ROADMAP OF GEOSPATIAL EDUCATION IN MEXICO

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ABSTRACT

Mexico has a long tradition on map making and geographic endeavors to generate geospatial information of the nation assets. Official database for the country's inventories on natural resources, demographics, economics and urban infrastructure are available via the Internet where scholars and researchers can visualize these datasets and make use of this information. Nonetheless, education on Geography and specifically on Remote Sensing at higher education levels in Mexico (i.e. universities and middle schools); requires a thorough review of academic programs and enhancement of institutional support to move forward the potential of geospatial education. This paper addresses the successful efforts undertaken at UACJ; a public university located in northern-central Mexico, on promoting the advantages provided in the use and relevance of Remote Sensing, GIS and GPS on their academic programs and applied research. The Transboundary Territorial Analysis Lab, sited at the Institute of Engineering and Technology at this university has developed a hardware and software infrastructure and created geodatabases with metadata under FGDC standards accessible via Internet-2, with the support and coordination of universities located in SW-US, such as NMSU and UTEP. These efforts have created a pool of bilingual geospatial information under SI units and with similar geographic projections related to topics such as economics, social and natural resources issues. Future works requires a further attempt on enhancing the scale of analysis of the geodatabases, and update the natural resources inventories, specifically those related to soils classification and water resources.

INTRODUCTION

Professions that pursue carriers on geospatial technology education are identified as the emerging sciences within the scientific community of the world. Students at higher education institution on the world have recognized the potential that Geography and in particular, GIS, Remote Sensing and GPS have brought into play for the enhancement of their research studies and work load. Professors at universities in the world report every year more

and more applications of their students research work that includes maps or satellite images for their analysis or research, (Granados, et al., 2006). The scientific community has observed how the improvement of GIS has evolved over the last 15 years where most of the universities and education institutions adopted the geospatial technologies within their everyday work, (Creel, et al., 2006; Brown, et al., 2005). While this transition into adopting the geospatial sciences has been straightforward at institutions on the developed countries, the evolution to accept, understand and put into operation these technologies on universities at developing countries has been more complex and their implementation has been limited to a few institution and special programs within third world countries, (AAG, 2006). Furthermore, in developing countries, the instrumentation of these geospatial research tools is limited to only a few scholars and researchers while the cost related to implementing these technologies, hardware and software, are still an issue of consideration for some institutions. While creating a GIS lab in developed countries may be easier and a simpler procedure, instrumenting a geospatial lab for research and academic purposes on the third world countries is a more difficult task.

Mexico, has evolve successfully into the geospatial technologies in the last few years and geospatial information can be easily found and visualize throughout web servers and the internet, (INEGI, 2007). However, this information is accessible only for visualization, and most users are not specialized or trained on geography to understand the basics on how to expand the potential of these geodatabases; hence, the given advantages these technologies might bring into the users needs, are lost or with a minimum application by the public. Furthermore, according with the Association of American Geographers (2006), in Mexico there are only 6 universities and colleges that have a registered program in geography as part of their academic offer, where the biggest university in Mexico, the Universidad Nacional Autónoma de Mexico (UNAM) is the one with the most important geography program, along with the Universidad de Guadalajara (UofG). There are also sparse initiatives by other smaller universities located outside from the countries capital with geographic information centers that specialized on applied geography such as the Geographic Information Center at the University of Quintana Roo (http://www.cig.uqroo.mx/) and specialized Research Centers, such as the Centro Geo (http://www.centrogeo.org.mx/) which is an initiative generated by the federal government in Mexico throughout the National Council of Research and Technology, (CONACyT).

This paper addresses the experience at a local university situated in northern Mexico, the University of Ciudad Juarez (UACJ), on implementing in coordination with SW-US universities with Geography and GIS programs such as NMSU and UTEP, a practical training workshop agenda in applied geography and geospatial education, paying attention on special training for professors, researchers and engineering students that had no background on the these geospatial technologies, while installing infrastructure and software on a GIS lab identified as the Transboundary Territorial Analysis Lab at the Geographic Information Center of UACJ (http://cig.uacj.mx/). The importance on spreading and implementing geospatial education in the world and particularly in Mexico is high and of relevant significance, since an interdisciplinary approach to problem solving with a holistic approach can only be accomplished by applying geoinformatics; hence, more trained people are needed for the application of the geospatial tools.

How Everything Initiated at UACJ

In order to keep the academias growing and to reassure quality of education, Mexico began an aggressive program on scholarships for professors teaching at public universities. In 1995, special programs named SUPERA and later PROMEP (Program for the Upgrading of Professors), both of these programs implemented by the Mexican Secretariat of Education (SEP) where established to enhance professors' level of education and to spread the linkages with overseas researchers creating a net of scientist to develop research collaborations between Mexican universities and other institutions in the world. With these opportunities, many professors took the challenge in pursuing PhD's and MS's enrolling in graduate programs at different universities. UACJ was not the exception, and a group of professor that had MS degrees enrolled on graduate studies at PhD level, mostly at USA universities. Different areas were covered by these professionals; however, special training in geography was the major field that many of these professors at UACJ took as major and minor fields of studies. During their specialized training most of these professors build a network of contacts with their graduate committees and other professors of these universities and other fellow students, during their training at these institutions. This was a major and important step to link a future joint venture on research and collaboration with these organizations.

The Following Steps

By 2000, four professors from UACJ had obtained a PhD in geography as major areas or in related fields on applied geoinformatics. However, no infrastructure existed at UACJ to start a geography program or to implement the minimum tools to initiate with research on these fields. Therefore, the professors graduating from these foreign

universities, before they had finished their training and while developing a practical training period as part of their last year education at these institutions, initiated a plan for implementing at UACJ the infrastructure required for developing and "paving" the road back to their university, so when they returned back to their field of work in Mexico, they will have at least the minimum equipment, software and computer hardware to initiate their research work in applied geoinformatics. Hence, scouting for economic resources, the group developed a proposal to a special program implemented by SEP which was known as FOMES (Funding for the Improvement of Higher Education) and a request for funding proposal was submitted by the group, where each one of the team members developed an area of interest on GIS, Remote Sensing or GPS technologies, estimating cost and type of tools required for their own specialty developed at the foreign university where they had finished their PhD training. One of the strategies taken into account by the group was the definition of a group leader to follow up on delivered items to incorporate into the document to be submitted to SEP. This job was undertaken by Dr. Javier Chavez, Leader of the Academic Group of Urban Planning and GIS at UACJ. Dr. Chavez was in charge of integrating and submitting this proposal to FOMES. After a couple of months of work and delivering proposals via internet to the group leader by all team members, the document was finished and a proposal was submitted, with positive results. A total of ~$400,000.00 Dlls were appointed to the project by FOMES. These funds were invested on computer hardware and specialized software on GIS and Remote Sensing, as well as, in GPS technology acquiring a high resolution GPS unit and other equipments relevant to the project. Output was also an important issue; therefore, printing equipment was bought to establish the needed output infrastructure concentrating on tools to deliver wide format printing and high resolution capacities on the output equipment.

DATA ACQUISITION AND RELEVANT INITIATIVES FOR A BASEMAP

For this endeavor, team members developed an aggressive task schedule to acquire a geodatabase server where geospatial information had to be integrated into the main server for the geodatabase. Much information on a GIS format was developed by continuing research that each of the team members had taken into account while their graduate research work was taken place; however, the need for a more robust geodatabase was a challenging task since no previous efforts to build a GIS lab had undergone within UACJ. Therefore, by the initiative of Dr. Granados-Olivas and Dr. Sanchez-Flores, the team members acquired the official Mexican geodatabase for the neighboring border states between Mexico and the U.S., where different layer coverages were integrated, including, most natural resources assessments such as: soils (FAO System), topography, geology, geomorphology, surface and groundwater hydrology, watersheds, and vegetation; as well as other type of information such as: landuse, roads, localities, land ownership and other infrastructure, such as electrical lines, railroads and geopolitical divisions. All this information was acquired at scales 1:250,000 and few to 1:50,000 (i.e., topography and surface hydrology), and referenced to UTM coordinates, under WGS84 datum. A main supporter of this effort was the National Institute of Ecology (INE) in Mexico since a special training was given to employed professionals on computer systems to implement an administrative figure identified as GIS Master Administrator, which was in charge of supporting a standardized geodatabase structure build under FGDA standards and to keep control on web page initiatives to post research products into the assign server.

The Need for a GIS Master Administrator

Every institution implementing a GIS research center requires a GIS Master Administrator. This figure is of relevant importance for quality assurance and quality control (QA/QC) of created geodatabase which at minimum need to have metadata. This was a big step for UACJ GIS Center since all data were supervised by this person making sure that posted GIS products met the minimum standards. This person was first trained by INE federal authorities in Mexico and the geodatabase structure was updated to a standardized system compatible with our neighboring counterparts in the US universities, such as the SW-US universities of NMSU and UTEP.

The professional profile of this administrative figure for a Mexican GIS center is relatively challenging to locate since trained engineers in computer science with a background in geospatial technology tools are not easily found on Mexican civil or environmental or on computer science engineering schools. Hence, the training of this person was key to assure the proper development of this GIS initiative at UACJ.

Linking with Past and Future Partnerships

Since all team members on the project had worked in the past with specialized professionals on GIS and Remote Sensing, it was not difficult for team members to enhance the collaboration network and link and revisit

friends and colleagues that observed their evolution and their research work as Alumni from these US universities. Brotherhood and support to homeland initiatives in Mexico by these professors was unconditionally given to start and enhance the GIS project at UACJ. Recommendations and guidance was received by US universities and colleagues such as Dr. Chris Brown from the Spatial Applications Research Center at the Department of Geography and Dr. Bobby Creel, Dr. John Hawley, Dr. John F. Kennedy and Dr. Carl Wood from the Water Resources Research Institute at New Mexico State University, Dr. Raid Aldouri and Dr. Randy Keller from the Pan-American Center for Earth and Environmental Sciences (PACES) at UTEP and from Dr. Steve Yool from the Geography Department at the University of Arizona at Tucson, as well as, Dr. Richard Wright from the Geography Department at San Diego State University, and Dr. Barry Hibbs from the Geology Department at Cal State University in Los Angeles; and finally, Dr. David Maidment, Dr. Daene McKenney and Dr. Carlos Patiño-Gomez from the Center for Research on Water Resources at the University of Texas at Austin. Other scientist from Mexico also collaborated into the GIS project at UACJ incorporating expertise in specialized areas of interest for team members on the project. Some of these Mexican scientists with high qualifications on geography were: Dr. Gerardo Bocco and Dr. Angel G. Priego-Santander from the Institute of Geography at UNAM; Dr. Ana Cordova y Vazquez and Geographer Jose Luis Perez-Damian from the National Institute of Ecology; Dr. Juan J. Martinez-Rios from the Juarez University of Durango, and Dr. Fabian Lozano from the Geospatial Education Lab at the Institute of Technology and Higher Education in Monterrey (ITESM).

The importance on scouting for new linkages with future partnerships is presently an aggressive program at UACJ, where professors and researches submit and present their papers and research results of developed work with this newly created infrastructure on GIS and Remote Sensing. Events such as the ASPRS 2008 Annual Conference, are giving the opportunity to academic groups within UACJ to keep meeting people and experts from all over the world and creating new working relationships. However, it was necessary to initiate with the described base platform of geodatabase and hardware/software infrastructure to initiate local and regional research on different topics that required the implementation of specialized processes within geoinformatics. Some of these new partnerships included the private sector industry on geospatial technologies such as Bohannan Houston, Inc. (www.bhinc.com), a private firm that has supported UACJ on different initiatives exploring potential joint venture projects in Mexico while offering special training on geoinformatics to grad and undergrad students of the Institute of Engineering and Technology at UACJ, where the GIS project is located.

Working Relationships with Local and Regional Governmental Offices in Mexico and Bilateral Funding

While implementing the acquired infrastructure and after team members initiated submitting RFP to different funding agencies, external funding for developing research on different topics related to applied geography flowed into the GIS center at UACJ. Many important agencies from Mexico and the US supplied economic resources to submitted joint RFP to develop research initiatives on transboundary watersheds between Mexico and the US. Among these funding agencies, the Secretariat for Social Development (SEDESOL) from the Mexican government, the Secretariat for Rural Development (SDR) from the state government of Chihuahua and the local authorities from the municipal government in the Municipio de Cd. Juarez, hired the GIS center to develop and implement geodata projects for strategic planning initiatives at these different levels of government. On the other hand, funding from US agencies such as the Southwest Consortium for Environmental Research and Policy (SCERP), the William and Flora Hewlett Foundation, the Ford Foundation, the National Science Foundation, and the New Mexico Environmental Department (NMED). All of these agencies were interested on mapping natural resources and infrastructure along the US-Mexico border region, which in turn help on identifying gaps and geodata needs for the border communities, on important, relevant and strategic projects such as the US Homeland Security initiative.

RESULTS OF UACJ INITIATIVES IN GEOINFORMATICS

During the period from 2000 till 2006, many initiatives where taken into account as strategic plans to motivate and to enroll UACJ professor into adopting geoinformatics and geospatial technologies as their everyday working tools. Special training was scheduled with continuous education workshops and training sessions on GIS and Remote Sensing while applying some of the most important software utilities available at the time on the market, (Fig.1). Also, academic programs offered at the bachelor program on civil engineering and the master degree program on environmental engineering and ecosystems offered at the Institute of Engineering and Technology (IIT) in UACJ, included basic training on GIS and Remote Sensing, as well as, GPS applications. Some of these training

Figure 1. ENVI Training Workshop on Remote Sensing in 2003.

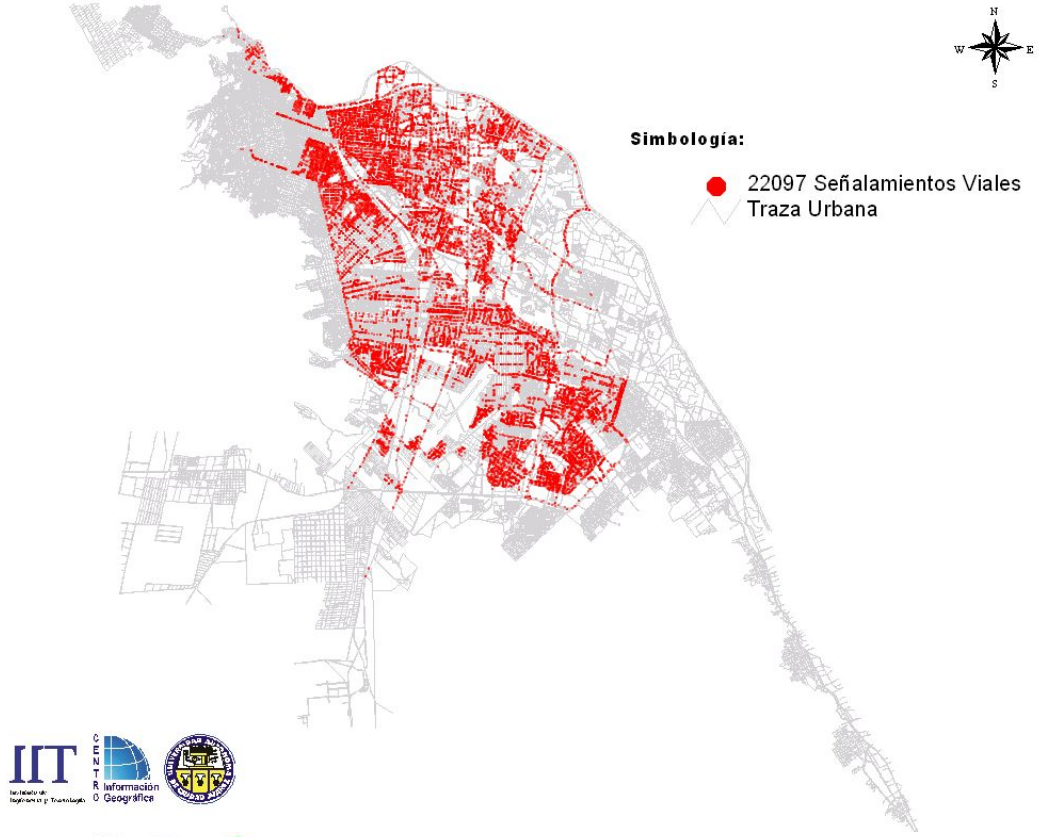
workshops where instructed by team members on the GIS project at UACJ and other training was contracted with institutions that promoted bending software of the different applications on geoinformatics; such as, ArcGIS, ArcView from ESRI products; as well as, ERDAS Imagine, ERMapper, ENVI and Definiens Professional, on the Remote Sensing technology side. Furthermore, GIS and Remote Sensing training was offered to Federal, State and Local governmental offices by means of signed agreements with no cost to these agencies, where these offices required special training on geoinformatics to incorporate a Decision Support System (DSS) on their own headquarters based on required geodata for their own applications. One of the advantages to UACJ with this kind of joint collaboration with governmental offices was the creation of a robust geodatabase with different types of geospatial information. Since all of these agencies had their own geospatial information developed by their own resources and format, and the GIS center at UACJ, developed and implemented a strategy to standardize information from these offices, a considerable amount of geodata were created populating our own server with this information. Grad and undergrad students from IIT at UACJ had the occasion to interact with these agencies and job opportunities were created for some of the students within these agencies. The later had an unexpected positive impact on federal evaluation programs for the assurance of quality on higher education programs impacting on the results of some of our academic programs.

Applied Geoinformatics Within Local Governmental Offices

Some of the most important projects developed in coordination with local governmental offices involved the implementation of GIS systems at these offices. One of such consulting projects was the development and execution of a GIS facility for the Public Works Office of the Municipal Government of Juarez (2004-2007). The products of this effort resulted on the establishment of a GIS lab that were to generate a geodatabase of urban infrastructure that included: traffic signals, traffic lights, bridges, stop signs, speed signs, play ground infrastructure, parks and green areas, number of trees and related species, growing stage, and other related geodata for the urban infrastructure of the City of Juarez (Fig. 2). Some of the map products with the surveyed infrastructure can be visualized on figure 3.

Figure 2. Generation of Geodatabase on Urban Infrastructure for the City of Juarez, Mexico.

a



b

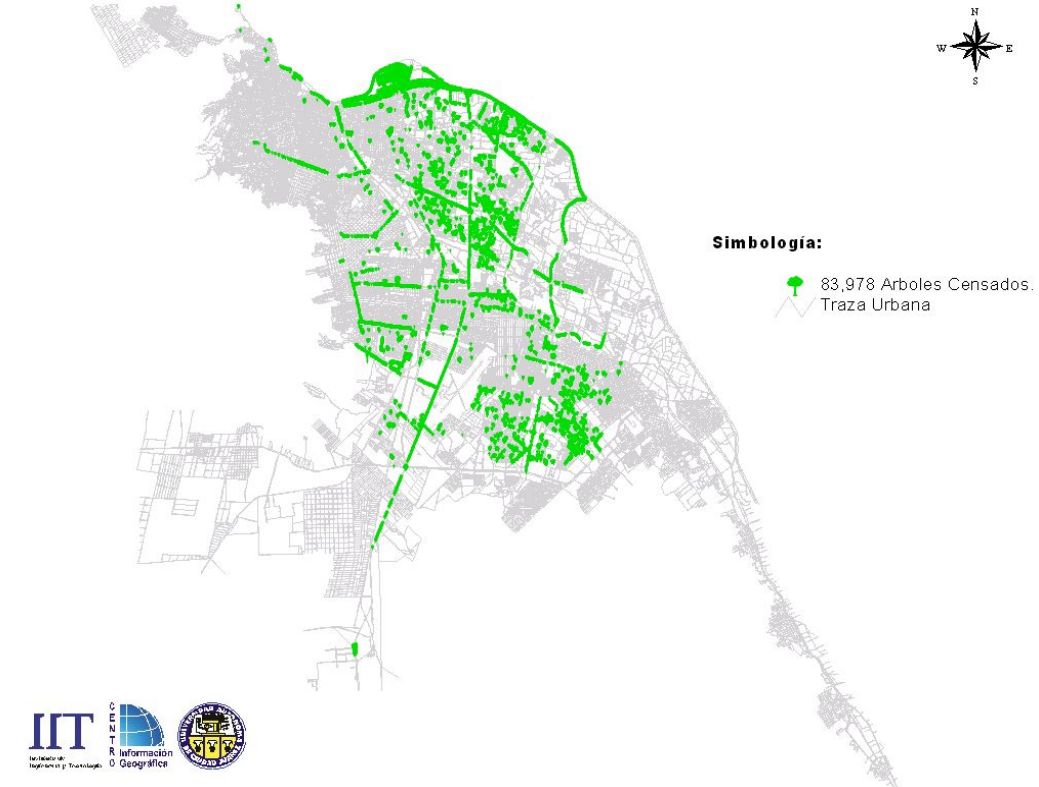


Figure 3. Products of the map survey for urban infrastructure on Cd.Juarez. a) stop signs and b) tree species.

CONCLUDING REMARKS AND FUTURE WORK IN GEOINFORMATICAS AT UACJ

Our work and planned strategies to implement a geoinformatics lab at this Mexican university was a challenging task since getting beyond paradigms is the most difficult part on adopting the needed changes to a better education at higher learning levels. It's almost a natural human condition to hesitate and refuse any changes from where comfortable conditions exist; hence, assuring a friable stable condition. Nonetheless, only those meeting the challenge of a dynamic changing world will succeed on their endeavors. Our project took the challenge and was successful on implementing new emerging technologies on geospatial education in northern Mexico, achieving recognition by university peers both on the US and Mexico. However, future work is still required to consolidate these areas on geoinformatics at UACJ by implementing a continuous support and update on computer infrastructure and upgrade on specialized GIS, Remote Sensing and GPS software and equipments. Our new generations of engineers are integrating a professional profile with a background on geospatial technology and eventually this has help them on getting better paying jobs at different Mexican institutions. Diversification on the applications of GIS and Remote Sensing technologies to other areas within the UACJ campus is presently underway, and the Department of Arquitecture and the Biology Department at our university are coping and adjusting our experience at the Civil Engineering Department, to implement their own GIS-Remote Sensing facilities.

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