

# COWI - Cadastre



International Conference on Enhancing Land Registration and Cadastre for Economic Growth in India, 2006  
Hotel Taj Palace, New Delhi, India, 31 January – 1. February 2006

# COWI is one of the leading consultants in Northern Europe

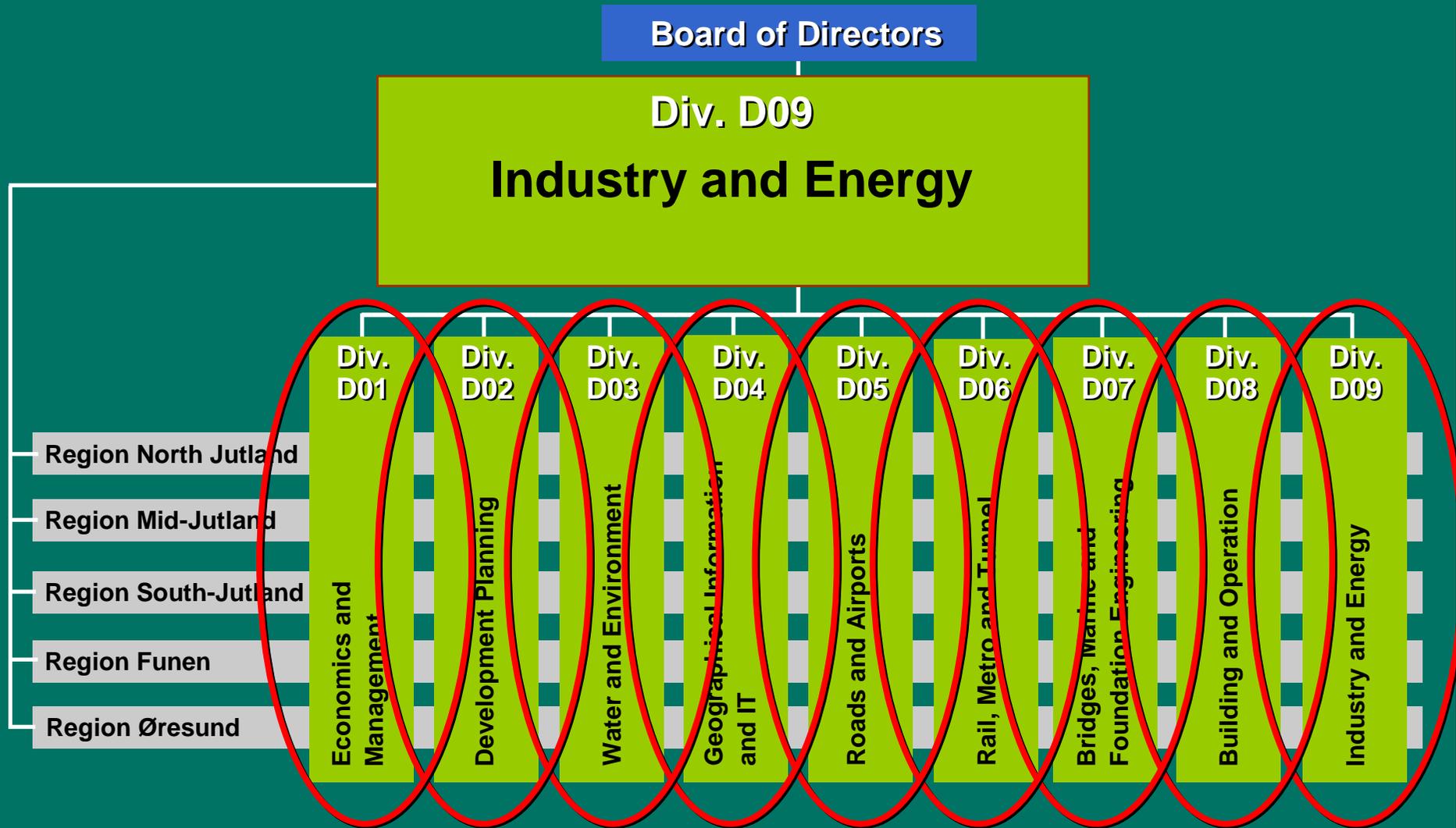
- **3400 employees generate a turnover of DKK 2.3 billion (309 EURm)**
- **COWI is independent. The COWI foundation is the major shareholder**
- **COWI provides consultancy services within engineering, environment and economics**

# COWI is an international company

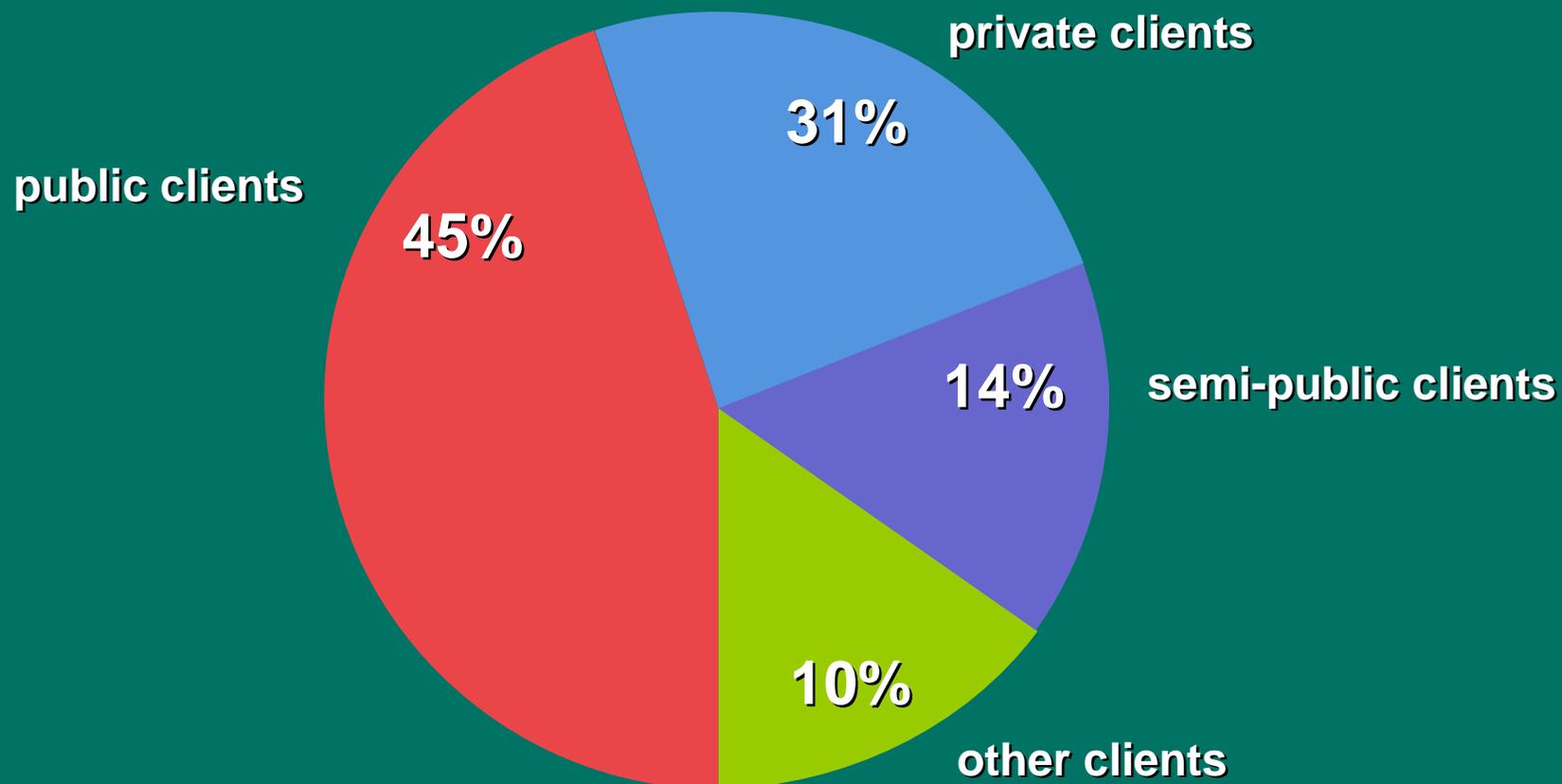
- 
- More than 1400 employees are based outside Denmark
  - They work in 20 subsidiaries, in several project and branch offices abroad
  - More than half of the turnover is generated outside Denmark
  - We have activities in 100 countries around the world

# Key figures



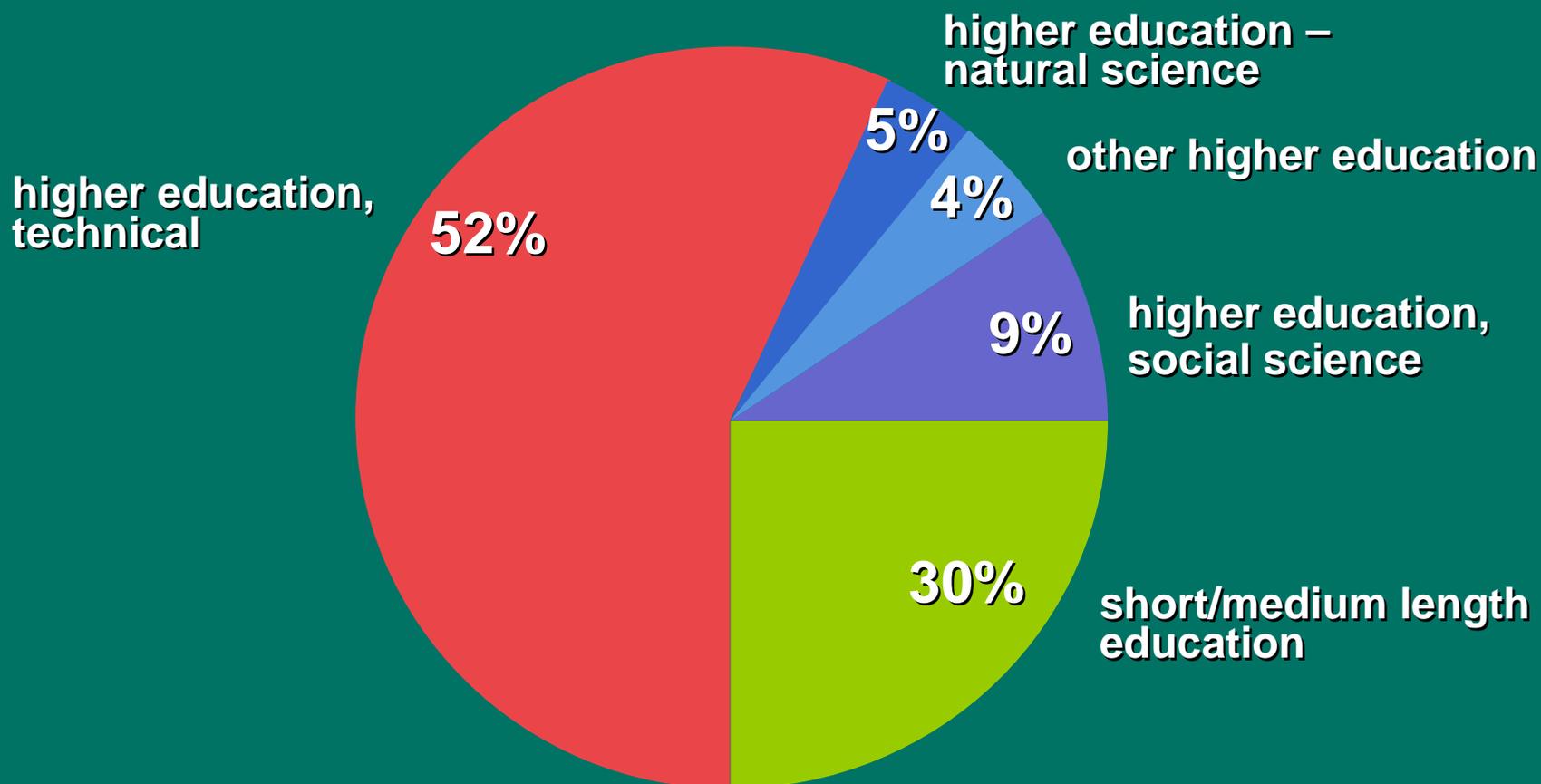


# COWI's clients



Source: Intellectual Capital Report 2003

## The employees are highly educated



Source: Intellectual Capital Report 2003

# COWI's organisation



## Inter-disciplinary co-operation

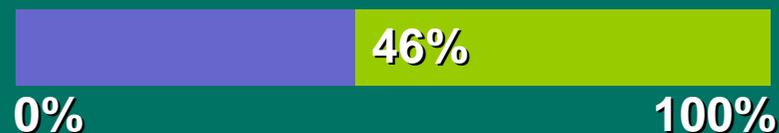
### Technical



### Natural sciences



### Social sciences



Source: Intellectual Capital Report 2003

# The Group

**Employees  
B-shares**

**COWI foundation  
A-shares**

**Codan and Danica  
B-shares**

**COWI**

## Danish offices

Lyngby <i>(Head office)</i>	Albertslund	Odense	Svendborg
	Esbjerg	Kolding	Holstebro
Vejle	Århus	Aalborg	Silkeborg
Viborg			

## Offices abroad

Norway	Uganda	Vietnam
Ireland	Panama	Korea
Kuwait	Qatar	Latvia
Sweden	Bolivia	El Salvador

**Wholly and partly owned  
companies abroad**

**Subsidiaries  
in Denmark**

# COWI globally

- Permanent offices
- International projects



# Railways

- **Railway planning and design**
- **Stations and terminals**
- **Infrastructure planning and management**
- **Upgrading and maintenance**
- **Project and construction management**
- **Quality management**



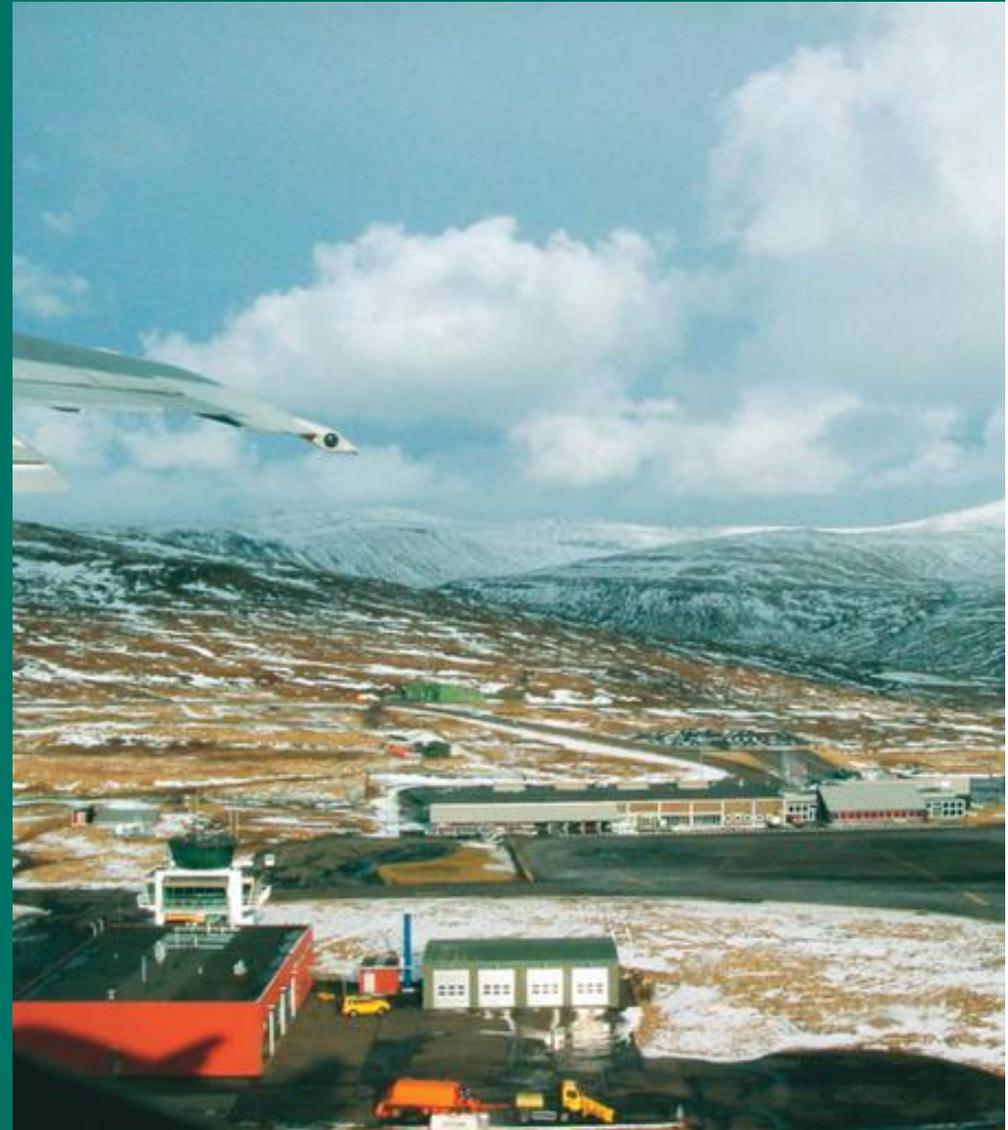
# Tunnels

- Bored and immersed tunnels
- Underground constructions
- Mechanical and electrical installations
- Geotechnics and geohydrology
- Environmental and socio-economic analyses
- Risk and durability analyses
- Project and construction management
- Quality management



# Airports

- **Planning**
- **Design**
- **Supervision**
- **Operation and maintenance**
- **Runways and aprons**
- **Buildings and terminals**
- **Technical installations**
- **Environment**



# Bridges

- **Bridges**
- **Cable supported bridges**
- **Moveable bridges**
- **Studies of fixed links**
- **Management systems**
- **Operation and maintenance**
- **Risk analyses**
- **Aerodynamics**
- **Safety evaluation**



# Marine and foundation engineering

- **Ports**
- **Geotechnical and foundation engineering**
- **Coastal and hydraulic engineering**
- **Research and development**



# Roads

- Motorways and highways
- Urban streets and parks
- Pavements
- Terminals
- Surveying and mapping
- GIS (Geographical Information Systems)
- Land acquisition and land management
- Operation and maintenance



# Environment, safety and health

- Risk and safety
- Environmental management
- Environment in construction and civil works
- Sustainable development
- Pollution control and permits
- Occupational health
- Environmental due diligence
- Decommissioning
- Noise mapping and abatement



# Water and wastewater

- **Water and wastewater treatment**
- **Water and wastewater networks, reservoirs**
- **Water and wastewater infrastructure**
- **Sludge treatment**
- **Supervisory control and data acquisition (SCADA)**



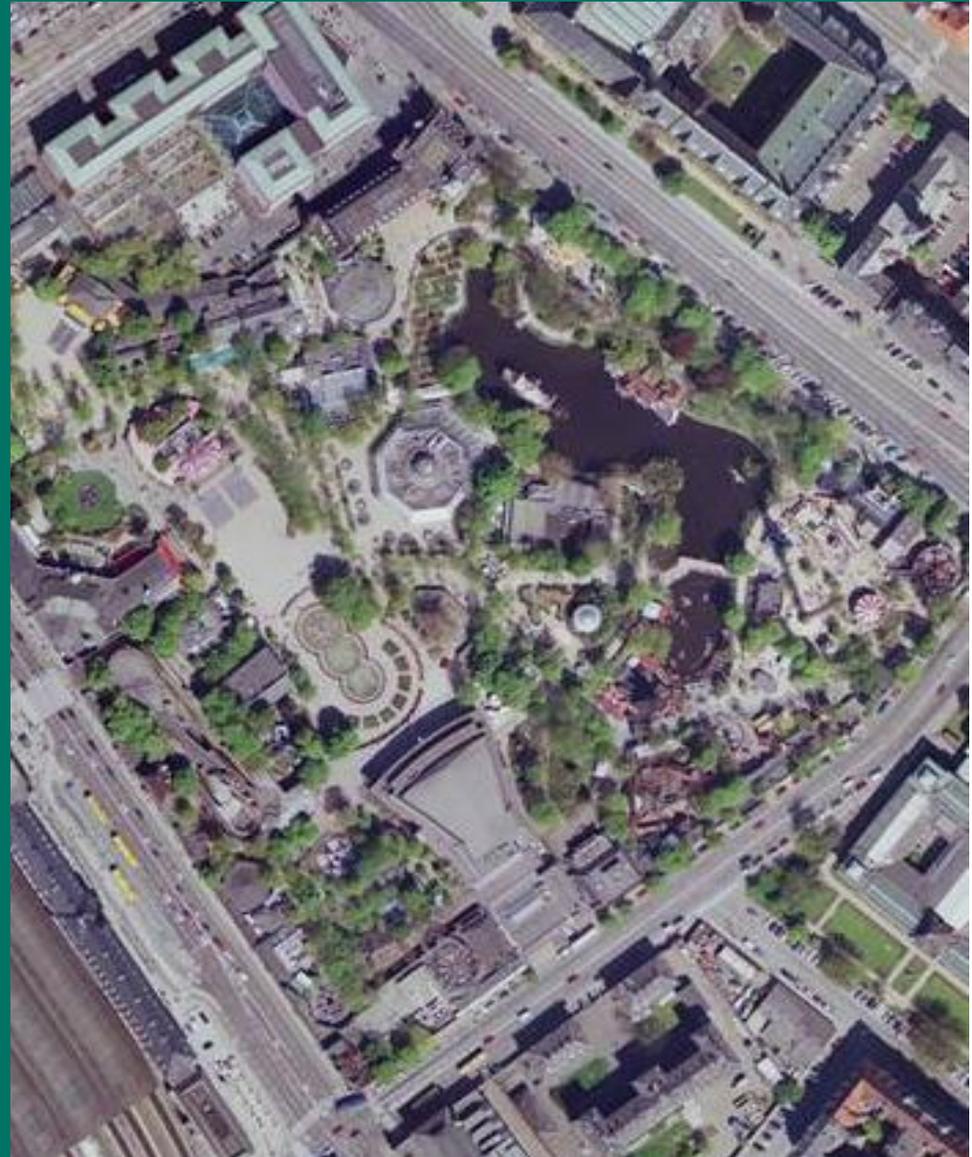
# Energy planning and infrastructure

- **Energy strategy and planning**
- **Kyoto mechanisms**
- **Energy system engineering**
- **New and renewable energy**
- **Energy from waste**
- **Rural and low cost electrification**



# Geographical information and IT

- Mapping and map production
- Aerial photography and laser scanning
- GIS software
- Utility mapping
- Orthophotos and remote sensing
- GPS and surveying
- Expropriation
- Management of land and rights
- Asset management
- Knowledge and information management
- Industrial IT solutions
- Traffic telematics
- Transmission and communication systems



# Fixed-scale aerial photographs



**The nationwide ortho-photo product DDOLand is now completed. A large number of municipalities, country councils and private companies have bought the atlas**

# Maps of England are being updated from the air



**COWI's subsidiary  
Kampsax is one of  
the big suppliers to  
Ordnance Survey GB**

# Cadastral and Land Registry

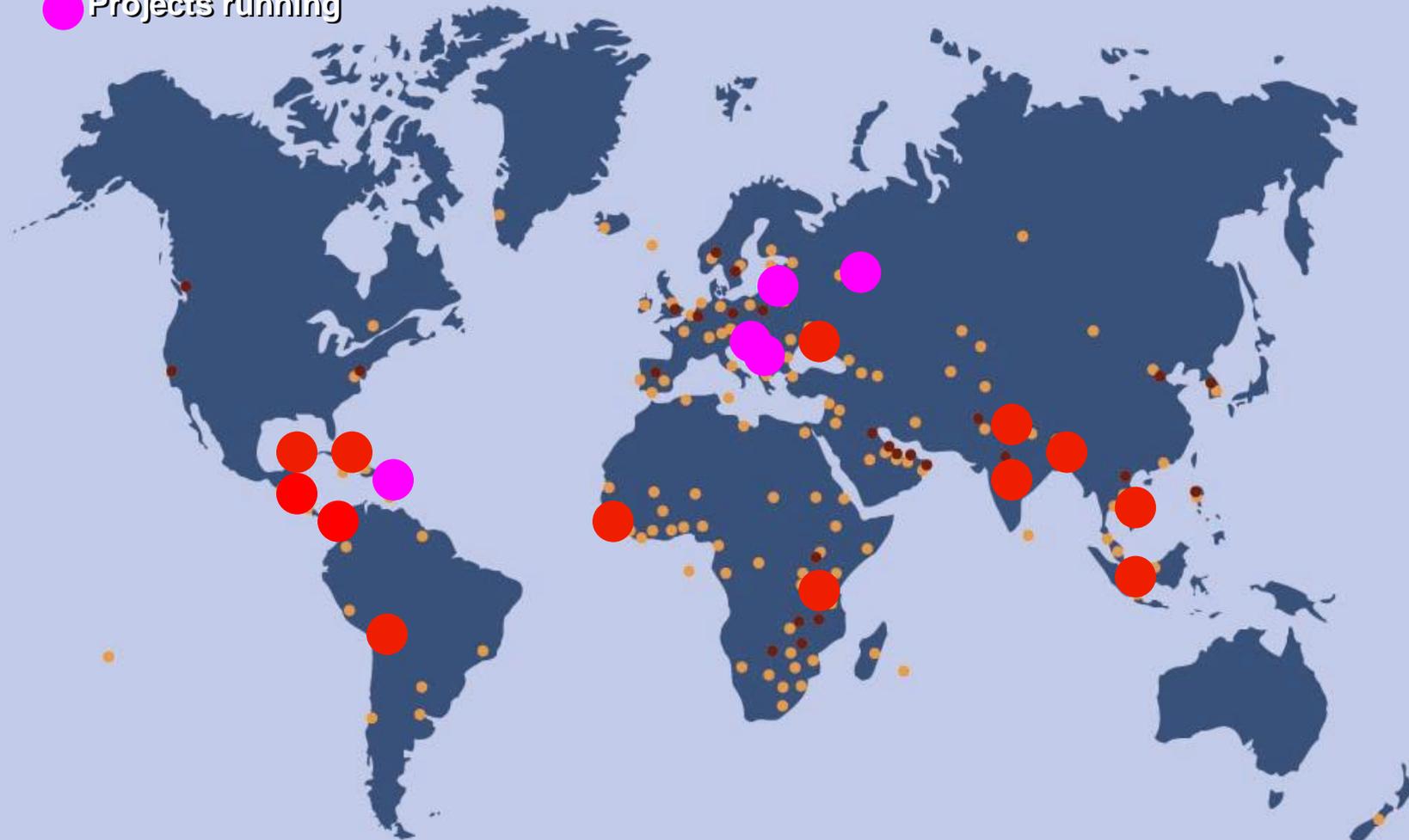
In the last 10 years, COWI/Kampsax has carried out cadastral projects with a value of more than **50 Mio USD** in **27 countries**.

Financing was given by

- The Worldbank
- Interamerican Development Bank (IDB)
- European Union
- Nordic Development Fund(NDF)
- European Commission
- DANIDA
- Private Companies

# Cadastral – projects

- Projects finished
- Projects running



# Cadastral – projects

## BOLIVIA 1999 – 2003

National Landadministration Project  
(Proyecto Nacional de Administración  
de Tierras, Catastro Rústico Legal  
(CAT- SAN))



**Adjudication and cadastre of more than 2 Mio  
hectares in the departaments of Sta. Cruz, La Paz  
and Beni**

Budget: 7 Mio USD

Financed by : Nordic Development Fund (NDF)

# Cadastral – projects

## PANAMA 2003 – 2005

Regularization of lands in five districts of the Chiriquí Province (ca 2000 km<sup>2</sup>)



**Establishment of a geodetic network, cadastre and registry of all existing rural and urban parcels,  
Creation of a cadastral GeoDataBase**

Budget : 2.09 Mio USD

Financed by : The Worldbank

# Cadastral – projects

## EL SALVADOR (1) 2001 – 2005

Update of real property register and cadastral in the departments of San Salvador/La Libertad



- **Ortophotoproduction and 3D-Restitution of 2500 km<sup>2</sup> rural and 456 km<sup>2</sup> urban area**
- **Cadastral and Legal register of all existing urban and rural parcels**
- **Creation of a cadastral GeoDataBase for the national Cadastral Information System (SIRyC (Sistema de Información Registral y Catastral))**

Budget : 11.5 Mio USD

Financed by : The Worldbank

# Cadastral – projects

## EL SALVADOR (2) 2003 – 2005

Update of real property register and cadastral in the department of La Paz

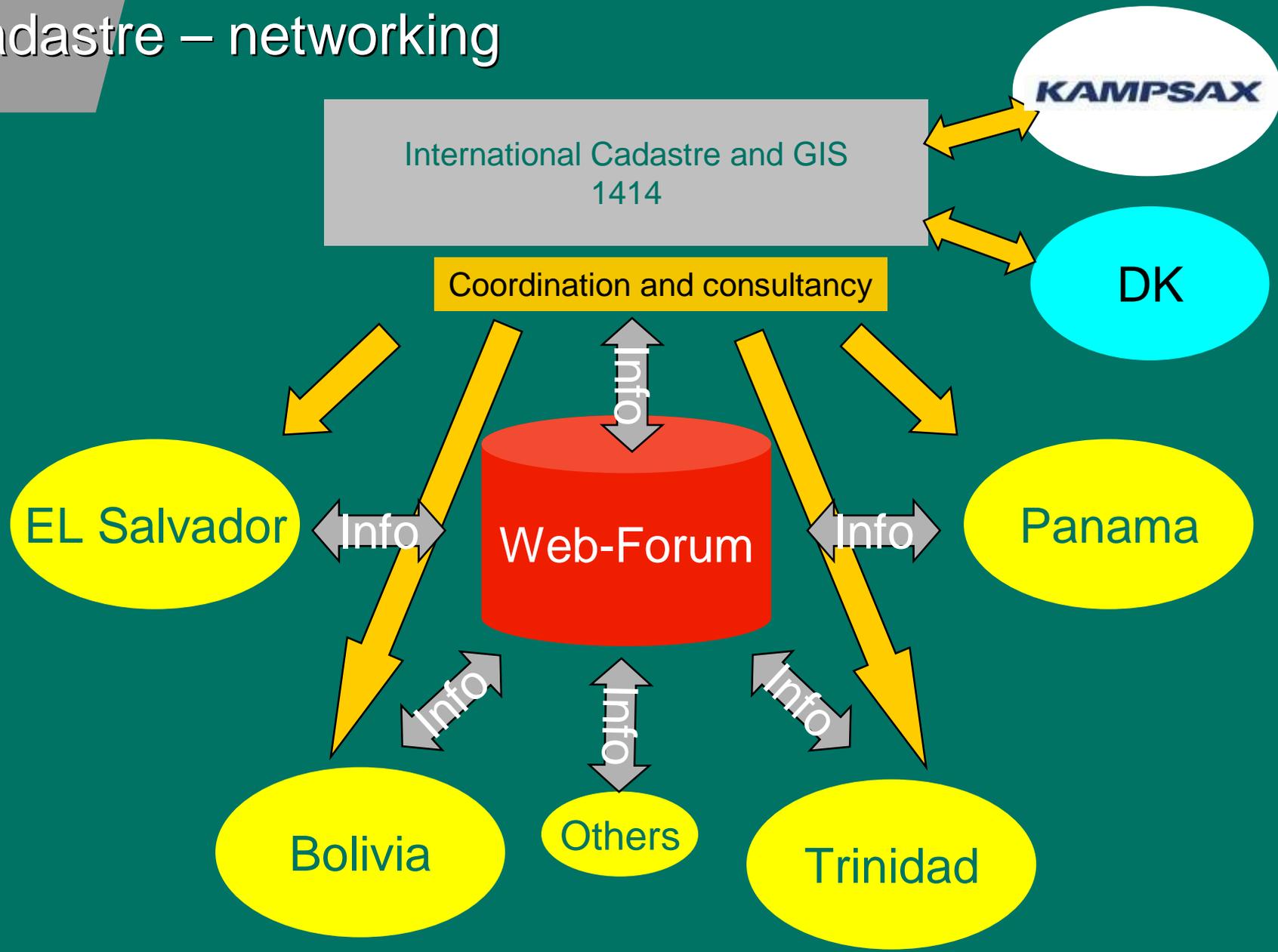


- **Cadastral and Legal register of all existing urban and rural parcels**
- **Creation of a cadastral GeoDataBase for the national Cadastral Information System (SIRyC (Sistema de Información Registral y Catastral))**

Budget : 3.0 Mio USD

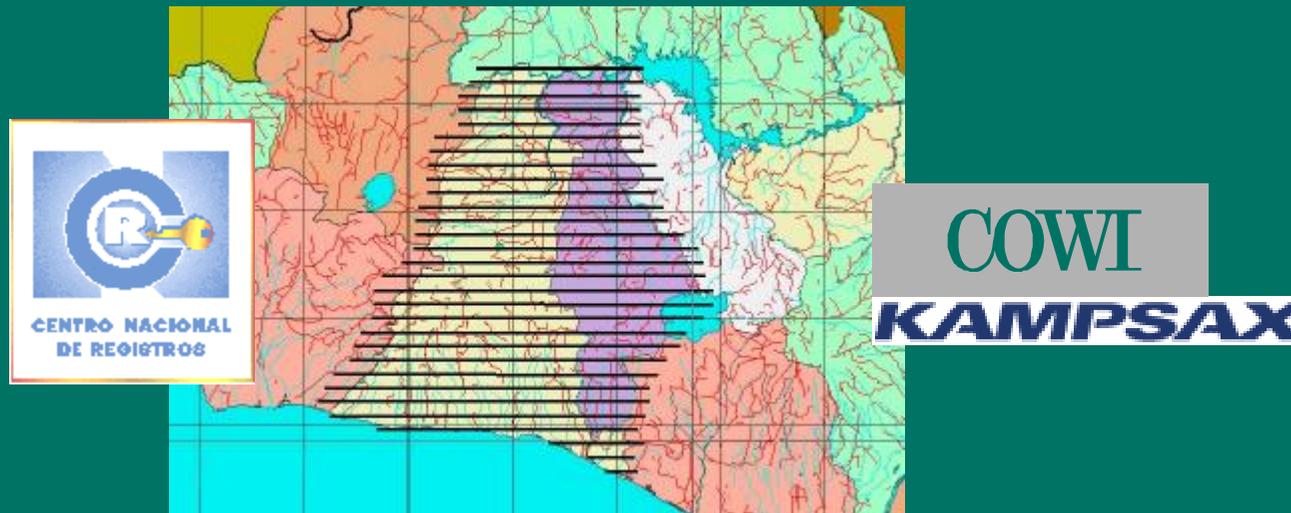
Financed by : The Worldbank

# Cadastral – networking



# Cadastral – El Salvador

Actualization of real property register and cadastral  
in the counties of San Salvador and La Libertad



# Where is El Salvador?



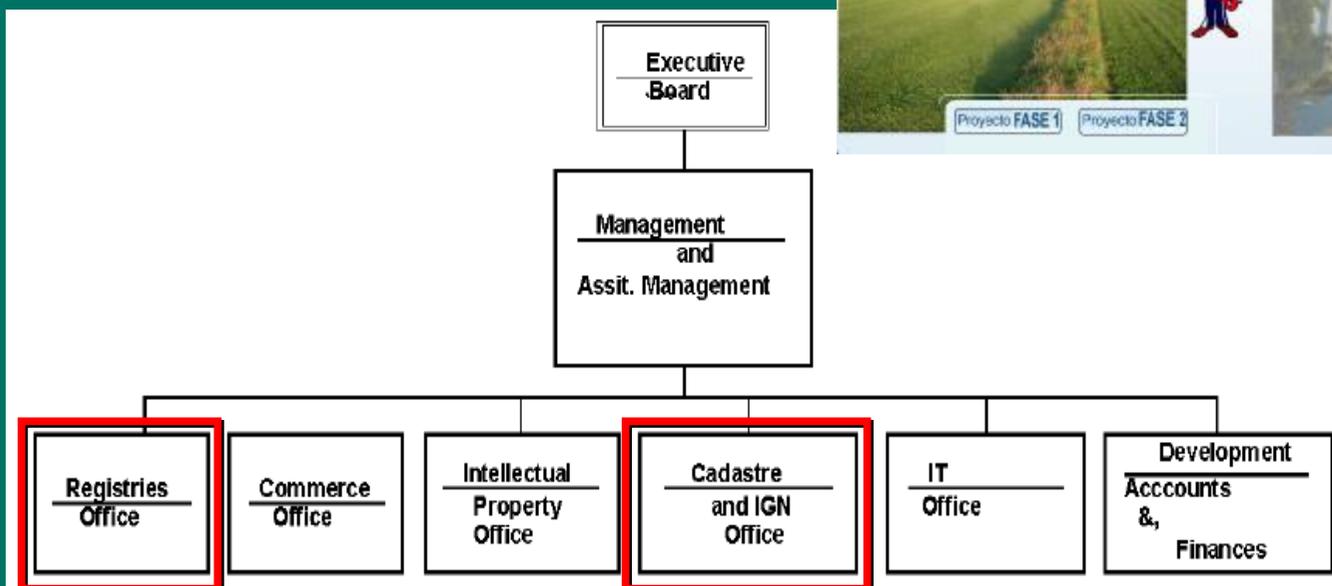
- Area: 20,740 km<sup>2</sup>
- Border Countries: Guatemala, Honduras
- Regions: Western, Central, Paracentral, Eastern
- Departments: 14
- Municipalities: 262
- Population: 6,9 million
- Population of the capital city, San Salvador: 2,1 million

# Where is El Salvador?



# Project San Salvador / La Libertad - Client

Since 1994 one authority



# Project San Salvador / La Libertad

## Project objectives

- **Public Campaign**
- **Establishment of a Local Geoid for Height Interpolation**
- **Orthophotoproduction**
- **Digital Terrain Model 10m\*10m**
- **3-D Restitution for urban Areas**
- **Cadastral and Land Registry in Rural and Urban Areas**
- **Delivery of a Cadastral GeoDatabase for SIRyC**

# Project San Salvador / La Libertad

## Items - Base Cartography

- Determination of a local geoid for the project area
- Photogrammetric Ground Control
- Aerotriangulation of flight scale 1:15.000
- Production of Ortophotos and DTM from flight 1:15.000 for 2500 km<sup>2</sup>
- Aerotriangulation of flight scale 1:5.000
- Production of 3D-stereorestitutions for 456 km<sup>2</sup> urban area

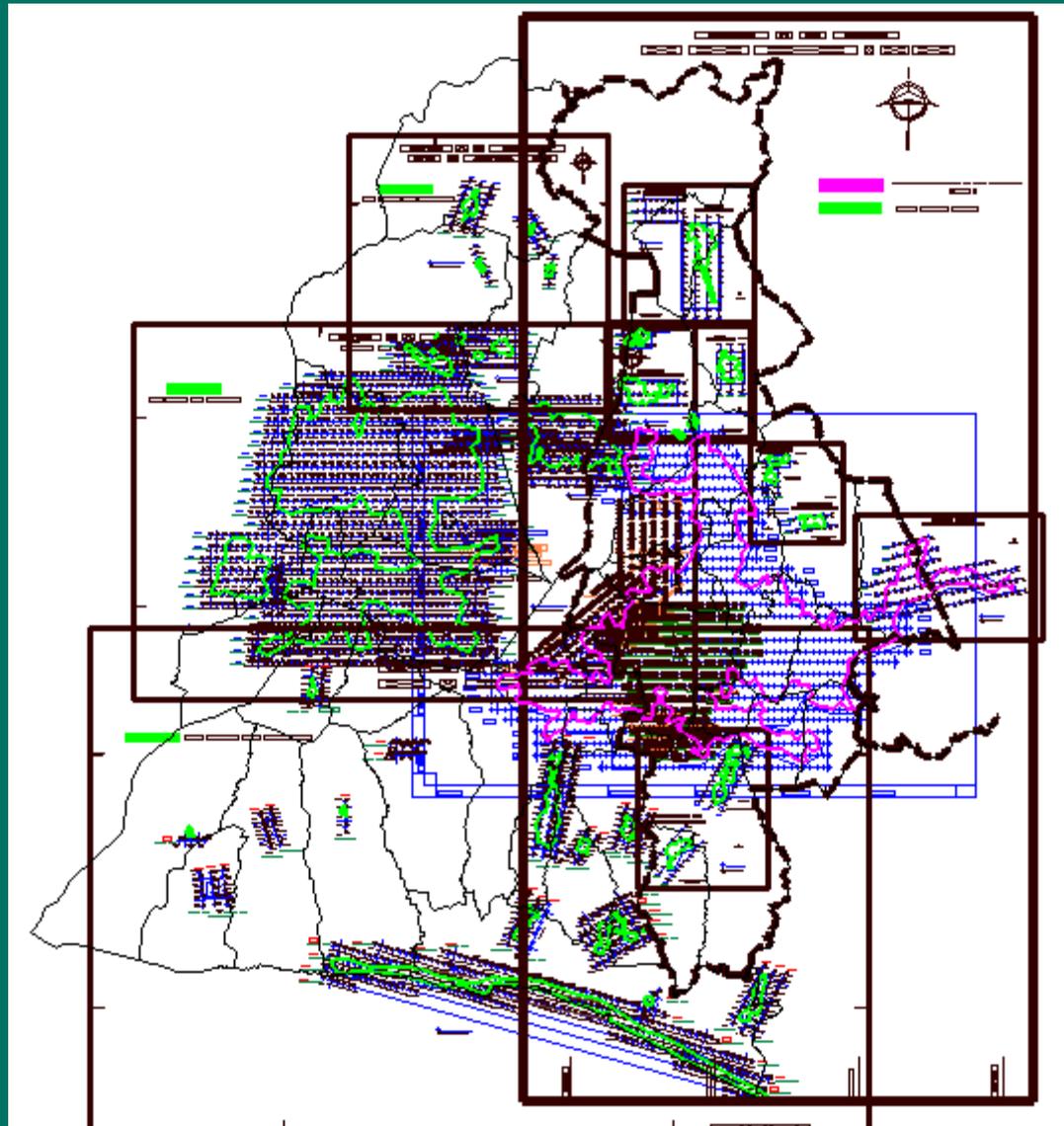
# Project San Salvador / La Libertad

## Items – Cadastre/Registry

- Cadastral survey and verification of rights in 2135 km<sup>2</sup> rural area and 95 km<sup>2</sup> urban area
- Production of digital topographic and cadastre maps in Microstation/Bentley Geographics
- Analysis of legal data and registry database in Oracle
- Application of a strict quality control process according [ISO 2859](#)



# Cadastre-El Salvador Flight coverage - urban



# Photogrammetry - Stereorestitution



**Typical urban area San Salvador**

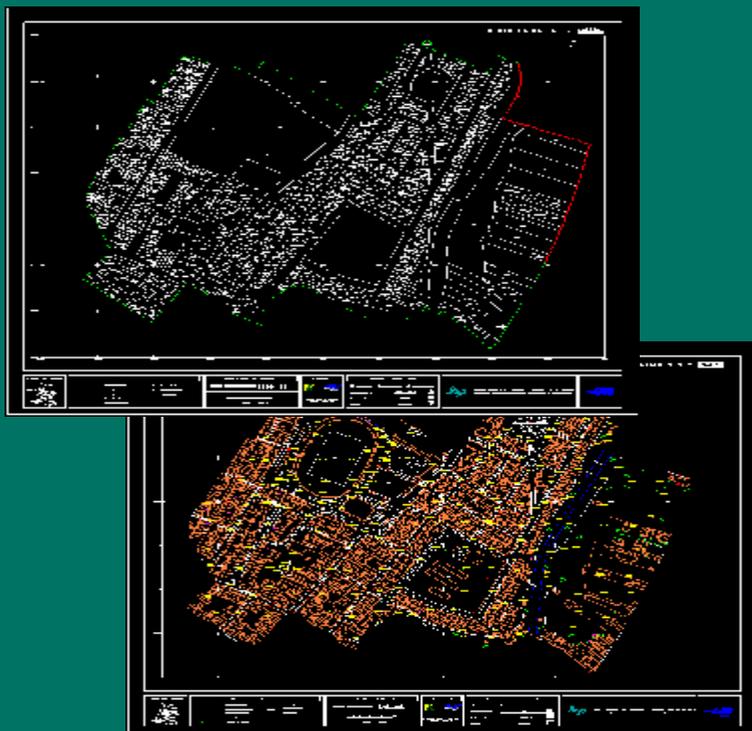
# Project San Salvador / La Libertad

## Precisions requested:

Geoide:	Precision of interpolation $\sigma = 15$ cm
Restitution	Horizontal: $\sigma = 0.20$ m Vertical $\sigma = 0.40$ m
Cadastre(rural)	Vertices $\sigma = 1.0$ m (Photoidentification)
Cadastre(urban)	Vertices $\sigma = 0.20$ m Determination by restitution or distances
Topographical Measurements:	Precision $\sigma = 0.20$ m

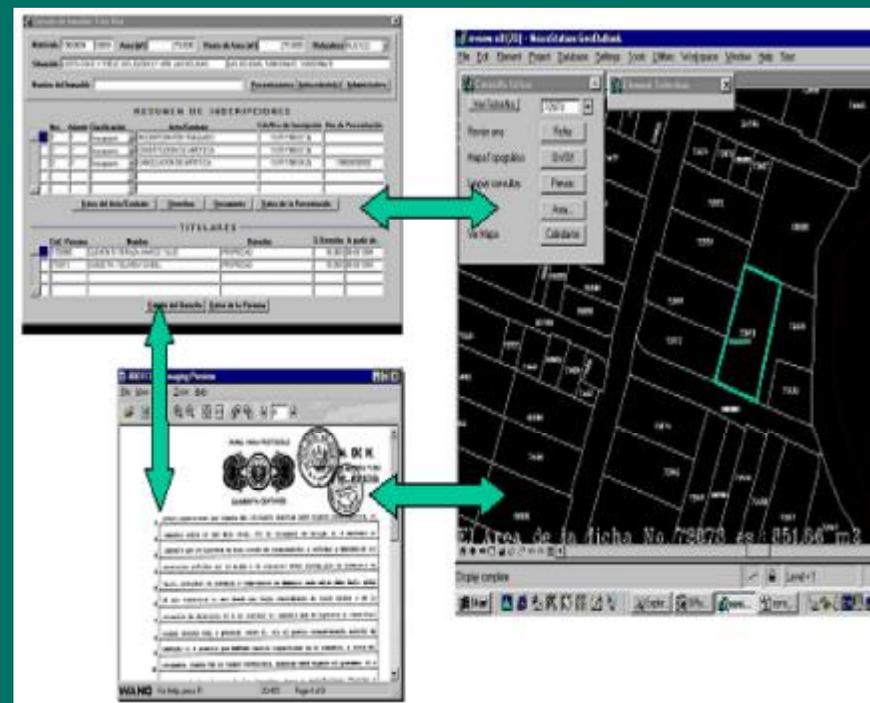
# Production – Products Cadastre

a. Cadastral / Topographical Map



Printable size A0 scale 1:5000(rur) and 1:1000(urb)

b. Cadastre with Link (Project) to legal Database



# Cadastre-El Salvador Projectteam

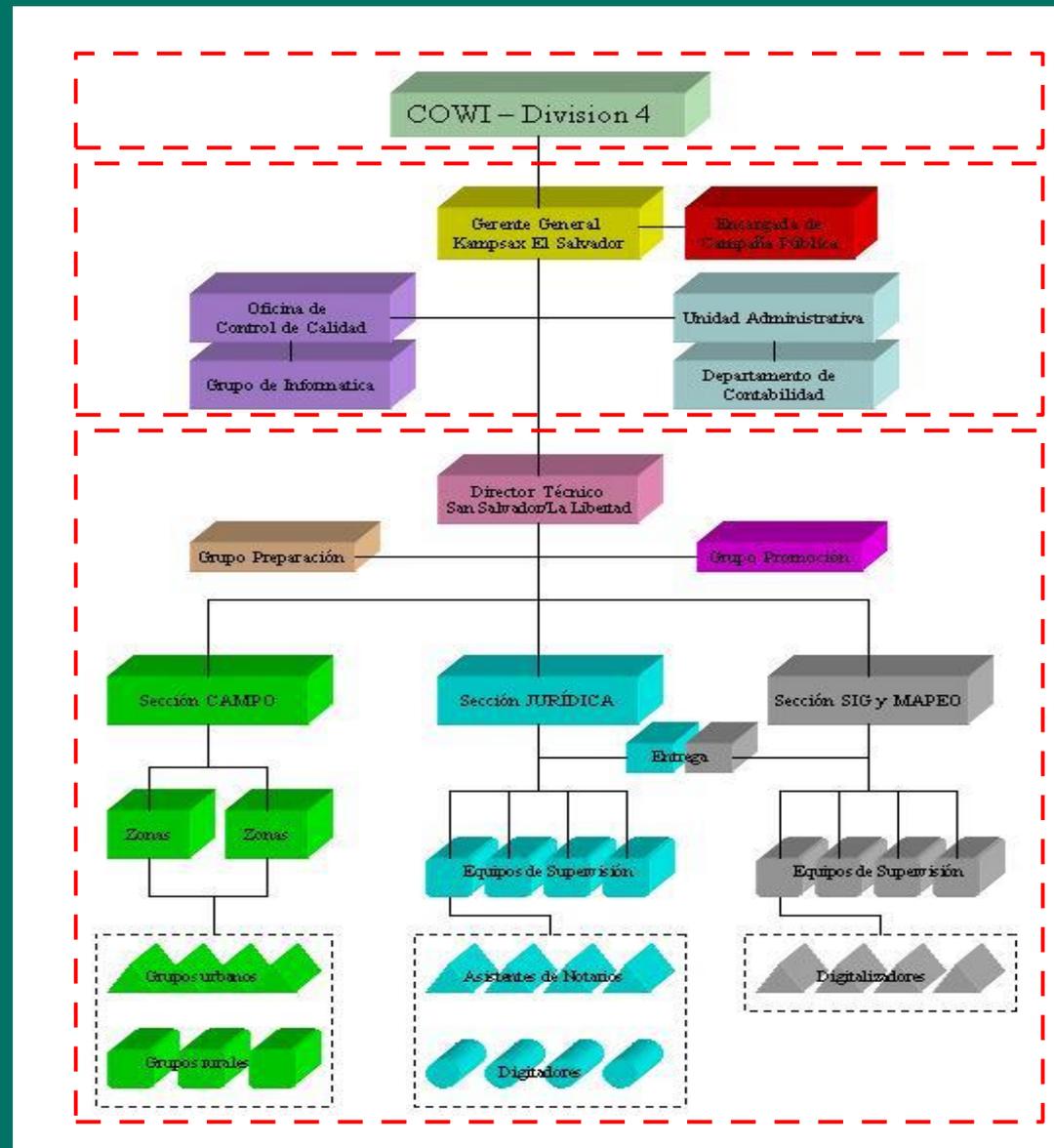


# Administrative structure

Denmark

El Salvador  
Management  
SS/LL and La Paz

El Salvador  
Project SS/LL



# Production - Personal

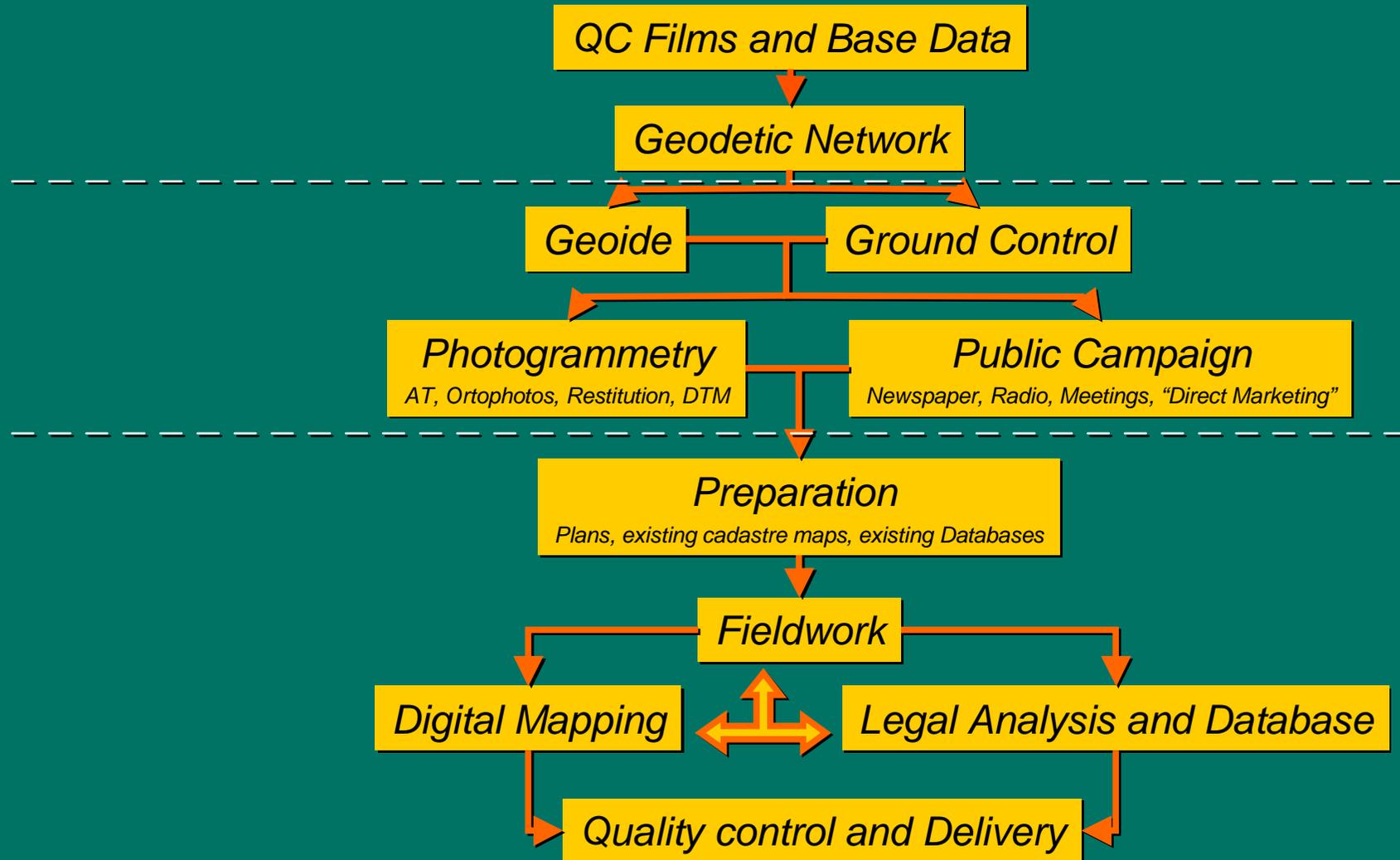


<u>Department</u>	<u>Personal</u>	<u>Production/month</u>
Preparation	6 Tec. Geo 7 Tec. Jur.	24 Sect (U) = 6km <sup>2</sup> 15 Sect (R) = 90 km <sup>2</sup>
Field	13 Ing./Arq. 7 Lawyer 106Tec.(Cad./Jur./Top.)	9.000 Pc (U) 4.000 Pc (R)
Mapping/GIS	5 Ing/Arch. 16 Tec.Geo.	9.000 Pc (U) 4.000 Pc (R)
Legal	2 Public Notaries 30 Lawyers	9.900 Fichas (U) 4.400 Fichas (R)
Quality Control	2 Ing./Arch. 3 Lawyer	650 Pc (U/R) 715 Fichas(U/R)
<b>Total</b>	<b>198 Pers. (+ 5 Staff y 10 PR)</b> <b>= <u>213 Pers.</u></b>	

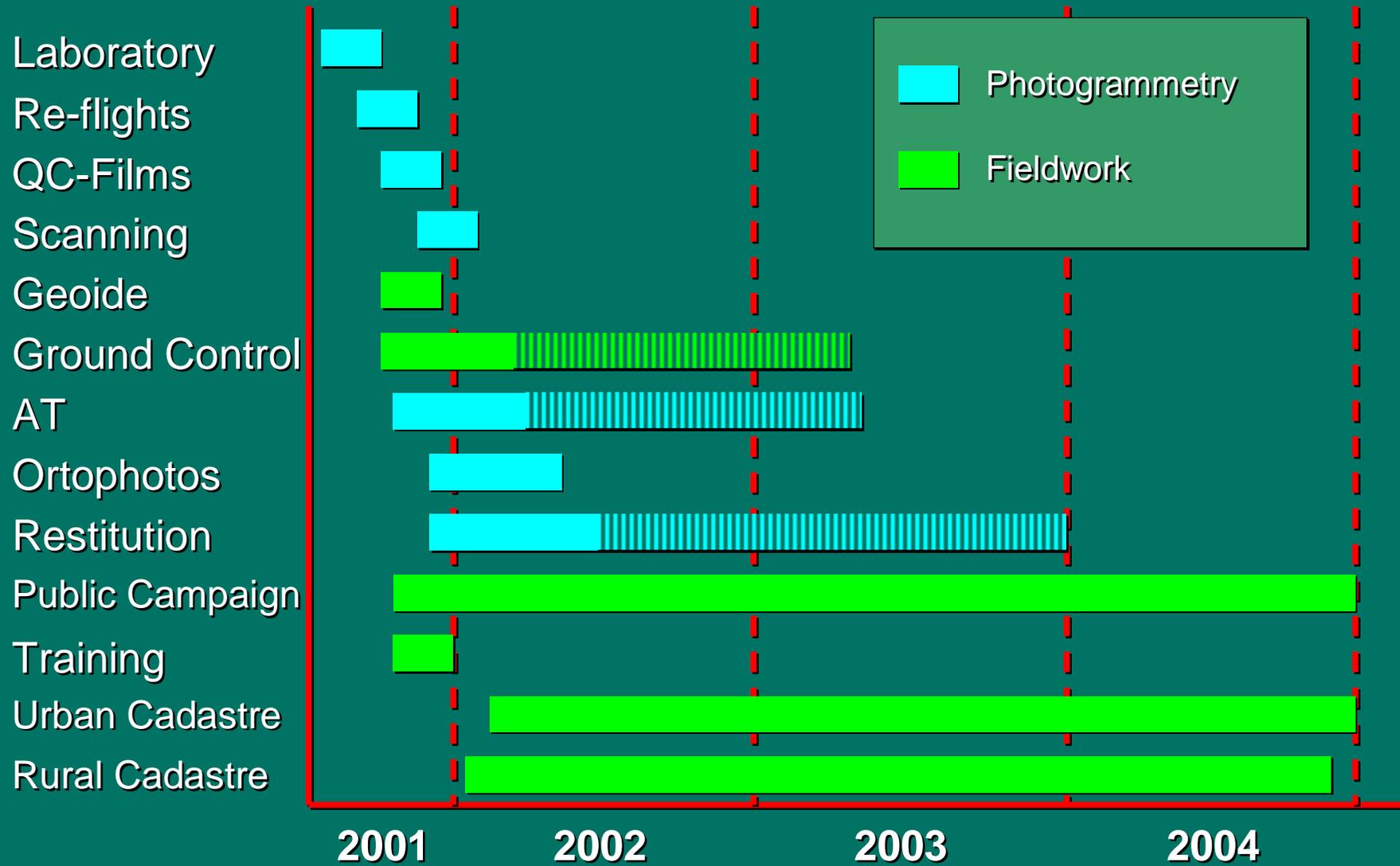
# Production - Equipment

<u>Dpt.</u>	<u>Technical Equipment</u>	<u>Vehicles</u>
Preparation	13 PC, 3 Plotter 24"/36" 1 Digitizer board A0	
Field	4 Pc 21 GPS single/double-freq., Leica RTK/Sokkia 3 Totalstations 26 Distancemeters Leica	26 Pickup/Jeep 4 Minibus 6 Motorbikes
Mapping/GIS	22 Pc 2 Printer	1 Vehicle
Jurídica	32 Pc 3 Printer	
Quality Control	5 Pc	1 Vehicle
<b>Total</b>	<b><u>76 Pc with periph.</u></b> <b><u>38 Vehicles</u></b>	

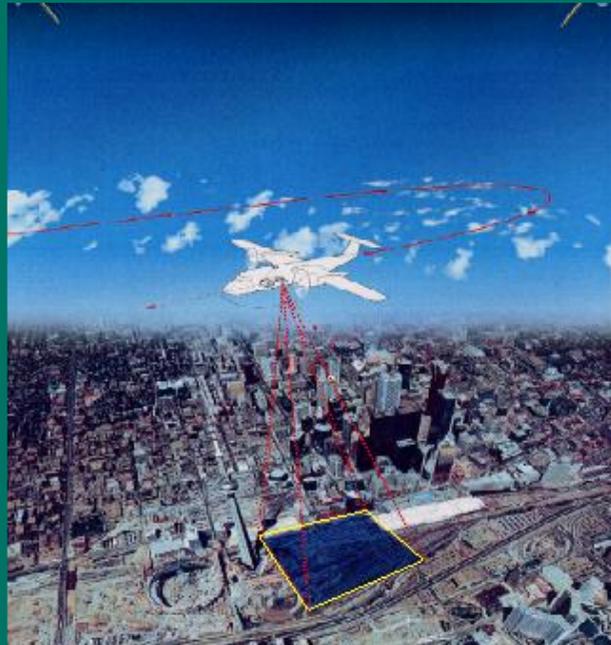
# Cadastral Workflow



# Cadastral - Timeframe



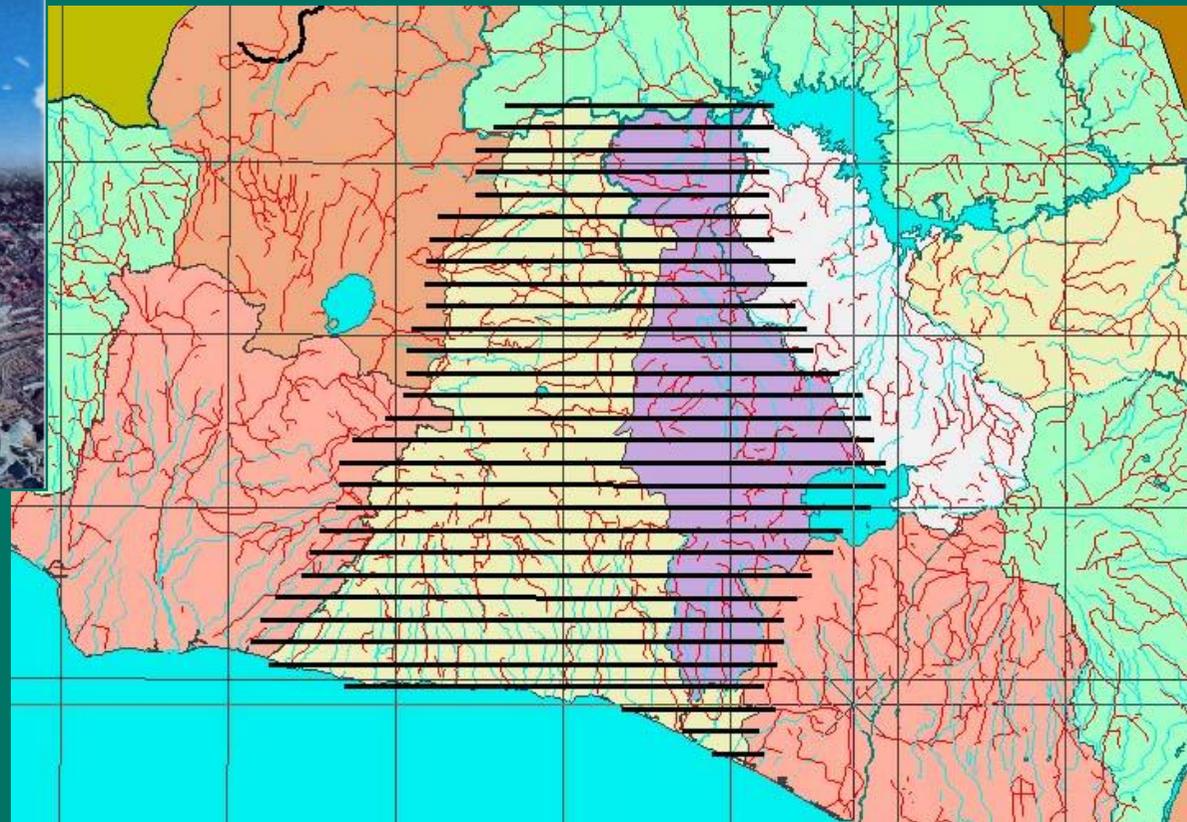
# Photogrammetry



## Rural Areas

Flight scale 1:15,000

COVERAGE DEPARTMENTS OF SAN SALVADOR LA LIBERTAD.



30 Lines

1,100 Photos

DECEMBER 2000

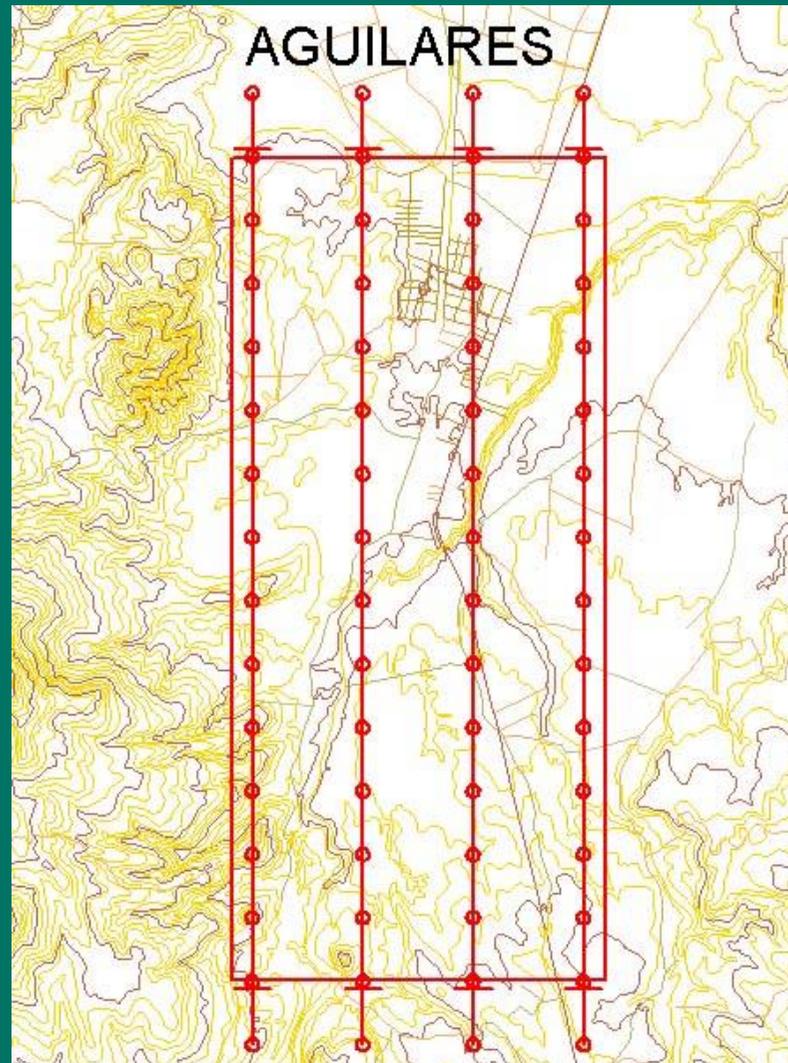
# Photogrammetry

Urban Areas  
Flight scale 1:5,000

**SAN SALVADOR**  
19 Municipalities  
1,544 Photos

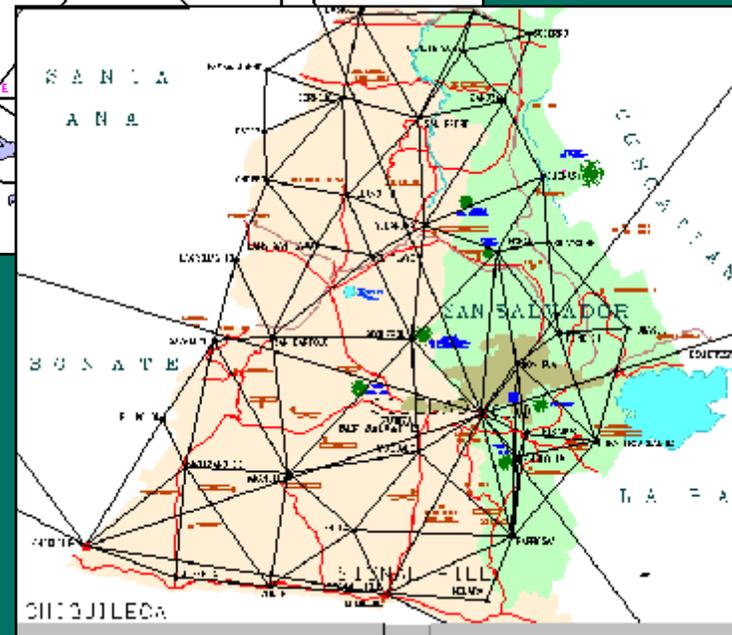
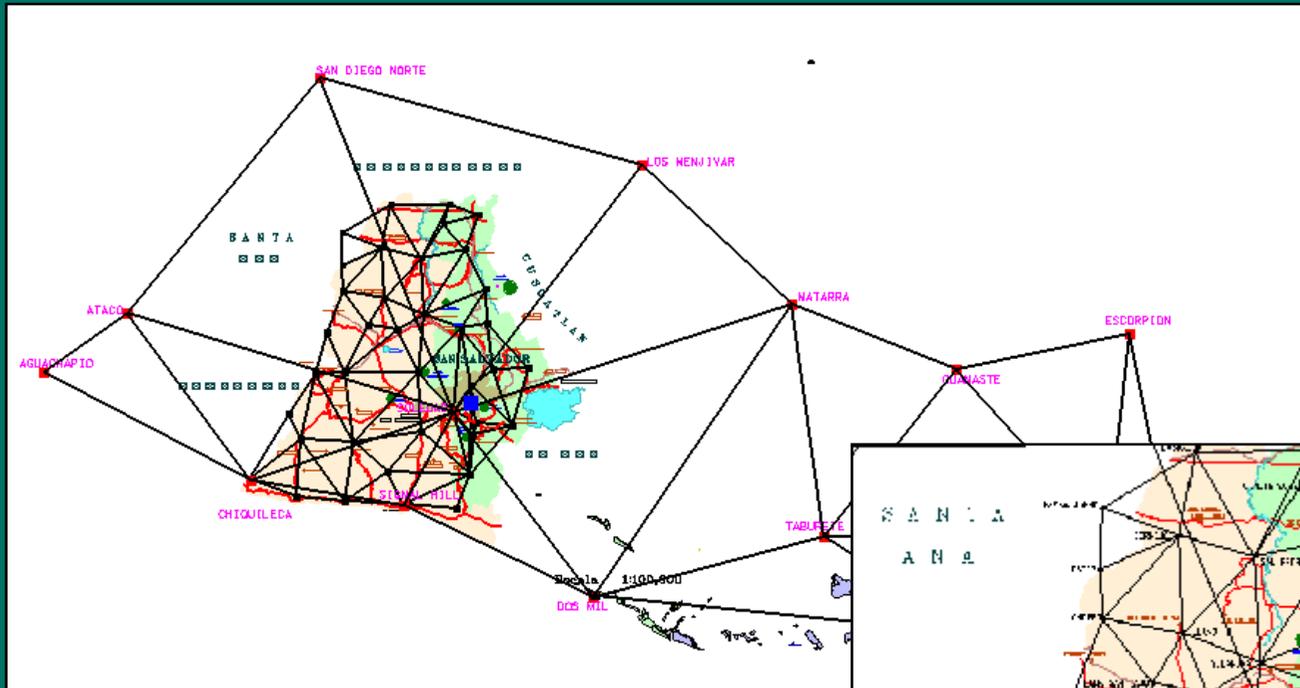


**LA LIBERTAD**  
22 Municipalities  
1,765 Photos



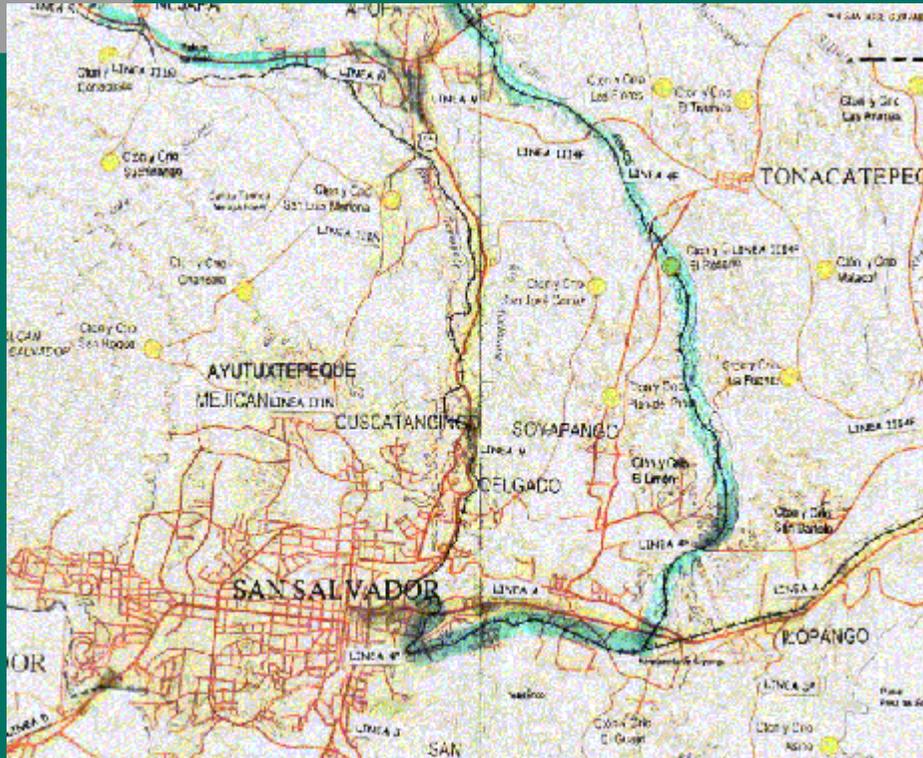
Scale: 1,5000

## GEODETIC NETWORK EL SALVADOR



**SAN SALVADOR**  
and  
**LA LIBERTAD**

# Geodesy



# ALTIMETRY

Usage of  
First Order Levelling  
Network

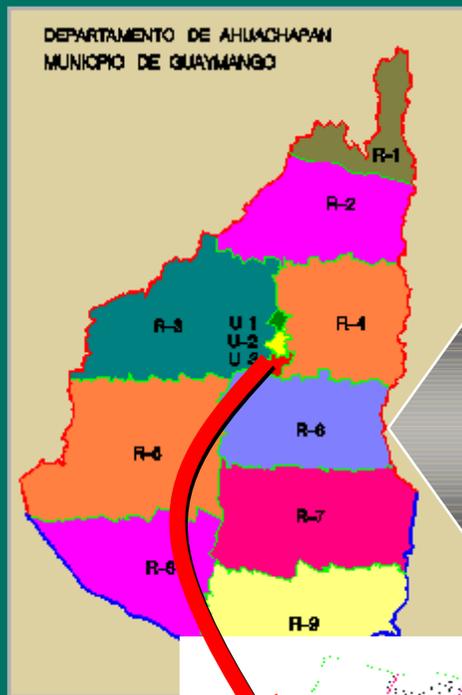
**PRECISION: First  
Order**

**LOCAL  
GEOIDE  
FROM  
40 POINTS**

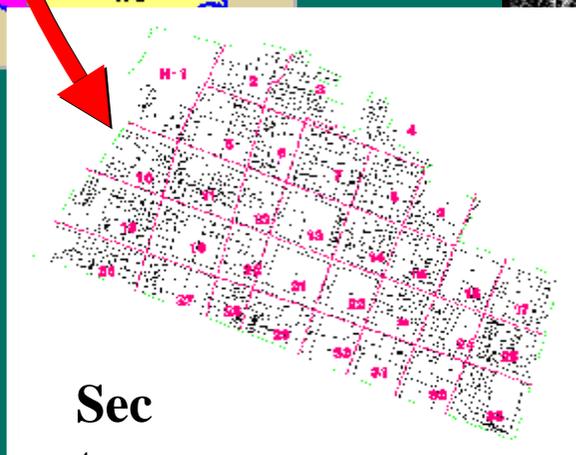


# Cadastre - Workflow

**SECTORIZATION**



**SUB-SECTORIZATION**



Sec  
tor  
UO

# Cadastre - Workflow



## Determination of Boundaries

- Photoidentification
- Restitution
- Direct Topographical Survey



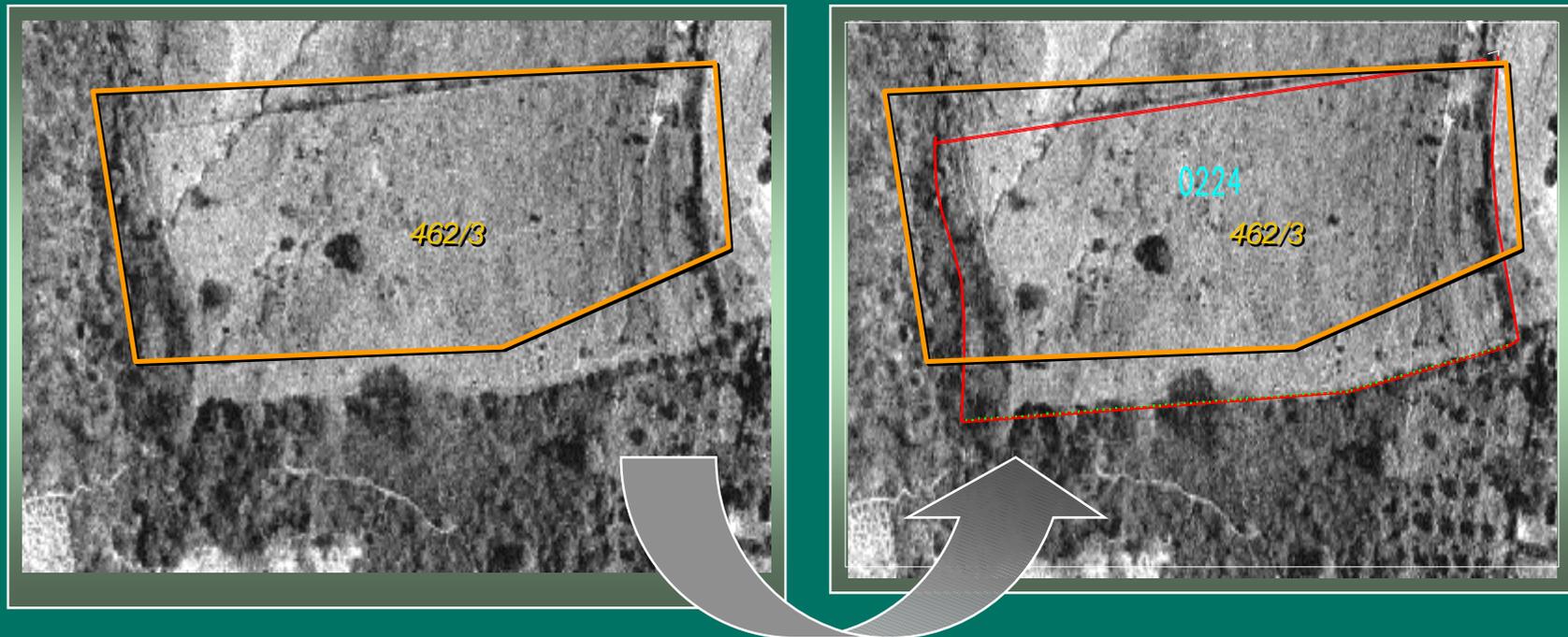
## Interview with the owner

- Interpretation of documents
- Verification with database

# Cadastre - Workflow

Limits which coincide with visible elements in the ortophoto. In this case the technician draws a line in the plot following the visible (linear) element.

## EXAMPLE:



# Cadastre - Workflow

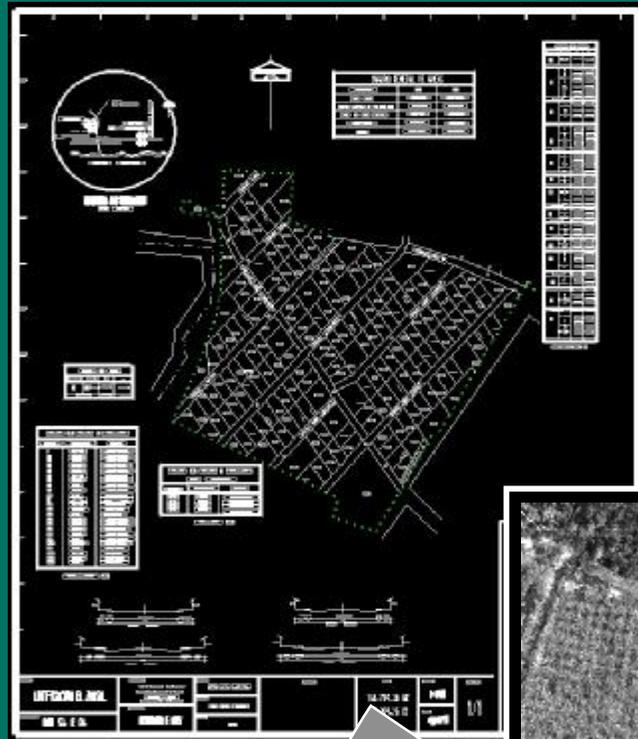


Limits which cannot be identified neither in the ortophotos nor in the restitution.

The topographers use

- Direct distance measurements
- Totalstations
- GPS

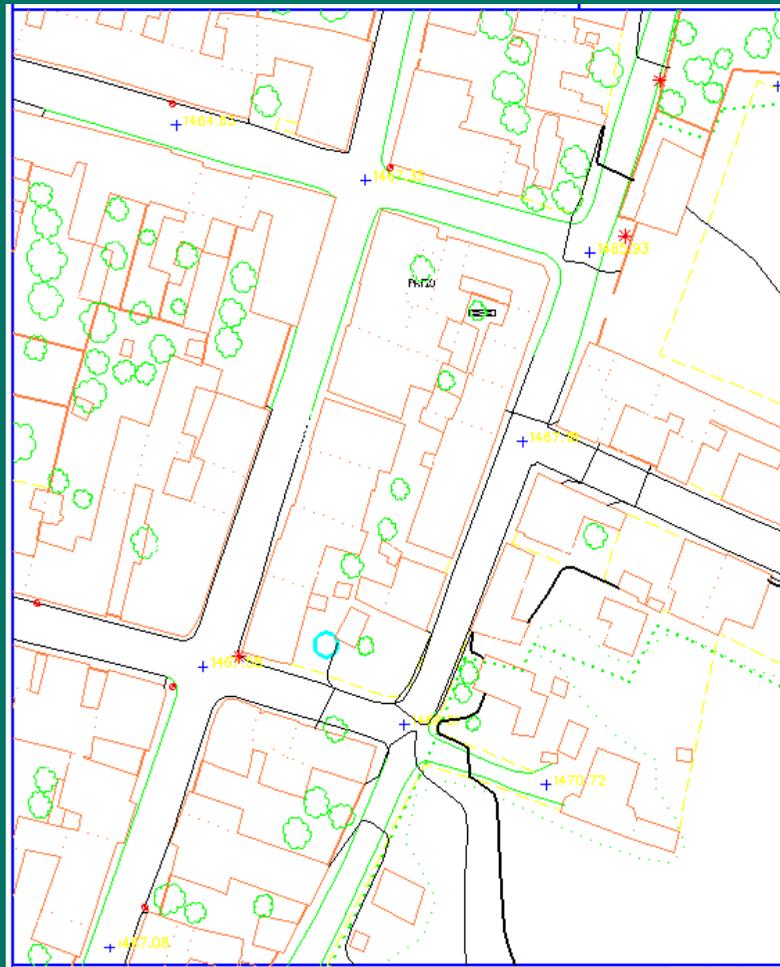
# Cadastre - Workflow



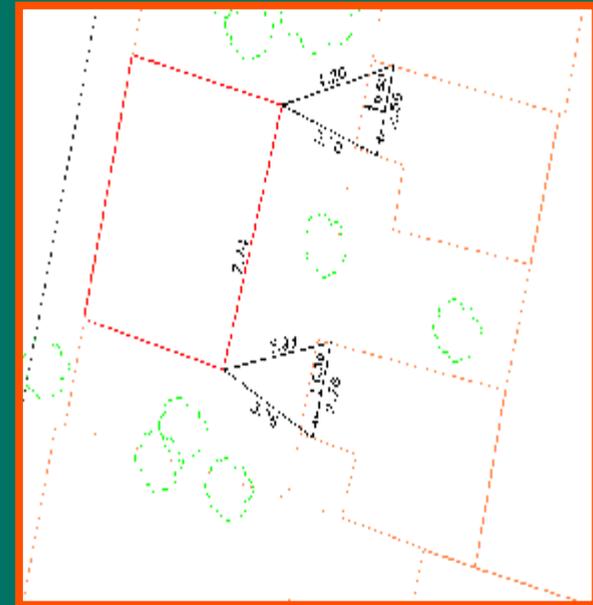
Existing plans of settlements can be identified in the field and be georeferenced (Helmert-transformation) to the reference framework.



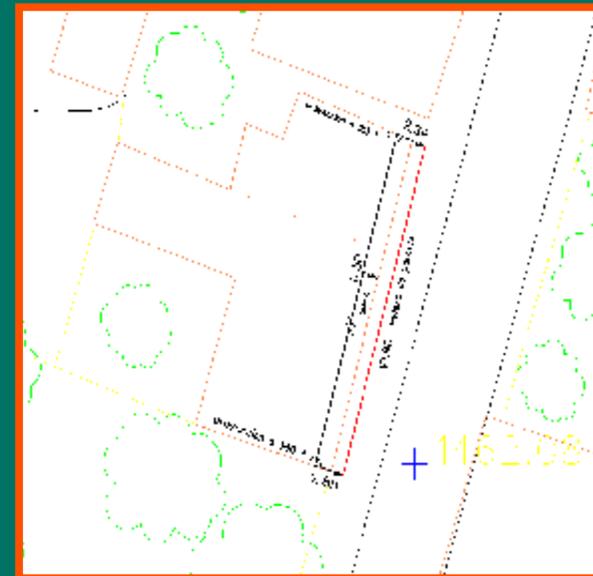
# Cadastre - Workflow



Intersection



Extension



# Cadastre – Workflow Office

## Legal Analysis



## Digital Mapping



## Legal Database



## Web-Based IS



# Cadastre – Problems

- **Existing Cadastre-maps with displacements up to 200m**
  - à Difficulties linking registry database to existing parcels
- **Budgeting/Workplan of the client completely different**
  - à Huge price differences in the tender process, discussions
- **Public Campaign started long before base cartography at the disposal**
  - à Strategic design with difficulties
- **Municipalities/Project area/Urban areas not well defined**
  - à Re-Works in border areas, Contradictions with old database, negative economic development
- **Sectorization/Time-table did not fit to the reality**
  - à Repeated planning

# Cadastre – Comments

## Use of Mapping and GIS

### Before the project

- Definition of a well adapted **feature catalogue**
- Assessment of the option to adapt old cadastral data(**update**)
- Early Identification of **municipal limits and project area**
- Exact **identification of urban areas** (and hidden settlements)
- Definition of the **working sequence** in the terrain (Simulation)
- Cost assessment (**budgeting**) taking in account density of parcels, access-roads, weather conditions, terrain

# Cadastre – Comments

## Use of Mapping and GIS

### During the project

- **Cost control** by GIS-based Monitoring System
- Supervision of **deliveries** and comparison with base-line
- Supervision of **productivity** in the departments
- GIS-based **Quality Control System** for geometric deliveries

# Cadastral – Comments

## Use of Mapping and GIS

### After the project

- Usage for **Cadastral Maintenance**
- **Web-based** Cadastral Information System
- Usage of cadastral data in **National GeoDatabase**