FINAL REPORT

GPS TECHNOLOGY TRANSFER IN ALBANIA: HISTORY, PROGRESS AND FUTURE STRATEGIES

Dr. Grenville Barnes
University of Florida
Gainesville

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Executive Summary

This report documents an ongoing study of technology transfer, specifically the transfer of GPS, in Albania. It examines the short history of GPS since its first use in 1992 and reports on the current status of this technology in the country, particularly the factors blocking further progress. The capacity of the private sector, notably private surveyors and GIS companies, and public sector are evaluated with respect to their capacity to adopt GPS technology. The report also recommends actions for the transfer of the existing GPS units to the private sector as well as optimizing the use of this technology.

A number of "action items" are recommended and these are listed below:

- Develop specific strategies to cope with loss of trained personnel
- Replace existing voltage converters by more compact and reliable transformer that transforms from 110V to DC
- Replace charging system with one that indicates level of charge in battery
- Test existing batteries to determine length of operation when fully charged and label this on the battery
- Follow up with Corvallis to ensure that new software and hardware keys have been sent (done)
- Obtain updated manuals for Corvallis software
- Translate key parts of the manual into Albanian
- Conduct a field test covering a whole village where PMU personnel collect all the data and post process it relative to two base stations
- Send receiver to Corvallis for firmware upgrade (done)
- Monitor Corvallis website for Y2K problems
- Obtain the necessary training (possibly over the InterNet) for two of the PMU technical staff to be certified as Corvallis trainers.
- Install a direct telephone line in the PMU Geoinformatics Center so that they have telephone, email and InterNet access
- Design contracts and pricing to encourage innovative use of GPS technology
- Lease one Corvallis base station unit to a private company and evaluate their performance after 9-12 months
- Investigate the viability of selling 4 rover receivers, a base station and the post-processing software to a private entity (private company or consortium of survey companies)
- Translate the executive summary of this report into Albania and disseminate

Additional recommendations for optimizing the use of GPS are included in Section 8. A follow-up paper will be written on this topic focusing on the analytical part of the report.

TABLE OF CONTENTS

LIST OF FIGURES:

LIST OF TABLES:

1. INTRODUCTION

1.1 Background

The main objective of the research described in this report is to evaluate the transfer of GPS technology in Albania and to recommend strategies for promoting greater diffusion of the technology in the future. This work forms part of the USAID-supported Land Market Action Plan and was carried out under a subcontract from the University of Wisconsin.

The initiative to introduce GPS into Albania began in 1994 with controlled testing on the UF campus and field tests in Albania. Since that time the Project Management Unit (PMU) in Albania has acquired its own GPS units, undertaken training, additional tests and established the geodetic infrastructure to facilitate the use of (Greening and Barnes 1998). In between this Albania has had to contend with several major political and economic crises which have led to substantial stoppages.

The specific terms of reference for this work were as follows:

(a) Prepare a history and overall evaluation of the introduction and use of the GPS technology in Albania for use in the first registration effort.

(b) Describe the capacities of private companies and individuals, including faculty in the University, to use GPS for various purposes.

(c) Explore options for making optimal use of the technology in the future, by the PMU and by private surveyors.

(d) Define how the GPS equipment should be owned in the future so that the University can prepare for the transfer of ownership.

I visited Albania from October 2 –15, 1999 and met with a number of private surveyors, PMU personnel, private companies using digital technology, a Geomatics professor at the Polytechnic University in Tirana and the PMU coordinator in Durres.

I would like to thank all of the individuals who spent time patiently answering my questions and sharing their experience. In particular, I am grateful to Rubin Kodra, Edmond Leka and Fatmir Kopella for assisting me with this research.

1.2 Technology Transfer

The transfer and diffusion of technology has been a topic of research for over fifty years (see Ryan and Gross 1943, for example). During this time researchers have examined transfer and diffusion of agricultural technologies, medical innovations, computer technologies and many other types of technological innovations. It is generally recognized that adoption of a new technology starts off slowly (phase I) and at around 20% adoption by the target population the adoption rate increases rapidly (phase II). This period of rapid adoption is followed by a saturation of the technology and a very slow increase (phase III) in the cumulative number of adopters (Valente 1995). This gives rise to an S-shaped curve as shown below in Figure 1.

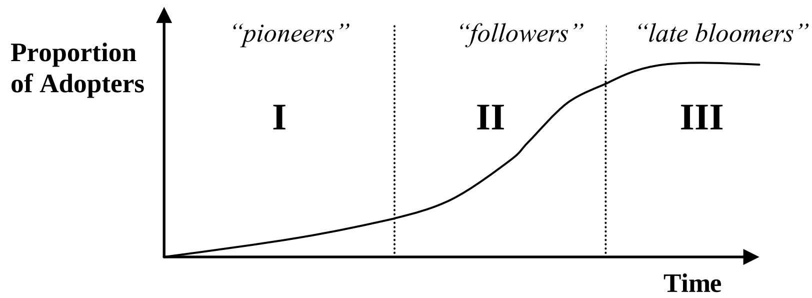

FIGURE 1. Typical S-Shaped Cumulative Adoption Curve for Innovation Diffusion

Researchers have tried to explain why this rapid adoption occurs as a means of facilitating the rapid adoption of an innovation. Valente (1995) emphasizes that diffusion is a social process and can be analyzed by focusing on individuals (threshold models) or social systems (critical mass models). Both approaches recognize the need to analyze 'who talks to whom?' and 'who influences whom?' Some of the main factors that influence this 'social network' are: education, 'cosmopolitaness,' media consumption, social participation, income and contact with change agents (Valente 1995; Ryan and Gross 1950).

In the context of GPS in Albania, I would add the following adoption factors: 'riskiness,' access to technical literature, and existing technical knowledge. 'Riskiness' relates to how much risk an individual is willing to take. This can be a function of personality as well as the general economic and political environment. Albania's economic and political environment is clearly extremely risky given the instability in the region and the massive economic transition that Albania is going through. Most of the technical literature on GPS is published in English, with almost no material available in Albanian. Access to technical knowledge on GPS therefore depends on either knowing English or knowing someone who can read the material and pass it on verbally. From a purely technical perspective (i.e. excluding language difficulties) adoption also depends on the existing knowledge base. Individuals with a geodesy or surveying background are more likely to understand the concept of GPS and how it operates and would be the most likely candidates for adopting the technology.

The dynamics of technology transfer has been depicted as a "symbiotic relationship" between technology and society which is subject to different legal, social and technological pressures. This approach has been used previously to examine the adoption of GIS technology in the US as summarized in Figure 2 below (Niemann et al 1988).

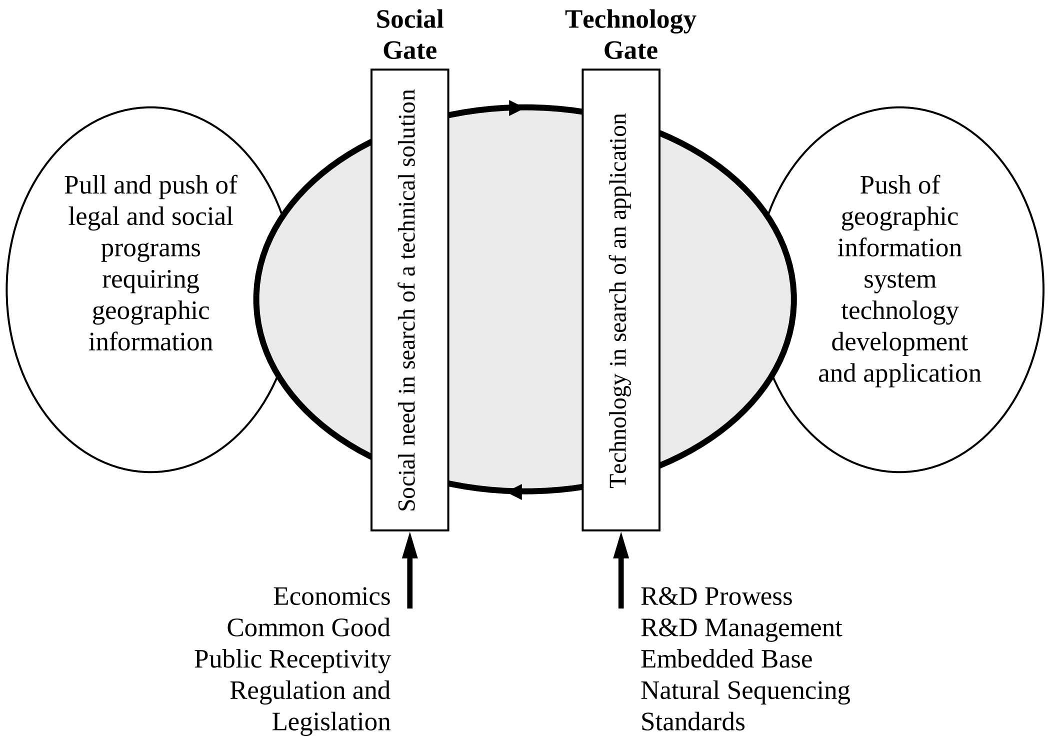

FIGURE 2. Analytical Framework for Examining GIS Technology Transfer

This approach is used as a starting point for analyzing GPS technology transfer in Albania. The adapted model for GPS technology transfer in Albania is described in Section 8.

2. HISTORY OF GPS IN ALBANIA

2.1 Initial Geodetic Investigations

The first step towards GPS actually occurred in November, 1992, when the University of Wisconsin contracted the Denver-based geodetic engineering company, MSI,[1] to evaluate the geodetic control network. They used geodetic-level GPS to re-observe two small triangular networks near Lushnje and in Northern Tirana. Although the relationship of the local Albanian datum and the global GPS datum was unknown at that time, they were able to make a limited assessment of the existing control network. Their conclusion was that the network is sufficiently accurate to support future mapping projects. However, they did recommend that the Albanian network be connected to the IGS global network and that a gravity survey be carried out to determine the relationship between the reference ellipsoid (Krassowsky) and the geoid[2] (MSI 1992, p. 10).

2.2 Initial Cadastral Investigations

In July, 1993, an international team visited Albania to evaluate the options for property surveying and mapping (Barnes and Moyer, 1993). Part of this work involved developing property surveying and mappings techniques to support land registration. Recommendations from this study included:

- The need to develop a dynamic private surveying and mapping sector
- The need for a strong professional surveying organization which represents the interests of all surveyors and mappers
- Inclusion of courses on legal boundary and property registration aspects, as well as modern technologies like GPS and GIS in the surveying curriculum
- The need for a land survey act and regulations

Because of the uncertain institutional framework and the lack of technical support and skills in modern technologies, we recommended that Albania continue with the "low-tech" approach towards property surveying and mapping. However, we recognized the potential role of GPS at that time[3] and included, as an appendix to our report, a proposal to develop and test a GPS[4] methodology for property surveying.

2.3 Initial Formulation of GPS Methodology

The proposal was subsequently funded through the University of Wisconsin. Given their previous experience in Albania and their extensive field experience with GPS, MSI were incorporated into the research team from the start. On June 1-2, 1994, we held a "brainstorming" meeting at the University of Florida to discuss the cadastral surveying environment in Albania and the potential GPS techniques that could be employed under

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[1] Now part of Analytical Surveys Inc (ASI)
[2] approximately mean sea level
[3] especially in areas with no base maps or where the sparsity of ground features, like canals, make it difficult to identify parcel boundaries on base maps.
[4] Initially this was to include GPS and total stations, but this was later narrowed to GPS only.

those conditions. At that meeting it was decided that the new generation of sub-meter code receivers held the most potential and that this equipment should be tested both in Florida and under typical field conditions in Albania.

2.4 Controlled GPS Tests in Florida

In order to test and analyze the performance of the GPS equipment under controlled conditions, we established a test site on the University of Florida campus. This comprised approximately 50 monumented points which were surveyed using high accuracy GPS and a total station. The resulting coordinates are accurate to within a few centimeters and for the purposes of our tests can be regarded as the "true" positions of these points. The tests at Florida focused on two critical questions:

- How far away (baseline distance) from the base station could we use the rover and still achieve sub-meter results?
- What is the minimum time that we need to occupy a point with the rover in order to achieve sub-meter results?

Effect of Baseline Distance on GPS Observations

The first question is critical as we would like to be able to operate at long distances (100-200 kms) away from the base station in order to minimize the need for control densification and the establishment of several base stations. In the context of Albania, the radial distance from the capital city of Tirana to the most distant point of the country is approximately 185 kms. If we could achieve sub-meter results up to 185 kms, this would imply that a single base station could service the entire country.[5]

For these tests we used a Trimble ProXL as the rover and a Trimble 4000SSE unit was used at the base station. Observations were taken at baseline distances of 2, 32, 65, 87, 135, 107, 147, 192 and 235 kms. The results showed that sub-meter results could be attained up to distances of approximately 130-150 kms from the base station (Barnes et al 1994; Barnes and Eckl 1996; Barnes, Eckl and Chaplin 1996). Standard deviations increased significantly beyond that distance. In some of these tests a systematic pattern was observed in which the scatter of the various positions appeared to be aligned with the direction between the base and the rover. No explanation could be found for this pattern, but it disappeared when a more recent version of the processing software was used. The new software also produced better results, easily yielding sub-meter accuracy up to a baseline distance of 180 kms..

Effect of Occupation Time on GPS Observations

The second question (occupation time) is also very important as this determines how much of a time advantage this methodology has over conventional cadastral surveying approaches. We felt that occupation times of less than two minutes per point would constitute a significant advantage over conventional methods, especially when considering the huge number of parcel corners to be surveyed. After testing occupation times of 15 seconds, 30 seconds, 45 seconds, 60 seconds and 5 minutes, we found no

[5] Of course, for checking purposes and as a backup one may require more than one base station

significant difference between them. This indicated that we could achieve sub-meter results with as little as 15 seconds of observations, but we feel safer to recommend at least 1 minute occupation times in order to obtain more redundancy in the measurements. This occupation time will also depend on the type of receiver and software.

2.5 Initial Field Tests in Albania

Field tests were carried out in four different areas in Albania - two rural (Ndroj village in Zhurje and Lumthi Village in Lushnje) and three areas on the urban fringe (Selita, Priest Hill and Kamza). The rural tests areas were located in flat, irrigated farmland with small parcels. A Trimble ProXL was used as a rover for these tests and a Trimble 4000SE as base. When compared with the conventional base mapping approach, the GPS methodology was estimated to be twice as fast in the field and 7 times faster in the office. These estimates assume that the GPS surveyor is experienced (i.e. beyond the learning curve).

2.6 DMA GPS Survey

In October, 1994, the Defense Mapping Agency (DMA)[6] carried out a geodetic survey of approximately 40 triangulation points in Albania (DMA 1994). This was the first determination of coordinates relative to the GPS datum, WGS84, in the country. In the field tests carried out earlier in 1994 (see previous subsection) we used approximate coordinates for the base station point as no WGS84 points were available at that time. The DMA survey meant that any of these 40 points could be used as a base station site for GPS observations.

2.7 First RFQ for GPS Equipment Acquisition

In 1994 the PMU decided that it would purchase GPS equipment to assist with the property surveys for first registration. The GPS equipment would be acquired by the University of Wisconsin as part of their contract with USAID. This meant that the acquisition was subject to State (of Wisconsin) purchasing procedures. Since USAID were providing the funding, it also meant that equipment had to be manufactured in the US[7].

In late 1994 a request for quotation (RFQ) was sent out to several leading GPS companies for the acquisition of two base station receivers, four rover receivers, two computers and any required software and accessories. The RFQ requested that respondents provide details on: equipment description and prices, shipping, service and maintenance, as well as prices for any accessories. In January and February, 1995, responses were received from three GPS vendors and a private consulting company that proposed to purchase, test and ship the equipment to Albania. A summary of the responses is given below in Table I.

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[6] Now known as NIMA

[7] This was not really a constraint with GPS equipment as at that time almost all GPS receivers were manufactured in the US.

Table I. Comparison of GPS Equipment Prices in First Round Bids

Item	Company A	Company B	Company C	Company D
2 Computers	3 400	6 320	-	4 559[8]
Processing Software	0[9]	4 995	0[7]	4 000
2 GPS Base Stations	27 300	25 789	27 300	36 000
4 GPS Rover Units	35 800	51 391	35 800	72 000
Shipping	1 000	1 500	375	1 320
SUBTOTAL	**67 500**	**89 995**	**63 475**	**117 879**
Service/Maintenance	n/a	n/a	4 190[10]	10 200[11]
Accessories	34 018[12]	0[13]	4 700[14]	-
TOTAL	**$101 518**	**$89 995**	**$72 365**	**$128 079**

The main discrepancies between the different prices appear to be:

- The rover receivers listed by Companies B and D are geodetic receivers (using phase processing as opposed to code) which are more accurate but also more expensive
- Company C only dealt with GPS equipment and did not provide a quote for the two required computers
- Company A included all necessary accessories such as tripods, tribrachs, plotters, etc.

It was clear from the responses that only Company A fully appreciated the conditions and needs of the project in Albania. In an effort to fully evaluate all proposals and to avoid an additional round of bidding, an attempt was made to loan the equipment from the various companies. The idea was to test the various receivers on the University of Florida test site to determine to what extent they met the specifications. Only one company agreed to make the equipment available, but this equipment had already been tested.

We concluded that to get more meaningful bids we needed to provide more background information and much tighter technical specifications in the bidding document.

2.8 Second Request for Bids

In October, 1995, a decision was made to send out a second request for bids. The University of Wisconsin (UW) Purchasing unit indicated at that time that contracting a private consulting company to purchase the equipment and transfer it to Albania was

[8] Includes 1 laser printer at $939
[9] Included in the price of the receivers
[10] 1 year firmware and software updates
[11] Service agreement at $1700 per unit per year
[12] Includes memory upgrades for base and rovers, geodetic antenna and 30 meter cable, tripods, tribrachs, range poles, 3 meter tapes, additional batteries, 2 laser printers, 2 plotters and additional software
[13] Price for tripods, range poles, and battery cables included in receiver price
[14] Tripod and Antenna kit

unacceptable.[15] It was also decided to separate the computer equipment from the GPS equipment in order to take advantage of an existing contract UW had with a specific computer company.

In January, 1996, I sent a draft of the technical specifications to UW. These were reviewed by UW Purchasing and comments from them were provided towards the end of February. The new specifications called for one permanent base station, one mobile base station[16] and 8 rover receivers. After resolving questions raised by Purchasing, the bidding document was finalized and sent out in early April, 1996.[17] Bidders were required to respond by May 23.

Bids were received from four GPS vendors. Two of these companies (B and D) had submitted bids in the first request for quotation. The specifications allowed bidders to submit solutions that could meet the sub-meter accuracy requirement "in less than one minute OR from one to three minutes occupation time." As a result, two companies provided an alternate bid for the 1-3 minute option (marked with an asterisk in Table II). Table II below summarizes the prices of the submitted bids for the less than one minute occupation time.

Table II. Comparison of Prices in Second Round Bids

Item	Company B	Company D	Company E	Company F-1	Company F-2*	Company G*
1 Permanent base station	**10 500**	**8 470**	**14 805**[18]	**7 495**	**7 125**	**4 496**
1 Mobile Base Station	**10 500**	**4 770**	**11 986**[19]	**7 195**	**6 900**	**2 171**
8 Rover Receivers	**55 960**	**33 360**	**71 208**	**54 400**	**52 000**	**17 370**
Subtotal	**76 960**	**46 600**	**97 999**	**69 090**	**$66 025**	**24 037**
Software	**2 200**	**-**	**-**[20]	**-**	**-**	**187**
Support/ Maintenance	**1 000**	**-**	**10 070**[21]	**595**[22]	**595**	**-**
Accessories		**-**	**2 511**[23]	**150**[24]	**150**	**-**
Shipping/Duty	**10 196**[25]	**-**	**3 788**	**-**		**-**
TOTAL	**$90 356**	**-**	**$114 368**	**$69 835**	**$66 770**	**$24 224**

* 1-3 minute occupation time option

15 Memo dated 4 December, 1995 from David Stanfield to Steve Smith, LTC
16 A base receiver that could be set up in the field over a known control point and powered by batteries for 12 hours
17 Final document is dated 4/16/96
18 Includes 12 channel single frequency receiver and geodetic antenna
19 Includes 12 channel single frequency receiver and compact dome antenna kit
20 Software included in price of receiver
21 Includes 1 year extended warranty of receivers, software and firmware
22 1 year warranty
23 Includes tripod, tribrach and tribrach adapter, 30 m antenna cable
24 Spare receiver battery
25 Includes $7696 duty

The length of the bids varied from 3 pages (hand written) to 18 pages. Ultimately, it was the best written (most responsive) bid that won, not necessarily the most appropriate GPS technology for Albania. I believe part of this is due to the current climate of a "sellers' market" where demand is almost outstripping supply. In addition, the larger more dominant companies did not appear to compete seriously for this bid, perhaps because of its small size.

In general, the responses were very poor and only one was close to conformance with the specifications. As part of the specifications, bidders were required to provide evidence that their equipment could achieve sub-meter accuracy over distances of 20 to 100 kms. Only one company attempted to demonstrate this capability, but they showed sub-meter repeatability over this distance not accuracy. Repeatability is a measure of the precision or spread of the measurements, whereas accuracy is a measure of how close the measurements are to the true position.[26]

In summary the major problems when acquiring this GPS equipment were as follows:

- Many GPS vendors do not understand basic measurement theory making it difficult for them to respond fully to "tight" technical specifications
- GPS vendors are not familiar with field surveying procedures and therefore are unaware of all the accessories required[27]
- Little to no technical support in countries like Albania
- Accuracy and performance claims are not supported by documented field tests and are based on ideal conditions

2.9 Acquisition of GPS Equipment and Initial Training

The GPS equipment finally arrived in Albania in October, 1996. Before the equipment could be used, the GPS company needed to provide training. Personnel from the GPS company traveled to Albania and offered a one week training course to six Albanians. During this time they also installed the permanent base station on the roof of the LRUI building where the PMU is housed.

Unfortunately, this activity was followed by economic and political turmoil in Albania due to the collapse of several "pyramid schemes" in which many Albanians had invested. The situation was described as follows in a New York Times newspaper article:

> *Albania, Europe's poorest country, is now into the second day of a state of emergency imposed by the hard-line President, Sali Berisha, who has lost control of the southern and richest part of the country…The revolt in Vlore and the unrest in other southern cities was set off by the collapse of fraudulent investment schemes that the Government allowed to operate without regulation….*

[26] Usually the true position is not known, but coordinates accurate to an order of magnitude better than what is required will usually suffice (1 cm in this case)

[27] The bidding document in this case specifically excluded this part from the evaluation

> *Almost every Albanian family put money into the schemes, which in fact were money-laundering and weapon-dealing businesses that were never capable of paying back the investors at the promised high rates of interest…(New York Times, 1997)*

The land registry office in Lushnje was also burned during this unrest destroying all the property records that were kept there.

2.10 Software Upgrades and Additional Field Tests

In September, 1997, a trainer from Corvallis visited Albania in order to install new versions of the post-processing software and GPS firmware. The following month, two of the Albanians who had been trained on the system carried out field tests in the village of Ku. Their test area covered approximately 50 hectares and 200 parcels. The work was achieved in one week. However, when they tried to post-process the GPS observations approximately 50% of the points would not process. The data was subsequently sent via email attachment to the Corvallis in the US, but the source of the problem has never been identified. This problem has had a major impact on the attitude of Albanian surveyors towards GPS

2.11 Geodetic Survey and Calibration of Corvallis Equipment

In January/February, 1998 we once again visited Albania with the purpose of undertaking a geodetic survey to connect the Albanian control network to the International Terrestrial Reference Framework (ITRF) and to test the Corvallis equipment (Greening and Barnes 1998). GPS observations were taken at five major control points[28] and these measurements were post-processed relative to four international base stations[29] which form part of the IGS network of permanently operating base stations. These points also coincided with some of the DMA points thereby allowing the DMA control points to be transformed into ITRF as well.

A calibration site consisting of 10 points was also established in the Tirana Botanic Gardens. This was identified as one of the few places in and around Tirana which was secure enough that these points would not be destroyed.[30] The purpose of the calibration site is to provide a set of accurate points which can be used to determine the performance of any GPS equipment in the future. While we were in Albania we did calibrate the Corvallis receivers over short distances and recommended that a similar calibration be done over longer distances (100-150 kms).

Transformation parameters to transform from coordinates based on the existing Albanian datum to coordinates based on the ITRF were also computed. By using these parameters any triangulation point can be transformed onto ITRF and used as a base station for future GPS work.

[28] Skodra, Tirana A, Kamza, Korca, and PMU0
[29] Situated in Italy, Austria, Hungary and Bulgaria
[30] In a subsequent visit in 1999 we noted that one of the points had been destroyed

A one day seminar was held at the end of our visit to describe the geodetic work done as well as the fundamental cadastral principles necessary to support a property registration system. The seminar was attended by 17 Albanians from the PMU, GGI, ITU, Tirana Polytechnic University and the private sector. During this work we also developed a typology of property boundaries and recommended options for the most cost-effective approach for surveying these boundaries.

2.12 Kosovo Crisis and Evacuation

In April, 1998, Serbians began attacking ethnic Albanians living in Kosovo. A newspaper article summarized the situation as follows:

> *Shock etched on their faces, thousands of ethnic Albanians fleeing the violence in Kosovo province gave firsthand accounts Tuesday of a major Serb offensive against separatists that is fast turning into an all-out civil war in the former Yugoslavia…*
> *The Serb attacks appeared to have intensified over the weekend, judging by the stream of refugees that began Sunday morning to Albania…(Wisconsin State Journal 1998)*

Albanians generously assisted the Kosovar refugees during this crisis and acted as a staging ground for much of the international assistance given to the Kosovars. Repatriation of ethnic Albanians back to Kosovo finally began in June, 1999.

In August, 1998, the US temporarily closed its embassy in Tirana following the attacks on the US embassies in Kenya and Tanzania. Not only was there a fear that the embassy in Tirana could be next, but there were suspicions that the attacks may have been linked to the American role in Albania. (New York Times 1998) All US personnel associated with the property registration project were evacuated and only returned 9 months later in May, 1999.

The political and economic turmoil described above is an important backdrop to GPS technology transfer in Albania as it prevents forward progress and creates an atmosphere of uncertainty and mistrust.

The history of GPS in Albania as described in this section is summarized below in Table III.

Table III. Highlights of History of GPS in Albania (1992-99)

1992	
(Nov)	• Geodetic Engineering Co (MSI) carries out limited tests of the geodetic network using GPS
1993	
(Jul)	• International team visits Albania to assess current surveying practices • advises continuation with existing map-based approach • proposes to develop GPS-based approach
1994	
(Jun-Jul)	• Initial tests undertaken at the University of Florida using sub-meter GPS

	• Pilot tests done in 4 different areas in Albania (Phase I)
(Oct)	• NIMA (DMA) introduces GPS datum (WGS84) to Albania through GPS observations at approximately 40 existing triangulation points
(Dec)	• First RFQ sent out for acquisition of GPS equipment for Albania
1995	
(Jan-Feb):	• Received responses from 4 GPS companies - all unacceptable
(Mar)	• Proposal to test respondents equipment on UF calibration site
(Apr-May)	• Respondents contacted to loan equipment for tests
(May)	• Tests carried out using Trimble ProXL on UF calibration site (Phase II)
(Dec)	• Decision to send out new bid
1996	
(Mar)	• Technical specifications finalized
(Apr)	• New bidding document sent out
(May)	• New bids opened – 6 responses. Only one bid responded to the TOR.
(Jun-Jul)	• Additional clarification and details requested from responsive bidder
(Oct)	• GPS equipment arrives in Albania
(Dec)	• One week training provided to 6 Albanians by Corvallis
	• Base station installed on roof of PMU building
1997	
(Jan-June)	*Economic and political turmoil due to collapse of pyramid schemes. Lushnje registry office burnt*
(Sept)	• Corvallis installs new GPS software
(Oct)	• Albanians carry out 1 week field tests in Ku Village – 50% of points fail to process
1998	
(Jan-Mar)	• Albanian geodetic network connected to international reference frame (ITRF96)
(Phase III)	• Transformation parameters determined for converting from the local coordinate system (based on Kryssowski ellipsoid) to GPS system (ITRF96)
	• Accurate coordinates determined for the main base station point and a calibration network in the Tirana Botanic Gardens
	• Corvallis equipment tested and partially calibrated
	• Geodetic survey and cadastral seminar
(May-Dec)	*Kosovo crisis causes massive movement of ethnic Albanians into Albania*
(Aug-Dec)	*All Americans evacuated following embassy bombings in Nairobi and Dar es Salaam*[31]
1999	
(Jan-June)	*Kosovo crisis continues*
(Jan-May)	Americans restricted from entering Albania
(Jul-Oct)	• PMU starts to contract out control surveys using GPS

[31] The US Embassy in Tirana was apparently the next embassy on the list

3. CURRENT STATUS OF GPS IN ALBANIA

The project has started working in the mountain areas where there is a need for control densification to support the subsequent conventional boundary surveys. Three to four private surveyors are doing ground control using the Corvallis GPS (see Section 4). The surveyors have to rent the GPS receivers from the PMU if they want to use them, except in the case of the control densification, in which case they are provided free of charge. One surveyor has started to use the units for surveying parcel boundaries, but there is still a general lack of confidence in this technology. This stems primarily from the fact that certain points cannot be post-processed.

As the first registration efforts move towards the mountain areas, it is anticipated that GPS will be used more intensively. In these areas there are generally no reliable large scale base maps and the complexity of the parcel boundaries makes it more cost-effective to use GPS (as opposed to total stations).

The base station on the roof of the PMU building is operational and currently runs from 4:00am to 9:00pm every day. The PMU has contracted a person who is responsible for maintaining this base station. They have had no recent power problems in Tirana as the power supply during the summer is usually reliable. However, this will change as they enter the winter months (Nov to March) and daily power outages ensue.

The major problems that they are experiencing with adopting GPS are discussed below together with recommended actions to resolve these problems.

3.1 Retention of Trained Personnel

One of the major problems that has challenged the transfer of GPS has been the emigration of trained personnel to other countries. Our initial counterpart in 1993-94 left to work for a private Italian company, while his successor, and our main counterpart in 1998 left in November of that year. This left a significant gap which was filled initially on a part-time basis until a full time person was hired in June, 1999. Almost all of the technical staff in the PMU are attempting to find positions in Canada and other countries. This turnover in technical staff will undoubtedly continue into at least the short term future of Albania. It should therefore be recognized as a major challenge to technology transfer and a specific strategy should be devised to maintain continuity over this period. Possible strategies include:

- giving a higher priority to training larger numbers of surveyors to increase the pool of trained personnel
- promoting a vibrant private surveying sector that offers a more promising professional future within Albania

Action Item: Develop specific strategies to cope with loss of trained personnel

3.2 Unreliable Battery Power

The main problem with the batteries is that there is no indication of level of charge in the batteries so that surveyors never know how much power they have when they go out into the field. A further complicating factor is that several batteries have been stored without any use for several months and it is not clear how much of a charge these batteries will hold, even though some are brand new. A new battery system was introduced by Corvallis two years ago replacing the system used when the units were first purchased from Corvallis. This new system is more unwieldy than its predecessor as it requires a voltage converter from 220V to 110V and then a second one to transform from AC to DC. Several of the voltage converters have burnt out and a more reliable alternative must be found.

<u>Action Item: Replace existing voltage converters by more compact and reliable transformer that transforms from 110V to DC</u>.

<u>Action Item: Replace charging system with one that indicates level of charge in battery.</u>

<u>Action Item: Test existing batteries to determine length of operation when fully charged and label this on the battery</u>

3.3 Software security not feasible

Whenever the PMU staff move software from one computer to another they are required to contact Corvallis for an authorization code. This is already a problem and will become more serious when the PMU requires private surveyors do their own post-processing. Previously Corvallis used hardware “locks” for protection and they have apparently gone back to that system with the latest release of their software.

While I was in Albania I requested an update of the Corvallis software which would be secured using hardware keys. Corvallis agreed to provide this.

<u>Action Item: Follow up with Corvallis to ensure that new software and hardware keys have been sent. (done)</u>

3.4 No updated manuals

The PMU is still working with the original manuals provided by Corvallis when the system was acquired over 3 years ago even though the software has been upgraded. I requested an electronic copy of these from Corvallis. The new updated software does include an electronic manual.

<u>Action Item: Obtain updated manuals for Corvallis software.</u>

<u>Action Item: Translate key parts of the manual into Albanian</u>

3.5 Uncorrected Data

The PMU personnel are still having intermittent problems with post-processing as some points do not process. Since the field collection of GPS data and the post-processing is divided between the private surveyor and the PMU, this issue raises the question of who is responsible in these cases where results cannot be determined. This problem did not arise during the tests we carried out in Jan/Feb, 1998 or on this visit, but all of our observations were relatively close to the base station.

<u>Action Item: Conduct a field test covering a whole village where PMU personnel collect all the data and post process it relative to two base stations.</u>

3.6 GPS Calendar Rollover

The GPS system works on a calendar of 1052 weeks which recently ended and the calendar was "rolled over" to zero again. Is the Corvallis firmware and software able to deal with this rollover? I contacted Corvallis and consulted their website on this issue. It appears that only one receiver was not prepared for the rollover.
<u>Action Item: Send receiver to Corvallis for firmware upgrade (done)</u>.

3.7 Y2K Compliance

A similar question to the GPS rollover arises with the regular calendar entering a new millenium. Once again, I raised this question with Corvallis while I was in Albania. With the new PC-GPS software that Corvallis will supply shortly, this issue should not be serious. However, Corvallis recommends that users monitor their website[32] for additional details on Y2K compliance.
<u>Action Item: Monitor Corvallis website for Y2K problems</u>

3.8 Training

GPS contracts are only given out to surveyors who have a certificate indicating that they have received training on the Corvallis system. Skander Kuci was a certified trainer[33] and he had provided this training to a number of Albanians on Corvallis. Since his departure no-one has filled the gap. Although Fatmir Kopella received the same training as Skander, he has not taken over this role and his recent appointment as chief of the PMU registry means that this is no longer a viable option for training. A solution must be found for this if GPS is to be used more widely.
<u>Action Item: Obtain the necessary training (possible over the InterNet) for two of the PMU technical staff to be certified as Corvallis trainers.</u>

3.9 Communication

Currently the whole of the PMU is served by only one telephone. This makes communication between the PMU and the public extremely difficult. It also means surveyors cannot contact the base station to verify that it is operating. In addition, the technical staff need access to email and the InterNet for problem solving, updating software, and gaining access to other GPS-related information.
<u>Action Item: Install a direct telephone line in the PMU Geoinformatics Center so that they have telephone, email and InterNet access</u>.

3.10 Market prices for Surveying

The PMU uses two methods for contracting survey services – an open bidding process and a more directed bidding process. The open bidding process is open to everyone and is generally used for large contracts (5-10 cadastral zones), whereas the direct process is targeted at 3 pre-selected companies and usually involves smaller contracts (single

[32] www.cmtinc.com
[33] Based on the training he received from Corvallis personnel when they visited Albania

cadastral zone or village). The direct process is also used to broaden the pool of surveyors involved in the fieldwork. In both cases a maximum (ceiling) amount is specified, based on calculations that take into account such factors as: distance from city, type of terrain and method of survey.

Given that there is essentially only one source of work and a specified maximum price, it is questionable whether the bid prices reflect a real market price. Surveyors interviewed complained that prices are substantially lower than the market price for non-PMU surveys. However, interviews with PMU personnel revealed that these prices have been adjusted, most recently in 1997.

One concern relating to the transfer of GPS technology is the removal of incentives to use more cost-effective technology. In a functioning market system, companies can become more competitive, and thereby win more contracts, by adopting technologies like GPS that are more efficient. If the type of technology is built into the maximum price on survey contracts in Albania, this could reduce a significant incentive to adopt technologies like GPS. This would definitely be the case if the PMU determines that the maximum price for GPS surveys is lower than that using other technologies or methods (tape and total station).
Action Item: Design contracts and pricing to encourage innovative use of GPS technology

4. CAPACITY OF PRIVATE COMPANIES

Since the only GPS equipment in Albania belongs to the PMU, it is difficult to make a broad assessment of GPS capacity based on any past experience. However, the GPS units in the PMU are being used by private surveyors for certain contracts. It is possible to evaluate this experience, even though it is limited to field operation and does not include post-processing.

In addition, there are other digital technologies (e.g. GIS, total stations) that are currently being used to capture, process, analyze and disseminate spatial information in the private sector. The digital technologies currently being employed for the computerization of paper registry index maps are shown below in Figure 3. It is informative to examine the adoption of these technologies as this reveals who and how they have been successfully adopted in the private sector. This should suggest possible strategies for greater diffusion of GPS in the next few years.

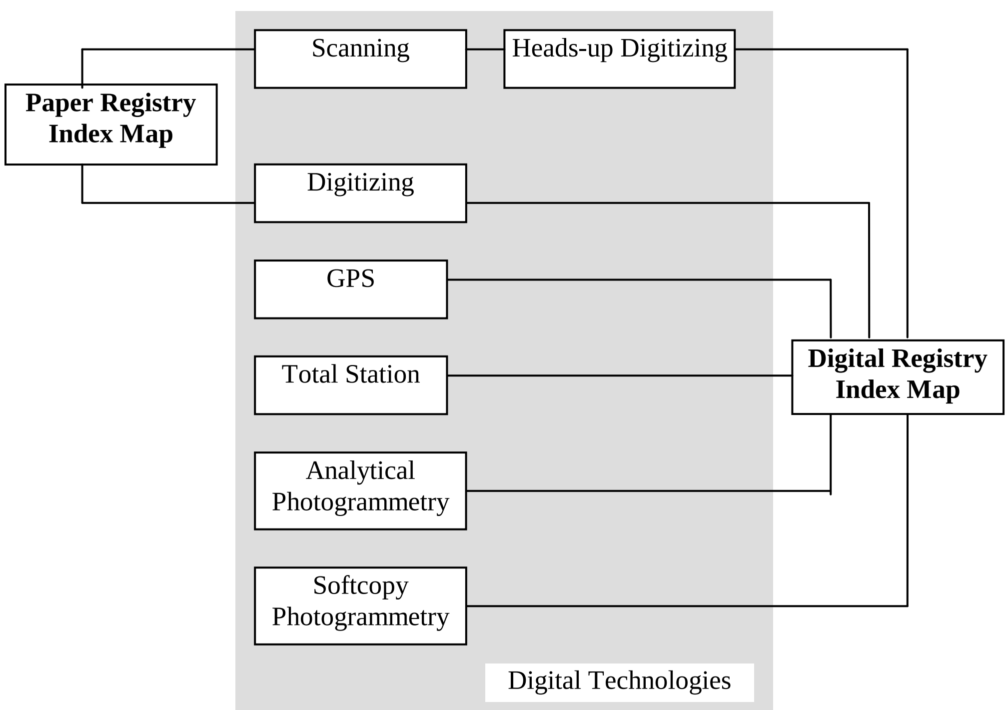

FIGURE 3. Digital Technologies applied to Spatial Registry Information in Albania

The key questions behind this investigation of private sector capacity are:

- who are the people that are successful in the private sector?
- why are they successful?
- how is the company organized?
- what lessons from this experience can be used to facilitate GPS diffusion?

The companies examined can be categorized as follows:

- private survey companies using total station technology
- private survey companies using GPS
- private companies doing digitizing, scanning and GIS work

There are currently no private sector entities with an analytical or soft copy photogrammetry capability. For public sector capacity, see the section following this one.

4.1 Private Surveyors using Total Station Technology

Two private surveyors, LZ and PN, working in different private companies were interviewed. LZ works in a private company that consists of three degreed surveyors and three assistants. He worked for three years in Greece (1994-96) where he obtained extensive field experience with total stations. On his return to Albania, he purchased a total station. He has 3 pc's in his office and uses Microstation and Leonardo[34] software.

PN works in a private company consisting of three degreed surveyors and one assistant. He also purchased a total station, with technical advice from LZ, by borrowing money from relatives and friends. He is paying this back slowly over time. He has one pc and uses Autocad and Arcview software. He obtained this software about six months ago and in the intervening time has become proficient in these two packages. Neither of these surveyors has a plotting capability and they pay specialist companies to do the plotting.[35]

They both bemoaned the fact that the PMU surveys are being priced well below the "market rate.[36]"

When asked why they prefer total stations to GPS technology they asserted that:

- GPS does not give the precision required for certain surveys, such as engineering surveys which require plans of scale 1:200
- lack of security that field observations can be processed and are reliable
- cannot check observations in the field as they have to return to Tirana to post-process relative to the PMU base station

4.2 Private Surveyors using GPS

This information is based on interview with two surveyors, JS and EQ, working in two different companies. JS is a graduate of the surveying program at Tirana Polytechnic University. He has been working on PMU contracts doing control densification using GPS. Each contract generally includes 4-5 villages which may cover an area of approximately 1000 ha. Since he does not own a car, he has to catch a bus to the nearest city, where he rents a car for the field work. Typically, the contract requires that one control point be established per 50 ha. If convenient, he will also survey 3 triangulation

[34] Italian coordinate geometry (CoGo) package
[35] about $3 for an A0 or A1 plot
[36] There really is no marker price for surveys at least boundary surveys

points in the area.[37] He collects GPS data for 3 minutes at all new points. The post-processing is done by PMU personnel even though JS has received post-processing training. No quality control is carried out on the 3 triangulation points as the PMU does not have access to the original coordinates for these points. These continue to be regarded as secret by the Military Topographic Unit.

The major problems he has experienced with GPS are:

- date and hour on receiver are occasionally incorrect
- cannot post-process certain points (approx 8-10 points out of 400)
- cannot get orthometric heights[38]

EQ is a graduate of the military topography program in Albania. He started surveying in 1980, initially within the military. He was laid off from the military in 1990 and worked for a few years with a government department dealing with irrigation. In 1994 he went into private practice and since that time has depended mainly on PMU contracts. There are four persons in his company - two with military topographic degrees and two with technical school[39] training. He generally only works with these four associates when he wins a contract.

Since 1995 he has been working with a total station (Zeiss) that has a range of 1.5 km. The usual approach for control densification with a total station is to do a four point resection (sometimes with distances measured as well) or to traverse between existing control points. When working with the total station he contracts out the calculations to a third party. He does have a computer and the knowledge to do the calculations, but it is faster to contract this out, thus allowing him to do more field work.

He notes the following power management advantages of total station over GPS:

- batteries can be bought locally
- battery life is approximately 4 to 5 years

He started using GPS for control densification in March, 1998. He took a one week course offered through the PMU. Briefly, the procedure for doing these types of GPS surveys are as follows:

- local PMU coordinator selects location of new control points to be surveyed
- if convenient surveyor will occupy a nearby control point
- Surveyor works for approximately two weeks and then downloads data from the data collector[40]

EQ estimates that he can do 50 to 60 points in a two week (12 working days) period, or 4-5 points per day. The main problems he has experienced so far are:

- old receiver batteries did not work

[37] With the disappearance of the signals of triangulation points, most surveyors do not tie into these points
[38] GPS measures heights relative to the ellipsoid not mean sea level
[39] This is literally translated as "high school" but it follows the 12 year school system
[40] EQ has been using the only data collector that has 8 mb of memory, the remainder have less

- new battery system is unwieldy with two additional transformer units required[41]

When asked why so few surveyors use GPS, he gave the following reasons:

- PMU is the only entity in Albania that owns GPS equipment
- use is restricted to control densification
- problems with post-processing (out of 600-700 points measured, he estimates 5-6 failed to process - approximately 1%)
- lack of confidence in the ability to process the GPS observations

The lack of confidence stems from field tests that were carried out by PMU personnel in Ku Village (see History section). Approximately 50% of the observations could not be post-processed. Since the PMU personnel who did the tests were the most knowledgeable people in Albania, other surveyors doubt that they would fare any better. It is critical that another test be carried out by current PMU personnel in order to prove the technology.

It appears that the private companies described above operate in a fairly loose manner, essentially coming together only when a contract is awarded. Most of the individuals in the company work out of their homes, thereby avoiding office overhead. It is clear that private surveying companies, and the surveying profession as a whole, is still in the early phases of development. This is not surprising given Albania's past history. However, this is not true for the GIS companies discussed in the next section.

4.3 Private GIS Companies

The International Computer Company, or ICC, was one of the first private companies to enter the informatics business in Albania[42]. ICC was started in April, 1992, by three professors from the Computer Science Department of Tirana University. The President and founder of the company obtained a PhD in computer science from Grenoble University in France and has worked in the Computer Science Department at Tirana University since 1983. He has headed this department since 1986. The two other co-founders of the company are also computer scientists, having graduated in the first graduating class (1989) in this field at Tirana University.

ICC is primarily involved in software development, management information systems (MIS), training, and the installation and maintenance of computer hardware, software and networks. As ICC became more involved with the registration project, they saw the need to create a focus in GIS. In 1994 they created a sister company, called GCC (GeoComp Company), and hired two professors from the Geodesy Department at the Tirana Polytechnical University. One of these professors has a PhD in photogrammetry from France and the other was educated in Tirana. The latter has through his own initiative become an expert in AutoCad and GIS. GCC now employs 16 additional people who

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[41] The new system requires one unit to transform from 220V to 110V, a second to transform from 110V AC to 18V DC, and a separate charger unit. The old system had one unit for transforming from 220V to 18V DC and the battery indicated the status of the charge (this is now done by the charging unit).

[42] This information is based on interviews with Maksi Raco and Bujar Drishti as well as an information pamphlet entitled "A Profile of IGI: The First and Largest Albanian Software House."

work primarily on the digitization of spatial map data. They have seven personal computers and three A0 digitizing tables. All of their scanning work is contracted out. Much of their work is through contracts from the PMU, but they also have other clients. However, almost all their work is through internationally funded projects.

In 1996 they created another sister company, called IMB (Institute of Modeling in Business), which focuses on computerized systems for accounting, payroll and budgeting. This company is staffed by two professors from the Business and Accounting Department at Tirana University. The three companies – ICC, GCC and IMB – are grouped together to form the IGI group.

I also visited another successful private company which does both GIS work and construction engineering. The Guri company is a "top 200" company directed a husband and wife team of engineers. He is a graduate (1988) of the geodetic program at Tirana Polytechnic and has worked for 4-5 years in the ITU as well as in Greece while his wife was studying there. They started the company in 1993 and focused initially on construction. Since 1996 they have been doing digitizing work. They also own the substantial building in which their offices are located. They have received three contracts covering approximately 8000 hectares from the PMU for surveying fieldwork. They own a total station and cooperate with other companies to rent equipment when the need arises.

This company is interested in maintaining a GPS base station at their office, which appears to be a good site for this purpose. They are centrally located, the top of their building is relatively free of obstructions, and they have a back-up generator which is employed when the power fails.
<u>Action Item: Lease one Corvallis base station unit to a private company (e.g. Guri Company) and evaluate their performance after 9-12 months</u>

5. CAPACITY IN PUBLIC SECTOR AND UNIVERSITY

The PMU is the only government department that has GPS. Originally, Corvallis trained two persons in PMU to operate the GPS receivers and do the post-processing. One of these persons (Skender Kuci) left the country in November, 1998, and the other person (Fatmir Kopella) has been transferred to the registration section of the PMU. Edmond Leka filled in together with other responsibilities until Rubin Kodra was hired in June, 1999.

These two persons have learnt to operate the receivers and software without any formal training. However, they feel strongly that they should be certified before they train other Albanians. This could be done through one of the following options:

- Contract Corvallis to come back to Albania for a 1 week training course (expensive)
- They carry out a small exercise involving data collection in the field and post-processing which is then submitted to Corvallis for evaluation
- Corvallis tests their capability through an InterNet-based course

Discussion with Corvallis indicated that they prefer the third option.

The GeoInformatics Center in the PMU has also employed two GIS specialist who appear to be extremely competent and knowledgeable. Additionally, one person in the Center has received training in softcopy photogrammetry at the University of Wisconsin and has through his own initiative produced several orthophotos in Albania.

The project has also established a Photogrammetric Center which is located on the premises of ITU. I interviewed the director of this Center, Cristaq Quirko. He is a graduate of the Surveying Program at the Tirana Polytechnic University (1987) and has also taken photogrammetric courses in Italy (2 months) and the UK (1 month). He manages a professional staff of six persons: 3 stereoplotter operators, 1 editor/processor, 1 aerial triangulation specialist, 1 softcopy photogrammetrist. Two of these persons have a surveying degree from Tirana Polytechnic, while another two have taken the military surveying course. The Center has 3 DigiCard analytical stereoplotters and CQ has provided the training in-house to the operators of this equipment. The focus until very recently has been on analytical photogrammetry,[43] but they have begun to experiment with softcopy photogrammetry.[44] It is notable that the Center has only lost one staff member since its inception.

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[43] Analytical photogrammetry makes use of a computer and stereoplotter as opposed to the mechanical stereoplotters where all the work was done manually

[44] Softcopy photogrammetry makes use of photos in a digital form and all processing is done on a computer, much of it automatically

The Center has focused on creating new maps from the aerial photography taken in 1994 as well as filling in gaps in the existing map coverage. All of this activity has been in support of land registration activities. KQ sees the need to continue maintaining such a center in the public sector. He is somewhat opposed to providing information from the Center to the private sector on the grounds that they will derive profit from work done by the public sector. This is a view that is consistently expressed, indicating the wide gap between the two sectors.

6. TRANSFER OF GPS UNITS TO PRIVATE SECTOR

Three to four surveyors are doing ground control using the Corvallis GPS (see Section 4). The surveyors have to rent the GPS receivers if they want to use them, except in the case of the control densification, in which case they are provided free of charge.

Perhaps the strongest arguments for stepping up the use of GPS are:
- independence from existing geodetic network which is disappearing physically and the coordinates of which are regarded as “secret”
- avoid the need to densify control in order to support conventional approaches (including use of total station)
- more cost-effective in mountainous areas where large scale maps are poor or non-existent
- faster than other methods when parcel boundaries are curvilinear

However, stepping up the use of GPS implies transferring this technology, either temporarily or permanently, to the private sector surveyors who will do the work. This includes not only getting the equipment in their hands but also transferring the knowledge necessary to operate the equipment and process the observations. The following options are available:
- lease out the 8 rover receivers and software keys to private surveyors when needed
- lease the receivers and software on a “lease for purchase” basis
- donate the receivers and software to survey companies who perform the best work
- sell the receivers and software to private survey companies at a reasonable price
- maintain a technology pool in the public sector and allow the use of the receivers and software free of charge for anyone doing work for the PMU or government
- sell all the receivers and software to a private company which in turn leases them out to private surveyors
- sell all the receivers and software to a consortium of private survey companies who make the equipment available to the members of the consortium

Much of the incentive for private surveyors to invest in this technology depends on the return they can get on this investment. More specifically, this means being able to use the GPS for surveying work that will provide an income. At present the USAID funding for Land Market Action Plan is schedule to end on March, 2000. However, there has been a request for an extension to December, 2001. It is not clear what will happen beyond this date, which means that surveyors who take the risk of investing in the technology will hope to get a quick return on their investment.

The advantage of a lease for purchase arrangement is that payment is extended over a longer period of time and is therefore more affordable. In addition, leasing, and therefore payments, will be directly associated with contracted work. The problem with this approach occurs when a surveyor has gained some equity in the equipment, but cannot continue to make payments. This could occur either when a surveyor fails to win contracts or when funding for surveying disappears.

A compromise solution would be to sell four receivers, a base station and the software to a private company or consortium of private survey companies. The remaining receivers would be retained by the PMU and leased out as required. By only selling half of the equipment, the front-end cost will be reduced making it more affordable. After 9-12 months a comparative evaluation should be done to assess the viability of using the private sector option.
<u>Action Item: Investigate the viability of selling 4 rover receivers, a base station and the post-processing software to a private entity (private company or consortium of survey companies)</u>

7. ANALYSIS OF GPS TRANSFER IN ALBANIA

The analytical framework applied to GIS technology transfer presented in the introductory section has been modified to take into account the focus on GPS as opposed to GIS as well as the Albanian environment.

The demand for this technology has stemmed from a need for a rapid, cost-effective methodology for defining property boundaries. On the "supply" side, GPS technology has been revolutionizing the general areas of spatial measurement and navigation over the past decade. It has the potential to out-compete traditional methods, especially in areas where these methods cannot be used (e.g. where there are no large scale base maps) or where they are inefficient (e.g. where property boundaries are curvilinear). This demand-supply polarity is depicted below on each end of Figure 4.

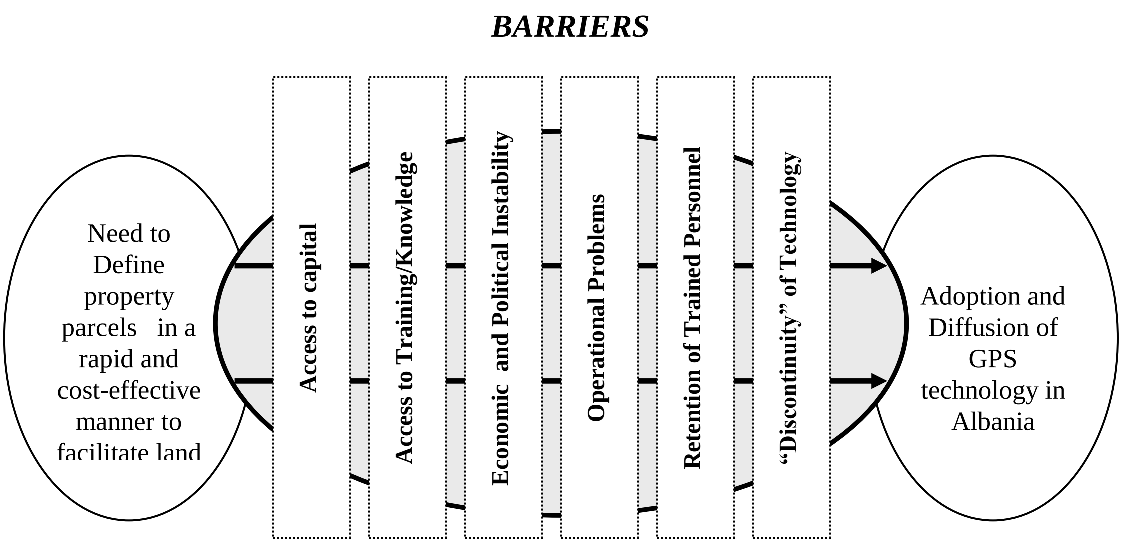

FIGURE 4. Analysis of GPS Technology Transfer in Albania

Even though there is a demand for and supply of GPS technology in Albania, there are certain barriers that stand in the way of the adoption and diffusion of this technology. The main barriers are as follows:

- lack of capital for private sector to invest in the technology
- lack of knowledge about technology (e.g. district surveyors)
- lack of training (e.g. district surveyors)
- political and economic instability increases the risk of investing in the technology
- technology has not proven itself in local field conditions
- dependence on unreliable power supply and a limited battery supply

- GPS is a "discontinuous" technology which means it cannot build on experience with other measurement technologies

Technology transfer and diffusion depends on the exchange of information and knowledge about a particular technology. There are two major factors that have a strong influence on information exchange and knowledge acquisition – language and attitudes towards sharing information. Language is a serious barrier to knowledge acquisition as there are almost no books, manuals, FAQ's, websites or other sources of GPS knowledge written in Albanian. This means that anyone interested in learning about GPS must first learn another language, such as English, before (s)he can acquire knowledge about the technology.

In Albania, as elsewhere, information is recognised as a source of power as well as a means to broaden one's professional activities. It is often seen as something personal that is only passed on to some trusted successor or personal friend. Documents are therefore often locked up or kept at a person's house in order to protect ownership. In all societies there is a strong relationship between possession of knowledge and ability to compete economically, but this appears to be particularly true in Albania.

Government employees who master a technology, or have certain information, are often reluctant to freely share that with persons in the private or commercial sector. The rationale being that the government person has invested significant personal time and energy into acquiring this information or mastering a technology, without material reward, and the private person will be able to use this technology or information for quick material gain.

It is interesting to contrast this attitude towards information exchange against that of a country at the other extreme. In Table IV information attitudes and policy in the US is compared with that in Albania.

Table IV. Comparison of Information Sharing Attitudes and Policies

US	Albania
Information used by government employees is freely accessible to anyone	Information used by government employees is sometimes available to the public at a negotiable cost
Coordinate information is made available free of charge through the Web	Coordinate information is "secret" by law, but can be obtained at a price
Information created in the public sector is by law freely available, except when it compromises an individual's confidentiality or is classified for military reasons	Information created in the one government department may only be available to other government departments if they can pay or exchange it for other information

One factor that makes GPS somewhat more difficult than some other technologies is the fact that it is "discontinuous." Surveying technology has typically developed in a continuous manner with an evolution from purely optical instruments, to optical theodolites integrated with electronic distance measurement (EDM) capabilities, to purely electronic total stations. This has meant it has mean relatively easy for Albanians to adopt and use total station technology. This is not true with GPS as it makes use of satellite signals and does not require line of sight between ground points. It also introduces completely new measurement techniques. This creates a barrier against GPS adoption until such time as surveyors have gained sufficient knowledge and training on the system and, more importantly, have gained the confidence to invest in it.

8. OPTIMIZING THE USE OF GPS

Reflecting on those companies that have been successful in adopting other digital geo-information technologies (see Section 4), a number of common conditions appear to have contributed to this success. These are:

- International education and training
- International experience and exposure through attending international conferences
- Relatively young (30 to 40 years old)
- Optimism in the future of Albania
- Access to capital, either through multiple businesses or through family members
- Private companies have a diverse work portfolio
- Ability to communicate in English or Italian

These factors suggest that the future use of GPS could be optimized by promoting these types of conditions. Specifically, the following recommendations are made:

- Select two candidates to pursue graduate studies in Geomatics, part of which should include aspects related to modern technologies like GPS and softcopy photogrammetry
- Select two or more candidates to attend 2-3 month courses on Geomatics topics related to GPS
- Continue to attend international conferences on topics related to GPS and property registration
- Employ younger (less than 30 years old) technical persons on the project so that they gain experience and knowledge
- Translate more technical material into Albanian to facilitate the spread of information and knowledge about GPS
- Disseminate information more widely to overcome lack of information sharing
- Employ a technical "extension" person who is knowledgeable about GPS and who can act as a resource person
- Transfer GPS receivers to the private sector (see Section 6)
- Promote a more unified surveying profession which should deal with regulations and norms associated with GPS use
- Organize workshops for members of the surveying profession in an effort to promote collegiality and an active professional body

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