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The cadastre as part of a spatial data infrastructure for developing countries**

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The Cadastre as Part of a Spatial Data Infrastructure for Developing Countries

1. Introduction

A spatial data infrastructure as formulated by former U.S. Vice President Al Gore, and as propagated by a great number of UN-affiliated NGO’s such as FIG, ISPRS and ICA is indeed a powerful tool to facilitate decisions for a sustainable development of all countries, as 80 % of decisions are based on a geospatial component.

The success of a SDI in the global, regional, national and local context greatly depends on the availability of data.

The UN Secretariat historically published the status of available surveying and mapping data in World Cartography. Yet the last UN survey on these issues was conducted in 1990 and published at the UN Conference in Beijing in 1993.

The data covered mapping coverage between 1:250 000 and 1:24 000. However, the collection of data on large scale coverage was not successful. Yet, of particular value was the survey of update rates, which showed that traditional mapping at the recorded scales was globally outdated.

In the meantime the Asia and Pacific and the Americas Regions have attempted to collect their own data. Nevertheless this was not done in standard form.

While global initiatives, such as the Global Map have initiated collaborations between nations do collect a digital global base and thematic map initially at the scale 1:1 million to be extended into the 1:250 000 range the pressing sustainable development issues rest at the larger scales, which are often not the responsibility of national mapping agencies, but of local governments and municipalities. This is particularly an urgent issue in the growing megapolis areas of the globe.

In view of the recent availability of high resolution satellite images from Ikonos 02, Quickbird and Orbview 3 with many other satellites from other nations to follow a rapid tool is available to replace the tedious large scale mapping process by geocoded image information collected and distributed through enterprise and web accessible geodata bases.

A geodata base now consists of available topographic raster of vector basic map data, of digital elevation models, of geocoded orthophoto and satellite images supported by vectorized administrative boundary data to which attributes have been linked.

A geodata base easily permits overlays between GPS controlled image data referenced to an ITRF epoch and map data collected to former reference datums. The fitting of the old and often outdated map data is a straight forward technical issue.

In the large scale domain sustainable development, however, depends on the use of land and the rights to land. At these scales land management greatly depends on cadastral records.

In countries, which have updated large scale mapping coverage at scales between 1:1000 and 1:5000 such as Germany and most other European countries the cadastre forms an integral part of the spatial data infrastructure.

2. The Situation in Developing Countries

Problem areas are the developing countries which did not have georeferencable cadastral data to start with or the reform countries, which have neglected the update of land rights information during the socialist period.

For these areas the donor agencies of European and North American countries and foremost the World Bank have instituted programs for the establishment and maintenance of a cadastral system.

While European donors mainly favoured the establishment of a multipurpose cadastre including cadastral boundaries with a topographic base, this approach was often not recommended by U.S. donors and the World Bank to save costs. Nevertheless, to be of use to a large scale SDI the integration of the cadastral data with a topographic base should be a requirement.

3. German Technical Cooperation Projects

German technical cooperation agencies, such as **GTZ** and **KFW** have favoured this approach in a number of countries, for which some examples should be cited:

In **Croatia** procedures were developed to overlay large scale digital orthophotos, geocoded via GPS control with digitized and outdated cadastral vector data. They revealed that the accuracy of the existing cadastral plans was not only affected by the inaccuracies of the old geodetic framework established decades ago by traditional methods. But they also revealed inaccuracies and the lack of updating in the historical local surveys and records.

The digital orthophoto and their overlay have thus proved themselves as the most effective quality control tool. This helps to define local areas, where cadastral resurveys are required.

In **Cambodia** and in **Georgia** usable cadastral map records did not exist. Thus another procedure was and is being used to gain initial cadastral records:
First a GPS densification network is established to the worldwide IGS frame to a few cm accuracy. The densified GPS network is used as reference to establish control (inflight and on the ground) for photogrammetric flights. They permit to produce digital orthophotos when these are used in pen computers or PDA's in conjunction with GPS ground surveys, occupying a closeby GPS reference station and a rover doing the measurement, the orthophoto in the PDA or the pen computer guides the survey process. The connection via pen computer of PDA is via Bluetooth. During or connected with this survey process the adjudication between parcel owners takes place. They have been asked to

Premark their boundaries together with their neighbours. The survey data including the images of presented documents (titles, deeds) are transmitted via GSM to the survey office for entry into the data base.

The survey result is published after compilation on a board at a local center, where it is subject for modification or confirmation for a one month period. Thereafter the cadastral records are considered as final, and a new law takes effect for the sporadic update procedures which are transaction based.

In Georgia it has become possible to establish the cadastre for 70 % of the country (2.1M parcels) at the cost of initially 10$/parcel and after experience and training at 3 $/parcel.

4. Use of High Resolution Satellite Images

In rapidly developing urban areas without existing of updated cadastral records interim short-cut procedures for developing an updated topographic and cadastral base map have been initiated in the city of Tirana, **Albania**. The former cadastral agency, which kept a cadastral map at the scale 1:1000 has ceased graphic update operations in 1992. Since then the city has grown from a population of 200 000 to 600 000 with uncontrolled construction. The need there is for a rapid regulatory plan at the scale of at least 1:2000 and an accuracy of ± 3 m, which at least shows buildings and visible boundaries (walls, hedges) for preliminary parcels. To identify such objects is possible by Quickbird imagery with 0.6 m ground sampled distance. For these identified objects a quick local survey is carried out which does not solve legal issues, but which gives the Municipality the possibility to plan by regulations and to enforce them for future development. The survey is intended in a six months period.

Following this a more costly and more time consuming solution to establish cadastral geometry and cadastral rights can be undertaken. Donors for five year project have already been approached after a cadastral urban restitution was carried out in a US/European sponsored pilot for about 15 % of the urban area.

The full cadastral restitution is not so much of interest to the planning authorities, but of interest to the parcel owner. By establishing boundaries and title to the land he will then improve his ability to obtain mortgages from the bank at a much higher value (e.g. 90 %), than it is possible now (e.g. 10 %). This will raise the capital available in the country, which is of interest to the national economy.

5. Conclusions

The examples shown demonstrate, that it is possible and useful to combine modern technologies such as GPS/DGPS, digital orthophoto production from aerial or satellite images, geodatabases, and even mobile technology for attribute data collection in a large scale SDI.