

A TWO-WEEK INTENSIVE COURSE IN GEOGRAPHIC INFORMATION SYSTEMS

GIS TRAINING OF THE EMPLOYEES OF
FEDERAL BUREAU OF STATISTICS



PROJECT COMPLETION REPORT

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DECEMBER 2005 – JANUARY 2006

1. INTRODUCTION

This completion report documents the two-week intensive training in Geographic Information Systems (GIS) of the staff of Federal Bureau of Statistics (FBS) in Islamabad, Pakistan. The training was held in the newly established GIS laboratory at the Islamabad head office of the Population Census Organization (PCO), which is a subsidiary of the FBS. United Nations Population Fund (UNFPA) in Islamabad sponsored the training as well as the capital costs of establishing the GIS laboratory. The course curriculum was designed by Professor Murtaza Haider of McGill University in Montreal, Canada. He was also the primary instructor for the course. Professor Haider is the principal of REGIONOMICS, which is a Montreal-based consultancy in regional and economic development.

2. BACKGROUND

PCO is mandated by the constitution of Pakistan to plan and conduct the decennial census in Pakistan. In addition, PCO is also the custodian of census data in Pakistan. The census data primarily consists of the socio-demographic data collected in the national census of population and housing. The other key data are maps that demarcate census boundaries. The socio-demographic census data have been archived digitally on computer servers using databases and appropriate computer hardware. The census geography remains archived on paper maps, which are maintained by the Geography Section at the PCO. The entire census geography is archived in thousands of maps that describe the delineation of Census geography in Pakistan.

The advent of GIS has revolutionized the way spatial data are collected, stored, and disseminated in Pakistan. Census organizations around the world rely on GIS to plan, execute, and manage census. The US Census Bureau and Statistics Canada maintain huge GIS sections that are responsible for maintaining census geography and dissemination of data according to the census geography.

Government of Pakistan would like to hold the next census in 2008. GIS could significantly enhance PCO's ability to plan, execute, and manage the next census in 2008. Specifically, GIS could improve productivity and efficiency of the demarcation of the evolving census geography as well as the analysis of census data and their dissemination.

2.1. DEMARCATION OF CENSUS GEOGRAPHY

The census data in Pakistan are collected according to pre-specified spatial hierarchies, which are mentioned below:

1. Provinces
2. Census districts (which may be different from the administrative districts)
3. Big urban areas
4. Small urban areas
5. Tehsils (basic municipal administrative unit)
6. Census Charges
7. Census Circles
8. Mauzah/Dehs (villages)

In total, PCO maintains over 55,000 individual maps that collectively describe the census geography of the spatial hierarchies listed above. The PCO delineated these boundaries in 1989. Maintaining the spatial integrity of spatial entities described in the above-listed maps and implementing the changes in their boundaries could prove a Herculean task if it were to be accomplished on paper using the traditional cartographic approach. The reason behind the inadequacy of the traditional pen and paper approach is the scope of the task, which covers the entire geography of Pakistan covering an area of almost 800,000 square kilometers, which has been documented in over 55,000 maps.

The task is made more challenging by the constant flux in the boundaries of the spatial hierarchies defined above. Apart from the provinces, the census geography evolves over time for all other spatial hierarchies. For instance, district and tehsil boundaries are regularly updated to reflect the changing demographics of these areas. Maintaining these changes on paper maps and their dissemination to the entire state machinery, which includes hundreds of other state organizations, becomes an overwhelming task. GIS could streamline the delineation of census and other boundaries and the dissemination of this information to all state functionaries. Similarly, the delineation of census boundaries, such as the ones for census charges and circles could also be maintained and streamlined using GIS.

2.2. USE OF GIS IN ANALYZING CENSUS DATA

Census data in Pakistan can act as the lynchpin in the effort to achieve the Millennium Development Goals (MDG). It is the census data that can provide the necessary benchmarks for the policymakers to determine the level of success of various policy interventions towards improving education, health, literacy, housing, and other municipal services at the community level. The community level planning, which corresponds to the census charge and census circle boundaries in Pakistan, will allow policymakers to evaluate the effectiveness of their policies at the intra-urban level. In the past, development statistics in Pakistan have been reported at the provincial or district levels that hide the heterogeneity in development indicators at the community level.

In the following section, we present a brief discussion on how GIS has played a pivotal role in improving the state of governance at the local level in developing countries. This

discussion could serve as a guideline for expanding the GIS-related training and implementation in Pakistan.

2.2.1. SPATIAL ANALYSIS & GOVERNANCE

The spatial distribution of demographics and economic behaviour in metropolitan areas in South Asia has been neglected in the past. More often than not, statistics are often reported at the aggregate national, provincial, or district (conurbation) levels, with an underlying assumption that economic behaviour and outcomes are spatially homogenous. However, the usefulness of analyzing intra-urban income distribution, health, and education levels for policy-making purposes in the developed world suggests that a similar analysis should inform policy-making and governance in the developing countries as well. In fact, evidence from the developing countries calls for the explicit recognition of intra-urban spatial heterogeneity in human development indicators. For example, there is a notable variance in the supply and quality of housing stock, water, and sanitation within metropolitan areas in South Asia. There is also evidence of spatial correlations between certain human development indicators. For example, neighbourhoods with poor quality of housing stock also lack adequate water supply and sanitation facilities. Likewise, there exists a correlation between the state of housing stock and socio-demographic attributes, such as literacy.

Given the growing size (population and area) of metropolitan areas in South Asia and the increasing challenges in delivering basic services to urban populations, the spatially disaggregate information on the quality of land, housing, health, and literacy becomes vital in formulating policy instruments that can effectively outline strategic and tactical measures to alleviate poverty at the local level.

Recently, municipal information systems and spatial analytical frameworks have been employed for 'democratic decentralization' in developing countries. Examples from India, the Philippines, Columbia, and Nigeria suggest that developing countries can benefit from Geographic Information Systems (GIS) in coordinating governance across multiple levels of government (Olowu, 2003). For instance, a participative planning and management tool for urban governance was developed for the city of Thies, in Senegal (Repetti & Prelaz-Droux, 2003). Similarly, a comprehensive plan to employ a mix of Information and Communication Technologies (ICT) and GIS to modernise and improve the efficiency of municipal governance was developed for Trujillo, Peru (Turkstra et al., 2003).

Traditionally, GIS have been used for poverty mapping in development studies. Poverty mapping in the developing world context has been used to plot the location of the poor, e.g., squatter settlements, on a map. A project in Pune, India, which went beyond mapping and used GIS to explore spatial data to aid policy-making, provides motivation for this paper (Sena et al., 2003).

The level of success in GIS applications varies considerably across countries and even across cities within the same country. A study of district level GIS applications in India found limited success (Walsham & Sahay, 1999). The authors argued for intervention from higher tiers of government and for innovative administrative structures to improve productivity of GIS in developing countries. Some researchers have even warned that GIS may not prove to be a "quick fix", especially when developing countries face constraints in human and financial capital (Dunn et al., 1997).

Researchers have identified personnel, data, technology, organisations/institutions, and finance as the five key elements for the successful application of GIS in developing countries (Cavric et al., 2003). A similar study in India reviewed the organizational and political issues affecting mass application of GIS, and identified the following four key elements for successful GIS applications: suitable equipment, appropriate information, proper organization, and adequate expertise (Klosterman, 1995). The authors further argued that inexpensive and easy-to-use technology would be more appropriate for developing countries.

More recently, the state-of-the-art GIS techniques have been applied to study urban growth in developing countries (Barredo et al., 2004; Leao et al., 2004; Barredo & Demicheli, 2003). These recent developments in computer technology, software, and availability of spatial data have allowed some developing countries to bridge the technological gap in implementing GIS. For example, the application of cellular automata technology in Lagos, Nigeria to help develop alternatives to urban sprawl has placed Lagos ahead of numerous other cities in the developed world. Another such example of technological leap-frogging is Sao Carlos, a medium-sized Brazilian city, where planners have used GIS-derived accessibility indices to curb urban sprawl and find suitable locations for new residential developments (Lima et al., 2000).

3. GIS TRAINING IN ISLAMABAD

In October 2005, PCO contacted Professor Haider to submit a proposal to train the FBS staff in GIS. Professor Haider submitted a training schedule, which has been attached as Appendix 1 with the completion report. The training was conducted from December 26, 2005 to January 7, 2006. The itemized listing of topics covered in the training is detailed in Appendix 1.

3.1. PARTICIPANTS

In total, 24 men and 1 woman participated in the training. The participants were drawn from FBS, PCO, and other related departments of the federal government. Most participants were semi-literate in computers, while only a couple of participants were experienced in database systems. Participants were also drawn from the regional offices of PCO in Lahore, Karachi, and Peshawar.

3.2. CURRICULUM DEVELOPMENT

The curriculum for the two week training contained basic and advanced introduction to GIS, hands on training in Maptitude, the GIS software used for training, and examples of spatial analysis of socio-demographic data using GIS. Examples from the United States, Canada, and Pakistan were employed to illustrate the use of GIS. The curriculum was developed to reflect the understanding and background of the participants. Thus, initial focus in the training was on the fundamentals of GIS. From their onwards, the training moved into examples of how GIS have been used to analyze Census data in the United States and Canada. The use of examples allowed the participants to comprehend the use of GIS as a tool in data analysis and dissemination. Afterwards, the training focused on the use of Maptitude software and on the logistics of geo-coding census data in Pakistan.

3.3. SOFTWARE SELECTION

The officials at PCO asked Professor Haider to recommend affordable GIS software. Professor Haider had worked with Caliper Corporation in Cambridge, Massachusetts, and he has been familiar with the use of Caliper's software by the US Census Bureau. On his recommendation, PCO acquired 10 licenses of Maptitude software, which proved to be an affordable and powerful tool. Maptitude can import from and export to other data formats, such as MapInfo ® and ArcGIS ®. The powerful and straightforward map editing tools make it an ideal tool for geocoding maps.

3.4. HANDS ON TRAINING

The training was divided into a series of lectures and hands-on training. Morning sessions consisted of lectures, followed by hands on training in the afternoon sessions (Figure 1). The hands-on training sessions were run in the GIS Lab at the PCO's head-office in Islamabad. The hands-on training focused on the use of Maptitude.



Figure 1: Professor Haider is running hands-on training session at the GIS Lab in PCO's head office in Islamabad

The training in geo-coding of census geography involved a guest lecturer, Mr. Saifullah Khan, who is a Ph.D. candidate in Geography at the University of Peshawar. Since the scanner and related peripherals did not arrive on time, participants were not trained in the use of scanner (Figure 2).



Figure 2: Industrial strength plotter and scanner in packed state at the GIS Laboratory

3.5. EVALUATION OF PARTICIPANTS

Participants were evaluated on the basis of assignments. In total, seven assignments were handed out to the participants of which three were designed to be graded. The participants returned two assignments for grading. The instructor handed over their assessment and grades to the Principal of the FBS training wing. Course completion certificates were handed out to the participants at the end of the training. The session was presided by Dr. Razia Tufail, who is the parliamentary secretary for Ministry of Economic Affairs and Statistics (seated in the middle in Figure 3).

Based on the performance of the participants it was felt by the instructor that the level of learning varied greatly among the participants. A large number of participants in the course had no or limited experience in computers. Such participants gained the least from the course because they struggled with the fundamentals of computers. On the other end of the spectrum were those participants who had been working with computers and databases. The computer literate participants gained the most of this course. The instructor pointed out three advanced learners to the joint Census Commissioner, Mr. Muhammad Saeed, and recommended that these three participants (two were from FBS and the third belonged to

the National Institute of Population Studies) be seconded to PCO's GIS laboratory to spearhead the digitizing of census geography in Pakistan.



Figure 3: Concluding session at the FBS head office in Islamabad.



Figure 4: A group photograph of the participants at the culmination of training outside the FBS headquarters

4. FUTURE DIRECTIONS

4.1. THE CHALLENGE AHEAD

The task of geo-coding the census geography lies ahead of the Geography section of PCO, which is headed by Mr. Abdul Hameed, who also attended the training.

4.1.1. SCOPE OF GEO-CODING TASKS

Based on the data provided by PCO, the scope of the work is presented in Table 1. There are 130 Districts and almost 500 Tehsils in Pakistan. These are administrative boundaries, which could serve as the main building blocks of the census geography. The District and Tehsil boundaries could be demarcated on the national map of Pakistan. Using each Tehsil's boundary as the outer envelope, urban charge, circle and block boundaries in urban areas and *qanun-go* circle, *patwar* circle, and *muzah* boundaries could be drawn for each Tehsil.

We are recommending a top down approach that will result in the creation of Census District and Tehsil level GIS before the lower, more detailed levels of GIS. This approach will allow PCO to demonstrate GIS capabilities to the policymakers and seek their support

for expanding the work to cover lower-level spatial boundaries, such as census charges and circles.

Table 1: Census and other administrative boundaries in Pakistan

Sr. No.	Name of Administrative Area	District Maps	Tehsils Maps	Big Urban Area Maps	Small Urban Areas Maps	Urban Charge Maps	Urban Circle Maps	Mauza/Deh Maps	Total
1	Punjab	35	132	21	220	453	2,714	25,930	29,505
2	Sindh	23	103	24	151	389	1,959	5,875	8,524
3	Balochistan	28	121	2	42	54	172	6,584	7,003
4	NWFP	24	60	4	44	66	337	7,326	7,861
5	FATA	7	42	-	5	5	6	-	65
6	AJK	7	18	2	16	18	45	1,853	1,759
7	NA	5	20	-	5	5	9	566	610
8	Islamabad	1	1	1	-	6	74	132	215
	Total:	130	497	54	483	996	5,316	48,066	55,542

4.1.2. CODING OF CENSUS GEOGRAPHY

PCO uses a nine-digit code to attach unique identity to individual spatial units. The following codes are operational:

- 0 0 0 First three digits represent District code
- 0 0 4th and 5th digits represent Census Charge
- 0 0 6th and 7th digits represent Census circle
- 0 0 8th and 9th digits represent Census block

It was discovered during the conversations with the PCO staff that Mauzahs are identified by names only. That is, the numerical coding is not extending to Mauzahs. This will cause problems with efficient use of GIS's search capabilities. Therefore, it was recommended that the 11-digit code developed by the FBS, which identifies each mauzah uniquely, be used as the primary key in developing the new GIS. .

5. PAKISTAN DATA BANK

A national level data bank is being proposed by the instructor to ensure that the data already generated by different agencies of the government should not be re-generated. This will prevent duplication of efforts and waste of precious resources. Numerous government departments have embarked on developing GIS in Pakistan. For instance, another federal government institution in Pakistan, NADRA, has reportedly developed the Mauzah levels maps. NADRA's objective is to develop the fiscal cadastral for Pakistan. PCO can avoid duplicating the efforts by obtaining the maps developed by NADRA.

However, a protocol does not exist between different tiers of government that would facilitate the exchange of information and data. The need for such a bank and the federally mandated authority for the data bank to seek data from all government functionaries will strengthen the workings of all government departments. Within the general databank, a

dedicated GIS cell may be established to coordinate archiving and dissemination of spatial data in Pakistan.

6. INTERNATIONAL EXPERT ADVISORY PANEL

The instructor would also like to propose an expert advisory panel comprising of experts in GIS and demographics to act as an advisory board to the PCO. The members of the panel may be drawn from local experts within Pakistan and academics/practitioners in the UN and the donor agency setup. The advisory panel will act as an internet-based network for providing timely advice and guidelines to PCO as it embarks on the monumental challenge of planning and conducting the next census in 2008.

7. BIBLIOGRAPHY

- Barredo,J.I. & Demicheli,L. (2003). Urban sustainability in developing countries' megacities: modelling and predicting future urban growth in Lagos. *Cities*, 20(5), 297-310.
- Barredo,J.I., Demicheli,L., Lavallo,C., Kasanko,M., & McCormick,N. (2004). Modelling future urban scenarios in developing countries: an application case study in Lagos, Nigeria. *Environment and Planning B-Planning & Design*, 31(1), 65-84.
- Cavric,B.I., Nedovic-Budic,Z., & Ikgopoleng,H.G. (2003). Diffusion of GIS technology in Botswana - Process and determinants. *International Development Planning Review*, 25(2), 195-219.
- Dunn,C.E., Atkins,P.J., & Townsend,J.G. (1997). GIS for development: A contradiction in terms? *Area*, 29(2), 151-159.
- Klosterman,R.E. (1995). The Appropriateness of Geographic Information-Systems for Regional-Planning in the Developing-World. *Computers Environment and Urban Systems*, 19(1), 1-13.
- Leao,S., Bishop,I., & Evans,D. (2004). Simulating urban growth in a developing nation's region using a cellular automata-based model. *Journal of Urban Planning and Development-Asce*, 130(3), 145-158.
- Lima,R.D., da Silva,A.N.R., Egami,C.Y., & Zerbini,L.F. (2000). Promoting more efficient use of urban areas in developing countries - An alternative. *Public and Nonmotorized Transportation in Other Nations; Women'S Issues in Transportation*,(1726), 8-15.
- Olowu,D. (2003). Challenge of multi-level governance in developing countries and possible GIS applications. *Habitat International*, 27(4), 501-522.
- Repetti,A. & Prelaz-Droux,R. (2003). An Urban Monitor as support for a participative management of developing cities. *Habitat International*, 27(4), 653-667.
- Sena,S., Hobson,J., & Joshi,P. (2003). The Pune Slum Census: creating a socio-economic and spatial information base on a GIS for integrated and inclusive city development. *Habitat International*, 27, 595-611.
- Turkstra,J., Amemiya,N., & Murgia,J. (2003). Local spatial data infrastructure, Trujillo-Peru. *Habitat International*, 27(4), 669-682.
- Walsham,G. & Sahay,S. (1999). GIS for district-level administration in India: Problems and opportunities. *Mis Quarterly*, 23(1), 39-65.

8. APPENDIX 1: TRAINING SCHEDULE

Week 1 (December 26 to 31): Introduction to GIS & Maptitude

December 26, 2005

- Inaugural session
- Fundamentals of GIS
- Spatial data
 - Points
 - Polygons
 - Lines, etc.
- Use of GIS in Census data delivery in US and Canada
- GIS in action

December 27, 2005

- Introduction to GIS theory
- Coordinate and projection systems
- Spatial databases and GIS
 - Displaying spatial data as maps
 - Displaying spatial data as tables
- GIS-based analysis of Rawalpindi's socio-demographics
- GIS-based digital atlas of NWFP
- Live demonstration of GIS in Pakistan
 - Street network files
 - Residential land uses
 - Ravines, etc.

December 28, 2005

- Maptitude basics
 - Working with Maptitude
 - Menus, Toolboxes, and Toolbars
 - Dialogue boxes
 - How to get help?
 - Windows and workspaces
 - Maps, layers, and map features
 - Saving, retrieving, and printing maps
 - Moving around the map
 - Saving and retrieving maps
 - Layers
 - Styles
- Using GIS to perform reports and analysis
 - A review of socio-demographics in Ottawa
- Hands on training in the GIS lab

December 29, 2005

- Maptitude basics
 - Working with Maptitude
 - Labelling
 - Freehand
 - Drawing tools
 - Presenting data as Themes
- Using GIS to perform reports and analysis
 - A review of socio-demographics in Montreal
- Hands on training in the GIS lab

December 30, 2005

- Maptitude basics
 - Tables, Dataviews
 - Working with columns
 - Data sorting, etc.
 - Creating dataviews from databases
 - Adding records and formula fields
 - Editing data in dataview
 - Data structures and modification
 - Filling columns
 - Searching and Querrying
 - Selection sets by condition
 - Selecting by geography
 - Computing Statistics
 - Joining Dataviews & Data
 - Aggregate joins, etc.
- Hands on training in the GIS lab

December 31, 2005

- Advance Maptitude
 - Geocoding and spatial analysis
 - Pin mapping
 - Locating by address
 - Districting
 - Merging by value
 - Bands and buffers
 - Overlays
 - Measuring distances and areas
- Understanding the Census Geography in Pakistan
 - Provinces
 - Districts
 - *Tehsils* & Union Councils
 - *Patwar* Circles

- Census Charges
- Census Circles
- Census Blocks
- Hands on training in the GIS lab

Week 2 (January 2 to 7): GIS in Detail

January 2, 2006

- Creating Maps in GIS
- Scanning paper maps
- Introduction to topographic sheets
- Registering digital maps
- Digitising census maps using geo-referenced scanned images of paper maps

January 3, 2006

- Digitising Census Geography for Lahore

January 4, 2006

- Error-correction in digitised maps
- Continuing work with digitising Census Geography for Lahore

January 5, 2006

- Linking digital maps with census data for Lahore
- Creating GIS-based demographic atlas for Lahore

January 6, 2006

- GIS-based Census planning in the US & Canada
- Using digital maps for planning the 2008/11 census

January 7, 2006

- Overview of training
 - Concluding session
-