Addis Ababa: The Road Map to Progress through Securing Property Rights with Real Property Registration System

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Key words: cadastre, immovable property registration, land information system, real property registration, street addressing system, parcel, land administration domain model, common cadastral database

SUMMARY

In September 2009 the Addis Ababa City Government called for tenders for the development of a new real property registration system and a new land information (cadastre) system. Development in the city, the redevelopment of slum areas, investment in building and infrastructure and the organisation of services was being hindered by the lack of up-to-date, accurate and reliable cadastre. The city additionally requested the implementation of a new street addressing system and the updating of existing cadastral map data. The new systems were viewed as pilots which could be ported over the entire country. Since the Addis Ababa project was to form the basis for a national solution, the transfer of knowledge and expertise to employees within Addis Ababa governmental agencies was considered vital. In addition it was considered essential that local people maintained ownership of the project throughout its development and implementation. Hansa Luftbild, a German based, geo-information and mapping company, with extensive international experience acquired the project and worked closely with the local administration to implement it. This paper gives an overview of the establishing of the new real property and cadastre system, the new addressing system, the updating of the cadastral map and the support, training and consultancy services provided by the company.

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1. INTRODUCTION

Addis Ababa, capital of Ethiopia, has witnessed rapid urban expansion over the last 20 years. This has put pressure on the city's land resources leading to increasing areas of slum settlement. The Addis Ababa City Government (AACG) has recently instigated programs for the redevelopment of slum settlements and the development of new housing areas, both of which require reliable and consistent systems of real property rights and ownership.

Land is a major resource essential for the future development of Addis Ababa. Enhancing the optimal utilization and administration of this resource is a fundamental factor in the development and furtherance of good governance. To this end Addis Ababa City Administration (AACA) is committed to securing and clarifying land and property rights and promoting reliable property transaction processes through registration. These aims can primarily be achieved with up-to-date city cadastral map data and a robust geo-database system.

In 1996 the AACA implemented a cadastral project to register all property owners so that valuation and taxes could be applied to properties. A multi-purpose cadastre was established and data collected to support urban planning, land and property transfers, the issuing of building permits and title deeds, and compensation payments. Over time insufficient integration between the various land information systems and inefficient updating mechanisms led to a significant erosion of the cadastral map's reliability. This led to widespread informal property settlements, land encroachment, inadequately secured land records and a general mistrust in official land transaction processes.

To alleviate these problems, in 2009, the AACG made a decision to develop and implement a new integrated land information system based on information communications technology (ICT). The primary purpose of the system was to establish real property registrations and a land cadastre system able to support land registration processes and municipal functions.

On taking this decision the AACG called for tenders from international experts who could help in the process. This paper describes the processes involved in updating the AACA's existing cadastral map data, the development and implementation of a new real property registration system and a new land information system, and the establishment of a street addressing system.

2. PREVIOUS SITUATION

Up until implementation of the current project Addis Ababa had operated an increasingly unreliable manual real property registration system. The cadastre map being used was an extract of parcels and buildings from a 1996 topographic map prepared for the design of the water supply system. It did not cover the entire city and hadn't been updated since 1996. The parcels and the buildings were not identified by a consistent and unique numbering system thus the links between the registry information and the parcels were unreliable. The street addressing system was not well designed and only partially implemented throughout the city. This adversely affected the provision of reliable municipal services. Moreover, the registration processes were carried out within a sub-section of an authority, and simultaneous update of the cadastre was not carried out.

Until recently the land and land related administration sector (LLRAS) of the city of Addis Ababa was organised into three authorities / offices. The three-authority structure of the land and land related administration sector (LLRAS) of Addis Ababa was organized into a Building Permit Authority, Urban Renewal Project Office and Urban Planning and Information Institute. The same administrative configuration is also set up for the ten sub-cities of Addis Ababa and the 116 districts within Addis Ababa known as Woredas.

The real property registration was carried out by the land administration and building permit authority (LABPA) and was based on title deeds registered in several books. The title deeds were the official record of the rights on land.
For each of the sub-cities there are six (6) so called "Big Books" which are structured as follows:

- main book with the basic data (LABPA-01)
- book of title deed transactions (LABPA-02)
- book of mortgages (LABPA-03)
- book of court injunctions (LABPA-04)
- book of condominiums
- book of condominium bank loans

Most of the information occurs two to three times in the books. This handwritten form of registrations is prone to errors.

In addition to the books there is a tenure archive containing all documents relating to a property. The archive is organized into folders. Each folder contains all documents related to a property, such as the title deed or related court injunctions. The tenure archive is indexed by sub-city, Woreda and house number. Some intermittent, but generally unsystematic, cross checking of the written records is carried out.

The inconsistencies and irregularities in the organization of the cadastre and its information were problematic. Manipulation of registration information, violation of planning and building regulations, overlapping allotment of land, missing archive files, cumbersome technical and administrative processes were amongst some of the problems caused by

weaknesses in the system. The system was not transparent and did not fulfill customer demand for reliable services and guarantee of land tenure.

In seeking to alleviate this situation the city administration identified key priorities for the facilitating of the development of new up-to-date, sustainable and reliable real property registration and land information (cadastre) systems. One of the key priorities was the setting up of an appropriate administrative framework, including the establishment of a new Immovable Property Registration and Information Agency (IPRIA) of Addis Ababa mandated to operate the registration and land information (cadastre) systems.

3. PROJECT OBJECTIVE AND AIMS

In September 2009 AACG called for tenders for the development of new real property registration and land information (cadastre) systems. The scope of work in the tender also included updating of existing cadastre map data, design and implementation of a street addressing system and support for the establishment of real property registration offices.

The objective of the project was to provide consultancy services and develop a cadastre (real property registration and land information) system for Addis Ababa City Administration (AACA) in Ethiopia. It was a two phase project with the following components:

Phase 1:
- updating cadastral map
- support for the establishment of municipal real property registration offices
- requirements analysis, design and specification of real property registration and land information (cadastre) systems
- development of addressing system

Phase 2:
- development and implementation of real property registration and land information (cadastre) systems
- support for the establishment of municipal real property registration offices

The consultancy services were to provide expert knowledge and advice for the setting up of immovable property registration offices as well as the update of existing cadastre maps. The development of the cadastre system included the implementation of a real property registration system as well as a land information system.

Hansa Luftbild an international geo-information and mapping company based in Germany tendered for, and won the project.

The **Integrated Land Management Information System Project Coordination Office** (ILMISPCO) at AACA had overall responsibility for implementation and management of the project.

4. PROJECT APPROACH AND METHODOLOGY

Hansa Luftbild's methodology and approach followed international standards. In order to develop and implement the new system, it was necessary to establish special working groups (WG). The working groups provided input to and support for Hansa Luftbild throughout the project duration. In addition the company was able to transfer know-how to the local professionals within the working groups.

The working groups, who were supervised by Hansa Luftbild, were involved in the entire development and implementation process in order to guarantee continued sustainable use of the implemented systems after completion of the contracted work.

The following paragraphs give detailed descriptions of the methodologies used for various components of the project.

5. REQUIREMENTS ANALYSIS AND SPECIFICATION AND DESIGN OF REAL PROPERTY REGISTRATION AND LAND INFORMATION (CADASTRE) SYSTEMS

The objective of the requirements analysis for the real property registration and land information (cadastre) systems was to model real property registration processes, and the derivation of products and services from the database. The products and services were tailored according to the requirements of the public and private sectors and the key input for the analysis was gathered during visits to selected sub-cities and during thorough and ongoing discussions with the project working groups. Analysis was carried out within the framework of a business process model. The Ethiopian constitution and law accords its citizens land use and property rights. These rights were taken into account during the requirements analysis.
The dynamic aspects of the real property registration system were described with use cases which detailed the business processes of the real property registration sector. In total 19 business' use cases were identified and detailed. The proposed systems were called Addis Ababa Cadastre Information System (AA-CADIS) and Addis Ababa Land Information System (AA-LIS).

The domain model of AA-CADIS describing the static aspects of the system, as such is the data model. It was developed with reference to international standards such as ISO/TC 211 standard No. 19152 the "Land Administration Domain Model (LADM)". The ISO conceptual model was used to develop a concrete feature catalogue for Addis Ababa. The data model for Addis Ababa consists of two parts, a real property registration database and a real estate cadastre database. The real property registration (RPRS) database is non-spatial while the real estate cadastre (RECS) database contains spatial data. These form the common cadastral database (CCDB) which constitutes the platform of AA-CADIS. Figure 1 shows the structure of AA_CADIS and AA-LIS.

The RPRS and the RECS are closely connected and operate on a common database to carry out the cadastre and real property business processes. The RECS maintains and administers the cadastre map data and its descriptive information and is linked to the real property registration database. The AA-CADIS is the base of the spatial reference system of AA-LIS.

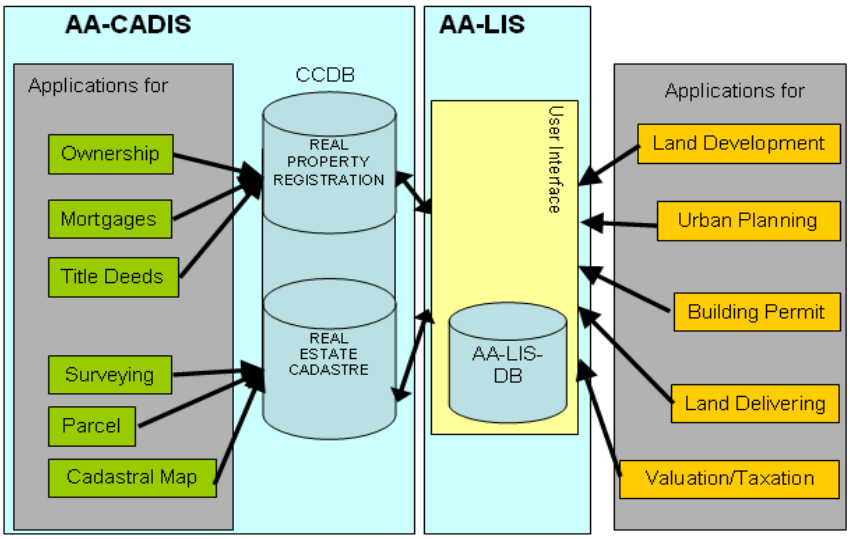

Figure 1: Structure of Addis Ababa cadastre information and land information systems (Source: Hansa Luftbild, 2010)

Figure 2 shows the organisation of AA-CADIS and its relationship to other land sectors of AACA.

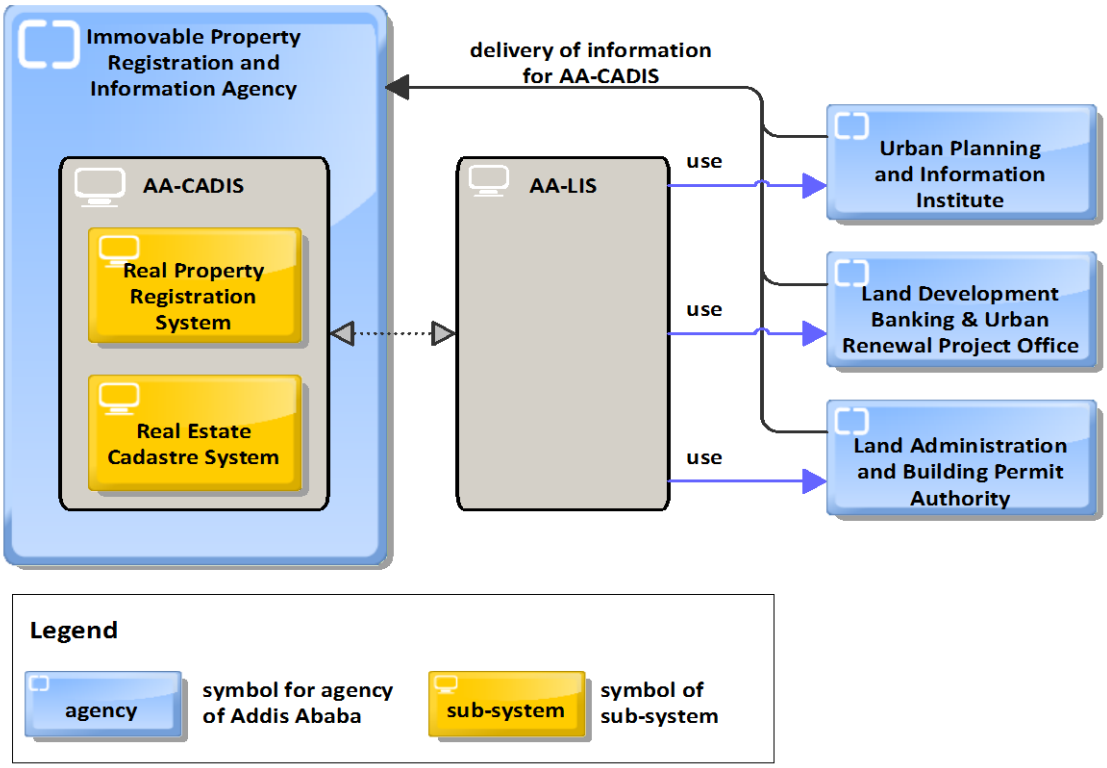

Figure 2: Organization of AA-CADIS (Source: Hansa Luftbild, 2011)

AA-LIS was developed to support and provide an interface to services used by public authorities and the private sector and is implemented on the basis of Open Geospatial Consortium (OGC) web services standards, for example Web Map Service (WMS), Web Feature Service (WFS) and Web Map Client.

6. UPDATING CADASTRAL MAP DATA

The updating of the cadastral maps was divided into 3 tasks:

- Identification of Data Gaps, Assessment of Cadastral Map Quality and Production of Updated Cadastral Map
- Verification of the Sufficiency of Existing Ground Control
- Development of a Unique Identification System

6.1 Identification of Data Gaps, Assessment of Cadastral Map Quality and Production of Updated Cadastral Map

This first task was split into three sub-tasks.

Identification of Data Gaps

To identify gaps the ortho-images, produced in 2005 / 2006, and the existing cadastre data were compared. The existing data was analysed and results of the analysis can be summarized

that cadastre data exists for about 60% of the whole city of Addis Ababa and that new data capture was necessary for 58.2% of the city while 41.8% of the city needed a data update.

Assessment of Cadastral Map Quality

To evaluate the quality of the cadastral map data, a two step comparison process was carried out. First orthophotos produced in 2005 / 2006 were compared with existing cadastral map data. Next orthophotos produced from aerial imagery acquired in 2010 were compared with the cadastral map data.

The comparisons were made over the entire project area by superimposing cadastral map data (vector) over the orthophotos. Changes were identified as is shown in Figure 3, a representative area in the sub-city of Addis Ketema. The cadastral map data is superimposed over the existing orthophoto tile.

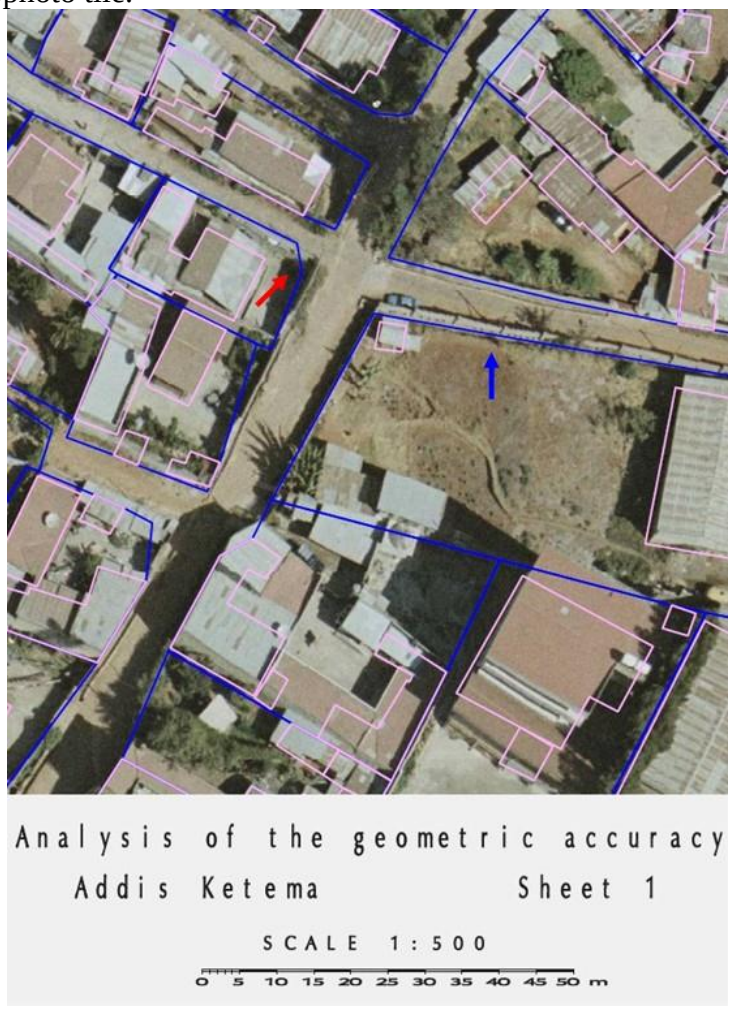

Figure 3: Cadastral map data in selected area of the sub-city Addis Ketema superimposed over 2005 / 2006 orthophoto (Source: Hansa Luftbild, 2011)

The two arrows indicate two representative situations:

- The red arrow points to a difference between the shape of the wall boundary on the ground and the cadastral boundary in the data set. During updating the cadastral map data was revised to match the real ground situation.
- The blue arrow points to a cadastral boundary which fits well with the foot print of the wall. This fit was checked and confirmed during updating using a photogrammetric stereo measurement method.

Major parts of the project area were treated as new mapping, rather than being updated and / or having missing parcels added to the existing data set. This was due to significant changes in the urban landscape having taken place across all the sub-cities of Addis Ababa.

Production of Cadastral Maps

New aerial photography was acquired in November 2010 in order to update and complete the data coverage of Addis Ababa. The digital aerial photography was acquired at a ground resolution averaging 17cm. This resolution was suitable for mapping at scale 1:2000 as well as for producing digital orthophotos at a ground sampling distance (GSD) of 20cm which is also equivalent to a map scale of 1:2000.

Figure 4 shows the new parcel data coverage after the updating. Figure 5 shows the existing building data before and after the updating.

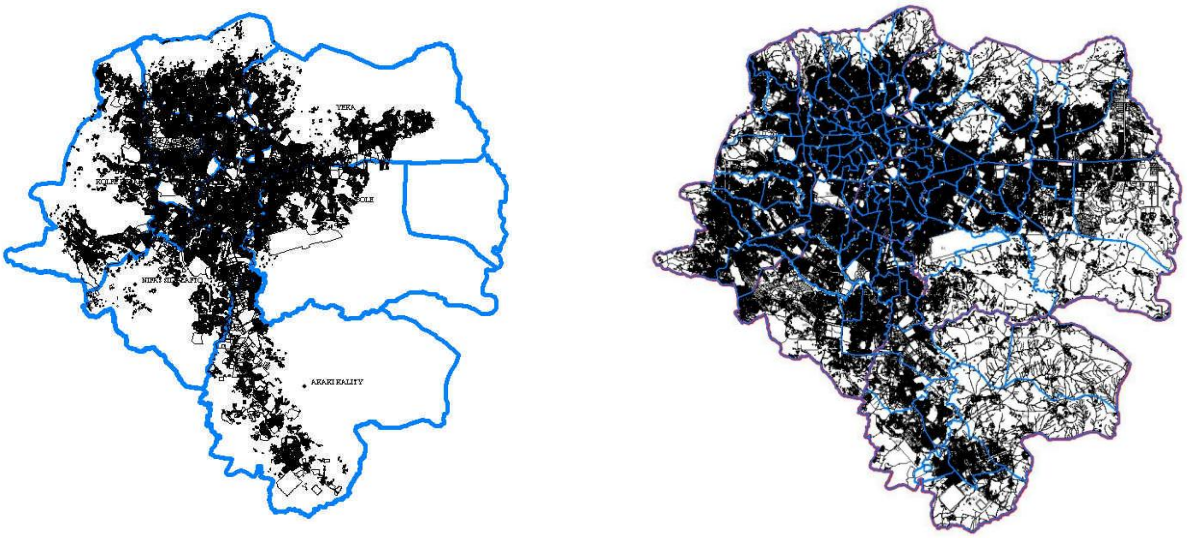

Figure 4: Old parcel coverage (left) compared with new parcel coverage after updating (Source: Hansa Luftbild, 2010 and 2011)

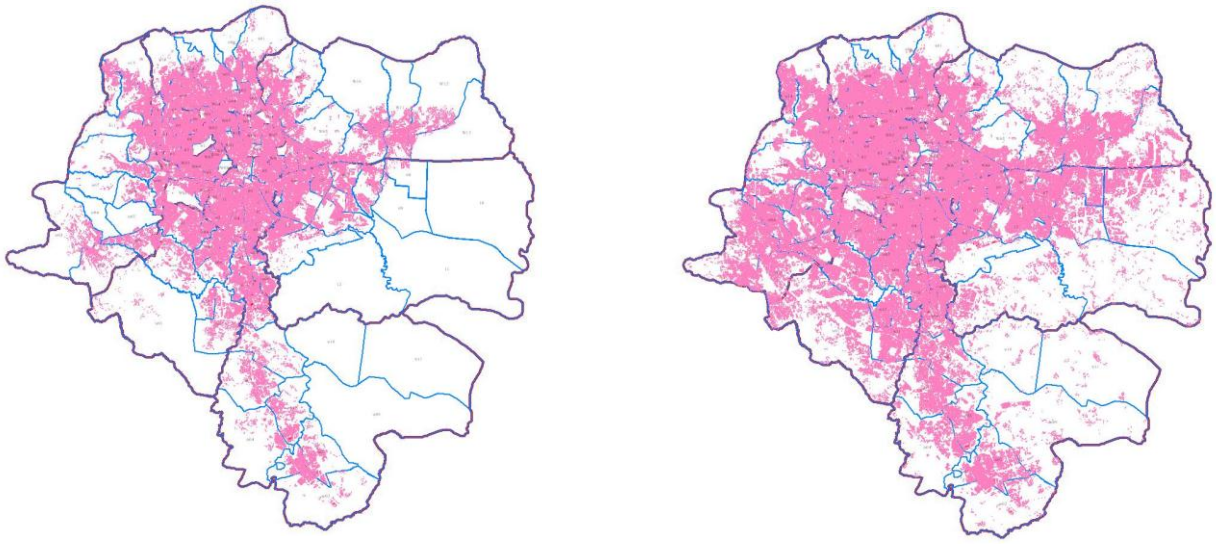

Figure 5: Old building data coverage compared with new coverage after updating (Source: Hansa Luftbild, 2011)

In addition to the parcels and buildings the street and road network was mapped and used to set up the street addressing system.

The photogrammetric data capture in a 3D – stereo environment was carried out on a Bentley MicroStation V8. After data capture the data was input in ESRI ArcGIS and processed so as to generate closed polygons, to assign unique identification numbers and to merge existing attribute data to new polygons.

In statistical terms the final results and output of the updating can be summarized as follows:

359,897 parcels were generated (the initial estimate of AACA was 296,000 parcels) of which less than 0.1% were unchanged parcels and around 49% were new parcels, and around 51% were changed parcels.

The number of building or construction features mapped was 1,145,690.

6.2 Verification of the Sufficiency of Existing Ground Control

The object of this task was to assess if the existing ground control points provided sufficient coverage for future accurate cadastral surveys.

One hundred and fifty ground control points have been established by the Ethiopian Mapping Agency (EMA) in Addis Ababa. These fall within the city boundaries and are distributed within the ten sub-cities.

During the ground points marking expedition in June 2010 surveyors checked the 150 ground control points and found that 31 points were damaged, or buried, or inaccessible.

Furthermore the distribution of the current ground control points was not suitable to adjust the photogrammetric block. Therefore 62 additional ground control points were determined and surveyed for that adjustment.

On the basis of the foregoing it was concluded that the existing ground points provided insufficient coverage for future cadastral surveys. This would particularly be the case when a highly accurate survey is required as in determining the exact area of land parcel or subdivision of blocks of land.

Hansa Luftbild recommended that AACA implement either one of the following two approaches in order to apply cadastral field methods to adjudicate existing parcels or to survey new ones:

1. establishment of an active GPS station network, or
2. densification of the existing ground control points to 1 point per square kilometre with a horizontal and vertical accuracy of 5cm and better

6.3 Development of a Unique Identification System

To locate a parcel in the cadastral map, it is necessary to link the parcel number with the geometry of the map, i.e. the geodetic reference system. Therefore an independent district and numbering concept for cadastral purposes with the Woreda as the smallest cadastre district was proposed by Hansa Luftbild and accepted by AACA.

This unique identification numbering system for the parcels consists of 14 digits with the following information code:

rrcccsswwppppp

rr	number or code for the region (AA for Addis)
ccc	number of city (000 for Addis)
ss	number of sub-city (e.g.: 06 for Bole, 08 for Nifas Silk Lafto)
ww	number of Woreda (e.g.: 10 at Bole)
ppppp	number of parcel (00001, 00002, 00003, …)

This concept uses parcel boundaries as district boundaries and includes road, railway, and river parcels. It is intended that this numbering will remain constant regardless of any future changes in administrative boundaries. Furthermore it is very similar to the German system which has continued to run reliably for more than 100 years. The advantages of this solution are:

1. it is independent of future changes in administrative structure;
2. database consistency checking is simple, area coverage of a parcel within a cadastre district (Woreda) is possible;
3. a special numbering concept for roads, railways and rivers is not needed.

All buildings inside the parcels were also captured and assigned a unique identification number similar to the parcel identification number however consisting of 15 digits instead of 14 due to the large number of buildings.

7. ESTABLISHMENT OF ADDRESSING SYSTEM

Until recently Addis Ababa lacked a fully functioning and cohesive addressing system, having only unsystematic and incomplete street addressing. Furthermore no single organisation was responsible for the assigning of addresses (ie house numbers).

The lack of an addressing system meant that AACA could not provide the public and private sectors with information and services, relating to address location and street information. Locations in Addis Ababa were described by referring to commonly known landmarks, and appointments or deliveries were handled through guides or make shift maps. This hindered the development and operation of the postal, public transport, security and rescue services.

According to the Addis Ababa Construction and Road Authority (AACRA) Addis Ababa currently has approximately 7,400 public road segments suitable for vehicle traffic, including paved and gravel roads.

The development of the addressing system was of critical importance and was foundational to the current project. Working Group 3 worked on and developed key concepts / solutions for a workable addressing system. The final concept agreed to by AACA was based on data published in the World Bank's manual "Street Addressing and the Management of Cities". To implement the agreed concept a street addressing unit was established within AACA.

Using the methodology outlined in the World Bank publication, a training manual containing 12 data sheets was prepared. These defined and specified the major components required in an effective street addressing system.
Two areas were chosen for piloting the implementation of the street addressing system. The two pilot areas were used to derive an estimated budget for the implementation. The cost estimation given by the World Bank manual starts at 0.50USD and goes up to 5.00USD. In line with these estimates the costs for Addis Ababa at today's exchange rate would be around 3.00USD (50 Birr) per registered city inhabitant.

8. SUPPORT FOR THE ESTABLISHMENT OF REAL PROPERTY REGISTRATION OFFICES

Supporting the establishment of the municipal real property registration offices was an important service delivered by Hansa Luftbild.

The key issues addressed during the consultancy period were:

- operational and procedural development and support;

- public and stakeholder information, education and communication;
- strategic management and business plan preparation; and
- training.

The Addis Ababa City Government's Proclamation No. 22 /2010 established the Immovable Property Registration and Information Agency (IPRIA). The proclamation which came into force on the 7th of June 2010 declared the IPRIA agency to be a legal entity directed by a board accountable to the city manager. In addition to IPRIA's head office the agency retains an office in each sub-city. Figure 6 shows the functions of IPRIA in relation to the other existing land and land related administration sector (LLRAS).

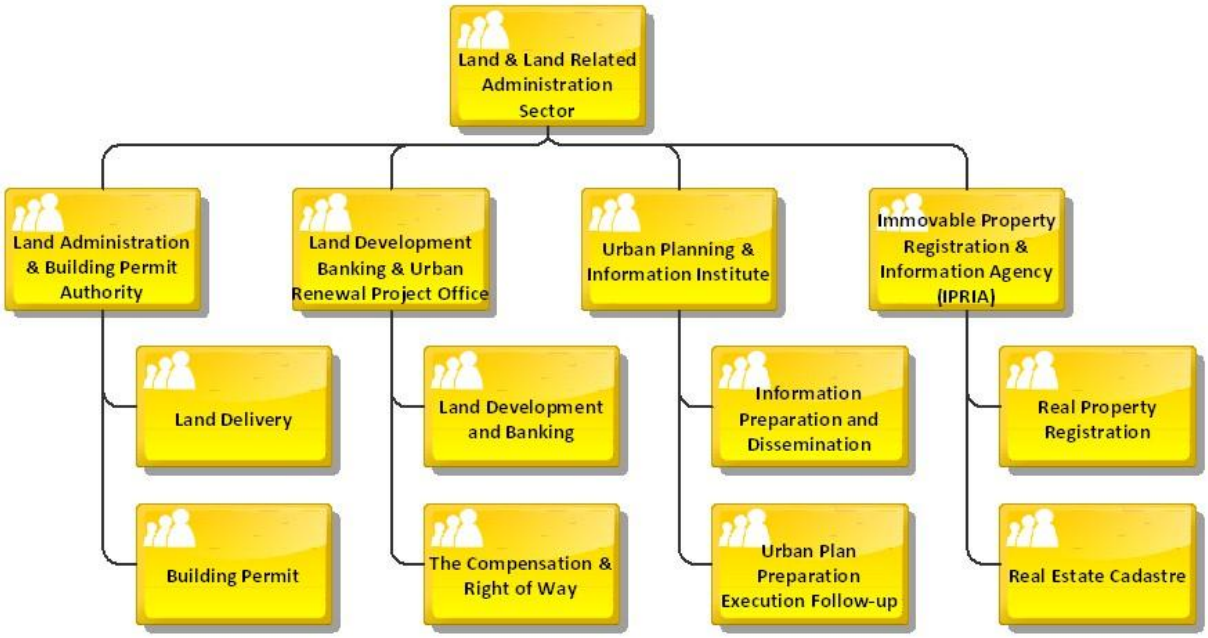

Figure 6: Functions of IPRIA within LLRAS (Source: AACA and Hansa Luftbild, 2011)

The principal tasks of IPRIA's head office are defined in Paragraph 7 of Proclamation No. 22/2010. Hansa Luftbild recommended that IPRIA's organizational structure be made congruent with the business use cases as defined in the requirements analysis. Figure 7 shows the structure of the agency at head office level.

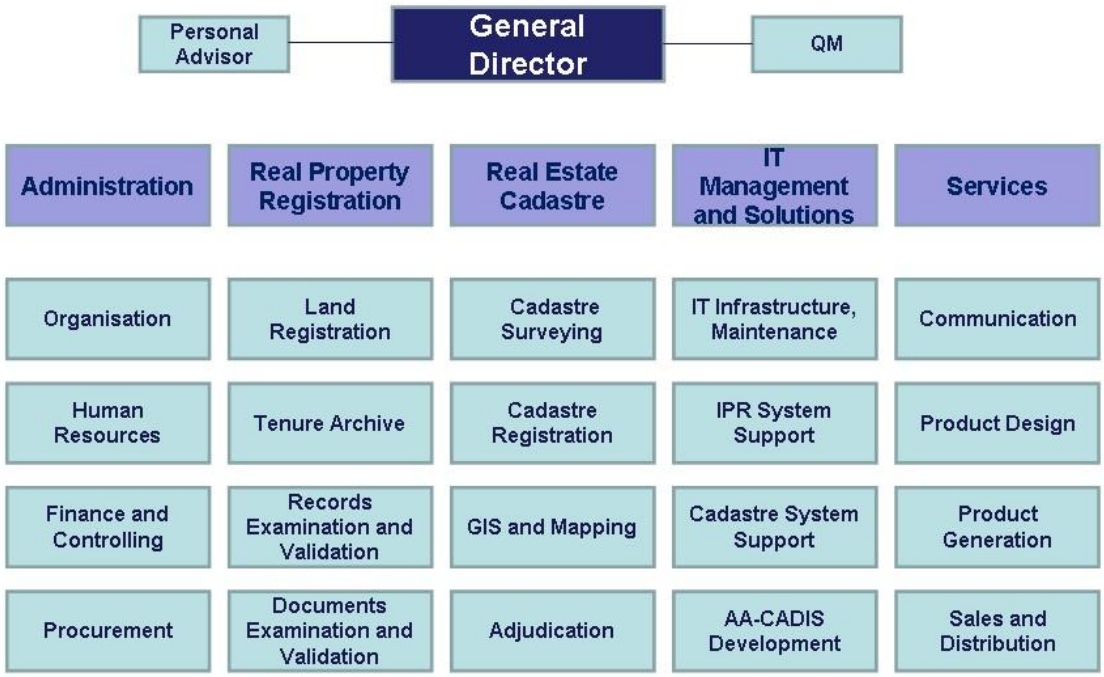

Figure 7: Organizational structure of IPRIA's head office (Source: Hansa Luftbild, 2011)

The powers and functions of the sub-city offices of IPRIA are also described in Paragraph 8 of Proclamation 22/2010.

9. DEVELOPMENT AND IMPLEMENTATION OF REAL PROPERTY REGISTRATION AND LAND INFORMATION (CADASTRE) SYSTEMS

Initially real time online communications between head office and each of the sub-cities was planned. However this proved non-viable and a partial online solution was designed. The systems were implemented as a three-tier architecture with a decentralised information retrieval system at head office level and sub-city level.

The connection between head office and a single sub-city comprises a standard connection provided by the Ethiopian Telecommunication Company (ETC). The bandwidth is mostly used for viewing data rather than changing data. The network infrastructure within the different sites (head office and sub-cities) is however a high capacity one.

The main advantage of the client/server architecture at the sub-city level is that real time data exchanges between sub-city and head office are unnecessary; this accords with the level of telecommunication infrastructure available. The systems can run using less expensive network infrastructure and if necessary can operate without permanent network connections between head office and the sub-cities.

Updates of the AA-CADIS (ie RPRS and RECS) system are not directly implemented on the central CCDB but through data maintenance jobs which are generated in the sub-cities at set times.

The RPRS client is a web application and is invoked from a local applications server in each of the 10 sub-cities and in head office. All maintenance operations are also carried out by data maintenance jobs.

In each sub-city servers were installed for the applications, the local data repository, the database and the OGC services. These services are used to provide access to the data repositories of the RPRS and RECS clients.

The replication of data from head office to the sub-cities is performed using specially developed replication tools since Oracle does not provide such tools for spatial data.

The three tier architecture consists of:
- client layer, responsible for presentation and user interaction
- service layer, and
- data layer

The RPRS and RECS are implemented at the **client layer** and their applications are connected to the AA-CADIS database server. One client maintains the RPRS and the other maintains the RECS of the core business processes. The RECS was implemented as a Bentley Map application and RPRS as Microsoft Windows application. The basic framework is Microsoft .Net. The **service layer** provides the services which can be used by the applications at the client layer as well as by external applications. Two components reside on the service layer, namely AA-CADIS and AA-LIS. The **data layer** holds the database consisting of two logical data sets. One set is for the real property (non-spatial) data while the other contains spatial data and its descriptive attributes. The real estate cadastral data set contains three types of data; parcels, buildings and fences. The real property registration data set consists of data of ownership and all associated attributes. Ownership relates to a parcel and/or a building.

All registration offices work with the current data while head office owns and maintains the data. The two client applications use only the necessary relevant data from both data sets and can only change the data applicable to their specific tasks. This helps ensure data security.

10. CONCLUSION

In conclusion the Addis Ababa City Administration in close co-operation with Hansa Luftbild was able to develop a new street addressing system and two working and practical real property registration and land information (cadastre) systems within the confines of the telecommunications infrastructure available. These two systems are being used to support many services and will develop the confidence and trust of the public with regard to legal land use right and ownership of property. During the development period the local staff acquired

skills and thus are able to run the systems independently. The two systems are populated with up-to-date cadastral map data produced by Hansa Luftbild and run at the newly established real property registration agency of the city. As well as being specifically tailored to AACG specifications the two systems were simultaneously developed to comply with international and Open Geospatial Consortium (OGC) standards, thus guaranteeing their transparency and interoperability, locally, regionally and internationally. From this perspective the solution in Addis Ababa can be seen as a blue print for Ethiopia at a national level and as potentially utilizable throughout the African continent.

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