

## **Extraction of Parcel Boundaries from Ortho-rectified Aerial Photos: A cost effective technique**

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**Key Words :** Land Laws, Land Registration, Informal Settlements, Orthophotos, Parcel Boundaries, GIS

### **Summary**

Most property in Afghanistan has never been surveyed. A majority of landowners do not hold legally recognized deeds to their property, but rather have customary land deeds with poorly defined property descriptions. The lack of clear boundaries is a major factor in the pervasive, bitter and often fatal land disputes. Courts play an important role in land relations, which prepare and archive legal deeds, and adjudicate on land claims. The ownership of real property is regulated by a complex of customary, religious and statutory law.

Years of war and civil strife prevented the import of modern survey and mapping technologies by which boundaries could be easily determined. A cost-effective methodology for surveying and mapping property boundaries to support the registration of property rights was developed in close collaboration with Afghan Geodesy and Cartography Head Office (AGCHO).

In countries like Afghanistan changes in the ways people are occupying territory are very rapid. Ambitious projects through latest photogrammetric technology are expensive to map these changes at frequent time intervals. The idea of using photos taken from a helicopter using a digital camera and then producing ortho-photos, comes from the development of digital Cameras that can produce a digital image of 8 mega pixel or about 3500 pixels x 2300 pixels.

A very simple procedure was used to rectify aerial photographs using the Orthomapper. ArcInfo was used to digitize the features from the orthorectified aerial photos and the extracted features along with the relevant attributes were stored layer-wise in MS Access mdb file to create a parcel index computerized database with a structure compatible with the GIS and the index is filled using existing cadastral maps

A team was formed to go house to house and mobilize the communities for updating the map by filling the form and storing the data in the geodatabase. The data stored in the geodatabase can be queried to produce cadastral maps along with parcel attributes and attached property documentation according to the need and could be regarded as a land information system which addresses in part the shortcomings in the land registration and land titling system in Afghanistan.

### **1. Land Administration In Afghanistan**

Successive governments in Afghanistan have adopted land allocation policies as a means of rewarding and consolidating their own support. To counter the widespread distribution of public lands to undeserving beneficiaries the Government issued Decree 99 in April 2002 to froze distribution of public land. In Afghanistan much of the land is currently being illegally occupied or controlled by powerful commanders. The land administration is under the Amlak and Municipalities. Mortgaging seems to be less common than expected (less than 2%). The land administration system is ineffective, centralized, dominated by the courts and no Ministry of Land has ever been created.

Courts play an important role in land relations, which prepare and archive legal deeds, and adjudicate on land claims. The ownership of real property is regulated by a complex of customary, religious and statutory laws. Rural Property is acquired, sustained and transferred customarily. There is no written customary law and each tribe and even community sustains and interprets the rules independently. Islamic laws are locally interpreted in property matters and widely referred to in both informal and formal land dispute resolution. The written Civil Code was compiled in the early 1970s and given the status of statute. It comprises more than 2,000 articles that draw tangibly upon mainly *Hannafi* (Sunni) jurisprudence and includes substantial chapters on land.



Land is the main source of livelihood in Afghanistan

Comprehensive land policy has not yet been formulated, however, several major policy documents have emerged in the six years since the fall of the Taliban. As per article Forty-one Ch. 2, of the constitution foreign persons do not have the right to own immovable property in Afghanistan. But the lease of immovable property for the purpose of investment and the sale of estates to diplomatic missions of foreign countries and international agencies, are permissible.

Land ownership in Afghanistan is starkly inequitable and a significant proportion of the rural population is landless. A mismanaged attempt at land reform was one of the major causes of the revolt against the communist regime in 1978.

Determination of the legitimate owners of land and property in Afghanistan is difficult due to the lack of official cadastral records and multiplicity of ownership documents. Conventional wisdom that Afghan women are entirely landless is not correct and fifty-six percent of female-headed households own land.

Major land tenure problems include land grabbing, overlapping claims to the same parcel and cumbersome procedures for the purchase and sale of land.

The land registration process is lengthy, expensive and requires completion of a number of forms and payment of tax at 5-7 % of the value of the land. The land records are corrupted and include widespread production of counterfeit documents.

The problem of land disputes is linked to the inequitable system of land ownership and the huge number of landless people. Land disputes sometimes spill over into violence and represent a stumbling block to peace. In 2002 a Property Disputes Resolution Court was established but its performance was widely criticized to enforce its decisions.

## **2. The Role Of Courts In The Land Administration**

An important role in land relations is played by the courts which prepare and archive legal deeds, and which adjudicate on the many contested claims involving land as well as other matters. In most provinces there are Primary Courts located in District capitals and an Appeal Court in the Provincial Capital, where there also is, or should be, an archive for all legal documents produced by all of the courts in the province, including legal deeds. Unfortunately, only a small percentage of transactions are documented through the court system.

#### **4. Government Land Policies**

Comprehensive land policy has not yet been formulated. However, several major policy documents have emerged in the six years since the fall of the Taliban. Thus Decree 99 of 2002 froze all sales or transfers of government owned land. Where as 2003 saw a stream of edicts striking at the perpetrators of “land grab” and demanding that various organs of the government attempt to recover land that belonged to the government but which was no longer in their possession; The Decree 83 of 2004 introduced rules making government land the default form of land holding, in the event that no other holding could be proven. It also acted against government exploitation of its power to appropriate land. The Constitution itself contains articles guaranteeing respect for property and ensuring that state appropriation only occurs in strictly regulated contexts subject to full compensation. As per article Forty-one Ch. 2, of the constitution foreign persons do not have the right to own immovable property in Afghanistan. However, lease of immovable property for the purpose of investment and the sale of estates to diplomatic missions of foreign countries and to those international agencies, of which Afghanistan is a member, is permissible in accordance with the provisions of law.

The MAI treats rangeland management together with forest management. So, its policies and strategies speak to both types of land use. The vast majority of Afghanistan’s land area is not suited for arable farming. The national cover survey of 1993 (FAO, 1995) classifies 54.6 million hectares (85 percent of the nation) as rangeland and forest land. Within this area, only a small fraction (1.34 million hectares, 2 percent) had a cover of natural forest in 1993, certainly much smaller today. Most of the non-arable land is unimproved pasture, most of which is on steep slopes and shallow soils in mountainous topography.

#### **7. Land Tenure Problems**

There has been a significant fall in the quality of life among a large section of the rural population with insecurity of land tenure as one of its basic causes. Conflicting claims to land have increased and so has the tendency to solve land disputes by force, falsified documents and other corrupt practices. All of these factors are creating social tensions which militate against efforts to promote national unity.

In 1963 a rural Land Titling Programme was formally launched through which the state sought to bring all landholding more firmly under its control for mainly taxation purposes. This was encouraged and assisted by a USAID funded cadastral survey and registration project. Because of the cost, mapping quickly gave way to a simple inventory survey (survey aajel) which numbered but did not map plots.

Some of the major land tenure problems include:

- un-authorized occupation of land (a term which means “land grabbing” by powerful people and the informal occupation of land for family uses), particularly land that has not been privately owned
- the overlapping of claims to private, public, government or community land, that is, the situation where two or more people have claims to the same parcel of land, a problem which particularly affects pasture land
- cumbersome procedures for the purchase and sale of private land;
- lack of agreed procedures for the community based effective and sustainable management of public, governmental or community lands;

## 8. Land Registration

In rural area the tax receipts are formally used as a source to establish ownership over lands, rather than as testimony of legitimate occupancy; that is, receipt holders can argue that their lands must comprise x area because this is the tax they have paid. Conversely, those who have been unable to pay tax or contribute tax to common properties have generally lost tenure.



Property titles (Qawala) are stored in the Makhzans (archives) of Provincial Courts

The registration process is lengthy and expensive; it requires completion of a number of forms, securing no objections from up to five offices, payment of tax at 5-7 % of the value of the land, etc. While the primitiveness of document management is a bureaucratic concern, the integrity of the system is a greater concern, long considered corruptible, and the records widely corrupted, including widespread production of counterfeit documents. Real adjudication is rarely carried out, relying on selected witnesses, often self selected. At the community level, owners with medium-sized lands tend to hold locally witnessed evidence of transfers including distribution at inheritance, variously referred to as Customary or Shari'a deeds. Such records are rarely held by the majority of land-poor smallholders. Finally, there are a large number of land grant deeds, many of which are in the hands of Pashtun nomads and others who have consistently been the main recipient group of such allocations from 1880 until the 1970s. The older the document the more limited the land description with some times only the district indicated and the size of the land area granted indicated.

Thus, while a relatively rich history of land ownership documentation and registration exists, its reliability and utility is questionable. Judges and clerks are deeply implicated in malpractice, with some judges having issues the same title deed more than one time.

Roots of tenure security currently included political and military might, tribal affiliation and community consensus in which documentation has limited importance.

## 9. Land Disputes

The problem of land disputes cannot be dealt with in isolation from tackling Afghanistan's other problems. Peace and stability are obvious pre-requisites for tackling the problem of land disputes. Land reform is a controversial subject in Afghanistan today, but the problem of land disputes is clearly linked to the inequitable system of land ownership and the huge, and growing, number of landless people. Land disputes sometimes spill over into violence and represent a stumbling block to peace. With the exception of relatively limited religious lands (waqf), all classes of real property are affected; from homes and shops to farms and pastures. Claimants are wide ranging, from widows to farmers to whole communities. Immediate causes of dispute are multiple, from conventional causes (domestic disputes, farm boundary disputes, rent and mortgage disputes) to a plethora of cases concerning alleged wrongful occupation of houses, farms and pastures and conflicting rights over common and public lands. Where as in rural areas, farmland and pasture rather than houses or other buildings (shops, mills) are the focus of dispute.



Informal settlements in Kabul

Formal court records do not provide a full picture of dispute levels, though they are high in number. For reasons of fear, futility or lack of means, many land disputes are never brought to court. The poor do not take their cases outside the community because they do not possess the status, financial means, documents or knowledge to pursue the matter successfully. Even those with means often see little purpose in taking their problem to the court; they complain of ethnic favoritism in decisions, and note the inordinate time involved with the likelihood of continuous challenge and upward appeal to the Supreme Court. Pashtuns in the north for example consider it futile to bring restitution of property claims to Uzbek dominated courts. They are also aware of the high failure rates of the Primary or Provincial Courts to resolve disputes and that even if they win the case, the court and police are likely to be impotent to enforce the decision. Another reason for avoiding the courts is where documentation issued by the court is at the heart of the dispute and the claimant does not believe he will gain a fair or honest hearing. Some seek to resolve their complaints locally through shura or other local mediation means. This is particularly so where the cases are of a more traditional

nature (i.e., domestic, boundary, inheritance or mortgage disputes). Others are too afraid of those against whom they are disputing to attempt this; this is quite common where warlords/commanders or their supporters are involved.

#### **10. Extraction of Property Boundaries:**

A cost-effective methodology for surveying and mapping property boundaries to support the registration of property rights in Afghanistan was developed in close collaboration with Afghan Geodesy and Cartography Head Office (AGCHO) with financial support from the USAID.

In countries like Afghanistan, changes in the ways people are occupying territory are very rapid. Ambitious projects through latest photogrammetric technology are expensive to map these changes at frequent time intervals. The idea of using photos taken from a helicopter using a digital camera and then producing ortho-photos, comes from the development of digital Cameras that can produce a digital image of 8 mega pixel or about 3500 pixels x 2300 pixels, and even 16 mega pixel images with about 5000 pixels x 3300 pixels. It means that if we produce a photograph that covers 1000X800 meter on the ground which means that we can get 30 cm pixel on the ground with the 8 mega pixel camera. This resolution, as distinct from satellite imagery, can very well support large-scale mapping needed for producing property maps in dense urban landscapes.

Based on my experience this has been the cheapest technology to observe and analyze rapid land use changes. Cost is still prohibitive for the poorer countries like Afghanistan, but Helicopters are easily available in most countries, including the poorer one.

This methodology requires existing maps (or ground control) and topographic data to create the orthophotos. Even if existing mapping with topographic data is as old as 30 years, but still shows relatively stable topographic features, it is quite useful and Geo-referencing of these maps is necessary.

A very simple procedure was used to rectify aerial photographs using the Orthomapper, a software available in Madison, Wisconsin. Orthomapper gives the possibility of rectifying the photos from digital cameras without the necessity of fiducial marks being on the photos. With Orthomapper, only ground control points (derived either from a map or GPS) and a DEM (digital elevation model) are needed. Using Orthomapper an experienced technician can control the size of pixel in the output. The resultant rectified photos can be checked in ArcGIS "ArcMap" to verify that there is a satisfactory overlay with existing mapping and also that there is enough accuracy between photos in the overlay areas.

Since the size of the pixel is the same for all orthophotos, it is relatively simple to merge them using "Adobe Photoshop" software. The results obtained from the Orthomapper and the use of any automatic tools for the merging process has not proven to be satisfactory. It is necessary to keep track of the world file information which Orthomapper produces for each rectified photo. After merging separate orthophotos, it is possible to organize the spatial information as desired, with cropping based on map sheet criteria, or other criteria. Since the resultant orthophotos are used for interpreting parcel boundaries in the field, therefore, print-outs in the A3 format are convenient for field surveyors.



The author of this paper (in red shirt) is supervising the aerial survey team

ArcInfo, a software from ESRI Redlands, California was used to digitize the features from the orthorectified aerial photos and the extracted features along with the relevant attributes were stored layer-wise in MS Access mdb file to create a parcel index computerized database with a structure compatible with the GIS (presumed parcel number, owner name , area, location) and the index is filled using existing cadastral maps when available – mainly in semi-rural peripheries.

A team was formed to go house to house and mobilize the communities for updating the map by filling the form and storing the data in the geodatabase. The data stored in the geodatabase can be queried to produce cadastral maps along with parcel attributes and attached property documentation according to the need and could be regarded as a land information system which addresses in part the shortcomings in the land registration and land titling system in Afghanistan.

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