.
C2	520	Business offices/ buildings	Mostly found in CBD. Single, multi-story buildings along the major thoroughfares.
C3	530	Hotels/ motels	Single and multistory buildings, usually found on the outskirts of the city along major access roads. Some located in CBD as multi-story buildings, where classified as C5 if they cannot be distinguished. Usually surrounded by residential/commercial activity. Parking areas and vegetation usually present for hotels outside the city proper, e.g. the Insular Hotel.
C4	540	Markets	Includes both governmental, e.g. Agdab Market, and private markets. No vegetation present, densely packed in urban core, long roofs distinguish markets in the urban core.
C5	550	Mixed use commercial/CBD	Mainly found in the downtown area of the city. This type represents mixed use of ground floor commercial activity such as tailors, electronics, general merchandise, fast food, and cinemas/movie houses, etc., and second floor residential housing. Density is high with no open space or vegetation. Streets are well defined and fairly regular. Almost all use of this type is found in the central business district.
C6	560	Warehouses	Medium to large-size buildings with small internal roads. Some vegetation found, next to major roads, in residential areas and along major access roads or near large scale industry along the coastline.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
C7	570	Retail	Appears as small collection of buildings along major access roads, both within and outside the urban core. Includes bakeries, "Sari-Sari" stores, gas stations and vulcanizing stores, ice making buildings, car sales.
C8	580	Private medical centers/ hospitals	Private medical complexes found on the outskirts of town, along major access roads. Usually large multi-story buildings.
I - Industrial			
Definition - GENCODE = 600			
Base Code Description - Large regular white shapes, small regular internal access roads with very little vegetation. Open areas inside appear as gray are unloading/loading areas. These areas are mostly found near the coastlines. Those on the coast have wharf or pier facilities that protrude into the water areas and appear as thin white lines on the image.			
Shading Color and Pattern - Orange high density cross hatching, individual types contain black code text in polygons.			
I1	610	Large-scale industry	Petrochemical plants along the coastline are classified as large scale industrial, e.g. Shell.
I2	620	Medium-scale industry	Intermediate size, includes bottling plants and food processing located next to major roads outside urban core.
I3	630	Small-scale industry	Smaller-scale, cottage industries, i.e. Jeepney and tricycle assembly, wire harness plants and wood frame factories. Located in small buildings along major roads, near residential areas. Characterized by low production and small numbers of employees.
I4	640	Depots/storage areas	Includes oil and petrol storage areas, visible as circular features along the coastline.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
N - Institutional			
Definition - GENCODE = 700			
Base Code Description - These types appear similar to some commercial and industrial areas and are largely defined through local knowledge. These areas can be defined in several types: large, open areas which appear as black or dark gray on the image with a single white block, or group of clustered white blocks representing large buildings. Very few interior roads, some vegetation, mainly trees found on the perimeter of the area. The second type are single white blocks representing large buildings which occupy the entire area i.e. the Capitol building.			
Shading Color and Pattern - Purple medium density cross hatching, individual types contain black code text in polygons.			
N1	710	Government building, provincial offices, etc.	Usually single large buildings found in key central areas of the city and adjacent to major access roads and/or junctions. Includes City Hall.
N2	720	Educational and cultural buildings	Groups of buildings with open space. Found in urban core. Clearly defined access roads and paths between buildings. Playing fields are visible in schools. Includes Libraries and museums.
N3	730	Health and protective services	Public facilities such as hospitals and clinics. Found along the major roads.
N4	740	Religious	Large single buildings. Usually found near major access routes and surrounded by residential areas and/or parks. Seminaries, monasteries, and convents are included in this category.
N5	750	Landfill/dumping site	Large site(s) with few or no buildings found within the rural areas with single access road.
N6	760	Prison facilities	Located outside the urban core, Davao's prison is located on the Ma'a road associated with open space.
N7	770	Military complexes	Open space surrounding clusters of regular buildings, found in rural areas, next to major roads.
N8	780	Agricultural research facilities	Not found in Davao.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
T - Transportation			
Definition - GENCODE = 800			
Base Code Description - This type is represented in three major types. The first is airport/airfields which appear as areas of large open space surrounding large regular white lines (runways) and clusters of white blocks which represent operational facilities and buildings. The open area appears as dark gray/black. The second type of transportation represent the port facilities. These are found on the coastline and appear as regular shaped (round or square) white blocks. There are regular, interior roads, single white lines protruding into the water represent docks and piers. These areas are found next to major access roads. The final type of transport is bus terminals and these areas can only be identified on the image through local knowledge. They appear as single white blocks usually surrounded by major access roads and high density residential areas.			
Shading Color and Pattern - Brown medium density cross hatching, individual types contain black code text in polygons.			
T1	810	Airport/airfield	Davao airport located outside the city appears as a single strip with associated buildings, car park and access road.
T2	820	Port	Several ports are present in Davao; jetties appear as long thin extensions into the Gulf of Davao.
T3	830	Bus terminals	Small buildings and open space (parking areas) located next to major access roads.
T4	840	Railway	Not found in Davao.
P - Parks & Recreation			
Definition - GENCODE = 900			
Base Code Description - Falls into two main types. The first represent the public parks which appear as dark gray or black on the image with very few if any internal roads or buildings. Where buildings do appear they are usually clustered groups of white blocks representing club houses/tennis courts etc. Trees are usually found and are seen as black lines or dots. The second type of park can only be identified through local knowledge and represent single park facilities such as stadiums. These facilities appear as single white blocks.			
Shading Color and Pattern - Green high density cross hatching, individual types contain black code text in polygons.			
P1	910	Public parks	Large open spaces within the urban area, e.g. Magsaysay park, appear as open areas within the densely packed urban core.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
P2	920	Sports facilities	Large single areas solely for sports, such as soccer, tennis, and swimming. Next to access roads, the sports stadium in the center of Davao is clearly visible.
P3	930	Golf courses	There are several golf courses in Davao. They arrear as open areas (fairways) separated by darker bushes.
U - Utilities			
Definition - GENCODE =1000			
Base Code Description - This category represents all facilities involved with utility functions such as power, water, and telecommunications. Identification of these areas on the image is through local knowledge as the facilities are represented by single or small groups of small white blocks representing the facility buildings. Older facilities are generally found within the city limits and are usually not surrounded by an open areas, newer facilities are found on the outskirts of the city and tend to have more open areas surrounding the buildings which appear as light gray/dark gray on the image.			
Shading Color and Pattern - Magenta high density cross hatching, individual types contain black code text in polygons.			
U1	1010	Power	Small walled compounds found outside the urban center. Small buildings surrounded by large transformer units. The offices of DLPC are found outside the CBD and are classified as C2.
U2	1020	Water	Water tanks and small reservoirs are found throughout the city. The offices of DCWD are found outside the CBD and are classified as C2.
U3	1030	Tele-communications	Small walled compounds found within the urban area, small buildings surrounded by microwave towers. The offices of PLDT are found in the CBD and are classified as C5.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
G - Agro-industrial			
Definition - GENCODE = 1100			
Base Code Description - Regular white blocks, some open large open spaces, some interior roads which appear as thin white lines. Usually found along major roads, operations such as chicken farms are represented by a series of thin white lines. Older facilities such as the abattoir are found in the interior city whereas new facilities such as chicken farms are found on the outskirts of the city. Some areas must be defined through local knowledge.			
Shading Color and Pattern - Orange and green mixed medium density cross hatching.			
G	1110	Agro-industrial	Mostly piggeries, poultry, and small cattle farms. Appear as long, thin, tightly organized buildings, surrounded by a fence or wall. Served by a single access road, found in rural areas or agricultural areas. Located to the south-west of Davao City.
A - Agriculture			
Definition - GENCODE = 1200			
Base Code Description - Appears on the image as dark gray, sometimes black, there is usually a lack of buildings, areas appear regular and well defined - usually by thin white lines that represent interior roads or footpaths. Those areas near the outskirts of the city are better defined, those found further from the city tend to be smaller, and less regular in form.			
Shading Color and Pattern - Green medium density single angled hatching, individual types contain black code text in polygons.			
A1	1210	Crop land	Major crops on small holdings, In Davao the main crops are tree crops - coconuts.
A2	1220	Plantation/farms	Large units with internal roads. In Davao the banana plantation in the Davao river valley is the most prominent plantation; it appears as a smooth dark area.
A3	1230	Rice fields	Includes both wet (irrigated) and dry land rice. Few areas in Davao.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
F - Forest			
Definition - GENCODE = 1300			
Base Code Description - General forests on the image are found mostly on the hills and appear as irregular groupings of dark granular or bumpy dots. Bare land is mostly located on steep slopes and appear as gray with a few black dots (trees). Grassland is mostly found on flat lands on the outside of the city. This particular category is the most affected by cloud, firstly through shadow from the clouds themselves which cast dark spots onto the image which are often confused with forest areas. The second type of cloud distortion is formed in gullies and other depressions due to the angle of the sun. These areas are also often confused with forest areas.			
Shading Color and Pattern - Green medium density cross hatching, individual types contain black code text in polygons.			
F1	1310	Forest	Forest lands that are not protected.
F2	1320	Grassland	Open land at the outskirts of the urban area, used as grazing land for cattle, sheep or goats.
F3	1330	Bare-land	Open or denuded land (subject to erosion), usually found in foothills.
F4	1340	National Park/ Reserve	Areas defined and demarcated by law.
F5	1350	Protected watershed	Areas defined and demarcated by law as protected watersheds.
D - Land under Development			
Definition - GENCODE = 1400			
Base Code Description - Large irregular areas mostly white with some gray speckles. Mostly found on the outskirts of the city or along the coast.			
Shading Color and Pattern - Magenta angled single hatching.			
D	1410	Land under development	Large areas on outskirts of the current urban area, next to urban access roads. Basic infrastructure may be present , e.g. roads. Areas are usually walled or fenced.

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Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
O - Open Land			
Definition - GENCODE = 1500			
Base Code Description - Defined as open or vacant areas within urban areas only. Usually appears as dark gray with no visible active use, few interior roads, little or no structures and irregular in shape and form.			
Shading Color and Pattern - Open areas not colored with hatching merely indicated through the black letter O in the center of each polygon.			
O	1510	Open land	Areas of open or vacant land within the urban core. Usually surrounded by residential or commercial areas and located next to access roads, usually covered in coconut trees. A considerable amount of open land is along Diversion road.
W - Water			
Definition - GENCODE = 1600			
Base Code Description - Lakes will appear black/ dark gray and usually are irregular in shape. Mangroves are found on the coast and are irregular in form and appear as light gray with regular white dots, interior water channels appear as dark thick lines. Salt pans vary in appearance form light gray to black, with form described as regular and surrounded by thin white strips (footpaths), salt pans usually have a small river or stream passing through the area to the coast. Aqua-culture is found on the coast and also out in water channels. The first type appears very similar to salt pans and local knowledge is needed to distinguish the two. The second type appears as a collection of thin white strips (pen boundaries) and are surrounded entirely by water.			
Shading Color and Pattern - Blue medium density cross hatching, individual types contain black code text in polygons.			
W1	1610	Lakes and rivers	Appear as dark areas on the image. Davao river is clearly visible. Smaller creeks can be seen discharging into the Gulf of Davao.
W2	1620	Mangroves	Not found in Davao.
W3	1630	Swamps (marshes)	Found in lowing areas, appearing as dark areas, often mistaken with open land in urban area.
W4	1640	Salt pans	Not found in Davao.
W5	1650	Aqua-culture	Found in Bunawan to the north of the city, appear as regular dark rectangles next to or in the sea.

Davao City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
Q - Quarries & Mines			
Definition - GENCODE = 1700			
Base Code Description - Usually found on the outskirts of the city on the foot hills. Usually delineated by a single round white area connected by a thin, regular white line representing an access road.			
Shading Color and Pattern - Black medium density cross hatching.			
Q	1710	Quarries/mines	Appear as white areas outside urban areas, can be confused with Land under development. All Quarries are located to the northern section of Davao, conveyor belts are also visible.
B - Beach Resorts			
Definition - GENCODE = 1800			
Base Code Description - Large developments found on the coast. Long white strips represent beaches, small regular buildings appear as both light gray and white. Small access roads with a few interior roads can also be seen. Most beach development is found at some distance from general urban development.			
Shading Color and Pattern - Yellow or orange dot pattern.			
B	1810	Beach resorts	Found on Samal island and on the mainland, e.g. Paradise island.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
H - High Density Housing			
Definition - GENCODE = 100			
Base Code Description - Gray, densely packed, a few white speckles. Internal roads not clear. Areas themselves usually defined by larger roads. Mostly found on marginal lands and close to industrial and commercial areas. Some housing of this type contains mixed use with small commercial activity occurring on the ground floor.			
Shading Color and Pattern - Red dense hatching, individual codes plotted in black text.			
H1	110	High density	In Lipa this type is defined by small government housing schemes that have on average approximately 80 dwelling units per hectare. Single-family units with small grass surrounds tightly placed together. These units are served with basic services. Found within the city proper, an example is the small community in Sabang just off the old Lipa road. The second type of housing is identified within the C5 code as the predominant use in Lipa is commercial (ground floor) with residential above. This type is also found in the city proper.
H2	120	Apartment buildings	Not currently found in Lipa City. General description for this type would be large multi-story buildings with large number of occupants. Usually the units comprise two or three rooms in a single level. BLISS projects would fall under this category.
H3	130	High density shanties	Not currently found in Lipa City. However, there are two types of medium density shanties found in Lipa City (please reference M4).[1]

[1]Density as applied to housing in Lipa City generally follows the density guidelines as currently adopted for Lipa City. These are: <21 dwelling units per hectare (du/Ha) - Low, 21-65 du/Ha - Medium, and >65 du/Ha - High.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
M - Medium Density Housing			
Definition - GENCODE = 200			
Base Code Description - Mixed gray and white, more trees and grass than H. Building shapes are more regular and defined. Some internal roads are visible. Areas usually defined by major roads and other uses. Some medium density areas are found in marginal areas such as gullies and on the urban fringe - these areas appear as a darker gray with little or no internal roads.			
Shading Color and Pattern - Red medium density cross hatching, individual types contain black code text in polygons.			
M1	210	Medium density subdivision	Organized urban communities with paved internal streets, telephone, and power poles. No or very little commercial activity is found in these areas. Houses are single-family units single or two stories. Units are separated by walls or fences and surrounded by some green space. Considerable vegetation is present.
M2	220	Medium density housing	Medium density housing regular in form mostly found along major urban thoroughfares outside the CBD. Many houses in this type are constructed of wood with tar and wood roofs. Some vegetation. Commercial activity is present, typically car repair/body shops, Sari-Sari shops, etc. Housing style is split between two-story and bungalow. Distance from the city proper increases so the density decreases and the vegetation increases.
M3	230	Medium density town homes	Referred to as "apartments" in Lipa, this type is identified by two-story buildings with six units per level. Mostly found within the city "proper" or Poblacion, very little or no commercial activity present.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
M4	240	Medium density shacks	In Lipa all shanties fall within two main types - both as medium and not high density (unlike Cebu or Davao). The first types of shanty are those found along the abandoned railway on the outskirts of town. These are small units with no service, constructed of irregular materials such as palm fronds (nipa) and plastic/ cardboard, with no permanent floor. Later stages of this development can usually be identified through more permanent building materials such as corrugated zinc/tin roofs (GI sheets) and a permanent floor base. Surrounded by open land and some agricultural activity. Sari-Sari type operations are present. The second types of shanty are those found in the creeks running through Lipa City. The density of this type is higher[2] than the railway shanties but the housing type is the same. Surrounded by other residential types. No service levels. Sari-Sari type operations are present. Note: "Squatter"[3] and "informal" settlements are the definition most often applied to this type.
M5	250	Medium density - villages (peri-urban)	Found at the outskirts and beyond of the urban area. These villages are small clusters of small single family dwelling units with Sari-Sari stores, churches, and schools. These areas have large amounts of vegetation, no internal roads, and very little in the way of services (water is provided though Artesian wells).

[2]The difference in density is defined by field surveys performed by the City Planning and Development Office. This survey found that on average the dwelling units per hectare was approximately 50 in the creeks and 35 for the railway (Squatter Survey Lipa City November 1993, Department of Social Welfare and Development).

[3]Squatter is a problematic term as by definition it means people who occupy land illegally, i.e., without clear, legal title. If this criteria is applied to the city of Lipa, it is possible that 40% of all housing would classify as a squatter settlements. Thus, it is the holding type and not legal condition that is more important to describe through high density shanty.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
L - Low Density Housing			
Definition - GENCODE = 300			
Base Code Description - Large white blocks, well defined, vegetation. Interior roads are well defined but do not appear as a regular grid fashion. Houses usually found in groupings which are loosely and irregularly defined in form. Large areas of dark gray appears and represents grass and vegetation. The other type of low density housing are medium to large blocks found mainly on the periphery of the city. Surrounding areas appear as dark gray and represent some grasslands and other vegetation, very few interior roads.			
Shading Color and Pattern - Red light density cross hatching.			
L1	310	Low density rest houses/villas	Mostly found outside the urban areas along major access routes to the rural areas. Large lots with buildings clustered together setback from the fronting road. Single-access road to building is usually present. Area surrounding buildings is generally open grassland with some trees. Lots served by Artesian wells, power supply is present. Some small-scale commercial activity is present, i.e., hogs and horses. Areas sometimes lived on by caretakers whose shacks are usually found at the periphery of the property.
L2	320	Farm sub-division	Mostly found in rural areas along single access route. Some small scale agro-industry is present, such as stud farm/cock raising. Agricultural activities such as small crop land (e.g., corn) is also found. Compound or subdivision is walled. Central recreational buildings present (e.g., club house, swimming pool, etc.), individual units have large ranch style housing. Some interior roads, and some tenant houses are also present. Vegetation is mainly found ate the periphery of units and compound.
R - Rural Settlements			
Definition GENCODE = 400			
Base Code Description - Very, small white dots, irregular pattern, clustered near a single access road. Usually less than 100 houses per settlements.			
Shading Color and Pattern - Mixed green and red fairly dense hatching.			
R	410	Rural settlements	Mainly found on single-access roads going from the city

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
C - Commercial			
Definition - GENCODE = 500			
Base Code Description - Larger, white blocks with some vegetation and car parks. Few interior roads. Mostly found next to major roads and surrounded largely by residential or industrial areas.			
Shading Color and Pattern - Yellow or orange medium dense cross hatching. Individual categories contain black land use code text.			
C1	510	Shopping centers/ malls	Not currently found in Lipa. Type generally large, single complexes of mega shops such as Mega Mall in Manila, and Shoemart in Cebu.
C2	520	Business offices/ buildings	Mostly found within the CBD. Single, multi-story buildings along the major thoroughfares. No parking or vegetation. Now there are only a few examples of this type in Lipa City, e.g., Senora Maria Bldg., and the Cuenca Bldg.
C3	530	Hotels/ motels	Single, large buildings or small clusters of buildings usually found on the outskirts of the urban area along major access roads (there are a few smaller hostels within the city but these are mixed with residential areas). Usually surrounded by residential or other commercial activity. Parking areas are present as is vegetation.
C4	540	Markets	Single, large complex found within C5. No vegetation present. Found along paved access routes.
C5	550	Mixed use - commercial district or CBD	Mainly found in the downtown area of the city this type represents mixed use of ground floor commercial activity such as tailors, electronics, general merchandise, fast food, and cinemas/movie houses, etc., and second floor residential housing. Density is high with no open space or vegetation. Streets are well defined and fairly regular. Almost all use of this type is found in the central business district along the major thoroughfares. Use also extends behind the first row and is reached through small paved roads and paths. All services such as power, piped water, and telephone are present here.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
C6	560	Warehouses	Medium to large-size buildings found with small regular internal roads. Some vegetation found, next to major thoroughfares and surrounded by residential and/or other commercial activity (i.e., M2 and C7). Mainly located outside the Poblacion along the major urban routes.
C7	570	Small-scale retail	This type is found only in a few locations. However, it is probable that this type will become more apparent, particularly along the urban route from Tanauan to Batangas City. Type is described by a collection of small facilities and stores such as motor repair, gas stations, and bakeries. A current example is the small "strip" development found opposite the De La Salle school complex.
C8	580	Private medical complex	Private, for-profit medical complexes found at the outskirts of town along major access roads. Large, multi-story buildings with vegetation and open space for parking. Usually surrounded by other commercial or residential activity. This category includes the two complexes currently under construction on the bypass road (Mary Mediatrix and Lipa Medical Center).
I - Industrial			
Definition - GENCODE = 600			
Base Code Description - Large regular white shapes, small regular internal access roads with very little vegetation. Open areas inside appear as gray are unloading/loading areas. These areas are mostly found near the coastlines. Those on the coast have wharf or pier facilities that protrude into the water areas and appear as thin white lines on the image.			
Shading Color and Pattern - Orange high density cross hatching, individual types contain black code text in polygons.			
I1	610	Large-scale industry	Use of this type not currently found in Lipa City.
I2	620	Medium-scale industry	Intermediate size industries, medium size white buildings within a walled compound. Located near to major thoroughfares and outside the urban areas, surrounded by open land and/or agricultural areas. Industries such as spinning mills, food processing (Nestle), plastic sack manufacturing, and textiles fall within this category.

Lipa City Land Use Code			
CODE	**NUMERIC CODE**	**TITLE**	**DESCRIPTION**
I3	630	Small-scale industry	Smaller-scale, cottage industries found mainly along major and smaller roads. Characterized by low production and small numbers of employees. Generally found in or near residential areas and closer to the urban areas. Characterized by Jeepney assembly, tricycle assembly, wire harness plants, and sash (wood frame) factories.
I4	640	Depots storage complexes	Not currently found in Lipa City.
N - Institutional			
Definition - GENCODE = 700			
Base Code Description - These types appear similar to some commercial and industrial areas and are largely defined through local knowledge. These areas can be defined in several types: large, open areas which appear as black or dark gray on the image with a single white block, or group of clustered white blocks representing large buildings. Very few interior roads, some vegetation, mainly trees found on the perimeter of the area. The second type are single white blocks representing large buildings which occupy the entire area i.e. the Capitol building.			
Shading Color and Pattern - Purple medium density cross hatching, individual types contain black code text in polygons.			
N1	710	Government building, provincial offices, etc.	Usually single, large, white buildings found in key, central areas of the city and adjacent to major access roads and/or junctions. Facilities such as city hall, provincial Capitol buildings are included in this classification. Very little vegetation present.
N2	720	Educational and cultural buildings	Groups of buildings usually with slightly more open space than surrounding urban areas. Mostly found within residential areas. Clearly defined access roads and paths between buildings. Universities are not currently present in Lipa. All facilities are found on major access roads. Libraries and cultural centers included in this category.
N3	730	Health and welfare	Public facilities such as hospitals and clinics. Found mainly along the major routes within the city.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
N4	740	Religious, churches, cemeteries	Large single buildings. Usually found near major access routes and surrounded by residential areas. Seminaries, monasteries, and convents are included in this category. Cemeteries found on access routes at the edges of the urban area. Small sites such as chapels or shrines are not defined here but are included as part of the description for various residential types, i.e., M3 and H1.
N5	750	Landfill/dumping site	Large site(s) with few or no buildings found within the rural area surrounded by agriculture. Single access road present. San Isidro (formerly Sapak) is the current site.
N6	760	Prison facilities	Not currently found in Lipa City. Note: police stations in Lipa currently have holding cells, but there is no single prison facility in the city.
N7	770	Military complexes	Large areas of open space surrounding clusters of regular, white buildings. Found near the outskirts of the city close to major access points. San Fernando Air Base contains multiple facilities within for aircraft maintenance and storage, military housing, sports complex (golf course), and others. Area enclosed by walls and fence.
N8	780	Agricultural research facilities	Single walled compounds often found near other government offices. Compounds contain multiple large buildings. Some internal roads are present and areas contain vegetation. Usually surrounded by residential or agricultural areas, e.g., International Training Center for Pig Husbandry in Maraouy, or the Dept. of Agriculture on the bypass road.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
T - Transportation			
Definition - GENCODE = 800			
Base Code Description - This type is represented in three major types. The first is airport/airfields which appear as areas of large open space surrounding large regular white lines (runways) and clusters of white blocks which represent operational facilities and buildings. The open area appears as dark gray/black. The second type of transportation represent the port facilities. These are found on the coastline and appear as regular shaped (round or square) white blocks. There are regular, interior roads, single white lines protruding into the water represent docks and piers. These areas are found next to major access roads. The final type of transport is bus terminals and these areas can only be identified on the image through local knowledge. They appear as single white blocks usually surrounded by major access roads and high density residential areas.			
Shading Color and Pattern - Brown medium density cross hatching, individual types contain black code text in polygons.			
T1	810	Airport/airfield	Not currently found in Lipa City. Note: The only airfield in Lipa is found within the SFAB and is not for civilian use.
T2	820	Port	Not present in Lipa City.
T3	830	Bus terminals	Small buildings on major access roads. In Lipa City there are two sites: the bus terminal on the bypass road near the new McDonald's, and the smaller Jeepney staging area near the public market in the city center.
P - Parks & Recreation			
Definition - GENCODE = 900			
Base Code Description - Falls into two main types. The first represent the public parks which appear as dark gray or black on the image with very few if any internal roads or buildings. Where buildings do appear they are usually clustered groups of white blocks representing club houses/tennis courts etc. Trees are usually found and are seen as black lines or dots. The second type of park can only be identified through local knowledge and represent single park facilities such as stadiums. These facilities appear as single white blocks.			
Shading Color and Pattern - Green high density cross hatching, individual types contain black code text in polygons.			
P1	910	Public parks	Open areas of grass and vegetation.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
P2	920	Sports facilities	Large single areas solely for sport such as tennis, swimming pools, and stadiums. Usually surrounded by residential and commercial areas and next to access roads.
P3	930	Golf courses	Not currently found in Lipa. Note: a small golf course and driving range can be found within the San Fernando Air Base.
U - Utilities			
Definition - GENCODE =1000			
Base Code Description - This category represents all facilities involved with utility functions such as power, water, and telecommunications. Identification of these areas on the image is through local knowledge as the facilities are represented by single or small groups of small white blocks representing the facility buildings. Older facilities are generally found within the city limits and are usually not surrounded by an open areas, newer facilities are found on the outskirts of the city and tend to have more open areas surrounding the buildings which appear as light gray/dark gray on the image.			
Shading Color and Pattern - Magenta high density cross hatching, individual types contain black code text in polygons.			
U1	1010	Power	Small walled compounds found at the edges of the urban area. Small buildings surrounding large transformer units. The administrative unit of Batelec II is found within the CBD and is included in the C2 category.
U2	1020	Water	Water tanks and small reservoirs are found through out the city. Administrative unit of LCWD is found in the CBD and is coded under category C2.
U3	1030	Tele-communications	Small walled compounds found at the edges of the urban area. Small buildings surrounding tall microwave towers. Administrative unit of PLDT is found in the CBD and is coded under C2.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
G - Agro-industrial			
Definition - GENCODE = 1100			
Base Code Description - Regular white blocks, some open large open spaces, some interior roads which appear as thin white lines. Usually found along major roads, operations such as chicken farms are represented by a series of thin white lines. Older facilities such as the abattoir are found in the interior city whereas new facilities such as chicken farms are found on the outskirts of the city. Some areas must be defined through local knowledge.			
Shading Color and Pattern - Orange and green mixed medium density cross hatching.			
G	1110	Agro-industrial	Mostly piggeries, poultry, small cattle farms, and organic fertilizer farms. Appear as long, thin, white and orange buildings tightly organized within a walled or fenced compound. Served by a single access road. Found apart from the urban areas and generally surrounded by agricultural land.
A - Agriculture			
Definition - GENCODE = 1200			
Base Code Description - Appears on the image as dark gray, sometimes black, there is usually a lack of buildings, areas appear regular and well defined - usually by thin white lines that represent interior roads or footpaths. Those areas near the outskirts of the city are better defined, those found further from the city tend to be smaller, and less regular in form.			
Shading Color and Pattern - Green medium density single angled hatching, individual types contain black code text in polygons.			
A1	1210	Crop land	General crop lands.
A2	1220	Plantation/farms	Large units usually fenced with multiple buildings. Some internal roads. Found apart from the urban areas and surrounded by other agricultural and agro-industrial lands. Includes mango, banana, sugar cane, coconut, and pineapple. No plantations are found within Lipa (unlike the Chiquita plantation in Davao), however, there are some farms present.
A3	1230	Rice field	Rice paddies.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
F - Forest			
Definition - GENCODE = 1300			
Base Code Description - General forests on the image are found mostly on the hills and appear as irregular groupings of dark granular or bumpy dots. Bare land is mostly located on steep slopes and appear as gray with a few black dots (trees). Grassland is mostly found on flat lands on the outside of the city. This particular category is the most affected by cloud, firstly through shadow from the clouds themselves which cast dark spots onto the image which are often confused with forest areas. The second type of cloud distortion is formed in gullies and other depressions due to the angle of the sun. These areas are also often confused with forest areas.			
Shading Color and Pattern - Green medium density cross hatching, individual types contain black code text in polygons.			
F1	1310	Forest	General category for forest lands not protected. Includes broadleaf, bushes, scrub, bamboo, and others.
F2	1320	Grassland	Open land at the outskirts of the city and in the hinterland covered with grasses. Often used for small stakeholder farmers to graze animals. Usually found on foothills.
F3	1330	Bare land	Barren and sparsely vegetated open areas either as former forest now denuded or rocky slopes, etc.
F4	1340	National Park/ Reserve	Areas defined and demarcated by law. Can be found as water and land related. In a conflict assessment the predominant use or distinction takes precedence, i.e., a National Park of mangroves would be classified as F4.
F5	1350	Protected watershed	Areas defined and demarcated by law as protected watersheds. Form crucial catchment areas in foothills and mountains.
D - Land under Development			
Definition - GENCODE = 1400			
Base Code Description - Large irregular areas mostly white with some gray speckles. Mostly found on the outskirts of the city or along the coast.			
Shading Color and Pattern - Magenta angled single hatching.			
D	1410	Land under development	Large defined areas on the outskirts of the current urban area, alongside urban access routes. Basic infrastructure

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
O - Open Land			
Definition - GENCODE = 1500			
Base Code Description - Defined as open or vacant areas within urban areas only. Usually appears as dark gray with no visible active use, few interior roads, little or no structures and irregular in shape and form.			
Shading Color and Pattern - Open areas not colored with hatching merely indicated through the black letter O in the center of each polygon.			
O	1510	Open land	Areas of open or vacant land found ONLY within the urban areas. Usually surrounded by residential or commercial activity. Some vegetation is present, area is mainly covered in bush and grass. Usually found along major access routes.
W - Water			
Definition - GENCODE = 1600			
Base Code Description - Lakes will appear black/ dark gray and usually are irregular in shape. Mangroves are found on the coast and are irregular in form and appear as light gray with regular white dots, interior water channels appear as dark thick lines. Salt pans vary in appearance form light gray to black, with form described as regular and surrounded by thin white strips (footpaths), salt pans usually have a small river or stream passing through the area to the coast. Aqua-culture is found on the coast and also out in water channels. The first type appears very similar to salt pans and local knowledge is needed to distinguish the two. The second type appears as a collection of thin white strips (pen boundaries) and are surrounded entirely by water.			
Shading Color and Pattern - Blue medium density cross hatching, individual types contain black code text in polygons.			
W1	1610	Lakes	Lake Taal is the only lake found in or bordering Lipa. Area appears as a single dark blue area.
W2	1620	Mangroves	Not found in Lipa.
W3	1630	Swamps (marshes)	Not found in Lipa.
W4	1640	Salt pans	Not found in Lipa.
W5	1650	Aqua-culture	Not found in Lipa.

Lipa City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
Q - Quarries & Mines			
Definition - GENCODE = 1700			
Base Code Description - Usually found on the outskirts of the city on the foot hills. Usually delineated by a single round white area connected by a thin, regular white line representing an access road.			
Shading Color and Pattern - Black medium density cross hatching.			
Q	1710	Quarries/mines	Found on the outskirts of the city on the foot hills. Usually delineated by a single round white area connected by a thin, regular white line representing an access road.
B - Beach Resorts			
Definition - GENCODE = 1800			
Base Code Description - Large developments found on the coast. Long white strips represent beaches, small regular buildings appear as both light gray and white. Small access roads with a few interior roads can also be seen. Most beach development is found at some distance from general urban development.			
Shading Color and Pattern - Yellow or orange dot pattern.			
B	1810	Beach resorts	Not applicable in Lipa City.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
H - High Density Housing			
Definition - GENCODE = 100			
Base Code Description - Gray, densely packed, a few white speckles. Internal roads not clear. Areas themselves usually defined by larger roads. Mostly found on marginal lands and close to industrial and commercial areas. Some housing of this type contains mixed use with small commercial activity occurring on the ground floor.			
Shading Color and Pattern - Red dense hatching, individual codes plotted in black text.			
H1	110	High density	Only housing as there are not high density sub-divisions. Single units many floors, with some grass areas, tightly packed. High density housing occurs within the urban core, construction materials vary with bricks and wood being used. They can be distinguished from mature shanty areas by the fact that each house is served by services (water, electricity). Residential areas above commercial activity are classified as C5.
H2	120	High rise apartments	Not found in Naga City, designated to avoid confusion with "apartments" which are classified as M3.
H3	130	High density shanties	These are small units with no services, constructed of irregular materials, such as palm, nipa, and plastic/cardboard with no permanent floor. Later stages of development can usually be identified by more permanent building materials. Concentrated along the river, railway and in swampy land in the city proper. Most other shanty areas are classified as medium density. Some have been relocated to rural areas.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
M - Medium Density Housing			
Definition - GENCODE = 200			
Base Code Description - Mixed gray and white, more trees and grass than H. Building shapes are more regular and defined. Some internal roads are visible. Areas usually defined by major roads and other uses. Some medium density areas are found in marginal areas such as gullies and on the urban fringe - these areas appear as a darker gray with little or no internal roads.			
Shading Color and Pattern - Red medium density cross hatching, individual types contain black code text in polygons.			
M1	210	Medium density subdivisions	Organized urban communities with paved internal streets, telephone, and power poles. Little commercial activity is found in these areas. Houses are single-family dwelling units, single or two stories. Units are separated by walls or fences and surrounded by some green space. Vegetation is present (e.g., Villa Grande). More recent sub-divisions are more tightly packed and have no fences or walls (e.g. Villa Corazon Phase II).
M2	220	Medium density housing	Medium density housing, regular in form, mostly found along major urban throughfares. Housing styles both one and two story. Not organized into a regular sub-division, occurs more commonly in urban core, with some open space and vegetation.
M3	230	Medium density apartments	This type is identified by two story buildings with one family occupying two floors, each building contains 3-5 units per building. found in all parts of the city.
M4	240	Medium density shanties	Most shanty areas in the city (away from the river and railway) are medium density, they have no services (usually a single standpipe provides water), description as H3.
M5	250	Medium density - villages (peri-urban)	Called "Sitios", found at the outskirts of the city. These villages are small clusters of single family dwelling units with "Sari-Sari" stores, churches and schools. These areas have large amounts of vegetation.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
L - Low Density Housing			
Definition - GENCODE = 300			
Base Code Description - Large white blocks, well defined, vegetation. Interior roads are well defined but do not appear as a regular grid fashion. Houses usually found in groupings which are loosely and irregularly defined in form. Large areas of dark gray appears and represents grass and vegetation. The other type of low density housing are medium to large blocks found mainly on the periphery of the city. Surrounding areas appear as dark gray and represent some grasslands and other vegetation, very few interior roads.			
Shading Color and Pattern - Red light density cross hatching.			
L1	310	Low density sub-divisions	Usually found inside the urban area. Large buildings set back from the access road, big compounds, fenced or walled. Surrounding areas are open as some areas have not been completed, e.g. Villa Concepion, Legaspi road.
L2	320	Low density housing	Individual houses with large amounts of open space, found inside and outside the urban core, often the houses stand alone.
R - Rural Settlements			
Definition GENCODE = 400			
Base Code Description - Very, small white dots, irregular pattern, clustered near a single access road. Usually less than 100 houses per settlements.			
Shading Color and Pattern - Mixed green and red fairly dense hatching.			
R	410	Rural settlements	Mainly found on single-access roads going from the city to other areas appearing as ribbon development. Small groupings of shanties and regular housing. Includes relocation sites, whether squatters have been moved from the urban core, e.g. Cararayan.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
C - Commercial			
Definition - GENCODE = 500			
Base Code Description - Larger, white blocks with some vegetation and car parks. Few interior roads. Mostly found next to major roads and surrounded largely by residential or industrial areas.			
Shading Color and Pattern - Yellow or orange medium dense cross hatching. Individual categories contain black land use code text.			
C1	510	Shopping centers/ malls	Not currently found in Naga.
C2	520	Business offices/ buildings	Mostly found within the CBD. Single, multi-story buildings along the major thoroughfares. Examples include the PNE building and Shoppers Mall building.
C3	530	Hotels/ motels	Single and multistory buildings, usually found on the outskirts of the city along major access roads. Some located in CBD as multi-story buildings, where classified as C5 if they cannot be distinguished. Usually surrounded by residential/commercial activity. Parking areas and vegetation present.
C4	540	Markets	Includes both government (e.g. Naga City public Market) and private markets, no vegetation present, densely packed in urban core. Supplemented by satellite markets, e.g. Barlin Street.
C5	550	Mixed commercial/CBD	Mainly found in the downtown area of the city. This type represents mixed use of ground floor for commercial activity, such as tailors, electronics, general merchandise, fast food, cinemas and second floor residential use. Density is high with no open space/vegetation. Streets are well defined and regular. Almost all this type of land use is found in the CBD.
C6	560	Warehouses	Medium to large-size buildings found with small internal roads. Some vegetation. Found next to major roads, and also in residential areas and along major access roads (e.g. San Miguel warehouse).

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
C7	570	Retail	Appears as a small collection of buildings along major access roads, both within and outside the urban core. Includes bakeries, "Sari-Sari" stores, gas stations and vulcanizing stores, ice plants and car sales. Many appear along Diversion road in Naga.
C8	580	Private medical complex	Private medical complexes found on the outskirts of town, along major access roads. Large multi-story buildings, e.g. Mother Seton Hospital, Ago hospital and medical school.
I - Industrial			
Definition - GENCODE = 600			
Base Code Description - Large regular white shapes, small regular internal access roads with very little vegetation. Open areas inside appear as gray are unloading/loading areas. These areas are mostly found near the coastlines. Those on the coast have wharf or pier facilities that protrude into the water areas and appear as thin white lines on the image.			
Shading Color and Pattern - Orange high density cross hatching, individual types contain black code text in polygons.			
I1	610	Large-scale industry	Not currently found in Naga.
I2	620	Medium-scale industry	Intermediate size, in Naga, appear as bottling plants (Coke and Pepsi), rice mills and food processing (e.g., noodles, sardines), located on major access roads, throughout the urban area.
I3	630	Small-scale industry	Smaller scale cottage industries: Jeepney and tricycle assembly, wire harness plants and wood frame factories. Located in small buildings along major roads, near residential areas. Characterized by low production and small number of employees.
I4	640	Depots storage complexes	Not currently found in Naga.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
N - Institutional			
Definition - GENCODE = 700			
Base Code Description - These types appear similar to some commercial and industrial areas and are largely defined through local knowledge. These areas can be defined in several types: large, open areas which appear as black or dark gray on the image with a single white block, or group of clustered white blocks representing large buildings. Very few interior roads, some vegetation, mainly trees found on the perimeter of the area. The second type are single white blocks representing large buildings which occupy the entire area i.e. the Capitol building.			
Shading Color and Pattern - Purple medium density cross hatching, individual types contain black code text in polygons.			
N1	710	Government building, provincial offices, etc.	Usually single, large, white buildings found in key, central areas of the city and adjacent to major access roads and/or junctions. Includes City Hall.
N2	720	Educational and cultural buildings	Groups of buildings with open space. Found in urban core. Clearly defied access roads and paths between buildings. Playing fields are visible. Universities and colleges are present in Naga. Libraries, museums are included.
N3	730	Health and protective services	Public facilities such as hospitals and clinics, police and fire stations. Found along main roads.
N4	740	Religious	Large single buildings. Usually found near major access routes and surrounded by residential areas and/or parks. Seminaries, monasteries, cemeteries, convents and memorial parks are included in this category.
N5	750	Landfill/dumping site	Large sites with few or no buildings, found in the rural areas with single access road, Balatas is the current site in Naga.
N6	760	Prison facilities	None at present (only in Police cells), one to be built in Del Rosa, next to the Slaughterhouse.
N7	770	Military complexes	Open space surrounding clusters of regular buildings, found in rural areas, next to major roads, e.g. Camp Canoto, Pili Municipality.
N8	780	Agricultural research facilities	Not present in Naga.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
T - Transportation			
Definition - GENCODE = 800			
Base Code Description - This type is represented in three major types. The first is airport/airfields which appear as areas of large open space surrounding large regular white lines (runways) and clusters of white blocks which represent operational facilities and buildings. The open area appears as dark gray/black. The second type of transportation represent the port facilities. These are found on the coastline and appear as regular shaped (round or square) white blocks. There are regular, interior roads, single white lines protruding into the water represent docks and piers. These areas are found next to major access roads. The final type of transport is bus terminals and these areas can only be identified on the image through local knowledge. They appear as single white blocks usually surrounded by major access roads and high density residential areas.			
Shading Color and Pattern - Brown medium density cross hatching, individual types contain black code text in polygons.			
T1	810	Airport/airfield	Naga airport, 20 minutes from the city is located in the municipality of Pili. Single strip with associated buildings, car park and access road.
T2	820	Port	Not found in Naga.
T3	830	Bus terminals	Small buildings and open space on major access roads. Bus terminals are located along Diversion road and Jeepney terminals in the CBD and other commercial districts.
T4	840	Railway	Includes PNR station at Tabuco and track and warehouses associated with the railway.
P - Parks & Recreation			
Definition - GENCODE = 900			
Base Code Description - Falls into two main types. The first represent the public parks which appear as dark gray or black on the image with very few if any internal roads or buildings. Where buildings do appear they are usually clustered groups of white blocks representing club houses/tennis courts etc. Trees are usually found and are seen as black lines or dots. The second type of park can only be identified through local knowledge and represent single park facilities such as stadiums. These facilities appear as single white blocks.			
Shading Color and Pattern - Green high density cross hatching, individual types contain black code text in polygons.			
P1	910	Public parks	Large open spaces in urban area.

Naga City Land Use Code			
CODE	**NUMERIC CODE**	**TITLE**	**DESCRIPTION**
P2	920	Sports facilities	Large single areas solely for sport such as soccer, tennis, and swimming. Next to access roads, includes cock fighting stadium on Diversion road. Includes private and public centers.
P3	930	Golf courses	Not currently found in Naga.
U - Utilities			
Definition - GENCODE =1000			
Base Code Description - This category represents all facilities involved with utility functions such as power, water, and telecommunications. Identification of these areas on the image is through local knowledge as the facilities are represented by single or small groups of small white blocks representing the facility buildings. Older facilities are generally found within the city limits and are usually not surrounded by an open areas, newer facilities are found on the outskirts of the city and tend to have more open areas surrounding the buildings which appear as light gray/dark gray on the image.			
Shading Color and Pattern - Magenta high density cross hatching, individual types contain black code text in polygons.			
U1	1010	Power	Small walled compounds found outside the urban center. Small buildings surrounded by large transformer units. The main offices of CASURECO are found outside the CBD and are classified as C2.
U2	1020	Water	Water tanks and small reservoirs are found through out the city. The offices of NAWASA are found outside the CBD and are classified as C2.
U3	1030	Tele-communications	Small walled compounds found within the urban area. Small buildings surrounded by tall microwave towers. The offices of PLDT are found in the CBD and are classified as C5.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
G - Agro-industrial			
Definition - GENCODE = 1100			
Base Code Description - Regular white blocks, some open large open spaces, some interior roads which appear as thin white lines. Usually found along major roads, operations such as chicken farms are represented by a series of thin white lines. Older facilities such as the abattoir are found in the interior city whereas new facilities such as chicken farms are found on the outskirts of the city. Some areas must be defined through local knowledge.			
Shading Color and Pattern - Orange and green mixed medium density cross hatching.			
G	1110	Agro-industrial	Mostly piggeries, poultry, cattle farms. Appear as long, thin, tightly organized buildings, surrounded by a fence or wall. Served by a single access road. Found in rural and agricultural areas.
A - Agriculture			
Definition - GENCODE = 1200			
Base Code Description - Appears on the image as dark gray, sometimes black, there is usually a lack of buildings, areas appear regular and well defined - usually by thin white lines that represent interior roads or footpaths. Those areas near the outskirts of the city are better defined, those found further from the city tend to be smaller, and less regular in form.			
Shading Color and Pattern - Green medium density single angled hatching, individual types contain black code text in polygons.			
A1	1210	Crop land	Major crops on small holdings.
A2	1220	Plantations	Large units, with internal access roads. In Naga mainly Sugar cane in Panicuason Carolina and Pacol.
A3	1230	Rice field	Includes both wet (irrigated) and dry land rice.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
F - Forest			
Definition - GENCODE = 1300			
Base Code Description - General forests on the image are found mostly on the hills and appear as irregular groupings of dark granular or bumpy dots. Bare land is mostly located on steep slopes and appear as gray with a few black dots (trees). Grassland is mostly found on flat lands on the outside of the city. This particular category is the most affected by cloud, firstly through shadow from the clouds themselves which cast dark spots onto the image which are often confused with forest areas. The second type of cloud distortion is formed in gullies and other depressions due to the angle of the sun. These areas are also often confused with forest areas.			
Shading Color and Pattern - Green medium density cross hatching, individual types contain black code text in polygons.			
F1	1310	Forest	Forest lands that are not protected. Concentrated in rural areas near Mt. Isarog.
F2	1320	Grassland	Open land on the outskirts of the urban area, used as grazing land for cattle, sheep or goats. Referred to as "upland" areas in Naga. May be covered by trees or bushes.
F3	1330	Bare land	Open or denuded land (subject to erosion), usually found in foothills.
F4	1340	National Park/ Reserve	Areas defined and demarcated by law (e.g. Sipocot).
F5	1350	Protected watershed	Areas defined and demarcated by law as protected watersheds.
D - Land under Development			
Definition - GENCODE = 1400			
Base Code Description - Large irregular areas mostly white with some gray speckles. Mostly found on the outskirts of the city or along the coast.			
Shading Color and Pattern - Magenta angled single hatching.			
D	1410	Land under development	Large areas on the outskirts of the current urban area, next to urban access roads. Basic infrastructure Basic infrastructure may be present (e.g. roads). Areas are usually walled or fenced.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
O - Open Land			
Definition - GENCODE = 1500			
Base Code Description - Defined as open or vacant areas within urban areas only. Usually appears as dark gray with no visible active use, few interior roads, little or no structures and irregular in shape and form.			
Shading Color and Pattern - Open areas not colored with hatching merely indicated through the black letter O in the center of each polygon.			
O	1510	Open land	Areas of open or vacant land within the urban core. Usually surrounded by residential or commercial activity. Some vegetation trees or rice (e.g. Felix Plaza St.) Usually found along major access roads.
W - Water			
Definition - GENCODE = 1600			
Base Code Description - Lakes will appear black/ dark gray and usually are irregular in shape. Mangroves are found on the coast and are irregular in form and appear as light gray with regular white dots, interior water channels appear as dark thick lines. Salt pans vary in appearance form light gray to black, with form described as regular and surrounded by thin white strips (footpaths), salt pans usually have a small river or stream passing through the area to the coast. Aqua-culture is found on the coast and also out in water channels. The first type appears very similar to salt pans and local knowledge is needed to distinguish the two. The second type appears as a collection of thin white strips (pen boundaries) and are surrounded entirely by water.			
Shading Color and Pattern - Blue medium density cross hatching, individual types contain black code text in polygons.			
W1	1610	Lakes and rivers	Small lakes are found in the foothills of Mt. Isarog, Naga river intersects the city.
W2	1620	Mangroves	Not found in Naga.
W3	1630	Swamps (marshes)	Found in low lying areas of the city, Naga city is prone to flooding.
W4	1640	Salt pans	Not found in Naga.
W5	1650	Aqua-culture	Not found in Naga.

Naga City Land Use Code			
CODE	NUMERIC CODE	TITLE	DESCRIPTION
Q - Quarries & Mines			
Definition - GENCODE = 1700			
Base Code Description - Usually found on the outskirts of the city on the foot hills. Usually delineated by a single round white area connected by a thin, regular white line representing an access road.			
Shading Color and Pattern - Black medium density cross hatching.			
Q	1710	Quarries/mines	Not found in Naga.
B - Beach Resorts			
Definition - GENCODE = 1800			
Base Code Description - Large developments found on the coast. Long white strips represent beaches, small regular buildings appear as both light gray and white. Small access roads with a few interior roads can also be seen. Most beach development is found at some distance from general urban development.			
Shading Color and Pattern - Yellow or orange dot pattern.			
B	1810	Beach resorts	Not found in Naga.

Table 4	Land Use Statistics by Detailed Code					
Land Use Code	Cebu		Davao		Lipa	
	Area in hectares	Percentage	Area in hectares	Percentage	Area in hectares	Percentage
110	514.75	2.77	660.63	4.54	68.64	0.38
120	439.11	2.36	356.95	2.45	0.00	0.00
130	266.02	1.43	269.09	1.85	0.00	0.00
210	1418.55	7.63	221.18	1.52	124.71	0.68
220	916.82	4.93	29.33	0.20	1402.59	7.68
230	504.47	2.71	0.00	0.00	0.00	0.00
240	942.40	5.07	0.00	0.00	6.96	0.04
250	2.33	0.01	0.00	0.00	228.66	1.25
310	1152.37	6.20	454.91	3.12	0.00	0.00
320	0.00	0.00	144.81	0.99	82.08	0.45
410	35.99	0.19	0.00	0.00	227.96	1.25
510	68.52	0.37	2.17	0.01	0.00	0.00
520	56.92	0.31	2.30	0.02	0.00	0.00
530	7.92	0.04	20.11	0.14	0.00	0.00
540	3.75	0.02	2.42	0.02	0.00	0.00
550	608.93	3.27	377.38	2.59	21.66	0.12
560	123.09	0.66	16.86	0.12	0.00	0.00
570	72.01	0.39	15.16	0.10	2.60	0.01
580	0.00	0.00	1.06	0.01	0.00	0.00
610	295.03	1.59	87.12	0.60	0.00	0.00
620	200.78	1.08	2.49	0.02	38.74	0.21
630	263.98	1.42	13.60	0.09	3.55	0.02
640	9.94	0.05	3.07	0.02	0.00	0.00
710	44.74	0.24	5.27	0.04	7.52	0.04
720	189.33	1.02	41.22	0.28	14.63	0.08
730	14.50	0.08	7.97	0.05	0.00	0.00
740	90.85	0.49	38.60	0.27	12.47	0.07
750	0.00	0.00	7.35	0.05	0.00	0.00
760	1.50	0.01	6.87	0.05	0.00	0.00
770	32.86	0.18	0.00	0.00	286.15	1.57
780	0.00	0.00	0.00	0.00	49.37	0.27

Table 4 Land Use Statistics by Detailed Code						
Land Use Code	Cebu		Davao		Lipa	
	Area in hectares	Percentage	Area in hectares	Percentage	Area in hectares	Percentage
810	0.97	0.01	16.45	0.11	0.00	0.00
820	83.83	0.45	2.90	0.02	0.00	0.00
830	0.00	0.00	6.47	0.04	1.19	0.01
910	81.11	0.44	8.12	0.06	0.00	0.00
920	2.93	0.02	4.91	0.03	2.48	0.01
930	0.00	0.00	60.63	0.42	0.00	0.00
1010	47.24	0.25	2.58	0.02	0.00	0.00
1020	37.07	0.20	1.81	0.01	0.00	0.00
1030	3.67	0.02	0.00	0.00	0.00	0.00
1110	82.62	0.44	0.00	0.00	312.19	1.71
1210	948.70	5.10	2834.19	19.46	15242.80	83.45
1220	105.74	0.57	1078.92	7.41	0.00	0.00
1230	97.46	0.52	4.05	0.03	0.00	0.00
1310	237.18	1.28	0.00	0.00	0.00	0.00
1320	1461.51	7.86	246.32	1.69	0.00	0.00
1330	843.99	4.54	0.00	0.00	0.00	0.00
1360	2248.13	12.09	0.00	0.00	0.00	0.00
1410	737.27	3.96	157.26	1.08	109.81	0.60
1510	584.37	3.14	254.83	1.75	18.67	0.10
1610	0.00	0.00	92.59	0.64	0.00	0.00
1620	262.80	1.41	16.33	0.11	0.00	0.00
1630	393.45	2.12	40.64	0.28	0.00	0.00
1640	452.67	2.43	0.00	0.00	0.00	0.00
1650	114.33	0.61	0.00	0.00	0.00	0.00
1660	104.49	0.56	4.85	0.03	0.00	0.00
1710	0.00	0.00	12.39	0.09	0.00	0.00
1810	18.18	0.10	27.26	0.19	0.00	0.00
1900	1367.93	7.36	0.00	0.00	0.00	0.00
9999	0.00	0.00	6901.42	47.39	0.00	0.00
Total	18595.10	100.00	14562.84	100.00	18265.42	100.00

PART II

EQUIPMENT COST AND BREAKDOWN

PART II

Equipment Cost and Type Breakdown

Cebu City

Qty	Specifications	Unit Price	Total Price
3	**BELTRON PC 486DX2-66** CPU, 80846DX2-VESA LOCAL BUS Clock Speed, 66 MHz RAM, 16 MB Disk Drive, 1.44MB 3.5" floppy disk drive Hard Disk, Two (2) 340 MB (Seagate) Drive Controller, IDE Video I/F, 2MB LOCAL BUS VGA (Trident) I/O, One Parallel Port Two Serial Port Keyboard, 101 keys Mouse, BELTRON Supermouse Microsoft/PC compatible		
3	**PHILIPS EVGA COLOR MONITOR** 15" Autoscan EVGA 1024 x 768 pixels Low emission Non-interlaced Model 4CM 8270		
1	**KURTA XLC 36" X 48" DIGITIZER** Resolution, 1279 ppi Accuracy, 0.01 inch (.254mm) IS/Pensmith & Cables & KURTA Drivers Compatibility, KURTA, Summagraphics Microgrid II, GTCO Digipad 5, CalComp 9100 Plan Holder and Pencil Holder Included Corded 16 button cursor w/large window crosshair		
1	**COLORADO TAPE BACK-UP-DJ-20** Native Capacity 125 MB Capacity w/Data Compression: 250 MB **DT-250** Jumbo 250 Formatted Mini-Cartridge 250 MB Capacity Tape w/Data Compression		

Qty	Specifications	Unit Price	Total Price
3	**BELTRON 500 WATTS A. V. R.**		
3	**DISK BANK 120 CAPACITY**		
1	3 KVA continuous on line uninterruptible power supply		
1	Roland 8 pen A-E size drum plotter		
1	HP Laser Jet 4 600 DPI printer		
1	ArcCAD 11.4 with ArcView		
Lot	Windows 3.1, DOS 6.2, Central Point Anti-Virus, and Norton Utilities		
	Total Lot Price		P 720,300.00

Note: this is the equipment specifically purchased by Cebu City for their GIS. An additional multi media PC with a color flatbed scanner was also purchased.

Lipa City

Qty	Specifications	Unit Price	Total Price
1 Unit	**PC AT 486DX-40** w/ 8Mb Ram On Board 256 Cache On Board CPU Built In real time clock One 5.25 1.2 Floppy Drive One 3.25 1.44 Floppy Drive Mini Tower Casing w/ Keyboard 200 Watts Power Supply	P27,500.00	P27,500.00
1 Unit	520 MB Hard Disk	P17,000.00	P17,000.00
1 Unit	**Non Interlaced SVGA 15" Monitor** w/ accelerator card. 28 Low Rad. 2 The Max Tseng Lab w/ IMB Ram	P15,500.00	P15,500.00
1 Unit	**Epson LQ-1170 Printer** 24 pin 132" Col	P22,000.00	P22,000.00
1 Unit	**Tape Back-Up 250 MB Colorado**	P 8,800.00	P 8,800.00
1 Unit	**ADMATE UPS** 800 VA	P11,000.00	P11,000.00
1 Unit	**KURTA XLC 35"/48" DIGITIZER**	P75,000.00	P75,000.00
1 Unit	**Roland DXY 1150 Plotter**	P32,000.00	P32,000.00
1	Idrisi version 4.1 GRID based GIS software	P85,000.00	P85,000.00
Lot	DOS 6.2, Windows 3.1, Central Point Anti-Virus, and Norton Utilities (included in system price).		
	Total System Price		P293,800.00

PART III

GENERIC GIS IMPLEMENTATION PLAN

PART III

Generic GIS Implementation Plan

This annex details a general implementation plan that can be used by the cities as a reference guide. For the most part, the structure follows a standard implementation plan that PADCO has created for developing country environments. Although Task Order 11C did not require an implementation plan, nor did it provide enough scope to do a "customized" version for each city, however this annex should provide each city with enough to help guide potential GIS development.

Overview

Implementation planning is an essential aspect of the GIS development process. A pragmatic GIS implementation plan uses a phased, incremental approach. Brief descriptions of the primary tasks required within each component in GIS implementation are provided. This phased implementation model divides the work effort into manageable segments which allows a logical work flow and serves as a checklist of the work items (tasks) that are important to the success of any GIS implementation process.

It is recommended that the cities use this section as a framework for developing a more detailed, customized implementation plan that is specifically adapted to their unique organizational structure and needs. Flexibility is critical, and the various tasks within each component should be tailored to meet the functional and technical requirements of individual projects.

At the start of each implementation phase, a detailed work plan and schedule should be developed which takes into consideration the availability of resources, the current level of automation, any existing development plans or work in progress, and other conditions which may affect progress.

The major benefits of adopting a systematic and planned GIS implementation methodology are as follows:

- Providing a proven, logical approach for successful GIS implementation;
- Identifying the required components and tasks that must be performed to produce a system;
- Providing a control mechanism for tracking and managing task responsibilities;
- Ensuring system testing, documentation, and training;
- Minimizing disruption in the event of personnel turnover; and
- Facilitating communication within the project team and between the project teams, users, and management.

Management aids such as Gantt charts and schematics should be used to illustrate the level of effort and commitment of time that will be required for each task. This schedule should be revised and updated during each phase.

The following sections outline the essential components of a GIS implementation process and the tasks which make up each component. These components are not always implemented in order and may be undertaken simultaneously. Also, the checklist of key tasks under each component activity can be used by the cities to monitor the progress of any external consultant or contractor hired to perform these tasks. Figure 1 below illustrates this concept.

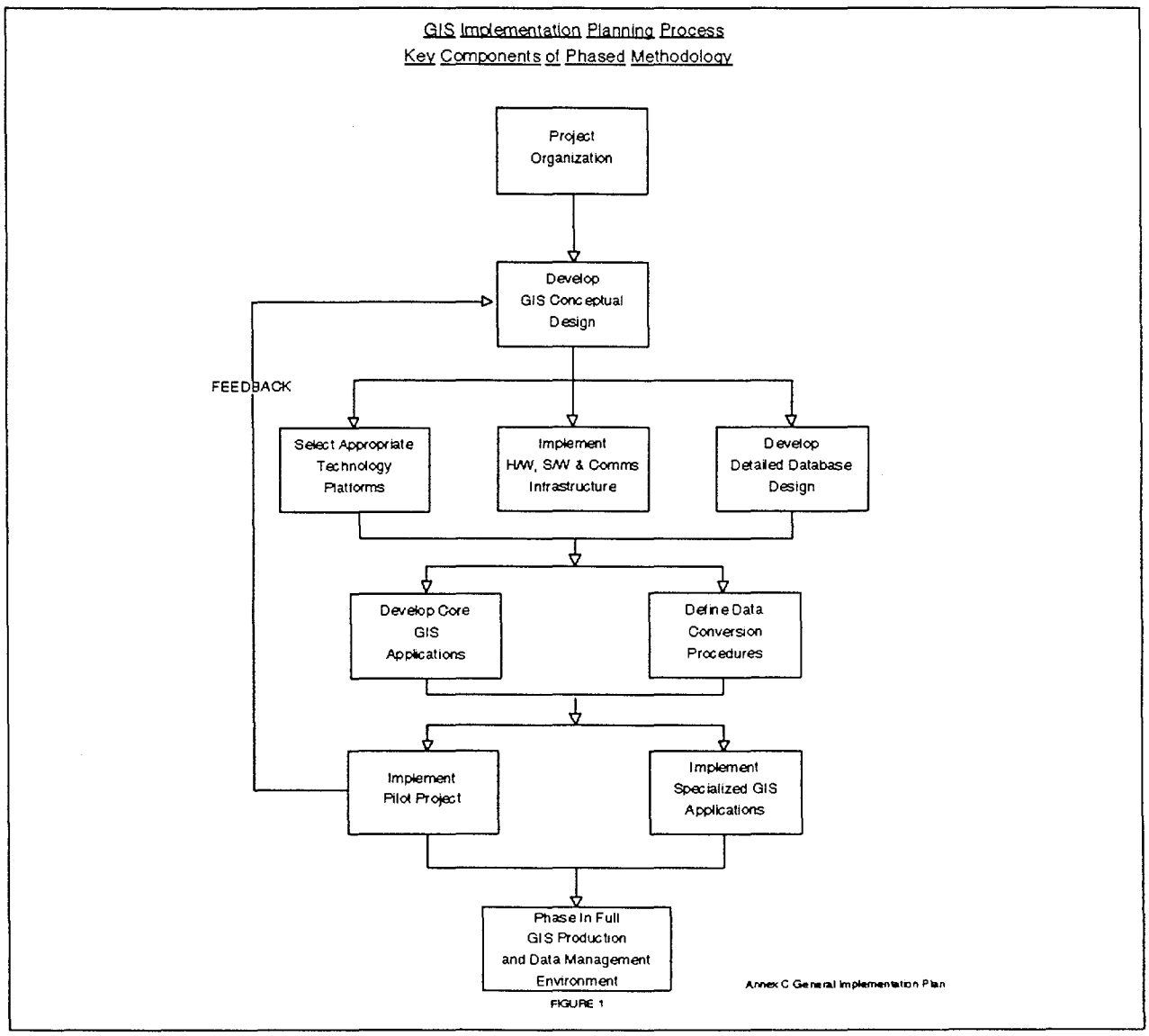

FIGURE 1

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1 Component A: Project Organization and Administration

Tasks:

1. Define the organizational relationships between internal and external participants, identify personnel requirements, and describe the roles and responsibilities for each group contained within the organizational structure.

2. Determine the high level resource requirements for GIS implementation, identify potential funding sources, and evaluate formal cost-sharing arrangements between participants. Funding mechanisms should be established in order to sustain planning and development of GIS technology and to ensure project continuity through all phases of implementation. Cost allocations must be fully understood among the participants before the execution of formal agreements.

3. Negotiate and execute formal agreements between external participants.

4. If feasible, organize and establish a public-private collaboration that will provide professional GIS administration, management, and technical support services to the site. The formation of public-private partnerships is a viable alternative that could provide the flexibility needed to facilitate both technical and administrative operations in an efficient and effective manner. For example, Cebu can establish relationships with the University of San Carlos Water Resource Center to help in providing detailed analysis and research—something more appropriate for the University to perform.

2 Component B: Develop GIS Conceptual Design

Tasks:

1. Using survey techniques and conducting user interviews, the functional requirements for GIS technology will be evaluated, prioritized, and documented. Typical issues to be addressed include:
   - Identifying and describing strategic processes that will benefit from GIS technology, such as road maintenance and tax mapping;
   - Assessing data accuracy requirements;
   - Summarizing the requirements for database content;
   - Inventorying and evaluating existing data sources;
   - Identifying and prioritizing GIS application requirements;
   - Documenting hardware/software/data communications requirements;
   - Defining system security requirements;
   - Determining training requirements;

- Evaluating data translation requirements; and
- Identifying system interface requirements.

2. General descriptions of the high priority applications will be documented in order to evaluate what software tools and functional capabilities will be required to support GIS applications development. This information will also be used as a foundation for the application/product design and development work to be performed in Components E and F of this implementation planning model.

3. Define data ownership and develop organizational strategies for maintaining all data elements to be converted into the GIS database. This means structuring user committees and work groups to maximize information flow.

4. Design a general framework for organizing information into the GIS database. The conceptual database architecture will include a thematic layering strategy for geographic data themes and definitions of the relationships between logical groupings of graphics data and textual (attribute) information. Factors to be considered include data requirements, information flow throughout the organization, and GIS application requirements.

5. Develop and document alternative hardware/software/data communications configurations which take into account the utilization of any existing technology. The type, number, placement, and projected costs of central data processors, computers, and other peripheral devices will be fully defined along with any networking strategy that supports the functional requirements of the GIS, including such operations as data access, data sharing, data transfer, data maintenance, system interfaces, and system backup/recovery. In Cebu, this would mean looking at the potential for establishing real-time links to the MICS AS400 database. In Davao, it means designing the integration with the existing novell PC network.

6. Develop high-level cost estimates and establish a budget that will support all of the GIS implementation activities summarized in the project work plan and schedule.

3 Component C: Selecting Appropriate Technology Platforms

In Cebu and Lipa, this task has already been performed with the cities resulting in installation of initial systems. However, other cities, as well as Cebu and Lipa, can use the guidelines listed below to help in the acquisition or the further development of systems.

Tasks:

1. Organize an evaluation team composed of key representatives from all participating groups and independent consultants with expertise in the use of GIS technology. Establish competitive procurement procedures, evaluation criteria, and a procurement schedule.

2. Develop detailed specifications for hardware, software, and data communications facilities. Define the terms and conditions of procurement. Incorporate both the technical specifications and terms and conditions into a formal request for proposals (RFP).

3. Publish the RFP and clarify procurement procedures and technical specifications for the prospective bidders. Evaluate submissions of written proposals and determine a short list of the most qualified bidders. Conduct functional benchmark tests if required.

4. Define terms and conditions and execute purchase contracts with selected vendor(s) and/or suppliers.

4 Component D: Implementing Hardware, Software, and Communications Infrastructure

Tasks:

1. Organize a technical project team, define the roles and responsibilities of the team members, and develop a detailed work plan and schedule for the project phase.

2. Determine the training requirements of the project team in relation to the GIS technology platform selected and the technical tasks required to complete the project component. Obtain training from hardware/software suppliers or other reliable sources.

3. Review hardware/software/data communications specifications developed in Components A and B of the project and prepare final design configurations for the selected GIS technology platform. Final configurations should be developed in cooperation and consultation with selected hardware/software vendors.

4. Install, configure, and test all of the hardware, software, and communications network components required to support GIS development and implementation operations. Design and implement system partitions for different operation, for example, acceptance testing of applications or the final production environment. Establish systems administration and backup/recovery procedures.

5. The acquisition, installation, and testing of computers and peripheral devices (e.g., plotters and printers) required to support GIS production activities should be phased in concurrent with the delivery of data and applications developed in subsequent phases of the project.

6. Integrate and test the technical environment in preparation for the GIS pilot project.

5 Component E: Developing the Detailed GIS Database Design

In many cases this will entail a complete and exhaustive review of the cities data and information processes. This stage is critical to the long term success of the GIS as it determines how the "lifeblood" of the system—the data can be turned into information.

Tasks:

1. Organize a technical team, define the roles and responsibilities of the team members, and develop a detailed work plan and schedule for the project phase.

2. Determine the training requirements of the project team in relation to the GIS technology platform selected and the technical tasks required to complete this phase of the project. Obtain necessary training from hardware/software suppliers or other reliable sources.

3. Review the conceptual database design architecture developed in Component B and refine the design concepts down to the data entity level. Describe the graphic data elements to be included within in each data layer and determine whether they will be modeled as point, line, polygon, or annotation features. Describe all textual data elements (attributes) that will be stored for each geographic feature. Assign data conversion and maintenance responsibilities down to the data element level. Document all design details in a logical database design report.

4. Translate the logical data models into physical data files and file types. Prepare entity/ relationship diagrams that document the data elements associated with each file and the interfile relationships. Prepare table descriptions that define the record layouts, file structures, indexes, and access keys for all required data files. Document all design specifications in a physical database design report.

5. Design and develop an on-line data dictionary that will support data conversion quality control operations and database administration functions. The data dictionary refers to the detailed description of what each element in the database is. For example, GENCODE in the land use coverage contains a series of codes ranging from 100 to 1800: what do they mean? The data dictionary would then detail that 100 is the numeric identifier for High Density Residential and 300 is the code for Low Density Residential and so on.

6. Interview key users and assess the functional requirements for all of the key applications identified in Component B. For each core application, a scope of work will be developed and documented along with detailed design specifications for user interfaces, application workflows, file and table descriptions, map and report product layouts, and query and graphics display screens.

7. Develop and document systems administration procedures required to support GIS production. Specific issues to be addressed include:
   - Changing/updating control procedures;
   - Problem Management;
   - System security and control procedures;
   - System backup/recovery procedures;
   - System performance monitoring and storage capacity planning; and
   - Network management procedures.

6 Component F: Developing Core or Priority Applications

To some degree this process has been started in Cebu, albeit in a rather sketchy fashion. The definition of priority applications is critical as it helps to build consensus and full support for the GIS by providing meaningful results for interested parties. The most obvious applications for the cities are land use mapping, road maintenance, tax mapping, and voting analysis.

Tasks:

1. Organize a technical project team, define roles and responsibilities of the team members, and develop a detailed workplan and schedule for the project phase.

2. Determine the training requirements of the project team in relation to the selected GIS technology platform and the technical tasks required to complete the project work. Obtain the necessary training from hardware/software suppliers or other reliable sources.

3. The principle objective of this task is to evaluate whether or not there are any application software packages available from private vendors or other sources that will meet the functional requirements for some or all of the core/priority applications. If appropriate packages exist for certain applications, it may be advantageous to procure those packages versus the alternative strategy which is to custom develop the applications software using internal resources. The costs for purchasing an existing package is cheaper than the custom development alternative, and it would significantly expedite the implementation schedule. Again, in the case of Cebu and Lipa, ArcCAD and Idrisi, respectively, have already been chosen and installed.

4. If a software package is selected, it will be installed and custom modifications developed as required. The application package will be tested and debugged where necessary. In those cases where an application is to be custom developed (e.g. by Geodata or Cybersoft), the software will be coded and tested in accordance with the detailed application design specifications developed in Component E and using a structured development methodology.

5. Procedures should be developed for both users and systems operations staff and fully documented in reference manuals.

6. All core/priority applications software will be ported to a staging environment where it will be integrated, tested, and prepared for user acceptance testing as part of a GIS pilot project.

7 Component G: Developing Data Conversion Specifications

In most cities, this task will entail converting analog products, such as old maps, into digital form. For the most part, this should be done through digitizing in order to maximize resources. It is also possible that private vendors, such as Cybersoft, Certeza, and GeoData in Manila, can provide reasonable costs for mass conversion of maps (if they cost). Data can also be found in tabular form, both in print and file format (e.g., spreadsheets and dBase). The largest potential requirement for conversion of data in Philippine cities is probably the conversion of real property tax records and deeds and titles (scanning).

Tasks:

1. Organize a technical project team, define roles and responsibilities of the team members, and develop a detailed workplan and schedule for the project phase.

2. Inventory potential map materials and records that may be used as a source for the conversion of all required data elements into the GIS database(s).

3. Evaluate the quality of all potential data sources and establish a data conversion source priority level for each data element(s) to be contained in the GIS database. The objectives of this task are to determine those sources of data that best meet the requirements for data accuracy and quality. The preferred sources for each data element will be used whenever possible as the primary data to be converted into the GIS database.

4. Define source material preparation and data scrubbing procedures. Depending on the accuracy, currency, and general quality of existing source map materials and other data records, a certain amount of work must be performed to prepare the documents for conversion into the GIS database. As with any computer system, it is only as good as the information contained in the database. To avoid the standard garbage-in, garbage-out (GIGO) syndrome, care should be taken to establish procedures for cleaning up problems or deficiencies with the data sources **before** any resources are spent automating the data. GIS certainly runs the risk of GIGO, but GIPGO (garbage in, **pretty** garbage out) is probably more appropriate.

5. Define detailed data conversion procedures and specifications for creating the GIS database from the data source materials.

6. Establish data error tolerances and acceptance criteria. That is, can we live with an error of ±10 meters for this application? This is an extremely important question and raises the point that cities must be willing to compromise on explicit accuracy. It is more important to get applications going with data that meets certain acceptable error tolerances than it is to wait 10 years for a superbly accurate database (at great cost as well). Develop data conversion quality control procedures.

7. Prepare a data conversion schedule and document all data conversion procedures in a detailed data conversion plan.

8. Select a geographic area where all data coverages can be converted as part of a GIS pilot project for testing and validating the data conversion plan and procedures.

8 Component H: Implementing a Pilot Project

For Cebu, Davao, Lipa, and to some degree Naga, this process has already been started through the land use mapping exercise. This sections lists out those key elements required to start a pilot project from scratch.

Tasks:

1. Transfer all core/priority applications software to the system and perform final systems integration testing. Install, configure, and test all hardware/software/communications equipment required to support the pilot project activities.

2. Develop user training materials and prepare a training schedule that includes representatives from all appropriate GIS user groups. Train the pilot project participants in the use and operation of the core GIS applications and related procedures, the data conversion procedures, and quality control operations.

3. Perform user testing for the core/priority GIS applications and evaluate all facets of application functionality from the end users' perspectives.

4. Convert all GIS data coverages for the designated pilot project area and evaluate the efficiency and effectiveness of the data conversion and quality control procedures. Evaluate and verify that each data coverage is properly converted in accordance with the database design specifications.

5. Evaluate the work flow efficiency and effectiveness of the procedures established for processing all data transactions.

6. Evaluate and document the results of the pilot project (applications and/or products) in a final report and present findings to both the technical and any steering committees.

9 Component I: Implementing the GIS Production Environment

Tasks:

1. Review the results of any pilot project and revise, modify, or enhance all core applications software/products as required.

2. Review the results of the pilot project and revise, modify, or enhance the data conversion specifications and quality control procedures as required.

3. Review the results of the pilot project and revise, modify, or enhance the management procedures as required.

4. Update the conversion workplan/schedule, prepare final procedures manuals, train all personnel on the data conversion team, and initiate full data conversion operations.

5. Transfer all core applications software to the final production environment. Update the user manuals and procedural documentation. Conduct final training sessions and phase in any core/priority GIS applications into production.

6. Implement all required systems administration procedures, user support functions, and application maintenance operations.

PART IV

LIST OF PARTICIPANTS

PART IV

List of Participants

Listed below are the city staff who attended training for land use interpretation and basic GIS software training.

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Rene Sanapo, Secretary to the Mayor
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