

**Alternatives for Economic Boundary Determination
in the Establishment of a Cadastral System**

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**Alternatives for Economic Boundary Determination
in the Establishment of a Cadastral System**

1. Introduction

why are efficient land registration systems needed?
Hernando de Soto and World Bank, Cadastre 2014, Options

2. Land Boundaries

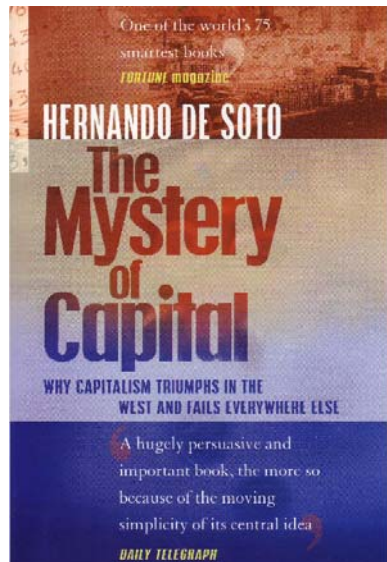
3. Monumentation of Boundaries

4. Modern Technology tools to establish a Parcel Fabric

- 4.1. GPS – GNSS
- 4.2. Digital Orthophoto Mapping
- 4.3. Digital Geodatabase Structure
- 4.4. High Resolution Satellite Imagery

5. Conclusion

1. Introduction



Hernando de Soto
Economist
born 1941 in Peru

he stated:
„insecure land rights
deprive a country of the
capacity of land to serve
as collateral for
mortgages; land becomes
dead capital“

1. Introduction

FIG stated:

about 50 countries have efficient land registration systems
another 50 countries are in the process to establish one
this still leaves another 90 countries without one

The World Bank:

has financed establishment of efficient land registration
systems with 1.2B \$ during the last 10 years

Professional Literature:

has been made available to discuss the benefits of
efficient land registration systems according to the
model „Cadastre 2014“

The tasks have been well described:

Jürg Kaufmann in Cadastre 2014:

Map and Register in digital form

Williamson, Enemark, Wallace, Rajabifard

Legal options (Deeds, Titles)

Advantages (Sustainable land use planning, Valuation, Taxation)

But not the global technical options:

for SDI and data providers

see butterfly diagram

Purpose of the Paper:

is to make a contribution in these aspects
particularly with respect to boundary descriptions



CADASTRE 2014: THE VISION FOR MODERN CADASTRAL SYSTEMS

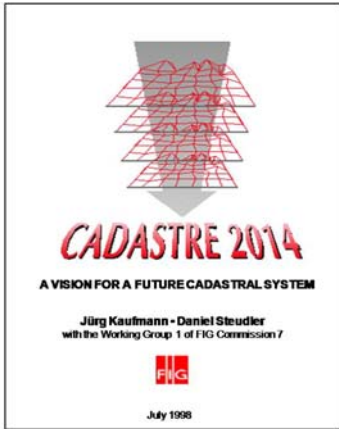
FIG studied the development of modern cadastres in the years 1994 to 1998.

The result of the studies was the publication Cadastre 2014: A Vision for Future Cadastral Systems.

Today Cadastre 2014 is still the base for further studies e.g. for Cadastre 2034.

The vision Cadastre 2014 is the base of the development trend.

The vision is becoming a reality.



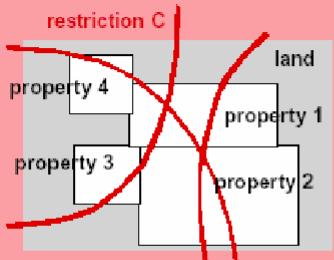
.NSDI Conference, 6-7 October 2011, Baku, Azerbaijan

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Legal Situation of Land

Statement 1 on Cadastre 2014

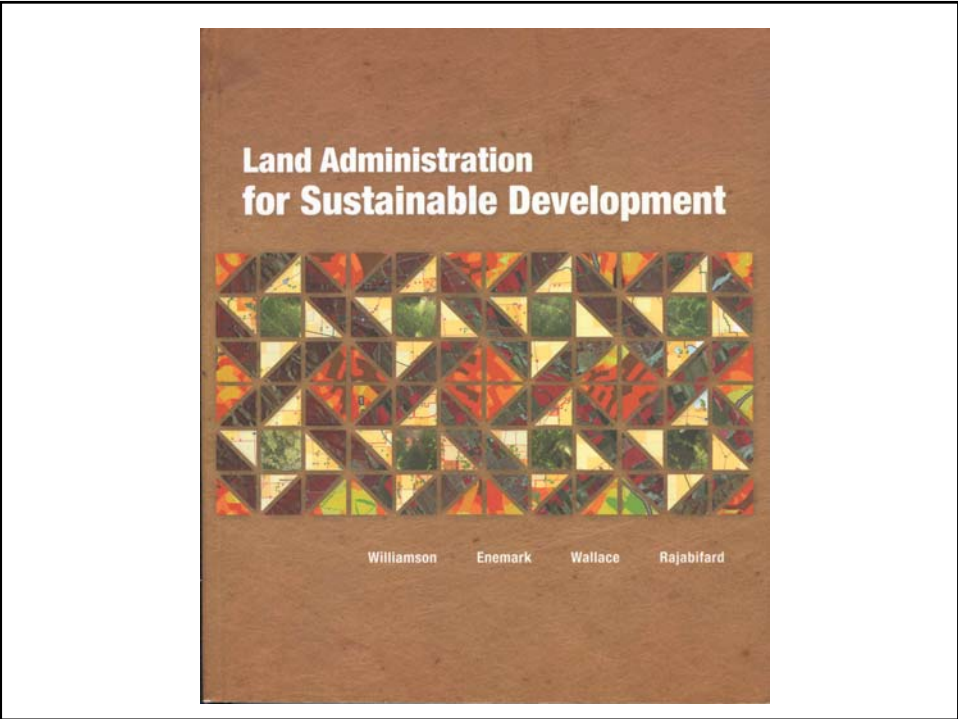
Cadastre 2014 will show the complete legal situation of land, including public rights and restrictions!

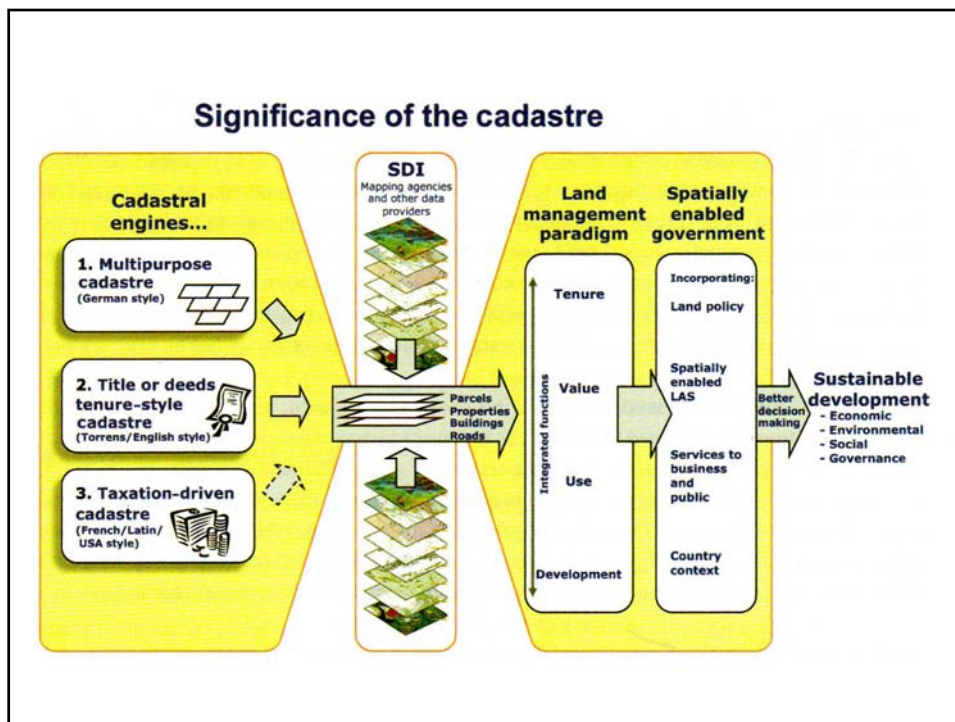


restriction A restriction B restriction C

Comment: The population of the world is growing. The consumption on the land is increasing. The absolute control of the individual or of legal entities of land is increasingly being restricted by public interest. To provide security of the land tenure, all facts about land must be made obvious by the cadastral system of the future.

Consequences: A new thematic model is necessary. Surveyors must take into consideration public law.





2. Boundaries and the Cadastre:

Options: which Cadastre?

1. **Tax Cadastre**
does not need boundaries, only areas (resolution 1m)
2. **Ownership Cadastre**
needs accurate boundaries,
but this is in the owner's interest only (resolution 1 cm)
3. **Multipurpose Cadastre**
needs map accuracy boundaries only,
this is in the public interest to create an SDI,
even though land registration does not need it
(resolution 1 dm)

Metes and bounds description of boundaries

used in the USA

disadvantage: not geocoded, no topology for parcel fabric

Map description of boundaries

if analog, limited to scale, but in general geocoded

if digital, coordinates of survey determine accuracy and topology

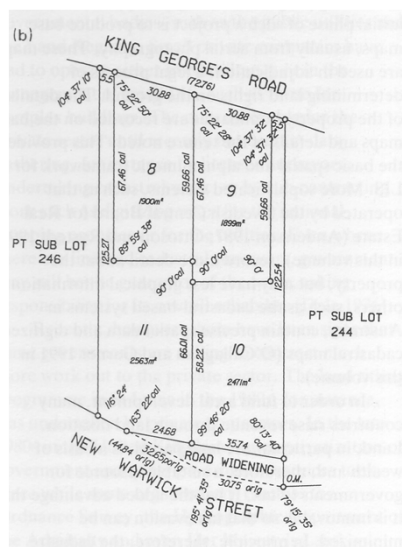
Object definition of parcels in digital data bases

the measured boundary point coordinates define

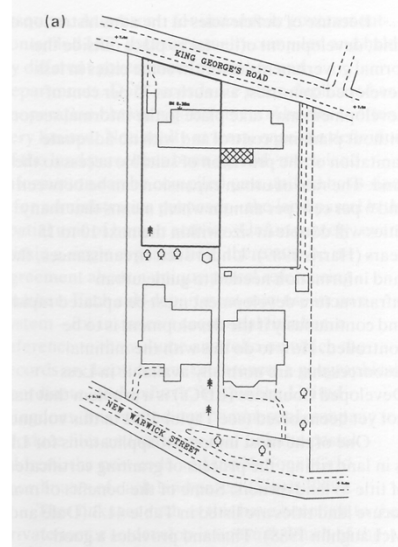
the boundaries with survey accuracy and the boundaries

determine the topology

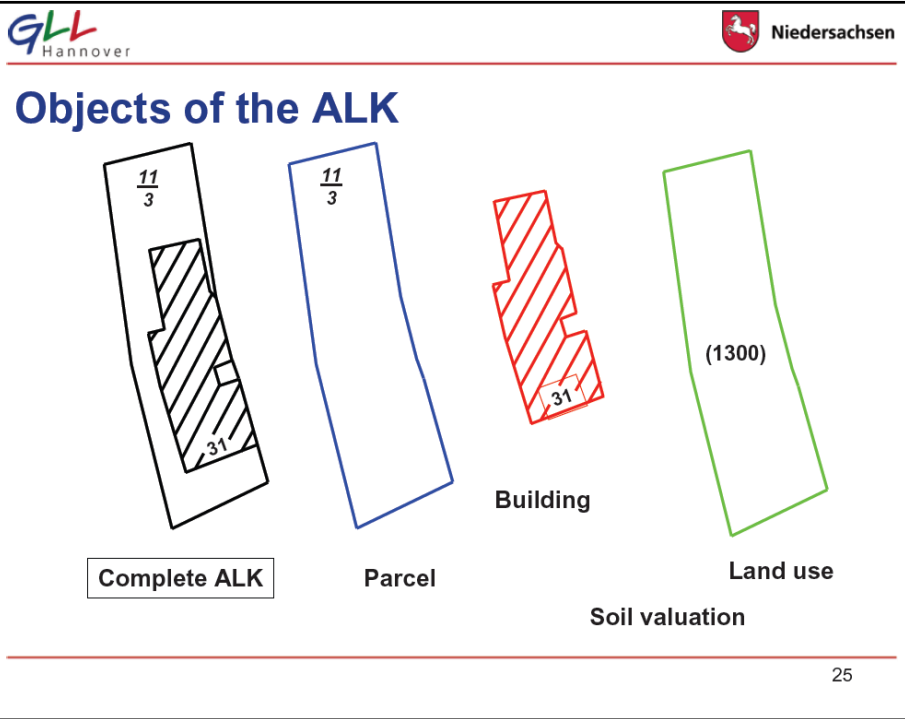
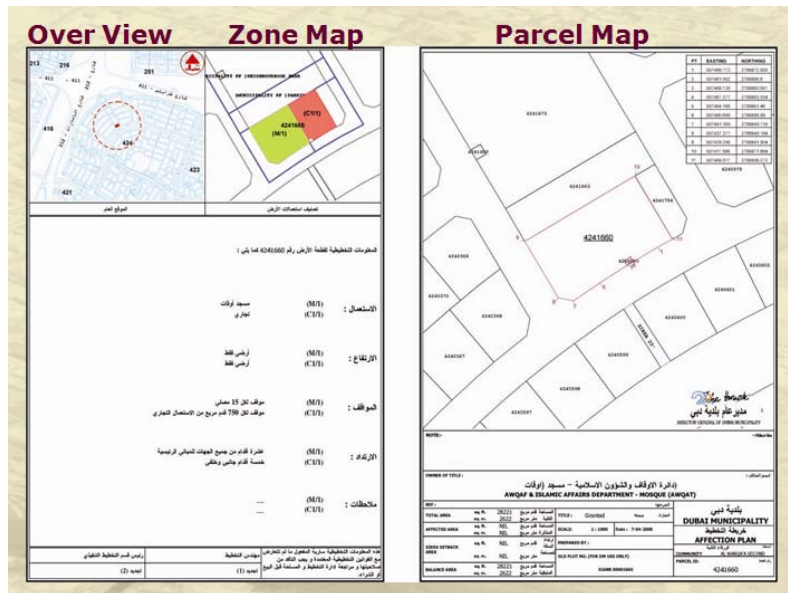
Metes and bounds description



Map description of boundaries



Map and Coordinate Description of Boundaries



**If buildigs are considered part of the cadastre,
then this is the first step to a multipurpose cadastre**

3. Monumentation of Boundaries

advantage: fixed to the earth surface

**disadvantage: monuments are destroyed due to erosion,
decay, construction, human action**

**monuments were surveyed in the past relative to topographic
objects (trees, buildings)**

**monuments already were used in Babylonia 1200 B.C. and by the
Romans 20 B.C. (Pollio) to 104 A.D. (Frontius)**

or absolute depending on current positioning technology

1700 – 1800 astronomic positioning

1800 – 1950 triangulation and traversing in geodetic networks

1950 – 1985 electronic distance measurement

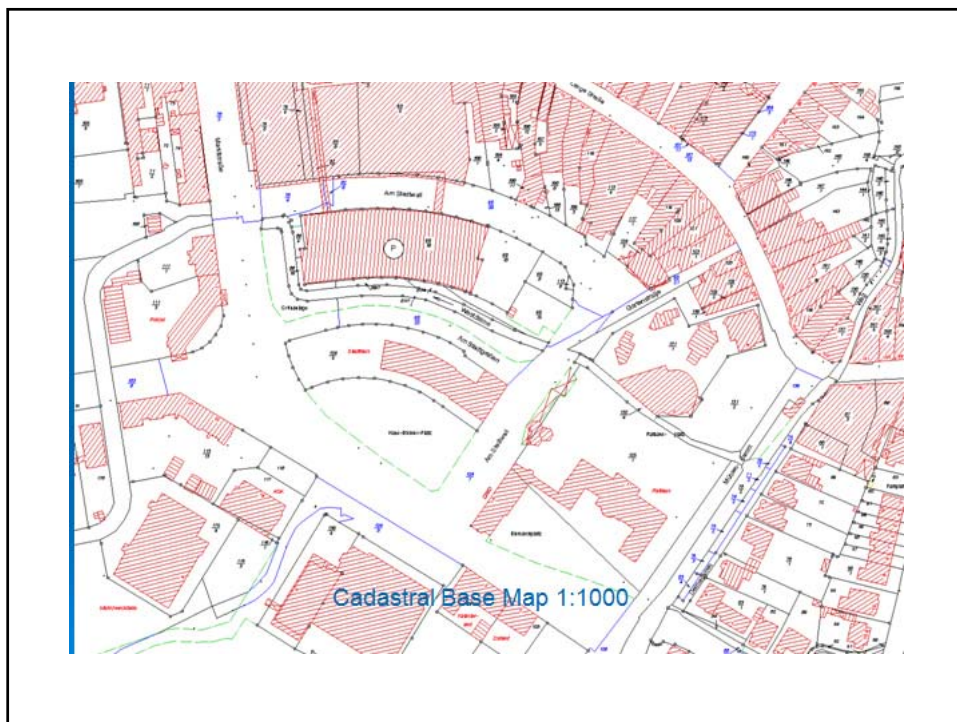
after 1985 DGPS


**Be careful:
a legally monumented boundary
is not a topographic boundary
as visible by a fence or a building!**




boundary
monument
in an urban area
Germany










Upcoming AAA - Sytem

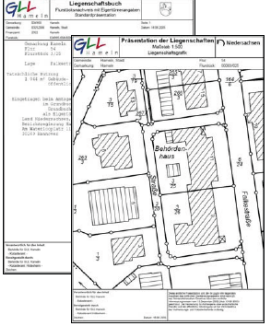
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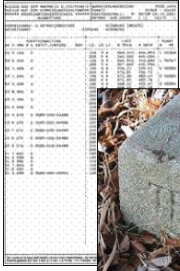

**Amtliches Topographisch-
Kartographisches
Informations-System**



ALKIS®

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Informations-System**



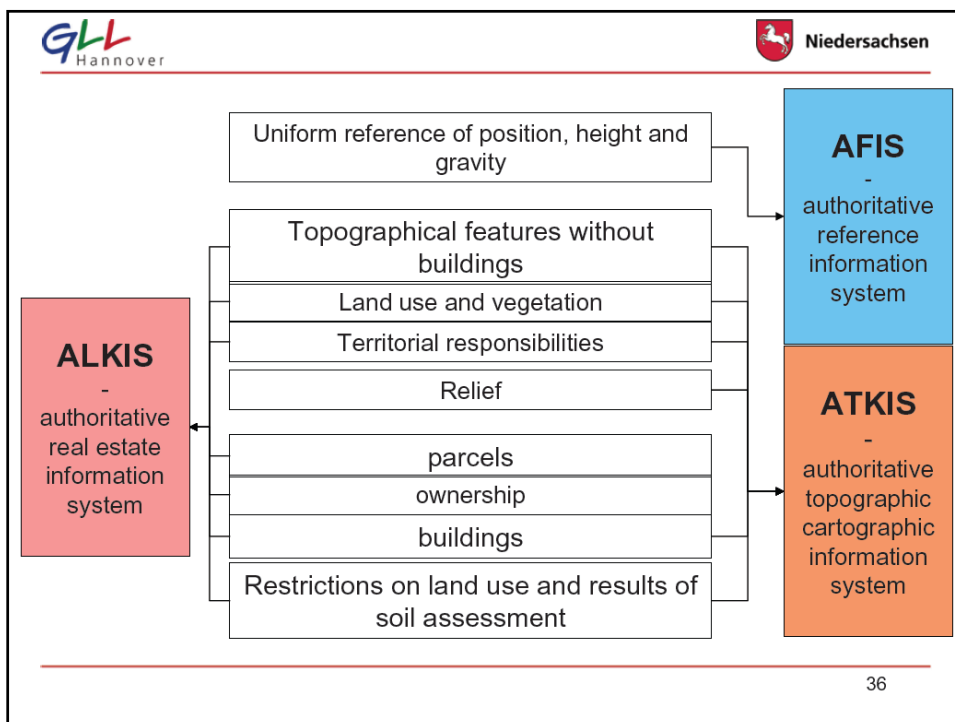
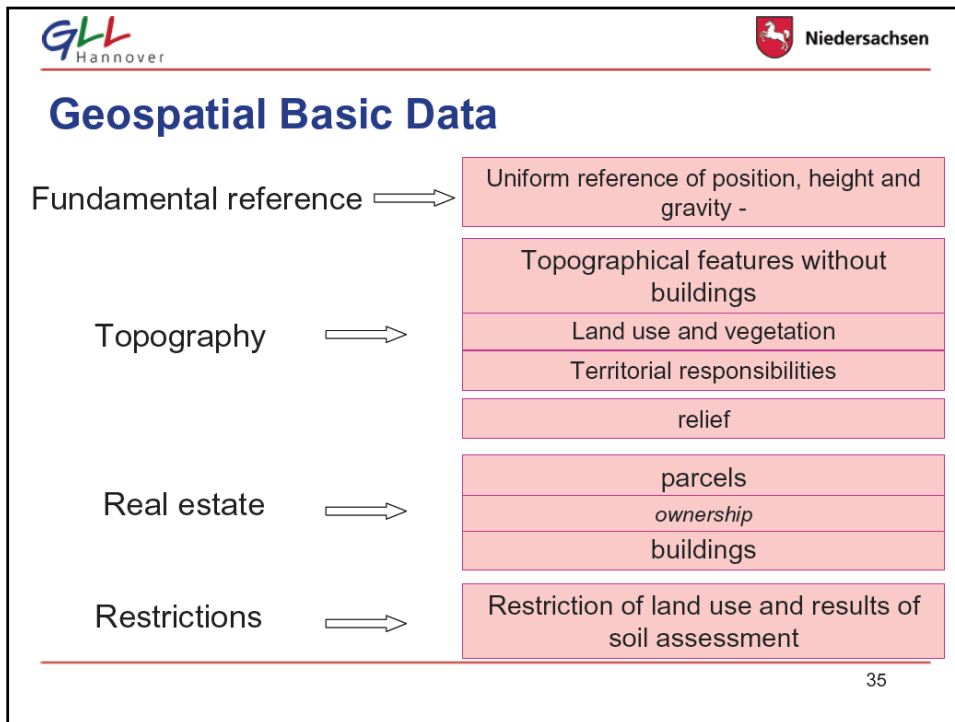
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**Amtliches Festpunkt-
Informations-System**

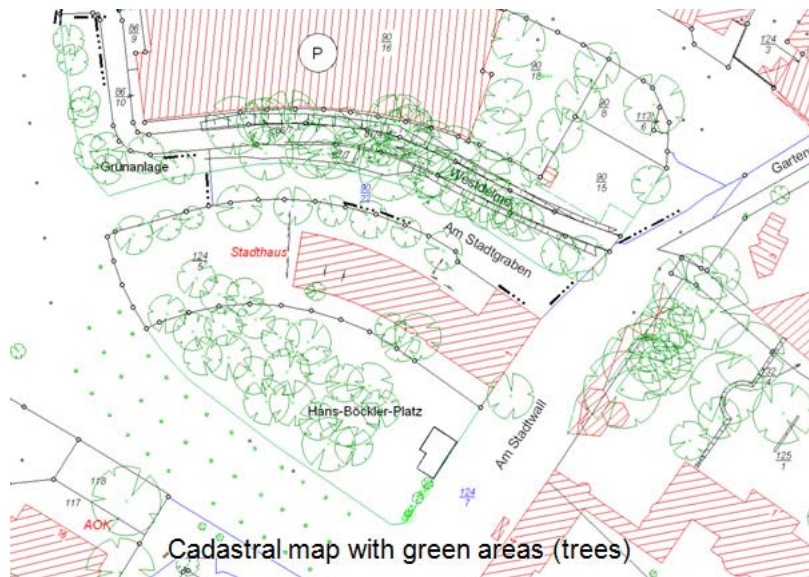
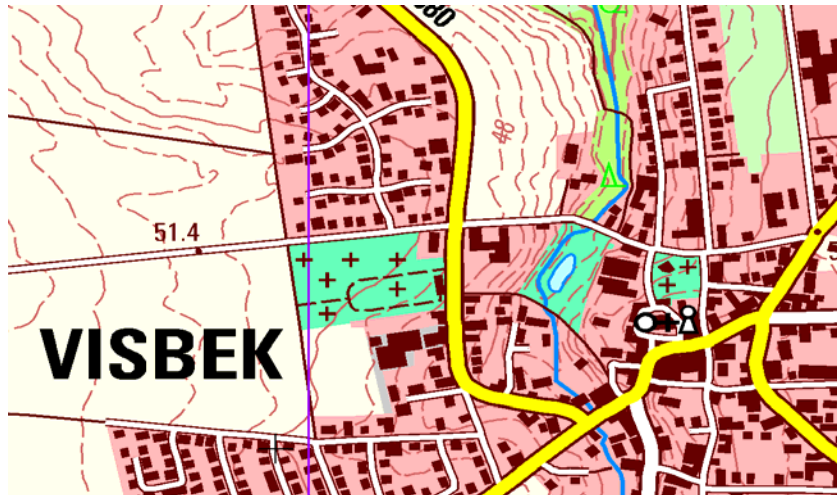
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Integration of cadastre, topography and utilities depends in multipurpose cadasters often depends on the existence of local SDI's and the laws to permit integration

Integration often does not occur because certain tasks are reserved for government operations and some for the private sector

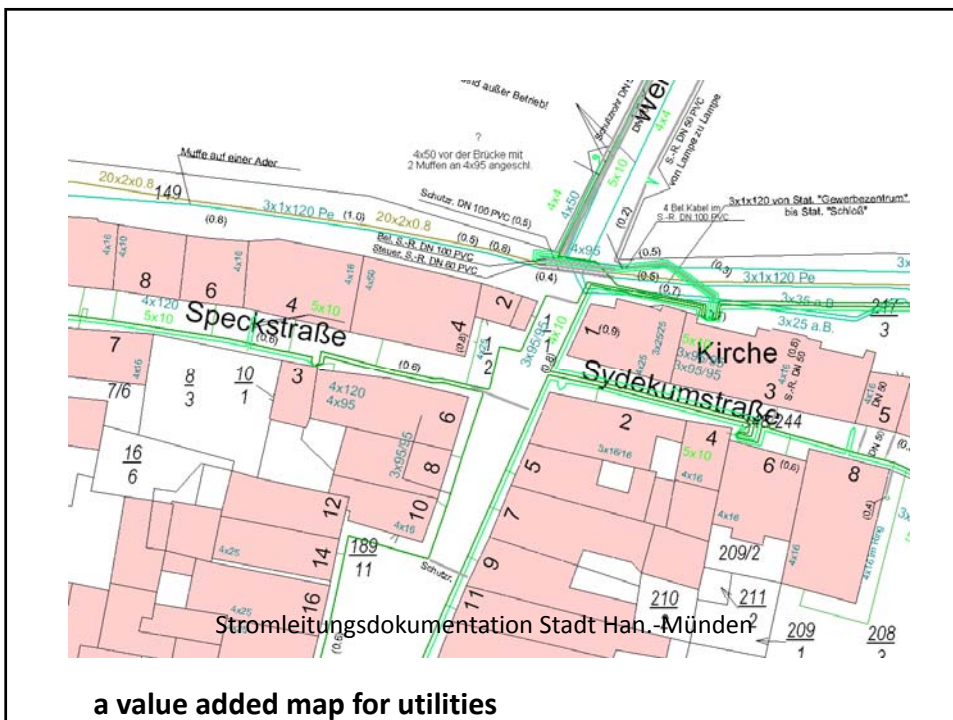
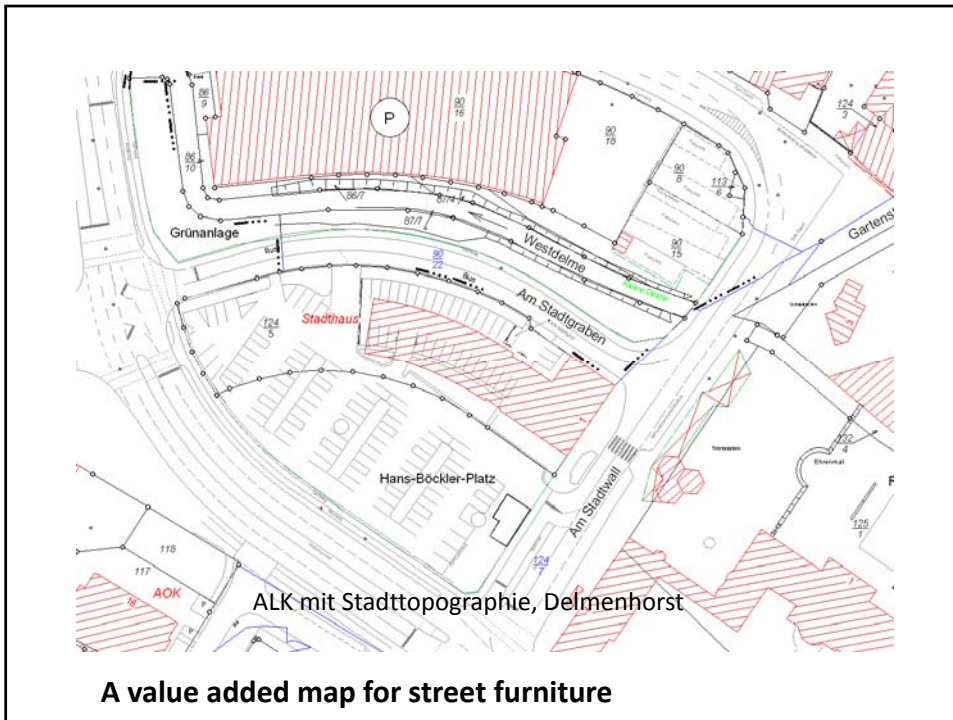


Digital Topographic Map - DTK 25



Cadastral map with green areas (trees)

example for a value added map



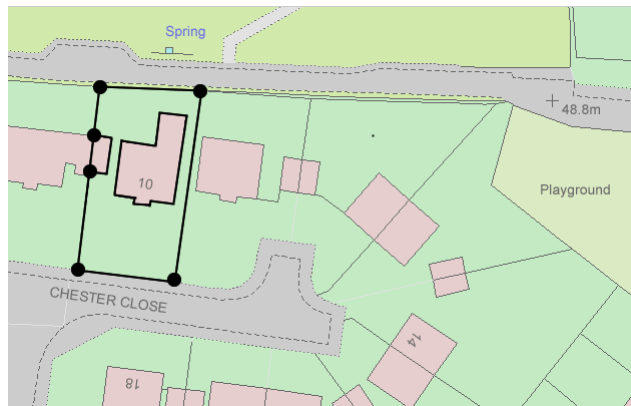


Feature Based
Feature Life Cycles
Change Only Update
Better description Of features
Database ready
Interdependency between layers

The survey of topographic point features by techeometry

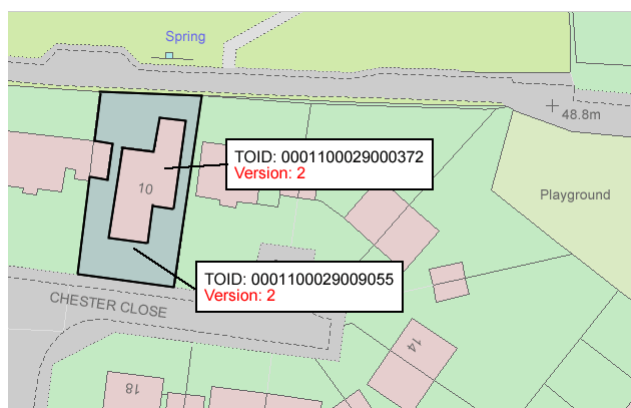
in the UK the Ordnance Survey has made a commitment to the public to update every topographic feature within 6 months

Topologically consistent data for areas surveyed with boundaries



True polygon data

area features are identified with a unique number, the TOID



Unique feature
IDs (TOIDS)
and
Version numbers

a topographic map is an „unsharp boundary map“

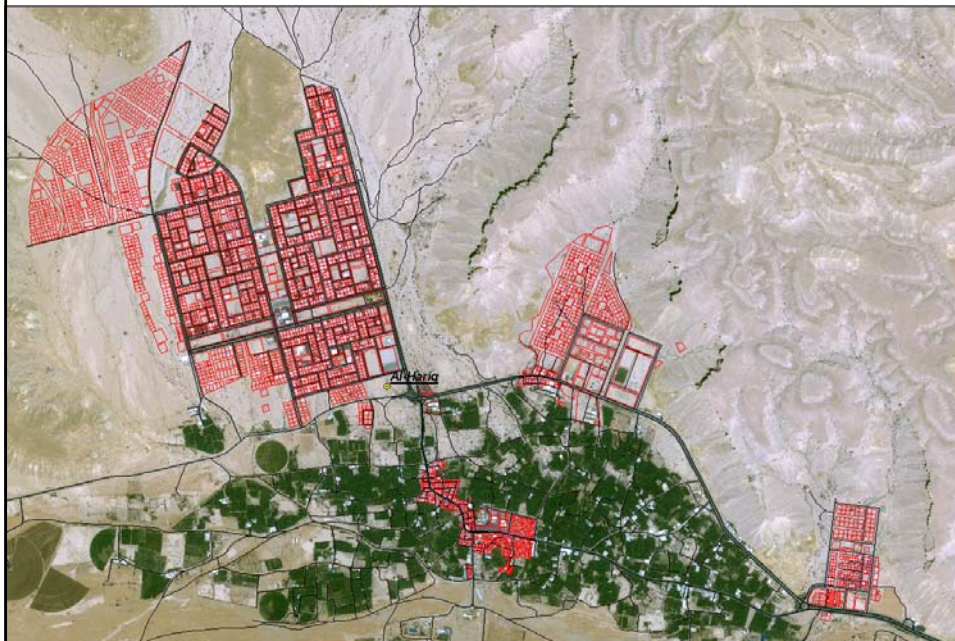
(as seen in the U.K.)

an iron bar is not a stable permanent boundary marker

(as seen in the Arabian desert)



Settlements are generally faster than maps



Rapidly growing areas with legal transactions are usually planned, often with computers

These planned developments just need geocoding, so that they can immediately be used as cadastral plans after stakeout

Cadastral problems therefore then concern

- **illegal occupation areas**
- **areas which have not been properly recorded**

4.1. Modern DGPS Adjudication Surveys via GNSS

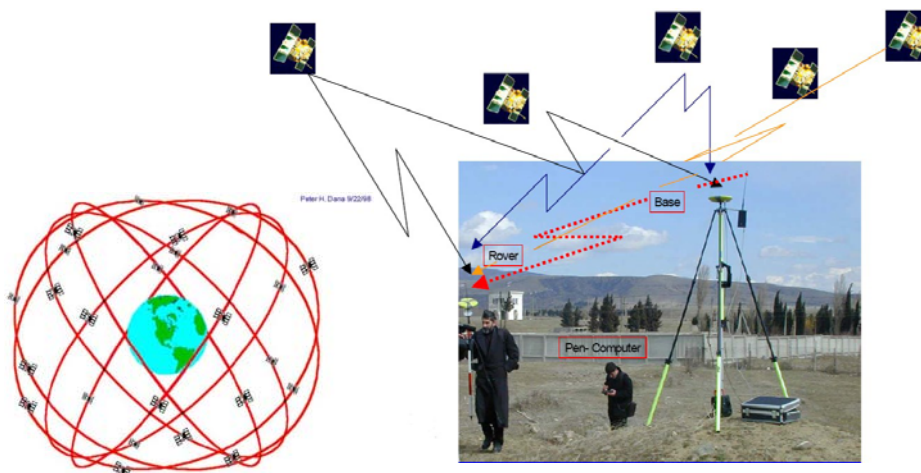
Used in Georgia and Cambodia for New Cadastre Establishment

Suitable for Transaction based Update Surveys

Photography of Deeds



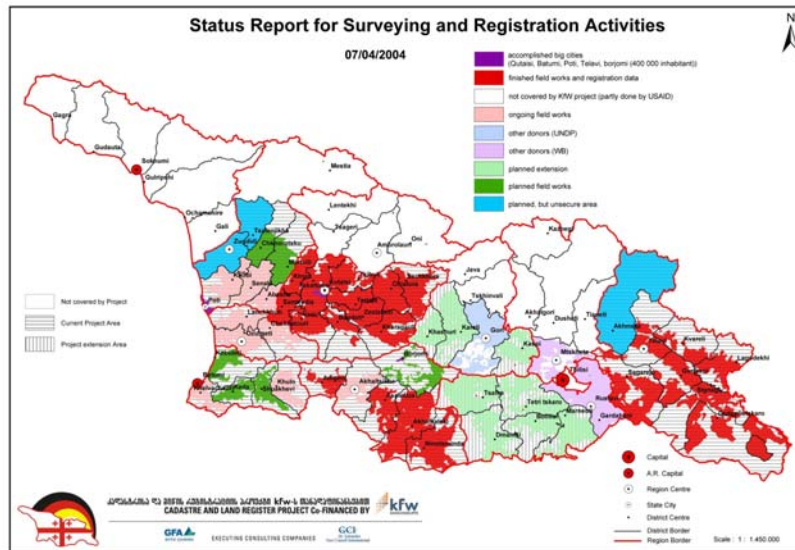
Used Technology – Georeferencing (example Georgia)



Local Boundary Survey



Cost for registering a parcel (includes adjudication and survey) 8€
Progress: Georgia within 5 years



4.2. Image Adjudication:

if topographic features can be identified in aerial images with 0.1 to 0.2m GSD in urban areas, or with 0.4m GSD in rural areas, or with 0.5 to 2.5m GSD in satellite images (GeoEye, Quickbird, Worldview, Spot5) then image adjudication becomes possible

Prerequisite for georeferencing is orthoimage generation and geocoding

The result is a Preliminary Parcel Map, which is adequate for the land register to identify each uniquely identified land parcel and attach attributes to it



5. Geodatabase

when the database for storing the geometric features is suitably structured according to identifiable points, lines, areas, then the geometry may be improved by a change in coordinates based on more precise surveys, e.g. by GNSS

This can be done sporadically, when transactions and new surveys occur

The Preliminary Parcel Map

may be geometrically improved sporadically for all cadastral objects, which require a change

In due time the database will improve its overall geometric accuracy

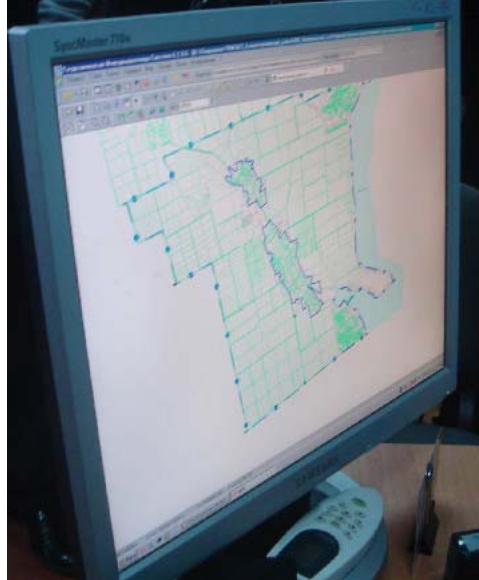
In Transformation Countries, such as the Ukraine,

- 1) agricultural land has been distributed to citizens,
- 2) They received a certificate from the Government
- 3) But local survey companies had to distribute the fields on the ground
- 4) The Government instituted an Orthophoto imaging program for the entire country as quality control
- 5) In the Odessa Oblast 17% of the parcels had to be geometrically corrected

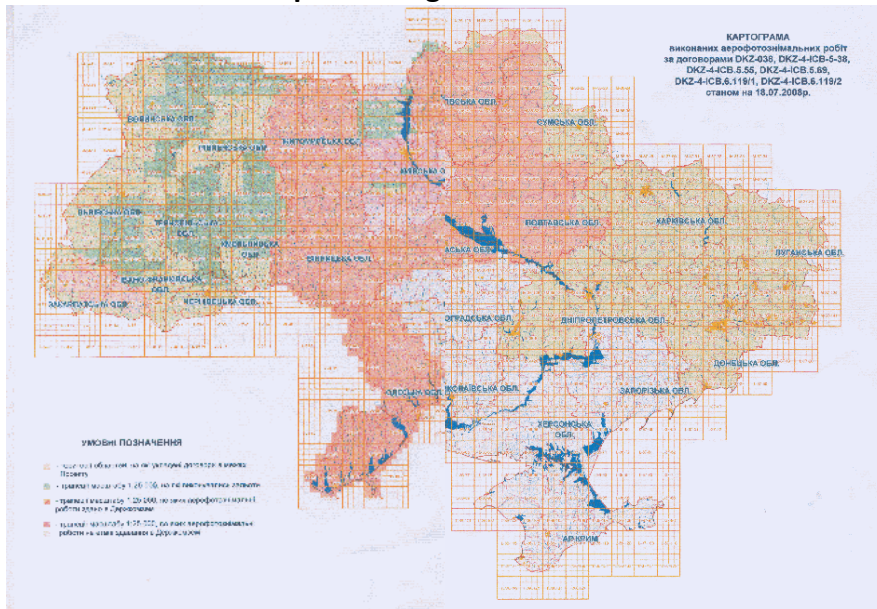
This means:

The image adjudication methodology using ortho imagery is also applicable for verification of inaccuracies of old or recent survey errors

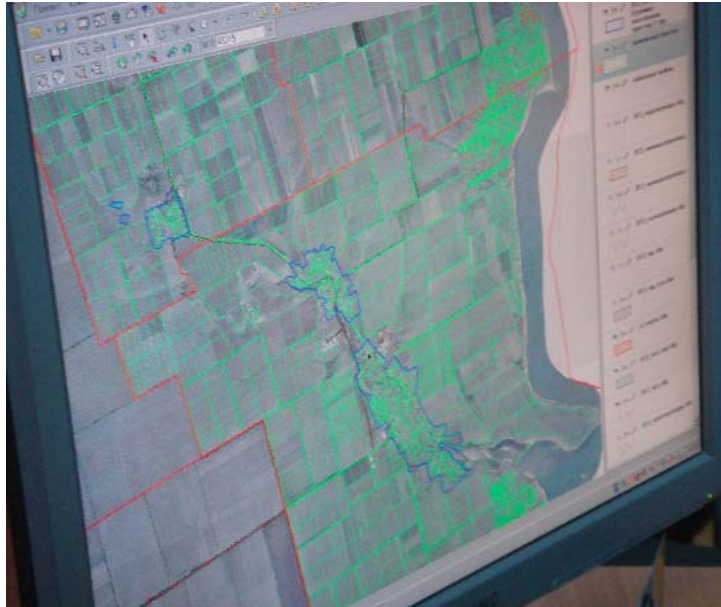
**Parcel
Fabric
as a result
of ground
surveys**



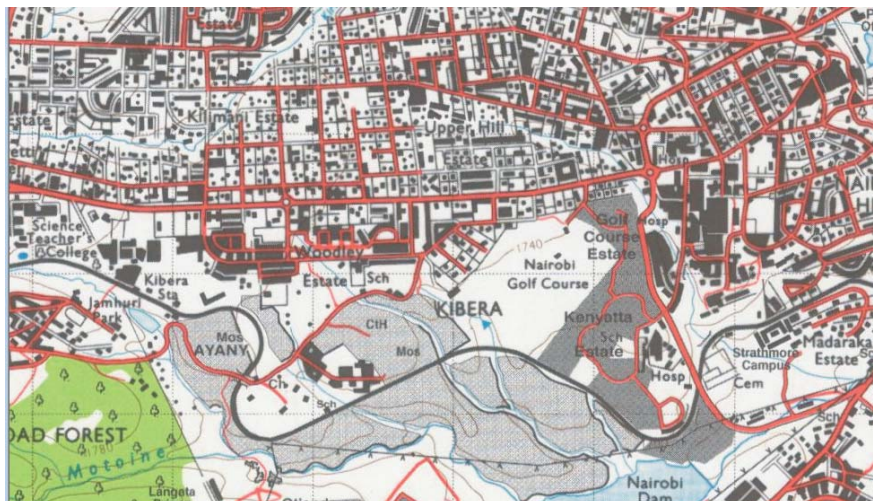
Orthophoto Program of the Ukraine



Superposition of Cadastral Fabric from Surveyors with Orthophoto



Kibera, the largest slum of Nairobi with 1.5M people does not show details in official maps (1:50 000)



**But details of Kibera, Nairobi's slum with 1.5M people
show well in Google Earth (Ikonos Image 1m GSD)**



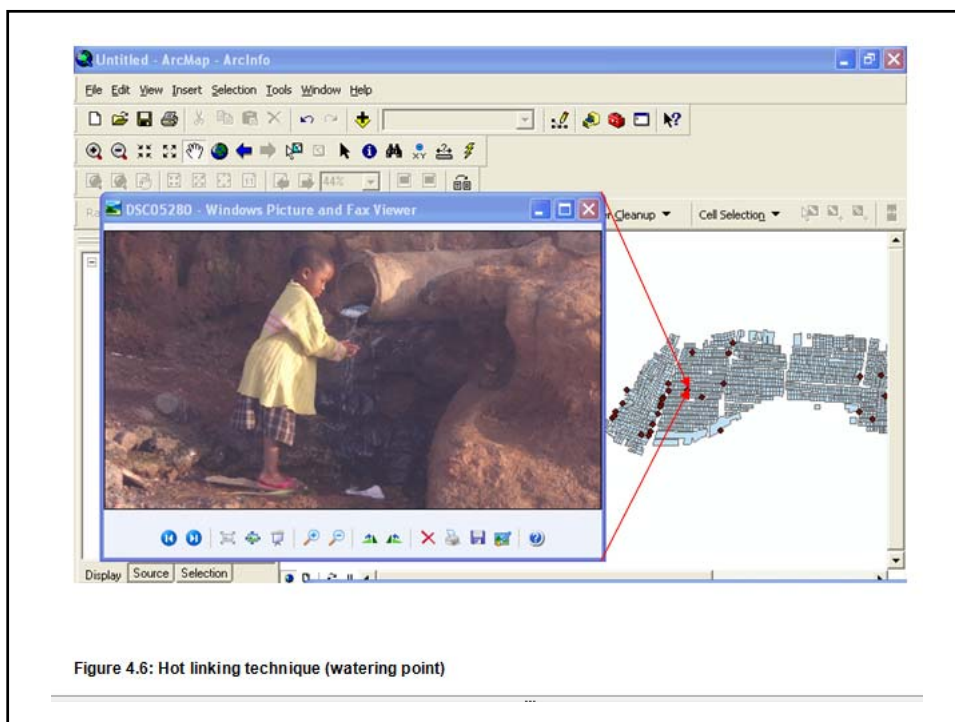
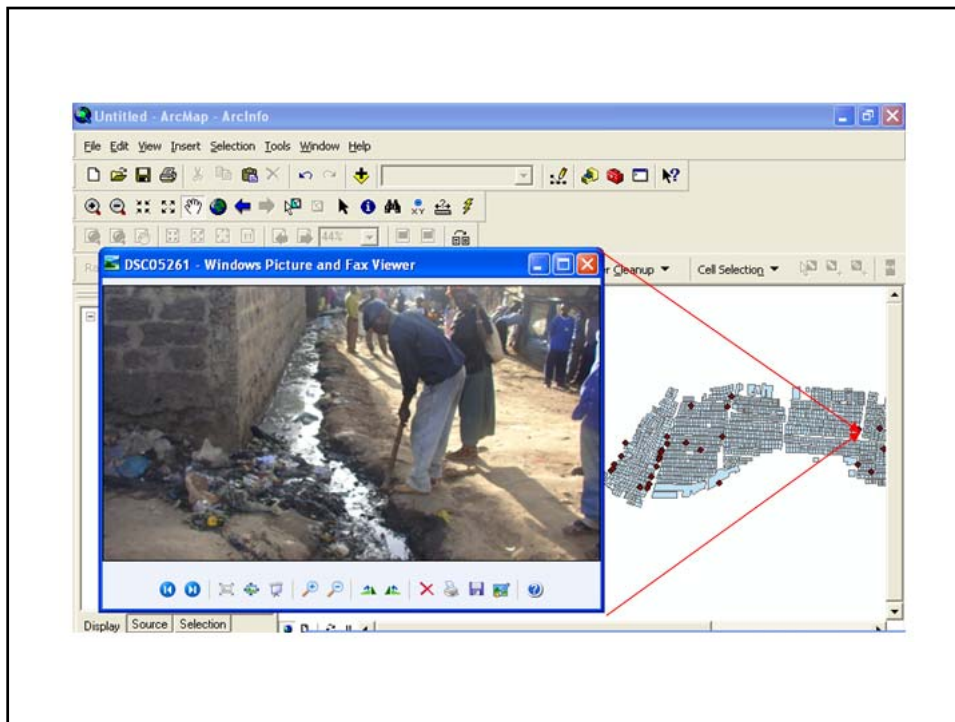


Figure 4.6: Hot linking technique (watering point)

Conclusion:

- 1. Classical Methods** of establishing a cadastre are expensive and time consuming, because of the ground survey procedures
- 2. Image Adjudication** procedures are an intermediate inexpensive and fast step to establish land registration systems efficiently
- 3. Ground Survey Adjudication** procedures using GNSS may be utilized in sporadic steps for needed transactions
- 4. Databases** with appropriate design may be used to gradually improve the geometric accuracy of the parcel fabric
- 5. Possibilities** should be made for fast and economic generation of land registration systems, so that the many countries not benefiting from one will be able to benefit as fast as possible