

# **Cadastral Survey Methodologies and Techniques in Developing Countries; Case Cambodia and Kosovo**

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**Key words:** Survey Methodologies, Survey Technologies, Sustainability.

## **SUMMARY**

The benefits of an efficient land registration system are recognized in most developing countries. In the past a lot of attention was given to accurate cadastral field surveys but today more cost-effective and flexible methodologies are utilized, including the use of ortho-photo interpretation with combination of different survey technologies depending on quality requirements and characteristics of the land.

Cambodia is used as a case study where a considerable development has been launched after the end of decades' long conflict. In this regard, the institutional and legal arrangement are briefly described as there were practically no institution or cadastral professionals in the country in beginning of 1980's.

Another case study presented is Kosovo, where the starting situation was much better than in Cambodia, however being far away from satisfactory. It was a great concern that cadastral records were destroyed during the Kosovo conflict but fortunately this was not the case and there were adequate amount of professionals available to reconstruct the cadastre. Problems comes up with inability to provide adequate services due to the missing information when cadastre is reconstructed from backups and copies while the originals are still kept by Serbian authorities.

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## **1. INTRODUCTION**

Traditionally the surveyors in developing countries have given a priority to implement accurate cadastral field surveys without giving much attention to the cost but since the turn of the new millennium more cost-effective and flexible methodologies are utilized. However, modern cost-effective methodologies do not neglect the quality but focus more on required accuracy on the user point of view, not on the surveyors' technical capacity and available equipment.

In many developing countries the use of orthophoto interpretation with possible combination of different survey methodology depending on local quality requirements and characteristics of the land is implemented.

This article presents two case studies; Cambodia and Kosovo. Both cases have their own very interesting historical backgrounds and characteristic that had influenced to the technologies and methodologies used and one need to be aware when evaluating the development.

Cambodians have suffered through a tumultuous recent history, during which the rules for rights to land have been in constant flux. During the pre-colonial era the sovereign owned all land, but households were free to cultivate as much land as they wished. The French colonists (1864-1953) introduced the system of formal private property rights, but were able to incorporate only the more densely populated areas into the system. The independent Cambodian government retained the French system, but made limited progress on formally registering property rights. The Khmer Rouge, which came to power in 1975, collectivized all land and destroyed all land records, including cadastral maps and titles. The right to own land was re-established in 1989, allowing farmers to claim possession rights of plots up to five hectares after five years of continuously cultivating fields, and households to gain ownership title to residential plots up to 2,000 square meters. 1992 a program was initiated calling for applications for land tenure certificates to confirm occupancy and use rights. More than 4 million applications were submitted, but only 15 percent of them had been processed due to limited capacity of government. (Cambodia Development Resource Institute, CDRI, 2001) Lack of national policies related to land, inadequate organizational structure, lack of educated professionals and equipment hindered and delayed establishment of land register.

Cambodia's land administration sector started development in 1993 after Paris peace agreement with international support. With international support from Governments of Germany, Finland and France first steps to develop more comprehensive land register were taken in 1995 to 1997. Different pilot projects during 1997 to 2001 finally lead to a multi-donor Land Management and Administration Project (LMAP) that started 2002 and has

adequate resources to implement systematic first land registration and develop a multi-purpose land register based on modern technologies.

Kosovo, an UN protectorate that was part of the former Yugoslavia and an autonomous province of Republic of Serbia had also its' long conflict during the late 1980' until 1999. However, situation to start development after the conflict was much better than in Cambodia but being far away from satisfactory. Even there were no land register the cadastral surveys were conducted for all territory during long period between 1930' – 1970' showing the possessors of the land. It was a great concern that cadastral records were destroyed during the Kosovo conflict but fortunately this was not the case and encrypted databases, cadastral books and copies of cadastral plans were found almost for every village. Even better, there were enough professionals available to start quick reconstruction and modernization of the cadastre according the Cadastre 2014 principles with international multi-donor support from Sweden, Norway and Switzerland with the Kosovo Cadastre Support Programme (KCSP). (Andersson, Onkalo, 2004) Problems came up later with inability to provide adequate services due to the missing information when cadastre is reconstructed from old backups and different copies. There are a large number of parcels where textual and graphical information is not available or not consistent with each other or textual information is available but the graphical not or vice versa. Many transactions are not surveyed and formally registered and available information is doubtful when comparing textual and graphical information with orthophotos to the real situation in the field.

The long conflict, some discriminatory legislation and lack of trust to public services led to a situation where most of the transactions were not registered into the cadastre. A methodology and techniques were tested and piloted during the KCSP I to collect missing information in sporadic and systematic ways and with a new multi-donor project it is expected that testing and implementation will further continue in selected areas.

## **2. BACKGROUND**

### **2.1 Cambodia**

The total area of Cambodia has is estimated 181.500 km<sup>2</sup>, of which 27.100 km<sup>2</sup> are cultivated under subsistence farming, and 10.000 km<sup>2</sup> are taken up by towns, infrastructure and waterways. About 17.300 km<sup>2</sup> are scrub land, undergrowth, non-wooded land and similar unused areas not yet declared to be under any specific ownership, control or use. (Cambodia Development Resource Institute, CDRI, 2001).

Any development project has to be based on sustainability where local professionals are able to continue their duties after training, equipment and other facilities are in place. In this regard Cambodia was a real challenge. There were only few professionals in the country after the fall of Khmer Rouge and no ability to educate new academic professionals locally. Some students were sent to study in former Soviet Union and eastern-European countries in mid 1990's for geography, engineering, architecture and geodesy. About 25 of them who have a Master's Degree or a Bachelor Degree are currently employed by the Ministry of Land

Management, Urban Planning and Construction. In addition, in-house Ministry training and a college providing a diploma on cadastre have contributed to educate more than 300 technical level cadastral staff. However, even with LMAP more than 50 % of the land registration staff have not participated to in-house training or do not hold diploma on cadastre.

## 2.2 Kosovo

The total area of Kosovo is approximately 10,908 km<sup>2</sup>, involving about 2.5 million parcels and about 400,000 landholders.

Kosovo Cadastre and Land Information System (KCLIS) at the moment consist of orthophotos and vectorised cadastral plans forms the graphical part of the cadastre. Immovable Property Rights Register (IPRR) forms the textual part of the cadastre. IPRR contains information about Immovable Property Units like land parcel, building or part of a building (flats etc.) that constitutes a separate object of ownership under applicable law. Information in IPRR can be linked to the KCLIS by common parcel identification numbers.

KCA started reconstruction of the textual land cadastre, in 2001 during the KCSP I and the reconstruction of cadastre is based on preliminary reconstruction pilots implemented by KCA and the Cadastre Reconstruction pilot project funded by Norway as part of KSCP II.

The only available cadastre maps in Kosovo after the conflict were copies of variable quality and state of update and have to be reconstructed to reflect the real situation in field. Most maps were from the 1970s to 1985, but some date from the 1930s. The scales of the cadastral maps are 1:500 and 1:1000 in urban areas and 1:2500 in rural areas. The reconstruction of the graphical part of the cadastre was therefore a real challenge. The traditional methods for producing new analogue maps were considered to be too time consuming and costly. Alternative methods and new techniques had to be introduced that also would pave the way for a modern digital multi-purpose and multi-used cadastre. To facilitate reconstruction and to make cadastre functional cadastral plans were scanned and vectorised. Digital orthophotos has been produced and will be used as background for updating of the cadastral maps during the reconstruction project. (Andersson, Onkalo, 2004)

Although there was a significant proportion of qualified staff present few among them had up to date relevant professional qualifications in 1999. Discrimination in the past led to a considerable skills gap among the professionals. Many were excluded from their posts on cadastral authority for a period of ten years and most were not exposed to new technologies or technical and managerial concepts. (Andersson, Onkalo, 2004)

## NEW WAYS OF CADASTRAL SURVEYS

### 2.3 General methodology

A digital integrated cadastre was selected as a development route for both cases. Stakeholders want digital data for both ownership records and maps. A digital cadastre also provides transparency and facilitates verification of the cadastre data. (Kaufmann, Steudler, 1998) The principles of FIG Cadastre 2014 are implemented by step-by-step approach taking into consideration local capacity and resources.

### 2.4 Cambodia

There are two approved methods for cadastral surveys at the moment: total station surveys and orthophoto interpretation, but in case resources available RTK (Real-time kinematic) GPS or other technologies in the future will be included.

Higher accuracy cadastral surveys are performed by total station traverse. The traverse must close on pass-points and a mathematical check must be performed on the work. These surveys are carried out in urban areas with required accuracy of  $0.1 + 0.005 * \sqrt{L}$ . (L = length of the boundary) Secondly, total station traverses are used in areas where orthophotos cannot be used as in dense residential areas and where there is heavy tree cover. Rural residential areas are required to survey with accuracy of  $0.3 + 0.02 * \sqrt{L}$ .

With normal care and the modern total stations, these standards should not be difficult to obtain by trained crews.

Lower accuracy cadastral surveys are performed by orthophoto-interpretation in the field and digitization. This method is most commonly used as registration at the moment is mainly implemented in rural areas where agricultural land (rice fields) composes about 80 % of the registration area. Required accuracy for rural non-residential area is 0.5 or  $1.0 + 0.05 * \sqrt{L}$  depending on the quality of the orthophoto. Supplementary measurements are made of the boundary lines with tapes with using land owners as field assistants when requested. This has supported poorly educated landowners understand better field surveys and decreased boundary disputes during the public display of cadastral index map.

Cambodia is quite well covered with aerial photography that makes it possible to use orthophoto-interpretation in rural areas. Land registration areas are usually covered with recent aerial color photography in scale 1:10.000 or 1:20.000. The whole country is covered with 1:25.000 black and white aerial photography (1992 – 1993) and 1:40.000 (2004 – 2005). It is important to notice that all photography are used for several projects and works including land registration, state land mapping, commune boundary demarcation, district and urban planning, irrigation project etc.

To ensure the integrity of the surveys in areas where different methods are used the surveys have to be connected to higher level accuracy surveys. A study is carried out to analyze if the

required accuracy is achieved with lower accuracy methods. During the study typical rural land registration area was surveyed with GPS, total station, tape and orthophoto-interpretation. The preliminary results indicate that with supplementary tape measurement quality required by the standards is achieved easily but with orthophoto-interpretation about 5 % of boundary lengths are with poorer quality. The errors were identified as misinterpretation of orthophoto or a boundary point with poor visibility in orthophoto that would require supplementary tape measurement.

When clear errors are not included the required accuracy levels can be achieved (table 1). This will require clear visibility of boundary points and orthophotos that are up-to-date (no changes in visible boundary features) and appropriate resolution.

boundary length	average error
1 - 25	0.17
25 - 50	0.38
50 - 75	0.27
75 - 100	0.35

Table 1. Average differences with measured boundary lengths (GPS and orthophoto-interpretation)

## 2.5 Kosovo

As a starting point for the reconstruction of cadastre the traditional methods for reproducing new analogue maps were considered to be too time consuming and costly. Alternative methods and new techniques were tested and introduced. To facilitate reconstruction cadastral plans were scanned as a priority action and vectorised later after system design was completed. Another priority action was to make aerial photography and digital orthophotos (2000) to be used as background to indentify areas where cadastral plans were outdated or inadequate quality and would require further actions. In Kosovo aerial photography and orthophotos were also very widely used by all stakeholder including KFOR, local ministeries and deparments, municipalities, donor projects and private sector. Use of orthophotos was so successful that a new aerial photography was launched 2004 – 2005 with aim to use it as a background for reconstruction and updating.

As the cadastral plans were copies the quality of the scanned cadastral plans was variable and directly had effect to the quality of the cadastral index map. However, even not fully complete and accurate the digital cadastre index map is considered far better than the pre-existing analogue cadastre plans. The digital cadastre index map is integrated with the textual part of the cadastre and the immovable property rights register that makes it possible to use for other purposes also.

The KCA assessed the the result and quality of the vectorisation and completeness of cadastre and came to conclusion that the cadastre cannot provide required services for the Kosovo society as long as available information do not reflect situation in the field. (PMM, 2006)

To achieve the conformity of the cadastre content with the reality reconstruction from orthophotos was considered adequate enough to define missing parcel boundaries and resurvey parcels that has different position in reality than in vectorized cadastral index map. Higher spatial accuracy of the parcel would have to be determined when needed by a request from the owner and for a fee based on cost-recovery and in urban areas and dense populated villages. Full coverage with parcel boundaries has been assessed as being more important than spatial accuracy to be able to serve the society with cadastre data as fast as possible.

The quality requirements set up for the reconstruction are in urban area  $\pm 0.15$  meter (cadastral map scale 1:1000), in rural area  $\pm 0.30$  meter (cadastral map scale 1:2500) and in mountain area  $\pm 1.50$  meters. Requirements for rural and mountain areas are defined on the assumption that signalized boundary points can be identified from the orthophoto and digitized. For buildings spatial accuracy is defined  $\pm 1.00$  meter when digitized from orthophoto. (PMM, 2006)

### **3. COST OF USED METHODOLOGIES**

The goal in developing countries should naturally be to develop a self-financing and profitable land registry organization. There are examples in many countries that it is possible to achieve. However, when activities are funded by international loans or directly from donors other priorities may be more important in short term. Especially with systematic first land registration as in Cambodia where the aim is to provide land titles (1.000.000 in five years) mainly to poor households in rural areas and to cover the whole country in 10 to 15 years with approximate 7 million titles one of the main priorities is to provide title with a low fee. The maintenance of land register is based on cost-recovery as well as issuance of title through sporadic first land registration procedure.

At the end of March 2006 the average cost per parcel was about 8.74 USD. In rural areas average cost is 6.20 USD and in urban areas 17.41 USD. The cost includes title production cost with salaries, material etc. Cost of equipment, aerial photography and technical assistance are not included. According to the World Bank report, Comparative Study of Land Administration Systems, Global synthesis of Critical Issues and Future Challenges the cost of systematically registered parcel is usually between 15 – 30 USD. (Brits, Burns, Grant, Nettle, 2003)

Country	Cost/parcel in USD
Cambodia	8.74
Moldova	9.90
Peru (urban)	12.66
Kyrgyzstan	15.76
Albania	18.00
Armenia	18.02
Indonesia	24.40
Thailand	32.80
Peru (rural)	46.86
Trinidad and Tobago	1,064.00
Latvia (sporadic)	1,356.00

Table 2: Average cost per parcel in systematic registration in developing countries.

The average fee paid in Cambodia at the end of March 2006 was 1.47 USD. In Urban areas average fee was 7.36 USD and in rural areas 0.98 USD. The Land Management and Administration Project (LMAP) that started in June 2002 has issued 500.000 land title certificates in the end of May 2006 and is currently issuing about 25.000 to 30.000 titles per month.

The work is carried out by the government staff but due to the lack of human resources contractual staff will be recruited to new teams 2007. In future part of the systematic first land registration work could be contracted to private sector but the legal framework is not in place yet.

In Kosovo the reconstruction of the cadastre will be done by the local private sector while the Cadastral Agency is responsible of quality control, public display of reconstructed cadastral information and dispute settlement.

#### 4. CONCLUSION

There are many technologies and methods available for cadastral surveys and one have make selection based on available resources and needs. However, cadastral survey based on accurate demarcation and field survey is a very expensive and time consuming procedure. Also keeping cadastral records only in analogue form cannot be regarded as a sustainable technology any more and with digital integrated multi-purpose cadastre the benefits are much wider to the government and general public.

The technology is only a tool to achieve required outputs and objectives. In general developing countries are advised to find the simply and low cost technologies to reduce the time and cost to complete cadastral mapping for the country. The accuracy

can't be a top priority, especially not in rural area where land values are low. Also for the buildings high accuracy is not essential and sometimes even the location point could be enough.

It is important to understand that with sharing of spatial data used for land registration as orthophotos, the cadastre can generate also incomes or make savings when cost are shared between different departments. While with systematic land registration the objective is usually to cover whole country in a reasonable time and cost, the technical solutions can not be too complicated and costly. However, it is important that the foundations are build to able improvements to spatial quality through the normal maintainance of cadastre by registration of transactions, transfers, subdivision etc. with cost-recovery.

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## **BIOGRAPHICAL NOTES**

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