

# Cartographic and remote-sensing data as a source of landscape ecological information on the Poznań metropolitan area

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**Abstract:** This paper characterises the system of organisation and access to spatial information in Poland based on the example of the Poznań metropolitan area. It describes the available cartographic resources, both topographic (general) and thematic. Particular attention was paid to remote sensing, being the source of the most current and non-generalised information on geographic space.

As a result of the implementation of the INSPIRE directive, activities aimed at integrating and sharing spatial data in a digital form were intensified. A practical outcome of the above is presented in the article published at Geoportal ([www.geoportal.gov.pl](http://www.geoportal.gov.pl)).

The final part of this paper shows the current applications and requirements concerning the use of spatial data in the modern management of a metropolitan area.

**Key words:** *Poznań metropolitan area, remote sensing, cartography, spatial data, GIS*

## Introduction

The modern space management requires access to possibly most up-to-date and reliable information on the local area. The traditional sources of such information are maps, plans and applicable documents and registers. The most significant cartographic compositions are large- and medium-scale topographic maps and thematic maps regarding specific issues. Until recently, the basic technique of reproducing and publishing cartographic material was printing. At present, it is also available as computer files saved in raster or vector formats, reproduced using diverse storage media and shared over the internet.

Over the recent years the significance of remote sensing as a source of information on the surface of Earth has risen considerably. The most common remote-sensing data are aerial pictures and satellite images processed into the form of an orthophotomap, i.e. a cartometric product. The advantages of remote sensing, especially in the age of digital technologies, are primarily the possibility to acquire the most current data on demand (at any time) and the fact that the resulting image of the Earth's surface is not generalised, which is an intrinsic feature of traditional maps (Monmonier, 1996).

Current information on land cover and use is a foundation for modern and competent spatial planning, whose principal purpose is to manage and use land according to the sustainable development principle and create spatial order. The implementation of geographic information and decision-making systems should have a positive effect on analyses, various documents and studies. Cartographic resources and remote-sensing data in a digital form are increasingly commonly applied in urban planning and architecture, natural environment protection and monitoring, agriculture, historic building restoration and even in promoting cities and communes (Kijowski, Mania, 2008).

Knowledge on the collected and available cartographic material, especially in the form of geographic information systems (GIS), has both a practical and economic dimension – reduces the time of source material collection, decision making, makes it possible to combine any thematic maps and geographic databases for a specific task and on a different level of detail, and permits the user to avoid redundant repetition of several compositions. Nonetheless, one needs to bear in mind that the usefulness of cartographic and remote-sensing material depends on systematic updating, particularly for areas undergoing intensive changes.

The purpose of this paper is to present the informative potential of remote-sensing and cartographic resources in integrated space management using the example of the Poznań metropolitan area understood as the city of Poznań together with the neighbouring communes: Buk, Czerwonak, Dopiewo, Kleszczewo, Komorniki, Kostrzyn, Kórnik, Luboń, Mosina, Murowana Goślina, Pobiedziska, Puszczykowo, Rokietnica, Stęszew, Suchy Las, Swarzędz, Tarnowo Podgórne, and communes situated outside the powiat of Poznań, namely Szamotuły, Skoki and Śrem.

This paper is part of the research project entitled The functioning and development trends of the Poznań metropolitan area.

### ***Cartographic resources concerning the Poznań metropolitan area***

This chapter presents the available geographic information resources applicable in spatial planning and management and natural environment protection which are provided by governmental, commercial and scientific institutions. Only resources created according to appropriate instructions were presented, which guarantees repeatability in respect of the thematic scope regardless of the place, time and author. The following cartographic products are available for the Poznań metropolitan area (tab. 1):

- Master map – a detailed surveying and cartographic study containing current information on the spatial distribution of general geographic objects and elements from the register of land and buildings as well as the infrastructure network.
- Topographic map – a map containing basic information on land cover and use forms.
- Topographic database – a system for storing, managing and sharing high-quality digital topographic data (GIS). The database includes a vector database, orthophotomap and a digital elevation model.
- V-Map (vector map) Level 2 – a result of Poland's joining the North Atlantic Treaty Organisation. It is a digital map showing land in a vector form with assigned descriptive attributes. Vmap L2 is a counterpart of a topographic map, scale 1:50 000.

Thematic studies include:

- Geological map – shows a comprehensive image of the geological structure in the near-surface zone and the stratigraphy and lithology of the formations located below the quaternary cover. It encompasses also information in the scope of hydrogeology, engineering geology, geomorphology and pa-

leogeography (Malinowski, 1979; Fortuna, 1987; Ber, 2000). The map is complemented by hydro-geological, geological-economic and geoenvironmental maps.

- Soil-agricultural map – presents complexes useful for farming, types and subtypes of soil, granulometric composition of near-surface and deeper layers, and the type and depth of the substratum (Bartoszewski, 1982; Budzyńska, 1998).
- Forest map – contains the boundaries of surface forest units and habitat-related features of forest stands (Olenderek, 2001).

Table 1. Characteristics of the main cartographic sources for the Poznań metropolitan area

No.	Map	Scale	Coordinate system	Years edited	Data form	Availability
1.	Master	1 : 250* 1 : 500 1 : 1000 1 : 2000 1 : 5000	PUWG-1965 PUWG-2000	ongoing	Plotter printout, photocopy, scan, planned as totally vector	Geopoz Poznań PoCGCD**
2.	Topographic	1 : 10,000 1 : 25,000 1 : 50,000	PUWG-1965	1975–1991	printout, photocopy, scan	SCGCD**
3.	Topographic	1 : 10,000 1 : 50,000	PUWG-1992	1998–2005 1998–2000	printout, scan, digital image	SCGCD
4.	Topographic database (TDB)	1 : 10,000	PUWG-1992	2006–2008	digital image, printout, plotter printout	SCGCD
5.	V-Map Level 2	1 : 50,000	WGS-84	2000–2004	digital image, plotter printout	COGC**
6.	Geological	1 : 50,000 1 : 200,000	PUWG-1942 PUWG-1942	1990–2008 1982–1996	printout, plotter printout, scan printout, scan	PGI** PGI
7.	Soil-agricultural	1 : 5000  1 : 25,000 1 : 100,000	various  PUWG-1992 lack	ongoing  1960–70s 1980s	printout, plotter printout  photocopy printout	Geodesy and Farm- land Office – Wiel- kopolska PCGCD IUNG**
8.	Forest	1 : 10,000	PUWG-1992	ongoing	totally vector, plotter printout	RDSF**
9.	Hydrographic	1 : 50,000	PUWG-1992	2000–2002	digital image, printout, plotter printout	COGC
10.	Sozological	1 : 50,000	PUWG-1992	2003–2006	digital image, printout, plotter printout	COGC

\* Depending on land urbanisation degree.

\*\* PoCGCD – Poviát Centre for Geodesic and Cartographic Documentation (orig. PODGiK), SCGCD – State Centre for Geodesic and Cartographic Documentation, Warsaw (orig. CODGiK); PCGCD – Provincial Centre for Geodesic and Cartographic Documentation, Poznań (orig. WODGiK); COGC – Central Office for Geodesy and Cartography, Warsaw (orig. GUGiK); PGI – Polish Geological Institute, Warsaw; ISSPC – Institute of Soil Science and Plant Cultivation, Puławy (orig. IUNG); RDSF – Regional Directorate of the State Forests (orig. RDLP)

- Hydrographic map – presents a synthetic perspective of water circulation conditions in relation to the natural environment, investment within it and its change (Chief Geodesist of Poland 2005).
- Sozological map – presents the condition of the natural environment as well as the causes and effects, both negative and positive, of the changes occurring in the environment as a result of various processes, including in particular human activity, and methods of protecting the natural value of the environment (Chief Geodesist of Poland 2005).

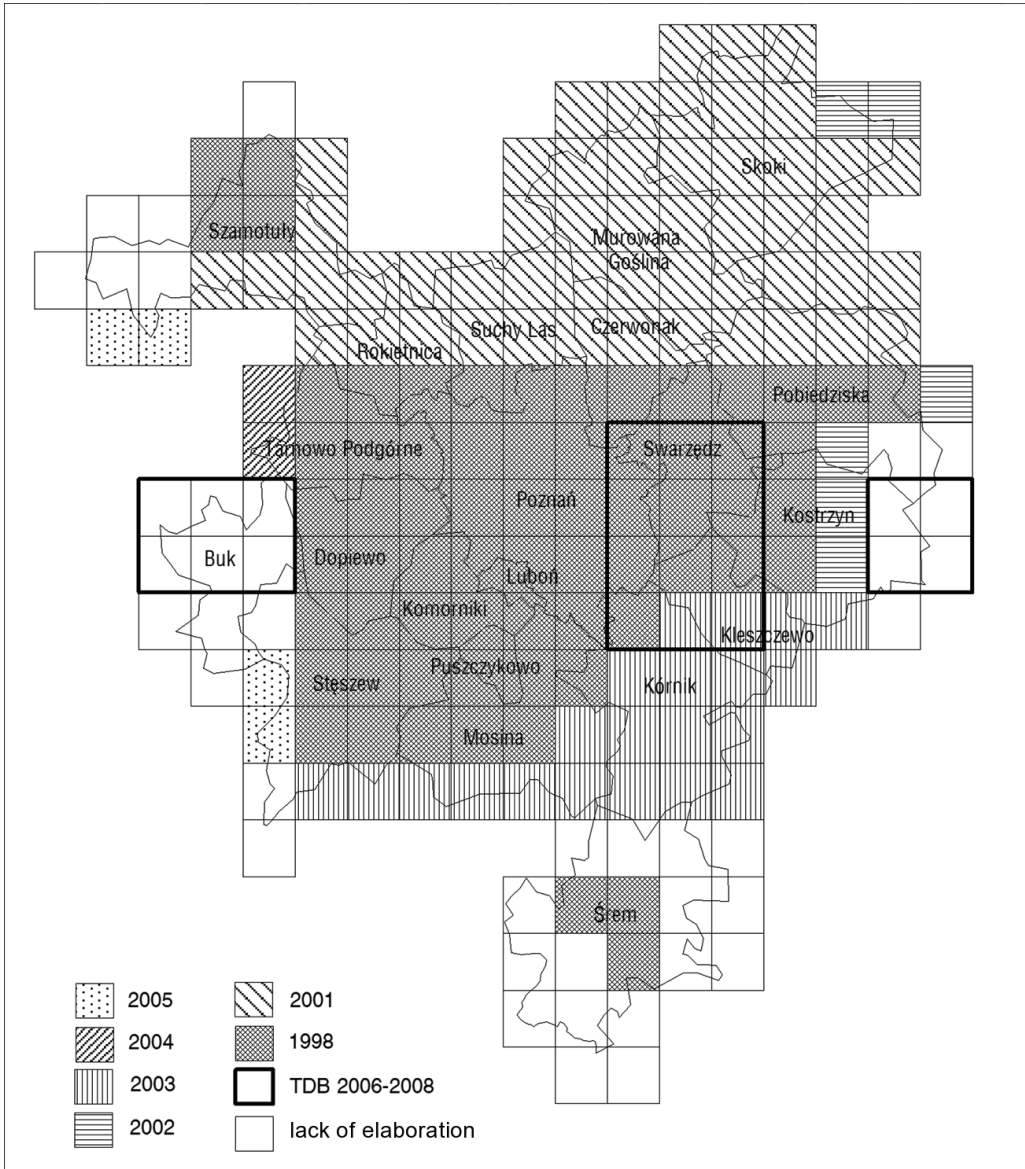


Fig. 1. Scope of topographic map, scale 1 : 10 000 (state coordinate system 1992), and topographic database with time of making (see text and tab. 1 for further explanation)

## **Methods of spatial data acquisition**

The most important institution whose tasks include providing spatial data is the State Centre for Geodesic and Cartographic Documentation based in Warsaw. The internet site of the Centre provides information on the resources (including indices) and forms enabling the user to order geodesic, cartographic and remote-sensing data (Kijowski, Mania, 2008). Private companies providing spatial data, primarily remote-sensing imagery for commercial purposes, are gaining increasing significance.

The most conspicuous result of implementing the INSPIRE<sup>1</sup> directive in Poland from the perspective of the user is Geoportal ([www.geoportal.gov.pl](http://www.geoportal.gov.pl)). The service contains information on the spatial data resources for Poland and, what is of primary importance, provides access to the data. Over the past two years Geoportal has been radically rebuilt and became a comprehensive and efficient tool providing access to geographic information (fig. 4). The main resources of Geoportal include:

- General Geographic Database – the most general composition, basic scale 1 : 250,000,
- topographic maps as raster images (editions PUWG-1942, PUWG-1965, GUGiK-80, PUWG-1992), scale from 1 : 100,000 to 1 : 10,000,
- panchromatic (greyscale) and colour orthophotomaps for years 2004–2009 made based on aerial photographs and partly satellite images (one pixel represents 0.5 m),
- cadastre data providing a plot search feature,
- digital elevation model with a resolution of approx. 30 m,
- topographic database – modern large-scale resource aimed to replace traditional topographic maps, scale 1 : 10,000,
- administrative boundaries and geographic names.

The resources can be accessed using a web browser and through WMS<sup>2</sup> servers – from any GIS programme. Server addresses are available at [www.geoportal.gov.pl](http://www.geoportal.gov.pl).

Services run by the Board of Geodesy and Municipal Cadastre GEOPOZ in Poznań ([www.geopoz.pl](http://www.geopoz.pl)) and the Powiat Centre for Geodesic and Cartographic Documentation (<http://podgik.poznan.pl>) have a similar or more advanced functionality. The WMS server for the powiat of Poznań (<http://podgik.poznan.pl/cgi-bin/poznan>) provides the following layers: orthophotomap, commune boundaries, geodesic districts, registered plots with numbers, buildings, streets and addresses. Other institutions providing data through WMS are also worthy of note, i.e. Polish Geological Institute.

## **Other spatial data sources**

Significant technological changes, being increased throughput of the network and technological improvement in both hardware and software, enabled the development of spatial information services at geographic websites. The most popular commercial services of this kind in Poland include Google Maps,

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<sup>1</sup> The INSPIRE directive adopted in 2007 by the EU (EU Journal of Laws 25.4.2007 L 108/1) regulates the problem of infrastructure organisation and access to spatial data in member states. The document is a great support to environmental protection activities but its implementation has an impact on a number of other areas in which spatial data is employed.

<sup>2</sup> Web Mapping Service (WMS) is a mechanism for providing spatial data via the internet in a form of raster images displayed on the computer screen of the user.

Targeo and Zumi. They provide schematic maps, aerial photographs and satellite images, indicate the location of the searched objects and provide simple analyses, such as route planning. The introduction of a new version of Geoportall decreased the attractiveness of the above services, in particular as regards professional uses. Nonetheless, they often give access to additional remote-sensing imagery with a large informative potential resulting from high-resolution images.

Table 2 gives basic characteristics of selected photogrammetric products available for the communes of the Poznań metropolitan area. The focus was on the basic product, namely the orthophotomap from state-owned resources. For the purpose of comparison data obtained from private companies were also presented.

Table 2. Selected photogrammetric products for the Poznań metropolitan area

No.	Commune	Orthophotomap SCGCD/Geoportal				Aerial photographic map Dedal Foto		
		Scope	Type	Scale	Period	Scope	Scale	Period
1	Buk	●	col/grey	1 : 5000	2007/2005	centre	1 : 2500	1995
2	Czerwonak	●	col/grey	1 : 5000	2007/2005	part of commune	1 : 2500	1996
3	Dopiewo	●	col	1 : 5000	2007	commune	1 : 10,000	1997
4	Kleszczewo	●	grey	1 : 5000	2004–2005	–	–	–
5	Komorniki	●	col	1 : 5000	2007	commune	1 : 2500	1995
6	Kostrzyn	●	grey	1 : 5000	2004–2005	centre	1 : 5000	1995
7	Kórnik	●	col/grey	1 : 5000	2005/2007	commune	1 : 10,000	2002
8	Luboń	●	col	1 : 5000	2007	town	1 : 5000	2007
9	Mosina	●	col/grey	1 : 5000	2005/2007	town	1 : 2500	1995
10	Murowana Goślina	●	col/grey	1 : 5000	2007/2005	centre	1 : 2500	1995
11	Pobiedziska	●	grey	1 : 5000	2004–2005	centre	1 : 2500	1995
12	Poznań	●	col	1 : 5000	2007	city	1 : 10,000	2007
13	Puszczykowo	●	col/grey	1 : 5000	2005/2007	town	1 : 2500	2004
14	Rokietnica	●	col	1 : 5000	2007	commune	1 : 10,000	1998
15	Skoki	●	grey	1 : 5000	2004–2005	centre	1 : 2500	1995
16	Stęszew	●	col/grey	1 : 5000	2005/2007	centre	1 : 2500	1995
17	Suchy Las	●	col	1 : 5000	2007	–	–	–
18	Swarzędz	●	col/grey	1 : 5000	2005/2007	centre	1 : 2500	2005
19	Szamotuły	●	col/grey	1 : 5000	2007/2005	town	1 : 5000	1998
20	Śrem	●	grey	1 : 5000	2004–2005	town	1 : 5000	1997
21	Tarnowo Podgórne	●	col	1 : 5000	2007	commune	1 : 10,000	1997

Commune scope: ● – full, ○ – partial

Type: col – colour RGB orthophotomap, b-w – panchromatic orthophotomap (grey-scale)

Source: Kijowski and Mania 2008 – ammended, [www.codgik.gov.pl](http://www.codgik.gov.pl), own resources 2010.

## ***Archival remote-sensing data***

Some tasks connected with urban studies, landscape architecture, historic building renovation and also ascertaining ownership and land use can be facilitated by the use of archival aerial photographs. The oldest aerial photographs for the Poznań metropolitan area date back to 1915–1920. Those and later archival resources are scattered over numerous institutions, libraries and science centres. A very interesting example are aerial photographic maps, scale 1 : 25,000, made in the 1940s by Luftwaffe. The access to those maps is, however, very limited as most of them are kept in the UK (see [aerial.rcahms.gov.uk](http://aerial.rcahms.gov.uk)), and only some are kept in Poland (e.g. a dozen sheets are kept in the archives of the Department of Integrated Geography AMU).

The post-war remote-sensing resources, being mainly black-and-white vertical aerial photographs, are kept at SCGCD in Warsaw. The photographs were made in different scale (e.g. ~ 1 : 5,000, ~ 1 : 13,000, ~ 1 : 16,000, ~ 1 : 26,000, ~ 1 : 30,000) at several years' intervals (depending on the region). Some of the photographs – those featuring military or industrial areas – are partly blackened.

## ***Selected examples of remote-sensing applications in commune management***

One of the problems which modern cities face is rapid suburbanisation accompanied by the city-centre crisis (Billert 2008). The most common and, which has been shown above, easily available source of spatial information on the changes in urbanised areas are orthophotomaps. They are more and more frequently employed as one of the layers in spatial information systems, primarily as an equivalent of topographic background used to present thematic content (Preuss, 2004).

Another group of remote-sensing applications is environmental protection. Images obtained by means of remote sensing can be utilised to monitor selected components of nature, such as vegetation, water (including flood protection) and soil. It is also possible to identify and perform quantitative assessment of human-related environment degradation (e.g. aggregate deposit extraction – compare Kozacki, 1980).

Forming landscape according to the sustainable development principle requires considering also cultural aspects, being the carrier of local traditions, history and values. Those qualities are manifested in landscape through elements such as field layouts, historic planning in cities, buffer strips, manors and historic buildings (also of an archaeological nature). All those are documented in aerial photographs (Rączkowski, 2005).

Still, the most common application is employing aerial photographs in spatial planning and architecture – from stock-taking, through local spatial management planning and architectural design, to visualisation and promoting completed investments. This application employs photogrammetric aerial photographs, orthophotomaps and oblique photographs.

## ***Conclusion***

Over the past two years the availability of spatial data increased significantly. One of the reasons for this is the implementation of the INSPIRE directive. Currently the basic platform for sharing spatial data is Geoportal, which provides the data both through a website and WMS servers. Institutions of a still great importance are Centres for Geodesic and Cartographic Documentation – the central in Warsaw, local in

provinces and poviats. Those institutions keep most of the traditional cartographic and remote-sensing resources. Moreover, a range of thematic maps are kept by institutions, such as the Polish Geological Institute, Regional Directorate of State Forests, and Geodesy and Farmland Office – Wielkopolska. A great deal of spatial data is available in a digital form.

At present, the Poznań metropolitan area has several sources of remote-sensing imagery. The main source is the orthophotomap for 2004–2007 with a pixel size of 0.5 m. The quality of this photogrammetric product is sufficient for a majority of tasks performed by local governments. It is possible to complement remote-sensing resources with other products (most often based on satellite images) offered by commercial specialist companies.

Many tasks concerning IT service in local governments are carried out by the Wielkopolski Centre for Self-Government Education and Studies. This institution along with the Powiat Centre for Geodesic and Cartographic Documentation and the Board of Geodesy and Municipal Cadastre GEOPOZ in Poznań can form a basis for an organised integrated spatial information system for the Poznań metropolitan area.

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